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Conceptual modeling in the ontological basis of a Data Warehouse- Environment University

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***Abstract*— the objective of this work is to establish an information system which would facilitate decision making for the exploitation of a model consisting of the main university stakeholders (teachers, students and administrators). This system is based on the relationship between actors (players) on the one hand and their activities and their aggregations in a graduate level on the other. It aims to make available to managers of the university a set of dashboards that can improve the quality of education.**

Meanwhile, ontology is now at the heart of the work of engineering knowledge and demonstrated in several areas. An ontology dedicated to the design of SD is a model of organization of knowledge for a given domain. It represents the multidimensional concepts of a domain and their multi-dimensional relationship (LDR) and semantic. After recalling our ontology construction method decision, we will detail in this paper the optimization phase of RMD after the enrichment of the ontology. This phase is governed by rules that we define optimization.

Keywords-Data warehouse conceptual modeling, ontology integration, information systems decisions.

I. INTRODUCTION

In this paper we are interested in modeling of actors and academic resources of a systemic point of view to change the information system of academic information system decision-making.

The model we use is a concept ontology decisions it is considered a way of waiting for assistance that connects players to the expression of academic activities related to its aggregation. And a resource to ontology is motivated by its ability to resolve semantic and syntactic ambiguities. Indeed, it is a repository that contains a set of concepts and their relationships that characterize a given area.

After recalling in our first issue, we begin with the creation of data warehouses that is an answer to the problem of integrating a large amount of data varied on a scope, and physically stored in different data sources. The data warehouse contains a form usable by treatments useful for decision support, information extracted from these sources that are potentially relevant to a particular category of decision makers in academia.

A. PRINCIPLE OF A DATA WAREHOUSE

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A warehouse is defined as a collection of integrated data, subject-oriented, non-volatile historized, summarized and available for query and analysis. The data warehouse stores data necessary for decision making and is fed and updated via data extractions on the basis of production that are considered in the decision-making chain as data sources.

B. Hypotheses

The hypothesis of this study is to show that if we start by modeling the university actors (teachers, administrators and students) above, taking into account the principle of decision-making and ontology specifications and expectations of each of them, we resulting in an improvement in satisfaction of the actors. This assumption applies in a Moroccan university.

II. Issues

We will start by modeling [4] actors up taking into account the requirements and expectations of each of them, namely:

- The student who wishes to have quality training and be endowed with skills facilitating integration into life.
- The teacher who has the task of producing and transferring knowledge.
- The administration staff whose task is on the one hand to facilitate the work of the teacher serving students,

disseminating and sharing information, and on the other hand to meet the needs of clients outside university.

Given this situation, it is a must that the task of the student [1], [2] and that of the teacher and the administrators be correlated. In fact, we are faced with a situation where we are aiming at the satisfaction of the customer / user with a specific university that concept actor / user; also as a business. Indeed, a company's approach to governance is 'profit', while that of a university is about positioning and achieving visibility of the organization. The company seeks a position of performance at its capital and the university aims to achieve quality and a high ranking both nationally and internationally. The company seeks customer satisfaction, whereas the university seeks to satisfy its stakeholders. Customer satisfaction in business is formalized in terms of costs but satisfaction in university occurs by meeting their needs.

A. Modeling the actors

Previously (in [1] [2]), we showed that applications for the actor level are based on information gathered from the databases (DB Apg, DB EN, DB AD, DB AC, DB AG, DB DOC). The design of a Decision Support Information System [3] requires a special approach to design and modeling complex [4]. We adopted a model to meet specific needs such as factor analysis [5] which has a policy to facilitate understanding and interpretation of a large set of multidimensional data. This analysis shows graphically the similarities between the data and quantifies the degree of correlation between several factors.

The model we get includes all actors involved in the university system. It is follows:

$$\text{Actor}=T_i\ ;\ \sum_{i=1}^{i=n} S_i\ ;\ \sum_{j=1}^{j=3} C_j\ ;\ \sum_{k=1}^{k=n-1} A_k\ ;\ (1)$$

With: S: Source activity for all players. C: Category. A: all aggregations.

III. Basic Concepts for Ontology Decision

The term 'ontology' has multiple definitions (in [8], [9]). One of the most simple and popular is that of Gruber (Gruber, 1993) An ontology is an explicit formal specification of a shared conceptualization. The terms formal and ontology defines a common vocabulary for users who need to share information in a particular field. They allow (Pierre, 2005):

- Share a common understanding of the structure of information.
- Allow the reuse of knowledge in a domain.
- Explain what is considered implicit in a domain.
- Distinguish between knowledge about a field of operational knowledge.

Our approach of building ontology is progressive and iterative decision-making (in [6],[7]). Intervention of the designer, throughout this construction is necessary or required. Indeed, they allow the approval of the results obtained and the resolution of some ambiguïtés.et test the reliability of our proposed model:

$$\text{Actor}=T_i\ ;\ \sum_{i=1}^{i=n} S_i\ ;\ \sum_{j=1}^{j=3} C_j\ ;\ \sum_{k=1}^{k=n-1} A_k\ ;\ (1)$$

After the consolidation of the formula 1, we obtain:

The portfolio of the source (S) defines all the activities to be performed during one cycle by each university players. Category (C) defines the three actors of the university: Student, Teacher, and Administrator. Aggregation (A) defines the needs of each player for a graduate level.

Activities (academic contribution to each player)			
1	Administer		
	Prepare	4	18
2	Organize	5	12
	Learn		11
	Train	8	
	Track	6	
	Correct		10
3	Information	7	
	present		9

Aggregations (by contributing to university each actor)			
	Regulation	5	10
	Budget	1	
15	Monitoring		11
13	Training		8
	Course	6	9
12	Registration	2	
14	Census	3	7
	Preparation	4	
16	Resources		

Beginning of the University Cycle:

- The portfolio administrative actors is the first actor at a time t:

  Administrative actor (PA)= {Ci (1≤i≤3) ; Aj(1≤j≤6)}
- The actor Teacher portfolio is the second player at time t+Δt:

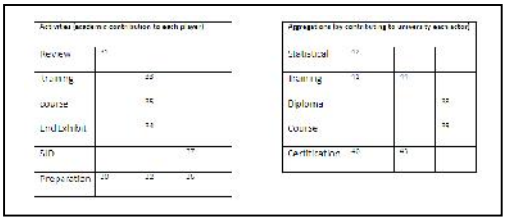
  Actor Teacher PE) = {Ci (3≤i≤8) ; Aj (6≤j≤11)}
- The Student Portfolio actor is the No. 3 player at a time t+Δt+1 :Actor Student (PT)= {Si (8≤i≤13) ; Aj (11≤j≤16)}

This model is then obtained:

$$\text{Actor}\ \{\ \sum_{i=1}^{i=13} S_i\ ;\ \sum_{j=1}^{j=16} A_j\ \}$$

End of University Cycle:

At the end of the cycle, the three actors are involved:



- The Teacher actor portfolio is the first speaker at the end of the academic cycle:
  Teacher Actor (PE)={Si(29≤i≤31) ;Aj (37≤j≤39)}
- The Student actor Portfolio is the second place at the end of the academic cycle:
  Student Actor (PT)= {Si (31≤i≤35) ; Aj (42≤j≤44)}
- The administrative actors portfolio is the last speaker at the end of the academic cycle:

Administrator Actor (PA)= {Si (35≤i≤37) ; Aj (39≤j≤42)}
The following model is then obtained:

$$\text{Actor} \quad \{; \sum_{i=29}^{i=37} S_i ; \sum_{j=29}^{j=44} A_j \}$$

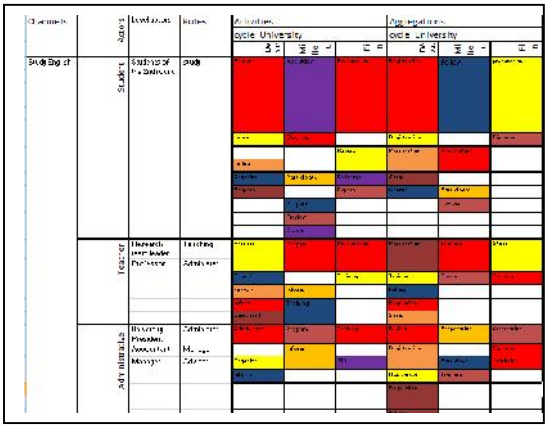


Table 1: Role, Activities, Aggregation of Actors

Model of application is to justify the balance between all the activities of all actors and their aggregations at the end of a graduate level.

In this context, we present, as an application of indicators defined by the makers of the university and programmed by technical information system making the institution in order to improve the performance of each actor.

To better understand this approach, we are using a graphic to show the equilibrium relationship between each actor and their activities at an undergraduate level [6] and its aggregation, taking into account the multiple observations to develop our model.

The rest of this section introduces the concepts of our model using the method of an ontology and decision-making, explains briefly the extraction phases multidimensional elements, the deduction of relations and standardization.

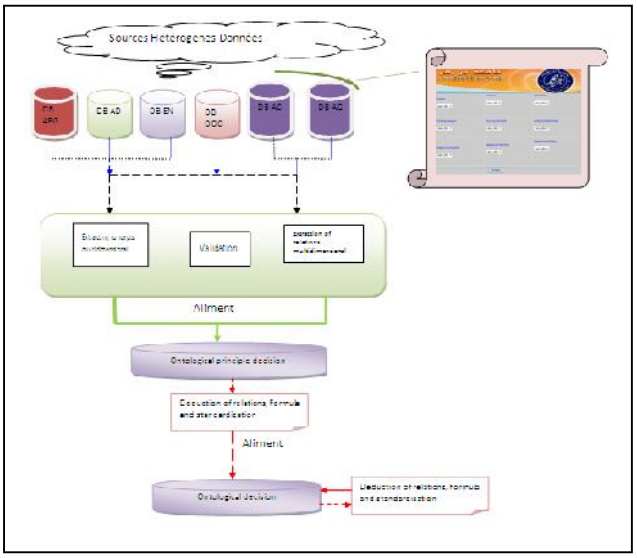


Figure 1. General architecture of a system for building ontologies decision.

A. *Basic Concepts for the OD*

The ontology is a representation of decision-making knowledge dedicated to decision support systems. It can be defined as a repository multidimensional elements, namely the concepts and relations that connects all the actors and university activities aggregations during the academic cycle

B. *Development environment*

The tool that implements our method has been developed in a Windows XP programming language Java, JDK 1.6. Ontology handled by this tool is in OWL format. The access and manipulation of the ontology is through the Protege OWL API development provided by the development editor of Protege ontology. This tool takes into account the relational database that references one or more ontologies. The conceptual model of the warehouse obtained is modeled using the class diagram of UML in which there are two classes of done. The diagram below express the environmental s implementation of the tool developed during the various stages of implementation.

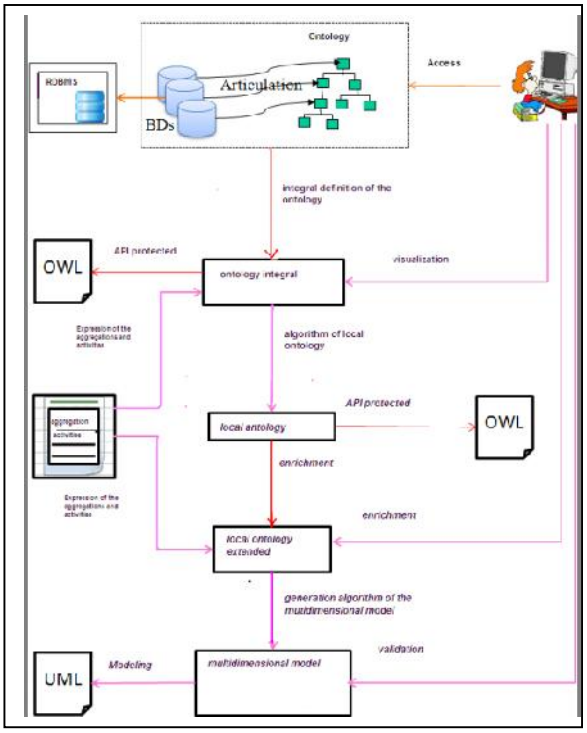


Figure 6.1. Implementation of our model MACA

IV. ETAPES OF IMPLEMENTATION AND INTERFACES

The developed tool implements our proposed model after modeling MACA (represents the activities of each category of actors in relation to their university agragations being an cycle university). It includes the following main features:

1) Visualization of ontologies or domain selected from the warehouse which will be built,
2) Expression of decision-making needs of the domain ontology and on the "local ontology
3) Constructions and expansion of the "local ontology,
4) Definition of the conceptual multidimensional, and
5) Validation of the diagram obtained by the designer.
6) Shows the main modules "implementation of our tool.and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar

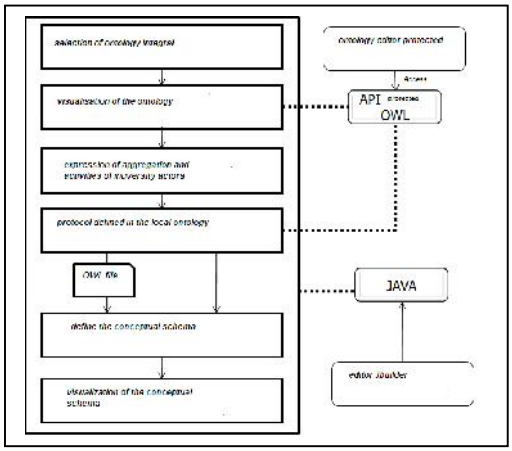


Figure 6.2. Implementation architecture of our model MACA

CONCLUSION

To implement this application, we went through three major phases. The first is the theoretical part that needs to have a model which is able to meet the academic context known by its complexity (different actors, the wealth of data, non-uniform data ...).

This requires a mathematical model defining simple relationships between the actors, their activities and their aggregations. The second phase focuses on gathering data and designing a multidimensional database this based on the principle of making the ontology. The third phase is devoted to the implementation and construction of a scoreboard checking all the proposals made in the theoretical part.

The results obtained from available data of the student actor at the university are encouraging. The availability of actual data of the other actors need is a comprehensive decision-making tool for the university.

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Privacy Concerns in Higher Education

Traditional Versus Online Education

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***Abstract*— Taking advantage of today's hyper connected world, many institutions of higher education have already implemented online education programs, while many others are currently investigating online education models for use in the near future. As colleges and universities gradually explore the feasibility of including distance education programs, privacy protection and securing computer networks remains a primary concern for them. Privacy concerns when using online education models increase as most of the communication among students, faculty, and administration occurs electronically. This paper analyzes privacy policies in three institutions that represent different education models: established face-to-face, established online and prospective online models. The paper addresses privacy laws related to institutions of higher education in general and offers recommendations for those institutions of higher education that are considering expanding their face-to-face offerings to include online education models.**

Keywords-higher education; traditional; online; privacy;FERPA

I. INTRODUCTION

Information technology has a conflicting impact on privacy. On one side, technology promotes the use of sensitive digital information; it digitally stores and electronically transmits customer and employee records. There is a potential danger that these records can be accessed in their storage devices or can be intercepted as they move across networks. On the other side, technology protects sensitive information through data encryption, authentication, and secure networks. This relationship between technology and privacy is best showcased in the area of education, especially online education. Traditionally, the privacy policies were originally created for traditional teaching models [1]. However, universities are beginning to experience the impact that increased use of online course delivery systems has on procedures and academic policies.

Over the past few years, there has been a significant increase in online education. New models include hybrid courses and online-enhanced courses, where several elements of online education are incorporated into face-to-face classes. Integration of the Internet in colleges and universities has been determinant in supporting distance learning, accessibility to massive information published in the web around the world, as well as radical improvements in applications and communication among tutors and students. On the other hand, faculty, and other university employees have become more and more dependent on information technology. They use computers and mobile devices to remotely access the university networks and expand their connections and communicate with their colleagues through professional networks.

The global reach of information systems at both the university and individual level has raised concerns over information security and has made universities more vulnerable to security threats. Documented cases of security breaches and privacy violations at universities and colleges include the theft of 173,000 social security numbers, an unsecured alumni database used by hackers, and lawsuits filed by alumni who sought class action status to represent any students, employees and other alumni whose privacy had been violated [2]. Mitchell [3] emphasizes the need to develop awareness of regulations and laws concerning course material usage in an online environment. Institutions of higher education face significant challenges regarding privacy and security.

Most colleges and universities perform similar types of commercial activities that raise privacy and security concerns. For example, a typical college would process electronic applications, accept donations, sell university merchandise, textbooks, athletic tickets, or serve food. In addition, universities also collect sensitive information from online transactions, grades, student records, and health records. A typical university will suffer an average decline of 6 to 8% in the number of donations when security breaches are disclosed [2].

The purpose of this paper is to explore the privacy concerns and policies in higher education. Three institutions are considered as case studies. The first case is from a university located in the southeast USA (UTC). Privacy issues at UTC and their protection are discussed in the context of UTC's traditional programs (UTC-T). The second case is from a university in the northeast USA and its online program (UMUC-OL). The third case incorporates an upcoming UTC online program (UTC-OL) being considered to start in fall of 2012. The hope is that the analysis provided in this paper can be used to address privacy concerns in existing programs at UTC-T, UMUC-OL, and establish privacy policies for the new UTC-OL.

In the next section, the paper addresses the three universities' mission statements and the importance of addressing privacy issues in the respective institution. Next, privacy laws in higher education in general, and Family Educational Rights and Privacy Act (FERPA) in particular, are

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discussed. Finally, several recommendations and conclusions are provided.

II. Mission Statement, Technology, and Privacy Issues at UTC-T

In order to illustrate the importance of privacy and the role of information technology to support the university's strategic goals, the mission statement of UTC-T is offered below:

> *The mission of the university is to provide quality educational programs that produce academically-prepared and business-world ready men and women for a competitive global environment. The colleges of the university provide high quality educational programs that prepare online and traditional students for managerial, professional, or entrepreneurial opportunities.*

This mission statement indicates the importance of technology to support the strategic goals of UTC-T. These goals include fostering multidisciplinary programs and innovative curriculum design and delivery, increasing global perspectives and providing international opportunities for students and faculty, and supporting research and professionally engaged faculty. It is implied that technology can also be used to strengthen financial and program sustainability, engage, challenge and support students, and build strong relationships with key stakeholders.

The dependence on technology becomes a source of potential violation of privacy laws and regulations. UTC-T must protect its students, faculty, and other employees from cybercrime in general and must ensure their privacy in particular. In order to achieve this goal, UTC-T must comply with federal, state, and organizational regulations.

III. Mission Statement, Technology, and Privacy Issues at UMUC-OL

UMUC has a clear mission statement. In order to illustrate the importance of privacy and the role of information technology to support the university's strategic goals, the mission statement of the university which is directly related to UMUC-OL is summarized below:

> *UMUC provides programs for part-time, adult students at off-campus sites on an as-needed basis. Its brokering functions include assessing needs, monitoring the scope of off-campus offerings, and coordinating System resources to address off-campus needs. UMUC conducts postsecondary degree and non-degree programs throughout the nation and the world.*

In order to reach large numbers of students throughout the world, UMUC-OL offers several online services: course and program offerings, online library resources, online registration services, online financial transactions, and online advising. UMUC-OL makes every effort to protect the privacy of its students, faculty, and staff. Pertinent to privacy concerns is the requirement that the university must release specific information to law enforcement agencies according to Foreign Intelligence Surveillance Act, 50 U.S.C. 1861, as amended by the USA PATRIOT Act.

IV. Mission Statement, Technology, and Privacy Issues at UTC-OL

UTC-OL is an integral component of UTC, and, as a result, UTC's mission statement is similar to the future statement of UTC-OL. Similarly to UMUC-OL, UTC-OL must strive to reach a large number of students, locally, regionally, and worldwide. As such, privacy concerns of UTC-OL are similar to those of UMUC-OL. Such concerns are raised due to potential violations of privacy as a result of information storage and communications in course delivery systems, online library resources, online registration services, online financial transactions, and online advising. Also, UTC-OL must make every effort to protect the privacy of students, faculty, and staff following federal, state, and local privacy laws.

V. FERPA and Other Privacy Laws at Institutions of Higher Education

Traditional and online education must comply with the fair information practices (FIP), which provide students and faculty with control over the disclosure and use of personal information. FIP also states organizational obligations for data protection. As a result, FIP provides the basis for both privacy laws and self-regulatory programs. Regulations related to higher education include FERPA, the Health Insurance Portability and Accountability Act (HIPAA), and the Gramm-Leach-Bliley (GLP) Act.

The main regulatory requirement related to cyber crime at an institution of higher education is the Family Educational Rights and Privacy Act (FERPA). FERPA is a federal law that applies to all schools that receive funds under an applicable program of the U.S. Department of Education. In order to protect the privacy of students and their records, the university and its colleges must follow FERPA requirements as applied to the college:

- Parents have certain rights when children are less than 18 years old. Since college students are typically over this age, the college must recognize that parents have transferred these rights to the "eligible students."
- At a college level, students have the right to inspect, and, if needed, correct their education records. Students have the right to a formal hearing if the school does not correct the records.
- The college must have written permission from the eligible student in order to release any information from a student's education record.
- The college may disclose, without consent, information such as a student's name, address, telephone number, date and place of birth, honors and awards, and dates of attendance. However, schools

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must allow eligible students a reasonable amount of time to request that the school not disclose directory information about them.

FERPA requirements must be followed by administration officials for both traditional and online educational models. These requirements include the online student registrations, online access of records, online advising office, and online access to academic programs. For example, both traditional and online models must pay special attention to grade posting. Some faculty members discuss or send grades to students via email. An unauthorized interception of the email or an inadvertent release to an unauthorized person can result in a violation of FERPA. Other faculty members post their grades online or in a public space. Even when student IDs or names are removed, posting the grades in alphabetical order may be considered a violation of FERPA requirements. The best way to post grades is to use approved platforms such as Blackboard, Webtycho, or Banner.

Online and traditional institutions of higher education must pay special attention to privacy issues related to other laws and regulations. For example, the GLB Act can be implemented in the financial aid and bursar's offices and HIPAA can be implemented in the student health center or in the office for students with disabilities. The GLB Act requires organizations (and universities) that offer loans or other financial products to consumers (and students) to explain their practices and information-sharing policies in order to safeguard sensitive data. HIPAA is designed to improve continuity of health insurance coverage in the group and individual markets, including student markets, to combat fraud, waste, and abuse in health insurance and health care delivery.

The state where the university is located also has approved regulatory policies that mitigate cyber crime. Since the university operates within the state, it must follow such legislation. For example, UTC-T and UTC-OL reside in the state of Tennessee, where the most relevant laws are the Tennessee State Law for Personal Information Breach (TSLPIB) and the Tennessee Computer Crime Act (TCCA). TSLPIB defines a breach of security systems as an unauthorized acquisition of unencrypted computerized data that materially compromises the security, confidentiality, or integrity of personal information maintained by the information holder. Any direct or indirect access of computer resources for the purpose of obtaining money, property, or services is considered to be a violation according to TCCA (University of Tennessee Security Policies, 2011).

VI. Suggested Changes to Improve Implementation of Privacy Laws

This section discusses several policies and cyber-related changes, which can be used to improve the implementation of privacy policies for students, faculty, and staff. These suggestions are useful for traditional, hybrid, and online models. The goal of these suggestions is to enhance the protection of privacy in the existing models (UTC-T and UMUC-OL) and design policies and guidelines for the new model (UTC-OL).

A. De-Balkanization of Cyberspace

The implementation of FERPA and other privacy laws has created silos of information. These silos are supposed to prevent information sharing and as such "protect" information about education, financial, medical, or other sensitive records. However, Cyphert and Garbutt [4] argue that while information silos make sense from a legal perspective, the lack of sharing can have a negative effect when dealing with troubled students or employees. If financial information is combined with information about classroom performance, behavior, or attendance, then an indication that a student is suffering from depression can be suggested. Separately, in a Balkanized cyberspace, it would be difficult to identify any future problems with disgruntled students or university employees.

Just as in many other universities, UTC currently uses information systems that do not "talk" to each other. Such Balkanization of student support services at UTC requires that students complete several FERPA forms, which then are distributed to each specific service. Also, typical to online established systems, UMUC-OL has been able to integrate several services in a single interface. It is strongly suggested that the UTC-OL model integrate protection of privacy through secure information systems and protect the security of students and faculty through an integrated information system.

B. Copyright Protection of Course Contents and Intellectual Property

Talab and Butler [5] provide several suggestions for traditional universities to enforce the protection of copyrights. Specifically, they suggest that every student and faculty must assume that content is copyrighted unless it states otherwise. Also, every user must read the terms of use for each file-sharing site and provide recognition or references for any citation used. Universities must also provide clear copyright policies related to the development of online content. In the case of online education, a great source of guidelines can be found in the TEACH Act Toolkit available at http://www.lib.ncsu.edu/scc/legislative/teachkit/overview.html. Another good source of information about intellectual property and copyright protection for online education can be found in the Educational Multimedia Fair Use Guidelines (EMFUG) at http://www.utsystem.edu/ogc/intellectualproperty/faculty.htm#mm.

C. Management of Sensitive Student and Faculty Records

All universities must store and protect sensitive student and faculty records. In addition, online universities have the added challenge of not only academic sensitive information, but often times the electronic delivery of this information. Rakers [6] suggests specific steps to control sensitive data and information. These steps can be used for both face-to-face and online environments. The suggested steps include an institution-wide commitment to security and privacy, implementation of tools to ensure protection in all areas, and education and active involvement in the privacy rights debate. Other suggested steps include the use of a dedicated security team to protect university data, harden the software and

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hardware against potential vulnerabilities, and mitigate risk by buying insurance coverage.

UMUC-OL provides an excellent example of how an online university can add to the above steps. Specifically, UMUC-OL protects sensitive information by physically securing servers that store content specific information, encrypting sensitive information that is transmitted electronically, and using authentication procedures to make sure that every individual who claims UMUC-OL association establishes their identity.

D. Encryption of Sensitive Information

Traditional and online universities are continuously shifting toward digital storage and electronic communication. From a technical perspective, encryption is a necessary measure to ensure that even when sensitive information falls in the wrong hands, the hacker is not able to understand it. Tables 1 and 2 provide a list of encryption technologies as suggested by Fritsche and Rodgers [7].

TABLE I. DISK ENCRYPTION SOFTWARE USED BY UNIVERSITIES

Software	**Supported Platforms**	**Install Time**	**Supported Storage Devices**	**Retail Cost (Single User)**
WinMagic SecureDoc 4.2	Win XP	72 min	Flash Drive, USB Hard Disk (I,E)	$129
PGP Whole Disk Encryption	WinXP MacOSX	82 min	Flash Drive, USB Hard Disk (I,E)	$149
Pointsec 6.0	WinXP Linux	135 min	Hard Disk (I,E)	$149
DriveCrypt 3.5	Windows XP/NT/2k	78 min	Flash Drive, USB Hard Disk (I,E)	$161
Utimaco SafeGuard 4.2	Windows XP/2k/Server 2003	73 min	Flash Drive, Hard Disk (I,E) SdCards	$240

It is suggested that online course delivery systems implement several network security improvements, including an effective campus-wide firewall strategy, secured wireless networks, and IP-source spoof protection software. Just as UMUC-OL, UTC-OL must also use a Virtual Private Network which encrypts data in transit.

E. Third Party Verification and Authentication Approach

Online universities may also partner with a third party corporation for the verification of online student identity. A third party corporation can employ "data forensic techniques," similar to techniques used in the financial service industry. Such an approach enhances the credibility of the online education process [8].

TABLE II. FILE, FOLDER, AND VIRTUAL DISK ENCRYPTION USED BY UNIVERSITIES USED BY UNIVERSITIES

Software	**Platforms**	**Encryption Algorithms**	**Cost**
Windows EFS	Windows 2000, XP	Data Encryption Standard (DESX), Triple DESX	Part of Windows XP/2000
AxCrypt	Windows 95, 98, ME, NT, 2000, XP	AES 128	Free
TrueCrypt 4.2a	Windows Linux	AES 256, Serpent, Twofish	Free
DriveCrypt	Windows 95, 98, ME, NT, 2000, XP	AES, Triple AES (768) Blowfish 256, 448, Triple Blowfish(1344)	$77.34
CyberAngel	Windows 95,98,ME,NT, 2000,XP	Blowfish 128, AES 128, 256, 448 Two-fish 128, 256, Standard DES and Triple DES	$25 (Software) $60/yr Maintenance

VII. CONCLUSIONS

Colleges and universities are using information technology as an effective tool to achieve their mission statements and strategic goals. Such dependence on the technology has created potential concerns with respect to privacy of students, faculty and staff records. Sensitive information may be exposed to potential threats of cyber crime.

This paper focuses on privacy concerns and policies in higher education using a mix of traditional and online models. The cases of UTC, UMUC-OL, and UTC-OL show the necessity of addressing privacy issues in order to achieve institutional mission statements. A detailed analysis of FERPA and other privacy laws illustrates the dual and contradictory impact of online technology on privacy matters.

The expansion of education models from traditional face-to-face to online is associated with increased concerns for the privacy. At the same time, the paper concludes that technology can be used to address such privacy concerns. Specifically, the paper recommends the use of encryption and third party verification and an authentication approach to protect the privacy of students, faculty, or staff. Other recommendations include de-Balkanization of information in student services, copyright and intellectual property protection, and a better management of sensitive information.

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Evaluation Framework for Secure Methodologies

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Abstract— In recent years, the various processes and with different aspects were created in order to response the needs of producing secure software. As a result of secure methodologies production to develop software, their evaluation is difficult to select a methodology for a specific project. Due to This need, a framework for evaluation and measurement methodology plays an important role. Evaluation must consider the various parameters of the software project and pay attention to the similarities, differences, features and application of available methodologies. So there is need for measures to cover these requirements. Despite the researches in the analysis and evaluation of secure methodologies for software production in various aspects, the lack of an overall framework for evaluating these methodologies is seen.

In this paper, we offer an extended framework for evaluating the secure methodologies that cover different aspects of a software development methodology. This framework will be considered the needs of project managers and method engineers in order to choosing an appropriate secure methodology in the desired project.

Keyword- Methodology; Framework; Evaluation; Security; Criteria

I. INTRODUCTION

Software development methodologies are a framework to establish software engineering activities with the aim of providing required fields for building software systems. Software development Methodologies consists of two main elements are as follows [1, 2]:

Processes of Software development: processes define a targeted framework for engineering activities to develop software products. So, a process determines the sequence of processes, products in the activities, responsibilities of individuals and teams during product development and criteria for monitoring and evaluation of products and activities of the project.

Modeling language: It consists of a set of grammatical rules and semantic for modeling the software.

In software projects, methodologies are evaluated and analyzed more precisely using appropriate criteria until the methodology are chosen based on the needs of organization. Methodology Evaluation can cause a better understanding of various aspects of the methodology [3]. Evaluation issues as a means to compare the methodologies and help the user to select the optimal methodology from several methodologies. Also, the evaluation results can accelerate development and enhance the methodologies [3]. As a result of the used methodologies to produce secure software and the researches in the analysis and evaluation of secure methodology in various aspects of software development, the lack of an overall framework is seen for evaluating the methodologies. So in this paper, we will present a framework and criteria for evaluating these methodologies and cover the Project Leaders' requirements in order to choose an appropriate methodology.

In the second part of this paper, we will explain the related work in this field and in third part, we will explain three features of a comprehensive framework for the evaluation should be had. In the fourth part of its proposed framework and methodology of the fifth to secure the CLASP using the proposed framework, we will.

II. RELATED WORK

SSE / CMM Infrastructure [4] is a reference model for processes that explains security aspects at different levels of evolution the processes and provides methods for evaluating the activities of security. Implementing security in a system and its associated sub-systems focuses on the requirements. The problem of this model is that does not dictate the use of a specific process in the organization. Its goal is the use of model in the processes of the organization. This makes difficult the understanding and implementation of SSE / CMM [5].

OCTAVE is a security system based on strategies and techniques. It has a comprehensive and systematic approach to information security risk evaluation and enables the organization's components for understanding and positioning of information security risks. OCTAVE's problem is delivered in this sector, as a self-management approach is considered. Organization's individuals are responsible for the organization's security strategy and it is possible, this work is not performed properly because of reasons such as lack of sufficient security knowledge and entrusting other responsibilities to them. [5]

ISO / IEC 15408 Standard provide a group of criteria for evaluating product security. In the past, there were some security features that a software product runs it. Recently, there are Functions has been implemented in the development process and ensure and validate that the software development will be safe. This standard provides criteria which users can implement security requirements in their products by them and

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assessors can evaluate the claims made by manufacturers about their products [6, 7].The problem of ISO / IEC 15408 standard is complex to implement and evaluate the security aspects of a software product. This standard requires certain knowledge that takes the cost and time [5].

ISO / IEC 27002 Standard has been created for the confidentiality, availability and accuracy of the information. of security controls can be achieved With its implementation which ensures the defined security objectives have been met. The problem of ISO / IEC 27002 standard is that it includes a large number of security controls that a description is not explained in relation to best implement these security controls in standard [5].

The PSSS process [7], Common Criteria [8] and NIST [9] have presented a method for evaluating security activities.

According to the listed models and standards, everyone presents methods to assess security activities, but neither of these models has not proposed a comprehensive framework for evaluating the secure methodology.

III. EVALUATION FRAMEWORK

For evaluating all basic aspects of the secure methodology and achieving to a comprehensive evaluation, We define the criteria for each of the main aspects .Therefore for every aspect of the evaluation criteria should be considered or we express the goal of criteria. Also In order to quantify the evaluation, we express possible criteria in quantify state and where, there is no standard method to quantify, we define the accurately method to evaluate measure and the possible values for the evaluation outcome.

Understanding the application scope of methodology require to define appropriate criteria with using of methodologies in action. According to main aspects of the methodology, it will be covered. Although this aspect may require more extensive measures are being.

Each of evaluations needs to all or part of the evaluation framework is defined based on the goals that follow them. For example, to examine and compare the available security features in a secure methodology, goal of the evaluation is analyzing the security and the criteria of methodology's main aspects will be requirements and used criteria.

IV. PROPOSED EVALUATION FRAMWORK CRITERIA(EFSM[1])

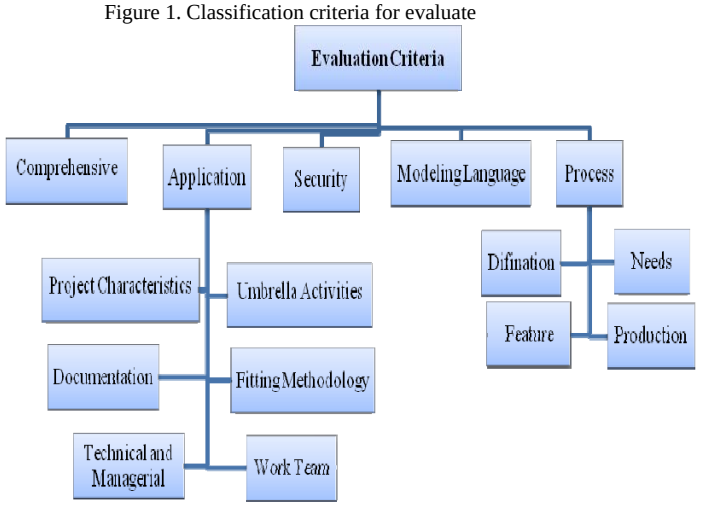
Collecting criteria has been done with defining a basic set and gradual improvement. It has used a basic set of defined fundamental aspects to define and the first step for each of the fundamental aspects, independent of other aspects, one or more criteria were defined. With putting together the criteria that are defined independently, we will have a set that has problems such as lack of completeness, inconsistencies, duplication and overlap with each other measures.

Therefore, in the second step, with solving the above problems, we purify the obtained set and measures set is gotten that cover all aspects respectively. The obtained Criteria set as the was considered a basic set and completed in later stages.

In the next step, we defined some practical scenarios, and applied the criteria set for evaluation and was trying to apply them in practice, obtained the shortcomings and defects. After applying any of the scenarios, the criteria set was completed according to overlapping and conflict. After the scenarios, the criteria set was achieved to sustainability and it was in a good level and spanning. In the last step, the final set of criteria has been formulated with regard to structure and it was used to the final evaluation for secure software development methodology.

Set of evaluation criteria are in five categories at the highest level: process, modeling language, security, applications and pervasive. Each of these criteria includes the following sub-categories of criteria, which include criteria for the evaluation of the approach under consideration sub-category. Figure A shows the classification criteria.

Figure 1. Classification criteria for evaluate



A. *Process Evaluating Criteria*

The criteria of this category focus on evaluating development process of methodology with different approaches. These criteria are divided into four categories: Definition; it evaluates definitions criteria of process in terms of attributes that definition of a process that should be had. Production; it evaluates and reviews the cycle of production and output characteristics of the process. Needs; it reviews and evaluates important issues in requirements engineering. Features; it considers development standards in this process fully. TABLE I shows the evaluation process, the first column, criteria, in the second column defined criteria, in the third column the range of criteria values and in the fourth column, evaluation of CLASP methodology [10, 11] as a methodology for secure software development using The proposed framework is described.

[1] Evaluation Framework for Secure Methodologies

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TABLE I. Process Evaluating Criteria

Criteria		Defined criteria	Range of values	CLASP
Definition	***Clear and unambiguous***	Is the production process defined as a clear and unambiguous?	Yes/No (specify why)	Yes
	Logical	Is the production process logical in terms of providing a broad description or very minor?[12]	Yes/No (specify why)	Yes
	Complete	The full definition is a definition that includes the basic components of the production cycle, roles, activities, language modeling, outputs / products, techniques / business practices, umbrella rules and activities.	Real number greater than zero and less than or equal to one	7/8
Production	***Cover the General steps of the production cycle***	Which stages of the production process of the general cycle of identification, analysis, design, implementation, testing, commissioning, maintenance, support and close the project does development process cover?[3]	Real number greater than zero and less than or equal to one	5/9
	Production line	How is The applicable policy to the production of outputs (software)?	Iterative, incremental, fast and ...	Iterative, incremental
	Enough	Does development process provide Typical output of the production process of public activities, including feasibility, describe the requirements, design, modeling, documentation, testing, training and commissioning? [13]	Real number greater than zero and less than or equal to one	4/8
	Coordination among the products	Is there a Coordination and logical relationship between products and Are they the complement each other?	High, medium, low	Medium
	Standards	Is there a standard for producing outputs and products?	Yes (Standard), No	Yes (write classes)
Needs	***Identification method of needs***	How are Software needs collected in process ?[3]	associated Activities with the identified needs, the roles involved and their output	By capabilities that produce of first phases
	format Description of needs	How are the requirements expressed?	Component, Usage scenario, User story, Feature, Use-case	Feature
	Based on operational / non-operational needs	Is The production process based on needs?	Yes (techniques), No.	Yes (production process is Base on needs recognition)
	Changing needs	Does the process support of changing the needs?	Yes (techniques), No.	Yes (review needs)
	prioritization Methods of needs	What are the criteria for prioritization of needs? [13]	Architectural value, functional value, business value and risk of implementation	risk of implementation
Features	***Size / complexity***	The relationship between size / complexity of building blocks are defined as a function of the production process (process, outputs, work procedures, activities and roles)	Integer greater than zero	(number of roles + 17)
	completeness	How much completeness is the Production process in terms of definition, , the coverage of public processes, and insufficient production cycle of products / outputs to the full extent?	Real number greater than zero and less than or equal to a	(4/8+ 5/9 + 7/8)/3
	Be applied	Is the production process practical?	High, medium, low	Medium
	Ability to apply	Is the production process applicable?	High, medium, low	Medium
	Documentation	Are The production process and the activities undertaken during the implementation process documented and provided to software engineers?	Yes , No	Yes

B. Modeling Language Evaluating Criteria

Since the modeling language in safe methodologies is less important, these criteria are expressed as compression at four subcategories and concern to evaluate the modeling language features. Having a similar structure to TABLE I, TABLE II also express evaluating criteria for modeling language.

TABLE II. Modeling Language Evaluating Criteria

Criterion	criterion definition	Range of values	CLASP
Simplicity	Is it easy to learn and use modeling language?	Yes, No	---
Power of Language	Is the modeling language powerful?	Yes (for example), No	---
Techniques to resolve conflict	Has the modeling language provided any techniques to resolve conflicts between the models?[3]	Yes (techniques), No	---
Methods for managing complexity	Has the modeling language provided methods to manage the complexity?	Yes (methods), No	---

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C. Security Evaluation Criteria

This criteria category, evaluate security features of methodology in various phases of product life cycle. TABLE III shows the security evaluation criteria.

TABLE III. Security Evaluating Criteria

Criteria	criterion definition	Range of values	CLASP
Software Security Training	What level of security training will be given to project team members?	High, medium, low	Medium
Security Information	What level of security Information is there in security requirements as a function of security analysis results information, information of product vulnerabilities discover in gander solving, software security events Information and changes information?	Real number between zero and one	3/4
Analysis of security requirements	Which of the security requirements are analyzed and identified?	Environment, functional, software development process	Environment and functional
Apply Software security principles in design	To what extend software security principles are applied in design?	High, medium, low	High
improve the security of design	What can be done in order to improve the design (of security)?	design evaluation, internal and external review of design (of security) ,design simulation	Design evaluation
Use security tools of executable program generation	What activities can be done to use of security tools generate executable programs?	Identification of security tools, use them correctly, function accuracy control	Identification of security tools and use them correctly
security monitoring After product installation	Is the product constantly monitored by security After installing?	Yes, No	Yes
Security Response	To what extent does it show a Appropriate response to the security problems?	High, medium, low	High

D. Application evaluation criteria

The criteria of this category which are defined in six subcategories, note to the most important aspects of methodologies application: Project Characteristics; this group of criteria, consider the parameters related to the project which have the most use for selecting the appropriate project methodologies and investigate them on methodology. Team Work; these criteria, investigate potential deals of working group. Technical and Managerial; this group of criteria, investigate and evaluate technical and managerial capabilities. Umbrella Activities; investigate the umbrella activities in methodology which are critical in real world use of methodology. Fitting Methodology; these criteria, consider the main points in the manipulation and adjustment methodology. Documentation; these criteria, evaluate methodology for using guide documents and using experiences reports. TABLE IV shows the application evaluation criteria.

TABLE IV. Application Evaluating Criteria

Criteria		Criteria definition	Range of values	CLASP
project characteristics	***Project size***	What is the size of the project?	Large, medium, small	Large
	Domain	What are the fields of project use?	System, prompt, business, engineering and scientific and ...	System, business, engineering and scientific
	Dynamism	How much is the change percentage in demands in a month?	Real number greater than zero and less than or equal to one	----
	Complexity	How much the computational complexity is?	High, medium, low	Medium
	Project Priority	What is the main goal of the project?[14]	Productivity, observation capability, repeatability, accuracy, reliability, compatibility, quality and security	Security
	restrictions	What are the particular restrictions of project?	Restrictions name	----
Team work	***Team size***	How many people are there in production team?[15]	Person	----
	Level of training	What level the training is on? [3]	3,2,1 B, 1A, -1	1B
	Level of experience	What level the experience is on?	High, medium, low	Medium
	Skills in project scope	On What level the skill in the project is?[15]	High, medium, low	Medium
Technical and managerial	***Style of programming***	What is the style of programming?	Simple, complex	----
	Abstraction mechanism	What is the mechanism of abstraction?	Object-oriented, agent-oriented and ...	----
	Procedures for testing and debugging	What procedures exist for testing and debugging?	Unit testing, compound testing, and acceptance testing.	Testing security
	Size of management team	How much is the management team size?[16]	Large, medium, small	Small
	project manager experience	On What level the Project manager experience is?	High, medium, low	High

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	Team management approach	What is a team management approach?	Central, distributed	Distributed
	Working culture	How is the work culture?[16]	cooperative, Partnership, non-cooperation	Cooperative and Partnership
Umbrella activities	***Project Management***	What level of process management activities (planning, scheduling, monitoring, and reviewing the production process) can be supported?	Real number greater than zero and less than or equal to one	4/4
	Configuration management	To What extend approaches and tools of software configuration management (SCM) are supported?	The supporting level of SCM	Incident
	Team management	Has The methodology provided a procedure for teams and people management?	Yes (techniques), No.	Yes (certain works teams)
	Quality Assurance	Does the methodology support the quality assurance techniques to?	Yes (techniques), No.	Yes (revision patterns and evaluation conclusion
	Risk Management	Does the methodology support the risk management techniques?	Yes (techniques), No.	Yes (schematization and development report)
Fitting Methodology	***Compliance / compatibility***	Whether the methodology provides consisting itself for the project needs?	Yes , No.	Yes
	Flexibility	Whether the methodology support changes in process modeling language during the run?	Yes (How), No.	Yes (Review schematization and process)
	Extend	Is the methodology extendable and Has it provided extend points?	Yes (the expansion), No.	----
	Merging with other methodologies	If the methodology was flawed and needs to complete some aspects, Has methodology provided methods for merging with other methodologies?	It is not necessary, it is necessary but not provided, it is necessary and provided	It is not necessary
Documentation	***Primary Documents***	is methodology training Documentation available?	Yes, No	Yes
	Experimental Evidence and Reports	is There Experimental evidence documents of practical use of the methodology?	Yes, No	Yes

E. Comprehensive evaluation Criteria

Comprehensive criteria, criteria which are defined on one or more aspects of process, modeling language, security and application or in general on methodology itself and evaluate easily by using the results of evaluating other aspects of methodology. TABLE V shows the Comprehensive evaluation criteria.

TABLE V. Comprehensive Evaluating Criteria

Criteria	Defined criteria	Range of values	CLASP
Performance	How much is the methodology performance as a function of team size , number of outputs, the number of involved roles and the speed of production team in each repetition?	Real number greater than zero	This criteria depend to assessor idea
Usability	How much is the Usability As a function of the number of guidelines, roles, consistency level of methodology with the scope and lean production process?	Real number greater than zero	This criteria depend to project
Completeness	How much is methodology Completeness based on the function of process completeness, umbrella activities coverage and determine a modeling language?	Real number greater than zero and less than or equal to one	(0.64+0.8+0) = 0.48
Methodology status	What is the current methodology's status?[17]	Young, growing, active, set aside	Developing
Production process	How is the methodology defined in the production process?	Explicit, implicit, undefined	Explicit
Restrictions	What restrictions on the use of the methodology are effective?	Restrictions name	----

V. CLASP EVALUATION WITH EFSM

In the CLASP process, the Others Successful experiences and guidelines have been used well in software development and are categorized as Activities and each activity steps. CLASP has considered different aspects for production and development secure software.

Lacks of work products definition which at each activity and its steps have to be produced are of major defects of CLASP. Implementation steps which has been introduced in each activity, sometimes are very general and the others successful experiences have been advised and referred in that field. In addition to the lack of precise descriptions of work that must be done at each step, it cause the lack of integrity in the work products which produced by the development team and its first loss is removing seamless properties and follow up ability on this process. Also not providing a integrated modeling language in this process, make the problem doubled and the system developers have to use various methods for describing and modeling in various activities and the implementation steps.

VI. CONCLUSION

The development in use of secure methodologies to produce software has made the selection of appropriate secure methodology in specific projects difficult. Analysis and

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evaluation of these methodologies can lead to a better understanding of various aspects of the methodology. Also, the results of the assessment can speed up expanding and enhancing in methodology. In spite of researches in analysis and evaluation of secure methodology in various aspects of software production, lack of overall and proper framework for evaluating these methodologies still exists.

In line with these requirements the EFSM framework was provided. This framework was created by using criteria collecting and integrating them and also by considering the required security activities in software production. The EFSM Is a multifaceted and structured framework, which aims to provide quantitative analyzing and evaluating safe methodology. This framework helps project managers and methods engineers in selecting the appropriate project method by evaluating safe methodologies. It also provides the criteria sets in a hierarchical form so with desired details consideration, the criteria repair capabilities and easy to understand and use it for the user will be provided.

The EFSM can be set as a reference shared model to estimate the maturity and ability to apply of secure methodologies. By considering general aspect of methodology, it can be argued that the superset criteria set framework which are proposed are from examined criteria set frameworks.

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Improving Mobility in eXtreme Programming Method through Computer Support Cooperative Work

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One of the most challenging in eXtreme Programming is composing the entire team member and customer onsite. This problem will become seriously when the entire team member unavailable in the same place or the customer cannot give representation person for the development team. This situation will make information imperfectly for both customer and team member. In this research, we solve the problem by implementing computer support cooperative work (CSCW) as a tool to improve eXtreme Programming method. By joining these two concepts, we get 15% productivity improvement as a ratio between XP projects with CSCW and without CSCW.

eXtreme Programming, CSCW, Software Development.

I. INTRODUCTION

Software development is a resource-limited cooperative game of invention and communication. The primary goal of the game is to deliver useful, working software [4]. Software can be developed by individual or team. When software is developed by the team, complexity of the communication can raise misunderstanding of the software itself. With the increasing need to collaboration work, programming work has had more and more of social components [3]. These social components consist of information sharing, resources sharing, and experience sharing. Table 1 illustrates the example of the social components in software development.

TABLE I. SOCIAL COMPONENTS EXAMPLES

Social Components	Examples
Information sharing	Team member shares the requirements to the others peers.
Resource sharing	Team member shares the third party component or article for the peers to tackle development problem
Experience Sharing	Team member shares the knowledge base for specific case that already solved in the past.

Social components might be imperfectly shaped when a team member is unavailable in certain moment. For example, when a member cannot attend the stand-up meeting, the member will lose some of the information as well as the other peers have to explain the member in the other day to make him know the project progress.

eXtreme programming (XP) makes great use of osmotic communication, face-to-face communication, convection currents of information flow, and information radiators on the wall [2]. This will become challenging when the team member has great mobility and information itself has quick lifecycle. Quick information lifecycle can be seen when a member write the information on the whiteboard in this day, and tomorrow the information is erased because the new information is come. The team member who does not see the information will also lose this information.

The impact of losing information is happening both in client and development team. When the client is too busy or they do not know what they really need. The software that delivered will fade away from the expected. Many clients take the word software development as simple approach of code construction. Therefore, some of them feel that they do not have to always onsite with the team development. Although Extreme Programming said it strongly needed, rarely client who want seat side by side every time.

Our idea to solve this kind of situation is provide the team as well as the client, a tool that support for collaboration and cooperative work. This tool is well known as groupware or computer support cooperative work (CSCW). We are mapping the need of information in XP with appropriate CSCW tool. In this research, we contribute some of practices below:

- We explain precisely how we setup the CCSW tool in line with XP information. Surprisingly, this has not been done before.
- We capture information architecture in CCSW tool as collaborative model in Extreme Programming

These contributions can be adopted for XP team who want to manage the information more precisely with the support of CCSW tool.

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II. MAPPING XP WITH CSCW TOOL

XP has four disciplines values that can be implemented in software development lifecycle. These values provide development team to learn and drive a set of software development practices. Figure 1 illustrates the values according to Beck (2001).

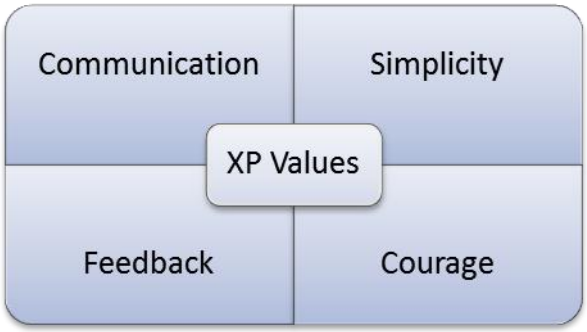

Figure 1. XP Values

Direct communication exposes a basic rule in XP team. When a person has knowledge about the system, he should share the knowledge with the others. Direct communication is not only about the transmitted information but also about a perception from the receiver. Perception can be synchronized through several modalities. Table II provides an example about direct communication modalities.

TABLE II. DIRECT COMMUNICATION MODALITIES IN SOFTWARE DEVELOPMENT

Modalities Models	Examples
Physicals Proximities	In stand-up meeting, The speaker may move closer to indicate aggressiveness or enthusiasm. The listener may move closer to indicate interest, agreement, or the desire to speak; or, the listener may move away to indicate fear, disagreement, or the need to think privately for a moment
Visual	Explain the concept through 3D visual information, like video, slide shows, or even a scratch diagrams on a whiteboard
Kinesthetic	Team member uses sensation of movement to help construct a new explanation or to help improve the building of a question.
Sound	The speaker uses pitch, volume, and pacing to differentiate and emphasize ideas in a sentence.
Low latency	Extreme Programming set the good of direct communication since this kind of communication is low latency in term of request and response communication. For example when the peer ask the question the others team feel it should to get immediate answer or response.

These values mentions as hot communication and only happens in face-to-face communication. The opposite of hot communication is called cold communication. Requirements paper, email, or video are examples of cold communication. Cold communication means there are no need to do immediate action.

Cold communication primarily happens when the unavailability of the team including customer is exists. This kind of communication will raise some problems such as:

- Missing information and different nerve perception.
- Slow motion of feedback. This happen since the member not engaged directly to response the communication.
- Lacking of simplicity. Team should create documentation or retelling the problem to make the same perception.

All of these problems indirectly told us that bad communication is the root problem to shape better XP values. Many of these problem is cannot avoided in mobility world today.

Starting with belief of computer support cooperative work (CSCW) will solve the communication gap; we build a model that can reduce the presence problem in Extreme Programming. CSCW is asset of theories that are often qualitative case studies with thick descriptions in an effort to develop common themes and patterns in cooperative area [7]. CSCW is adopted as software tool that famously called as groupware.

Groupware provides shared workspaces for the entire user that joined in the group. Shared workspaces aim at supporting cooperative and communication tasks. They provide users with a virtual space in which information can be shared and exchanged [8]. Shared workspace consists of some well-known features such as:

- Forum discussion. This feature enable user to discuss specific topic in forum model.
- Instant Messaging, this feature enable multiple user to chat using textual feature.
- Sketchpad, this feature enables multiple users to collaborate the idea through a whiteboard like feature.
- Shared Calendar, this feature enable shared calendar that can be accessed by the entire user.

XP captures information through several forms such as release plan document, class responsibility collaborator, story card in the wall, and personal communication log. This kind of communication should be plotted with existing groupware feature. Figure II illustrates how we plot between XP information and Groupware features.

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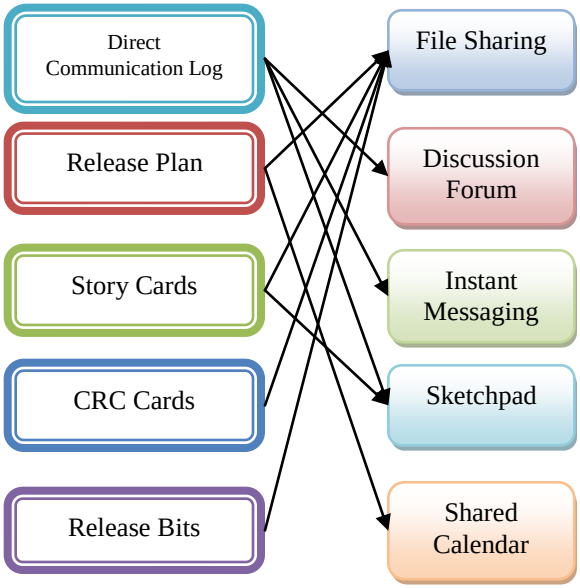

Figure 2. Relation between CSCW Features with XP Information

Figure 2 illustrates us some fact that:

- Some of the XP information is highly dependent with file sharing.
- Direct communication log have greater tendency with some of features in CSCW.

The first fact drives us to create a structure model in file sharing. The structure model in our file sharing is adopted through several directories that each directory has its own purpose. Table III show a directory structure that we are developed for XP file sharing.

TABLE III. FOLDER STRUCTURE MODEL FOR XP

Folder Name	Functional Descriptions
Bin	This folder consists of all small software release that we already created.
Res	This folder consists of available resources that we need to tackle the problem in our software constructions. Books, articles, or images that related with the project.
Lib	This folder contains the sample source code, library, or third party component that we will use in the project.
Doc	This folder contains development documentation such a release plan, CRC cards, or user stories document.
Temp	This folder acts like temporary folder. This temporary folder can be used for backup files, when one or more team member, make a change through the courage spirits in XP.
Misc.	This folder contains files that are not related directly with the constructions process. In example proof of receipt, lost and found, and another managerial stuff.

Project leader create this entire folder in file sharing tools and manage every changes of it through manual versioning files. Manual versioning is done by adding additional document info through its name. Our naming template is codefile-projectname-builddate.extension. For an example if we have release plan document for project named Whistler that saved in 12 January 2009, we will name it as releaseplan-whistler-120109.doc. There are some others approach to name the file like by using metadata information or add it in the body of document. However, we find manual versioning is simple, yet powerful, and no need extra processing. We apply this manual versioning for document, source code, and binary release.

The second fact drives us to examine more clearly about direct communication log. XP comes with various shape of the direct communication. Started from planning game, stand up meeting, pair programming and postmortem in every small release.

Direct Communication is the main interaction between customer and development team. When the customer cannot meet directly with the development team, CSCW tools will support both parties through multimodal communication. The detail of the multimodal communication is incrementally adopted with the need of communication user experience. We notice three aspects that needed in multimodal communication which are:

- Presence
- Perception
- Interactive

These aspects drive us to choose instant messaging, as a primary tools that provide which are:

- Presence through status tag.
- Perception through various way communications like textual chat, video chat, and audio chat.
- Interactive through its instant model.

There are two types of instant messaging collaborations. The first one is private model person-to-person, and the second one is conference model when many-to-many collaboratively together. Figures 3 map the instant messaging model with XP activities.

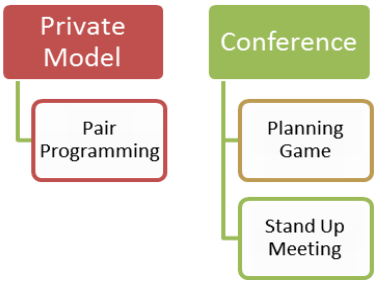

Figure 3. Mapping Instant Messaging Model with XP Activities

We save every communication log in both communication models when permits and store it in folder /Misc/ in file sharing system.

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In order to enrich the sharing experience we combine the chatting tools with sketchpad or even with screen sharing. Screen sharing is somewhat useful when we do pair programming in separated area.

For more 'cold' captured content that need to be follow up, we implement forum discussions. This will give a team more memory to remember the flow of the information and submit their argument, idea, or more discussions in time manner. Figure 4 illustrates us the meaning of forum to provide clear view of the information tracker like a tree.

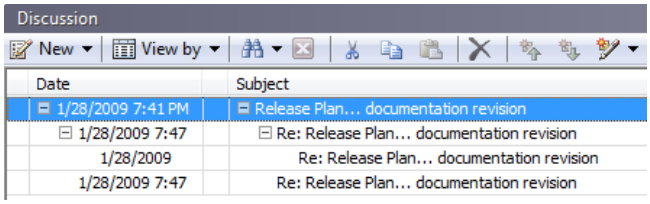

Figure 4. Forum Provides Information Flow for the Team

III. MAPPING MODEL IN MOBILITY WORLD

We find that the three approaches provides us more efficiently to guide a person both team member to always up to date, even they can't attend one or more meeting. For an example when they do not come to attend a stand-up meeting, they will do such as action, which are:

- Asking the peer about what he miss
- Searching through the computer or the code, what the changes happen and learn the changes from there.

Both of the possibility action will guide a team member into ineffectiveness time and work. CSCW concept that we implemented provides a team member to do action:

- Discovering the missing information through one single point, that is the file sharing system.
- Exploring the information flow and the architecture through file versioning, forum, and sketchpad
- Seeing the important pieces of experience knowledge through communication log.

These actions can be combined with chatting tools, sketchpad, or screen sharing in CSCW feature. All of these features provide the team to keep in touch while on the go. Therefore, when the team member or the customer cannot reach onsite, they can still communicate through this chatting platform.

Smoothing the step of the CSCW as a support tool in XP provides us some basic understanding that the CSCW tools should:

- Proficient to map between XP practices with the suitable tools
- Proficient to facilitate direct communication action that exist in XP through its features

Beside the means of the tools, we also think the management process to build, maintain, and trace the information architecture. We exhibit this by doing small experiences through two identical projects. We said identical since the projects have characteristics such as:

- Having same complexity in terms of time, resources, cases, and budget.
- Having same client, since this project is a part of the long-term contract with the client.
- Doing by identical team members in term experience, and skills.

We see a great successful rate by using manual versioning, as well as discipline to save every conference log into file sharing. We tabulate five interesting cases that reflect the interaction between team and client, there are:

- Initial management setup, it is a time for each team to setup and create baseline workspaces.
- Miscommunication in stand-up meeting, this case somewhat happen when team member or client have different perception in term of concept or vision. We capture this since this is one of the core problem that raises when member don't have
- Lost and Found is a term for us that explain the searching and finding related information that not explicitly exist in release plan document or user stories.
- Building wrong releases is happen when the member build new code in old or unstable release of software. This happen when member doesn't get current source code this can be happen when they miss the latest email, don't download the latest source code, or miss the last stand up meeting.
- Complaint received from the client is happen when the client feeling misperception the result with their expected. In our case, the client is in offshore so the client is not in perfect condition to always onsite with the team.

Table IV provides our result in this experiment to handle two identical projects in complexity with or without CSCW tools.

TABLE IV. XP WITH OR WITHOUT CSCW

Case	Project A (with CSCW)	Project B (without CSCW)	Percentage Ratio A/B
Initial Management Setup (hours)	4	1	-75%
Miscommunications in stand-up (cases/project)	3	7	+42%
Lost and Found (cases/week)	1	4	+25%
Building in wrong releases (cases)	1	3	+33%
Complaint received from the client (cases)	3	6	+50%
Means			+15%

We quantitatively count the ratio between project A and project B. We investigated that Initial management setup

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provides a high time consumption when using CSCW, this happen since every member should prepare, and configure the tools. We investigate that they should configure and setup this followings actions:

- Setup the software for each workstation.
- Configuring network connection for CSCW tool in each client.
- Creating and configuring model for CSCW tool like create folder structure and enabling the specific feature.

When setup completed, then the software lifecycle is started and XP is applied. This is the time when an interaction sometime creating miscommunication, lost and found, building wrong releases, or even complaint from customer. Table IV shows us that CSCW gives more flexible way to:

- Making same perceptions through some facts from CSCW.
- Finding information faster and better through structured management folder.
- Making the communication between peer and client more structured and logged for better communication and traceability.

Quantitatively we average that the productivity gain can be achieved about 15%. This number can be achieved by averaging the percentage ratio for each case that inspected. The number provides our first class result that integrated CSCW in XP can enhance the productivity of mobility communication.

IV. RELATED WORK

Our work is focused in accelerating software development through the mean of better collaboration tool that support member mobility. The result is somewhat have same impact with Augustin, et al research [1]. They work to get better result through Collaborative Software Development. However, our subject and the method are somewhat different.

Our work also research about the meaning of instant messaging technology in XP methods. We find that the investigation is proposing some management session model that focused in XP methods. This result gives as same pattern that Hansen and Damm [6] did in their investigation for context aware instant messaging, this result is best combined with the wiki collaboration in collaborative software development [9]. This wiki structures we find valuable and we adopt it as file structure model in our XP methods. All of the features that we implemented are encapsulated by the term workspaces. The good workspaces organized concept is also adopted from Rubart et al research [8]. They organized enterprise workspaces through component-based cooperative hypermedia.

Mobility and interaction term sometime provides us a small conflict between team, such a miscommunication and different perception. Many of this mislead happen since the peer is limited in information than the other. Limited information can be happen when the user miss the meeting or in mobility. We see a lot useful information about conflict in collaborative software development [5]. We adopt some of their concept in our mapping between CSCW roles and XP.

V. CONCLUSIONS AND FUTURE WORK

We create the mapping model between XP methods and the CSCW tool. We map some of the CSCW features with XP. We discover that versioning in folder structure; capturing communication log through instant messaging as well as store cold information in discussion forum can be good practices to tackle mobility problem. In order to support our model, we create some field experiment that shows the productivity different and low conflict by using CSCW tools.

Our model is still lack of assessment, as well as evaluation model. The integration model that we delivered is also insufficient in detail actions. For example, we do not investigate further experience for CSCW implementation in pair programming practices. We see this can be a topic for further research.

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Using Two levels danger model of the Immune System for Malware Detection

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Abstract— **Most signature–based antivirus products are effective to detect known malwares but not unknown malwares or malwares' variants, which make them often lag behind malwares. Also most antivirus approaches are complex for two reasons. First, lots of malicious and benign codes as training dataset are difficult to collect. Second, they would consume lots of times when training classifiers.**

Immunity PE Malware Detection System (IPEMDS) was designed to give computer systems PE homeostatic capabilities analogous to those of the human immune system. Because the constraints of living and computational systems are very different, however, we cannot create a useful computer security mechanism by merely imitating biology. IPEMDS approach has been first to choose a set of requirements similar to those of the immune system. It then created abstractions that captured some of the important characteristics of biological homeostatic systems and then used these abstractions to guide the design of two levels of defense called them IPEMDS.

The goal of IPEMDS are to obtain high detection rate and a very low false positive. IPEMDS enter in a challenge to a chief this goal from depending only on a finite numbers of benign files to classify between a new benign and malware executable files, and both of them unseen before by IPEMDS.

Keywords: Heuristic analysis, Packed Executable, Homeostasis, Dentritic Cell Algorithm (DCA), Toll-like Receptors (TLR), Global Alignment, API.

I. INTRODUCTION

The reason of Windows PE viruses are becoming more and more popular return to the ever–growing PE viruses, were are easy to propagate between different platforms and are difficult to detect by antivirus because of their portable file format. In addition, PE viruses have become the favorite target of most malware writers who exhibit their technique in the malware community. All these actions led to the development and upgrade of PE malwares, which make the antivirus more and more difficult to detect them [1].

Also the reason of a malware is growing rapidly belong to the number of malware applies various techniques to protect itself from the anti-virus solution detection. As a result, these many protection techniques are applied to a malware, a representative of those is a Packing. It is not an exaggeration that most of the malware currently is distributed. In other words, a packer is widely used for a malware protection. Therefore analysts must determine whether the malware was packed or not and if the malware is packed, what packer is used, before an analysis of the malware. For these procedures, some packer detection tools were released and used [2].

There are relatively few mechanisms in existing computer systems which are analogous to the immune system. Anti-virus (AV) scanners primarily detect viruses by looking for simple virus signatures within the file being scanned. The signature of a virus is typically created by disassembling the virus into assembly code, analyzing it, and then selecting those sections of code that seem to be unique to virus. This approach can be easily subverted by simply changing the virus's code (and thus the virus signature) in trivial ways [3]. Most viruses in the wild today are of the "simple" type – not encrypted or polymorphic, and many of them have variants that come out afterwards. These variant are inherently similar to the original virus, yet current signatures fail to detect these variants without further updates from AV vendors. This indicates that present–day signatures are too weak to withstand simple changes to the virus body (i.e. dates, port numbers, variable names, etc) [3]. None of these systems, however, are anywhere as robust, general, or adaptive as the human immune system.

To improve the performance a novel immune base approach for unknown Windows PE malwares detection is proposed, based on static analysis of PE executables files without needs to run and load them into memory. Another property for system is only depend on PE benign executables files at the beginning to gather information database. So the idea of approach opposite a challenge to separate between unseen benign executables files that enter to computer continuously and all unseen and unknown PE malwares.

In immunology, there are two distinct viewpoints about the main goal of immune system; the classical self-non-self viewpoint states that immune system discriminates between self (human body cells and molecules) and non-self (other invading cells and molecules), and the danger theory viewpoint describes that the immune system looks for dangerous elements and events whether self or non-self [4].

In this paper the term suspicious means that it may be benign or malware.

II. THE DATASET

The IPEMDS only considers malware based on the PE format of Win32. So the specific training set consists of 300 benign programs that were randomly gathered from the system files of windows XP operating system. There are also another

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different 300 benign programs that make up the specific test set for unseen benign programs.

The IPEMDS has used 'VX Heavens Virus Collection' [5] database which is available for free download in the public domain. Malware samples, especially recent ones, are not easily available on the Internet. As mentioned earlier the IPEMDS only consider Win32 based malware in PE file format, so the IPEMDS has been tested on the three most popular malicious: 100 worms, 120 trojans, and 100 backdoors malwares collected from "VX Heavens Virus Collection" [5].

It is important to note that the IPEMDS is differentiating between packed and non-packed files and also it works regardless of the packed/non-packed nature of the file.

III. Malwares and Executable File Infectors

The execution of such types of malwares is similar to the execution of any normal applications or programs that run under Windows OS. Malwares use many Windows functions stored in Kernel mode and user mode called Application Programming Interface (API). To call these functions, malwares should have the physical addresses of the needed APIs, which cannot be obtained easily, and which Windows OS will not simply provide. Thus, malwares find ways to collect these addresses from the Windows OS [6].

Malwares are programmed to know that each normal application that runs under Windows OS has a predefined list of API names and addresses. The listed API is imported by the application during execution or exported to other Windows applications. Malwares attack these PE applications to collect API addresses and control the execution of infected applications. They change certain fields and locations to direct the execution of the normal application PE to their codes, and then return the execution control to normal after performing their functionalities. They also modify the list of needed API functions to include other functions required during code execution [6].

IV. Static PE Analyzer

The PE structure consists of headers and sections that explain the logical and physical information of file storage and execution, see figure 1. The physical part is called 'file header", which contains such information as number of sections and size of optional header. The logical part, known as "optional header', has information such as "relevant virtual address, file or section alignments, address of entry points", and many others. The third header, "section header", is also called "section table". It is a structure that contains information concerning the PE sections that follow this header. It is one of the important layers that scans for malware detection because each PE file is described in specific directory in the section header [6].

In general, sections are used to store data and codes of the file separately. Windows applications have nine predefined sections: .text, .bss, .rdata, .idata, .rsrc, .edata, .pdata, reloc, and .debug. Some applications may not need all of these sections, whereas others may require still more sections to suit their specific needs [6]. Codes and instructions of the PE file are stored in the .text section, whereas data of the PE file are stored in .bss, .rdata, or .data, sections based on their types [6].

The most important sections that malwares always scan are .edata and .idata. These sections contain information about the physical addresses of the Windows functions, which are called application programmable interface (API). The .edata section contains information about APIs that the file exports, whereas .idata features information about APIs that the file imports. The "Import Address Table" in the .idata is used by malware analysts to identify whether or not a PE file is infected [6].

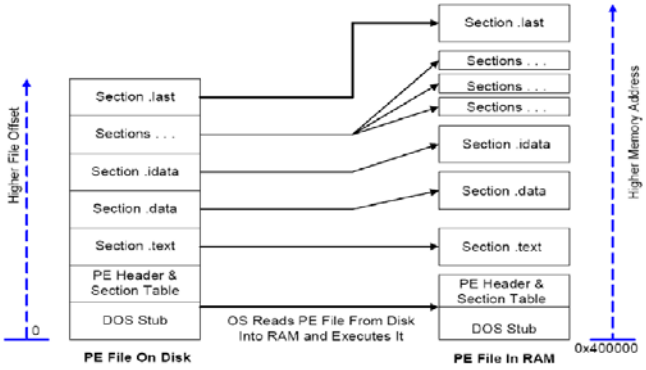

Fig. 1: PE File Layouts on Disk and in RAM

Inspired by the functioning of Major Histocompatibility Complex (MHC) in the human body, the static PE analyzer analyze PE behavior by observing which APIs use them when execute.

In summary the implementation of our static PE analyzer involves extract the following information from the entered PE file without disassembling it:

1) Verifying if the file is a valid PE file, from if PE signature "PE00" was exit; and compute how many PE signatures there are in current PE file, benign PE has only one PE signature.
2) Extract from MS-DOS header: Magic number "MZ" which is a DOS exe signature, *e_lfanew* which contain the offset of PE header.
3) Examine how many DOS stub there are in current PE file, benign PE has only one DOS stub program;
4) By *e_lfanew* value it can be reach to PE header, and extract all its components, but the most important components the IPEMDS focus on are *NumberOfSections, SizeOfOptionalHeader, Characteristics*;
5) Extract from Optional header: all its components, but the most important components the IPEMDS focus on are *SizeOfCode, AddressOfEntryPoint, ImageBase, SectionAlignment, FileAlignment, SizeOfImage, SizeOfHeaders, NumberOfRvaAndSizes*.
6) The value of *NumberOfRvaAndSizes* determine the number of Data Directories in the current PE file. So here the IPEMDS extract the array details of data directories which contain *VirtualAddress, Size*; for each one.

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7) The value of *NumberOfSections* determine the number of sections in the current PE file and for each section there is it's section header. So the IPEMDS here extract the section headers, and there most important components are *VirtualSize, VirtualAddress, SizeOfRawData, PointerToRawData, Characteristics*.
8) Find IAT, and extracting DLLs and API function names.
9) The static PE analyzer extract 10 features put them in packed structure, to use it later to decide if this PE file is packed or not.
10) The static PE analyzer extract 17 features put them in heuristic structure, to use it later as a tool aid to decide if this PE file is malware or not.

V. Portable Executable file Homeostasis (PeH)

The static PE analyzer make a first step towards a homeostatic PE files, by gathering information about the APIs the benign windows PE files were used. It must be confirmation that homeostatic operation only done on windows benign PE files.

The IPEMDS use sequences method, which mean record the APIs by using fixed window size in profiles, the better window sizes are 4 or 6. when input all dataset of benign PE files to static PE analyzer, the outcome is DLLs names and the APIs names used from them, here the PeH start to built a special six profiles as a database use them later in detection operation, these profiles are as follow:

1) *DLL&APInormal*: for each PE file record number of DLLs and APIs used and there names.
2) *PeHSimilarityHashSeqNo*: for each benign PE file record in one line the Hash sequence value for each pair (DLL-APIs) of it . the IPEMDS will use this profile in Global Alignment method describe later to find the similarity with other files.
3) *allAPIname&HashSeqNo*: for all benign PE files records the (DLL-APIs) pair and its *Hash sequence* value.
4) *PeHSequences*: for each PE file slide window on its APIs once for each step to produce sequence. For a window of size x, number of output sequences are:
NoAPIseq = *NoAPI* – x + 1; ……. (1)
5) *PackediDC*: for each PE file collect 11 features and consider them as one immature Dendritic cell (PackediDC), and record it in current profile.
6) *HashiDC*: for each PE file
   - Get the hash sequence for it;
   - Apply Global alignment between current PE file and hash sequence of all benign PE file dataset;
   - Compute 6 distinct similarity & differentially measures;
   - Record the measures values in Profile as one HashiDC.

VI. Global Alignment

Before describe Global Alignment it must clarify the meaning of Hash Sequence. While the outcome of static PE Analyzer are (DLL-APIs) pairs contain their names, the hash value used to avoid collision. For each new pair unseen before there is a new hash sequence value use instead of the pairs name, table (1) lists part of (DLL-APIs) pairs and its hash sequence values.

In order to compute similarity, the direct comparison of two sequences is insufficient. So first the IPEMDS apply sequence alignment to the hash sequences and the IPEMDS goal is to find the longer two similar pieces from two sequences.

Global alignment which aligns every element in every sequence, attempts to find the best possible alignment from the start to end of sequences. For example [7]:

Sequence 1: F T A F F T L
Sequence 1: F F T A V T L

Global alignment: F – T A F F T L – Gap
F F T A V – T L

The selection of global and applied the Needleman-Wunch algorithm, is a general global alignment to hash sequences. The Needleman-Wunsch algorithm is in [7].

TABLE 1: (DLL-APIs) PAIRS AND ITS HASH SEQUENCE VALUES.

(DLL-APIs) pairs	hash sequence
kernel32.dll getmodulehandlew	8
kernel32.dll createfilew	7
kernel32.dll loadlibraryw	9
user32.dll messageboxw	3
user32.dll sendmessageA	4
kernel32.dll createfilew	7
user32.dll open	6
user32.dll messageboxw	3

VII. Similarity and Differentially Measures

There exit many similarity and differentially measures for sequences. For greater efficiency, the selection done on six popular measures: four similarity measures and two difference measures.

1) *Cosine measure:* it computes the angle between two sequences and captures a scale invariant according to the similarity [7].

$$S_{Cosine}(X, Y) = \frac{X^T Y}{\sqrt{X^T X Y^T Y}} \quad \text{…….. (2)}$$

2) *Extended Jaccard measure:* is computed as the ratio of the number of shard attributes of X AND Y to the number of X OR Y. [7]

$$S_{Jaccard}(X, Y) = \frac{X^T Y}{X^T X + Y^T Y - X^T Y} \quad \text{……(3)}$$

3) *Cosine–Jaccard average:* also the similarity of two sequences is computed as [7]:

$$SCos–Jac(X, Y) = \frac{SCosine(X, Y) + SJaccard(X, Y)}{2} \quad \text{…. (4)}$$

4) *R–Contiguous:* The rcb matching rule, is defined as follows: If x and y are equal-length strings defined over a

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finite alphabet, match(x, y) is true if x and y agree in at least r contiguous locations [8][9]. but here R value not fixed but looking for the maximum matching between two sequences.

5) *Hamming distance:* The Hamming distance between two strings is defined as the number of different characters between the two strings [10].

6) *Euclidean distance:* A Euclidean distance is defined as [9][11]:

$$d(x,y) = \sqrt{\sum_i (x_i - y_i)^2} = \|x - y\| \quad \text{……..} (5)$$

VIII. PACKED EXECUTABLE CLASSIFICATION

A. PE Packers

In general, runtime packers compress the original executable and attach an unpacking stub to it. Upon execution of the packed executable, the stub unpacks the original code (and data) and transfers control to it. PE Packers typically follow that scheme as well [12].

Generaly, a packed executable is built with two main parts during a two phase packing process. First, the original executable is compressed and stored in a packed executable as data. Second, a decompression module is added to the packed executable. The decompression module is used to restore the original executable [13].

B. Packing Detection

Packed PE files were analyzed and it was found that nearly every type of packed PE file with common characteristics in the PE header that differ from the normal files which are not packed can be detected. For example, with a packed file, it is necessary to unpack the packed codes to execute the intended original codes. To unpack and rewrite the codes, the code section should contain both executable and writable attributes simultaneously. Typically, however, normal PE files do not contain sections of executable and writable attributes together [14].

IPEMDS classification approach's has a much better generalization ability than signature-based approaches and is able to distinguish between packed and non-packed executables with very low false positive and false negative rates.

It use binary static analysis to extract information. And this information allows us to translate each executable into a *pattern recognition receptors* (PRRs) of one iDC. It then apply TLR algorithm to distinguish between packed and non-packed executables by using iDCs of them.

In this IPEMDS, the encoded executable file detection technique utilizes these differences between the packed and normal files and entropy analysis for some parts of PE file. To present the different features of the packed and nonpacked of PE files effectively, the PRRs of iDC are defined, which consists of 11 PRR that can show these differences effectively. It use the TLR algorithm to classify a given PE file as “Packed” or “Non-Packed”. It shows very good performance, as it checks only the selected 11 PRRs.

C. Feature Extraction Module

If a file is packed, some relationships between the attributes are broken. In this paper, this feature is utilized to detect packed PE files [14]. Detection technique utilizes the differences between the attributes of normal and packed files in the PE file header [14].

From PE file to PRRs

Here the feature extraction process were described, it use to translate a PE file into a *packing signals list* which will be encounter PRRs of iDCs. These eleven packing signals list are:

- **Number of Standard and Non Standard Sections**. The PE file of non-packed applications usually contains a well defined set of standard sections. On the other hand, packed executables often contain code and data sections which do not follow these standard names. For example, the UPX executable packing tool (http://upx.sourceforge.net) usually creates PE files that contains two sections named .UPX0 and .UPX1, respectively, and a section named .rsrc. The two sections .UPX0 and .UPX1 are not standard and may be used to distinguish an executable packed using UPX from non-packed exectables. Besides UPX, a number of other packers usually generate PE files which contain code and data sections having non standard names. Therefore, counting how many standard and non standard section names are present in a PE file gives us a clue on whether the executable is packed or not [15].
- **Number of Executable Sections**. While analyzing the output of executable packing tools, we noticed that the PE file of some packed executables do not carry any executable section. Therefore counting the number of executable sections in the PE file helps in distinguishing between packed and non-packed executables [15] [14], if there is a not executable but a code section, then the IPEMDS can consider the executable code is modified.
- **Number of Readable/Writable/Executable Sections**. The Packed file needs to include at least one section which is Readable/Writable/Executable at the same time, which means that a executable section could be modified during the running time. On the other hand, the executable sections (usually the .text section) in the PE file of non-packed applications do not need to be writable, and the Writable section flag is not set. Therefore, counting the number of sections which are writable and executable at the same time adds a piece of evidence to the conclusion whether the executable is packed [15] [14].
- **Number of Entries in the IAT**. Most non-packed executables import many external functions. On the other hand, packed executable often import very few external functions. The main reason is in that the unpacking routine does not need many external functions. The basic operations the unpacking routing performs are read and write memory locations in order to decrypt the code of the packed application on the fly. For example, no window on the screen or network operation is usually needed. This is

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reflected in a small number of entries in the IAT of a packed executable [15].

- **If the position of the PE signature is less than the size of IMAGE_DOS_HEADER**. are about the size calculation and resizing problem of the created sections.
- **Looking on SpecialAPIs**. PE packers typically remove most of the original import data as well and keep or add only a few imports, like *LoadLibraryA*, *GetProcAddress*, and *ExitProcess*.
- **PE Header, Code, Data, and File Entropy**. The encrypted code of an application P packed (i.e. hidden) into P' is usually stored in a code or data section of the PE file. So we measure the byte entropy of the code and data sections in the PE file. If the entropy of a section is close to 8 bits, which is the maximum byte entropy, the section likely contains encrypted code [15].

There are parts of the PE header dedicated to optional fields that are not necessary for the correct loading of the program into memory by the operating system. Some packing tools may therefore hide encrypted code in those unused portions of the PE header. For this reason we measure the byte entropy of the PE header as well. Considering that the PE file is quite complex and contains other such unused spaces (for example, portions of the header of each section), the encrypted code may be hidden in several other locations. Therefore, we also measure the entropy of the PE file as a whole to take into account these cases [15].

Also Entropy analysis does not need signature of packer update which is a limitation of signature-based classification method [16]. By using the fact of measured entropy of compressed information is higher than of the original information [13]. Shannon's formula is devised to measure information entropy, as follows [13, 16]:

$$H(x) = -\Sigma_{ni=1}\, p(i) \,.\, \log b\, p(i) \,, \ldots\ldots\ldots\ldots (6)$$

where H(x) is the measured entropy value and p(i) is the probability of an ith unit of information in event x's series of n symbols. The base number of the logarithm can be any real number greater than 1. However, 2, 10, and Euler's number are chosen in general.

The 11 PRRs extracted described are summarized in table (2).

TABLE 2 : SUMMARY OF THE FEATURE EXTRACTED FROM PE FILE.

	PRRs	Range of Values
1.	Number of standard sections	integer > 0
2.	Number of non-standard sections	integer > 0
3.	Number of Executable sections	integer > 0
4.	Number of Readable/Writable/Executable sections	integer > 0
5.	PEsig-less-DOSheader*	[true, false]
6.	SpecialAPIs*	Integer [1–3]
7.	Number of entries in the IAT*	integer > 0, or -1 if the PE file has no IAT
8.	Entropy of the PE header	[0–8]
9.	Entropy of the code sections	[0–8], or -1 if the PE file has no code section
10.	Entropy of the data sections	[0–8], or -1 if the PE file has no data section
11.	Entropy of the entire PE file	[0–8]

D. Detecting Packing status by TLR Algorithm

The name 'TLR' is in reference to Toll-like Receptors, which are biologically the membrane-bound proteins responsible for processing changes in PAMP concentration by DCs. The signals used in the TLR algorithm are binary signals, representing 'signal present' or 'signal not present', compiled during a short training period. A list of signal values is compiled during a training period, termed as the '*infectious signal list'*. This list consists of discrete signal values which, when sensed by a DC, 'activate' the TLRs (i.e. sensors) on the DCs. The infectious signal list is initially generated to cover all values possible for the three signals [17].

The IPEMDS consider packing status as a Danger status detecting it by TLR algorithm, and it consider packing status as a Danger signal used it later for malware detection. As shown previously it became obviously how to collect 8 PRRs (not marked in table 2) for iDCs, where each PE file represented by one iDCs, and the new PE file represented by Ag has 11 PRRs. So the TLR algorithm will compare Ag with all iDCs and then decide it status (Packed or NotPacked). The TLR algorithm be as follow:

Algorithm 1: TLR Algorithm for Packed Detection.

Input: All benign PE files from PeH,
New PE file wanted to detect it status (Packed or notPacked)
Output: Packed or NotPacked
For (*each benign PE files in PeH*) **Do**
Extract the 8 PRRs; /* not marked in table 2 */
Create *iDC* with signals *PRRs*;
Record *iDC* in PackediDC profile;
End For
Extract the 11 *PRRs* for the new PE file;
Create *Ag* with signals PRRs;
No–sDC = 0;
No–mDC = 0;
For (*iDC in PackediDC*) **Do**
Compare *Ag PRRs's* with *iDCs PRRs's*;
Update No–sDC;
Update No–mDC;
End For
If (*No–mDC > No–sDC*)
Print "Ag is Packed";
Else
Print "Ag is NotPacked";

IX. HEURISTIC ANALYSIS OF 32-BIT WINDOWS MALWARE

The IPEMDS use several heuristic key technologies of Win32 malware as an second aid tool to detect a malware, which are as the following:

A. The relocation module

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In the normal program, the positions of variables in the memory are well calculated when compiled. The programmers do not need to relocate them. The variables are directly used by their names. However, for the virus programs, the locations of virus variables vary with the infected host programs. Different positions of the virus variables are the result of their attachment to different host programs when loaded in the memory with the host programs. Since these variables or constants do not have fixed addresses, the virus must rely on itself to relocate these addresses to normally access to the relevant resources when executed in the memory. Therefore, the Windows PE virus must have an inherent relocation module, which is usually at the beginning of the virus program with few codes and need little changes, so as to be executed in the Windows platform correctly, the Common code of relocation module is in [18, 1]. The reason why relocation module is chosen from between the others module because is usually at the beginning of virus source code, and always small and little changed code easy to extract [1].

B. The module of obtaining API address (IAT not in it Place)

In general, normal programs have an import address table, where there are the actual addresses of API functions. Thus, when being called by the program, the corresponding API functions addresses can be found in the import address table of the Windows PE file. However, For Win32 PE virus, it has only one code section, which does not include the import address table so as to reduce the virus code. The Windows PE virus program cannot directly obtain the address of API functions, and must firstly identify these addresses in dynamic link library. Therefore, the Windows PE virus must have such module that can obtain the addresses of Windows API functions called by the virus [1, 18].

C. The module of searching target files

PE viruses need to search target files continuously to spread themselves. Therefore, the PE viruses need a target files searching module [18, 1]. In the Win32 assembly, file-searching function is generally achieved through the *Find First File*, *Find Next File* API functions[18].

D. The module of mapping file to the memory

Memory-mapping file provides a group of independent functions. The applications can directly read and write the file in disk by the pointers, instead of using normal I/O functions. Memory-mapping file typically improves I/O performance because it does not require copying data between buffers. The data in the file can be operated directly in the memory, thus, PE virus can quickly infect the target files, which can greatly improve the access speed, reduce the system resources occupied by the virus [1, 18]. The *createfilemapping* API function is use to memory mapping.

E. Section Virtual Size is incorrect

Some of malwares may infect sections without change there virtual size in Section_Header, or not rounded up to the closest section alignment value. So it is suspicious enough to check sections's virtual size.

F. Non standard NumberOfRvaAndSizes value

NumberOfRvaAndSizes is a value in Optional_Header, which is the number of valid entries in the DATA_DIRECTORY array. This value is not fixed but it has maximum allowable value is 16. So it is suspicious enough to if it exceed 16, or it be zero to reduce file size.

G. Suspicious Section Characteristics

All sections have a characteristic that describes certain attributes and that holds a set of flags indicating the section's attributes. The code section has an executable flag but does not need writeable attributes because the data is separated. Very often the virus section does not have executable characteristics but has writeable only or both executable and writeable. Both of these cases must be considered suspicious. Some viruses fail to set the characteristic field and leave the field at 0. That is also suspicious [19]. The Characteristics value in Section_Header is a bunch of flags describing how the section's memory should be treated. So from this heuristic technique two features can be gotten:

1) *Writable executable Sections*
2) *Suspicious Sections:* If the characteristic field leave zero.

H. Entry-Point Obscure

Address of entry point, relative to image base, when executable file is loaded into memory. It is the value you need to add to the base address to get the linear address [20]. The Entry-Point address used by malware writers in several obscuring techniques to access malware's code, like selects position near to the original entry point of the application; therefore, the virus code will likely get control when the original application is executed [19]. So the IPEMDS check wither the Entry-Point address refer to the state of code section or not.

I. Number of Non-Standard Sections

Described earlier in Packed feature extraction module section.

J. Possible Header Infection

If the entry point of a PE program does not point into any of the sections but points to the area after the PE header and before the first section's raw data, then the PE file is probably infected with a header infector [19].

K. Renaming Existing Sections

Some viruses change the section name to a random string. As a result, heuristic scanners cannot pinpoint the virus easily based on the section name and its characteristics [19]. So the IPEMDS check sections names with standard names.

L. Import Address Table Is Patched

If the import table of the application has GetProcAddress() and GetModuleHandleA() API imports and imports these two

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APIs by ordinal at the same time, then the import table is patched for sure. This is suspicious [19].

M. API String Usage and Suspicious KERNEL32.DLL Imports

A very effective antiheuristic/antidisassembly trick appears in various modern viruses. An example is the W32/Dengue virus, which uses no API strings to access particular APIs from the Win32 set. Normally, an API import happens by using the name of the API, such as *FindFirstFileA*(), *OpenFile*(), *ReadFile*(), *WriteFile*(), and so on, used by many first-generation viruses. A set of suspicious API strings will appear in nonencrypted Win32 viruses [19].
The import table must be checked for a combination of API imports. If there are KERNEL32.DLL imports for a combination of *GetModuleHandle(), Sleep(), FindFirstFile(), FindNextFile(), MoveFile(), move(), GetWindowsDirectory(), WinExec(), DeleteFile(), WriteFile(), CreateFile(),CreateFileA(), CreateProcess()*, *deletefile(), createprocess(), *.EXE, readprocessmemory(), writeprocessmemory(), virtualallocex()*.

The *.EXE string, as well as almost a dozen APIs that search for files and make file modifications. This can make the disassembly of the virus much easier and is potentially useful for heuristic scanning [19].

N. Multiple MS–Stub

IPEMDS note that several PE malwares have several MS–Stub, where benign PE should only has one. So it suspicious enough to count them.

O. Multiple PE Headers

When a PE application has more than one PE header, the file must be considered suspicious because the PE header contains many nonused or constant fields. This is the case if the **e-ifanew** field points to the second half of the program and it is possible to find another PE header near the beginning of the file [19], or in the case where PE signature is duplicate more than one time.

P. heuristic count

All the previous heuristic features are summed in heuristic count to use it as an aid tool in HashScan and TLR (First line of Defense).

X. HASH–SCAN AND TLR (FIRST LINE OF DEFENSE)

All the previous explained techniques and algorithms, and there gathered information like: build PeH, HashiDC profile, PackediDC profile, heuristic count; are used here in a special detection techniques called *Hash–Scan and TLR*, it can be summarized in the following steps, for each input files:

1) Get the Packed status for the current PE file.
2) Get heuristic count for the current PE file.
3) Read the *allAPIname&HashSeqNo* profile which has all the (DLL-APIs) pairs and there *Hash sequence* values of the PeH.
4) Extract (DLL-APIs) pairs, and find the *Hash sequence* values for them with take into account the *Hash sequence* values of the PeH, if the new pair in them, it must has the same value, else it must has a new no repeated value
5) Read the *PeHSimilarityHashSeqNo* profile which has the *Hash sequence* values for each benign file alone.
6) Apply the Global alignment between the new file and all benign PE files in the PeH.
7) Apply similarity and differentially measures on the strings result from step 4,
8) Create a Hash Antigen (*HashAg*) for the current PE file contain the following:
   a) Maximum Euclidian distance value.
   b) Maximum Hamming distance value.
   c) Minimum Cosine measure value
   d) Minimum Extended Jaccard measure value
   e) Minimum Cosine–Jaccard average value
   f) Minimum R–Contiguous value.
   g) Packed status.
   h) Heuristic count.
9) Get the danger for the current *HashAg* by using TLR algorithm, its inputs are *HashAg* and *HashiDC* profile. As the TLR algorithm used in Packed detection.

XI. APIS SEQUENCES SCAN & DCAS (SECOND LINE OF DEFENSE)

In this line the IPEMDS emphasis on a type of matching of APIs sequences (its length depend on window size parameter) between Suspicious file and PeH. So this line do several comparisons and the arbitrators on comparisons results are three algorithms: cDCA, dDCA1, and our proposed dDCA2.

A. APIs Sequences Scan

When PeH was built up, the *PeHsequences* profile is composed from APIs sequences by sliding window on the APIs of each benign PE file in PeH. So the new suspicious file also its APIs will organized in sequences by the same window size. The results in this step for each new suspicious file are *MaxMatchSeq, MaxNotMatchSeq, MaxMatchDLL, MaxNotMatchDLL, MaxMatchAPI,* and *MaxNotMatchAPI*. These value with heuristic and packed status are combine in a special way to be used as a four signals of DCAs.

B. classical Dendritic Cell Algorithm (cDCA)

The purpose of a DC algorithm is to correlate disparate data-streams in the form of antigen and signals. The DCA is not a classification algorithm, but shares properties with certain filtering techniques. It provides information representing how anomalous a group of antigen is, not simply if a data item is anomalous or not. This is achieved through the generation of an anomaly coefficient value, termed the "mature context antigen value" (MCAV). The labeling of antigen data with a MCAV coefficient is performed through correlating a time-series of input signals with a group of antigen. The signal categorization is based on the four signal model, based on PAMP, danger, safe signals, and inflammation. The co-occurrence of antigen and high/low signal values forms the basis of categorization for the antigen data [21][22].

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The DCA is a population based algorithm, with the population consisting of a set of interacting objects, each representing one cell. Each DCs process input signals to form a set of cumulatively updated output signals in addition to the collection of antigen throughout the duration of the sampling stage. Each DC can exist in one of three states(immature, semi-mature and mature) at any point in time. However, the differences in the semi-mature and mature state is controlled by a single variable, determined by the relative differences between two output signals produced by the DCs. The initiation of the state change from immature to either mature or semi-mature is facilitated not by the collection of antigen, but by sufficient exposure to signals. This exposure is limited by the assigned "migration threshold" [23][24][21][22].

IPEMDS use cDCA with Antigen Multiplier in order to assess the type of an antigen, it would be presented multiple times, each time to a different iDC, so that MCAV value can be generated for it depend on different iDC, see algorithm 2.
The general form of the signal processing equation is shown in equation (1) [21][22]:

$$\text{Output} = (\sum (P_n * P_w) + \sum (D_n * \mathrm{D_w}) + \sum (S_n * S_w)) * (1 + I); \ldots\ldots.(7)$$

where P_w are the PAMP related weights, $\mathrm{D_w}$ for danger signals etc.

Algorithm 2: cDCA Algorithm for Malware Detection.

```
Input: Ag with four signals (PAMP, DS, SS, Infsig),
Output: Benign or Malware,
Initialize: AgMultiplier, PopDCsize, iDCLife, cDCAthreshold
For (i to AgMultiplier) Do
    Copy Ag;
End For
For (iDC in PopDCsize) Do  /* Initialize iDC*/
    Initialize iDC: LifeSpan, CSM, semimature, mature, storeAg
                    Random MigrationThreshold;
End For
While (AgMultiplier) Do
    For (iDC in PopDCsize) Do
        While (CSM output signal < migration Threshold) Do
            get antigen;
            store antigen;
            get signals;
            calculate interim output signals;
            update cumulative output signals;
        End While
        cell location update to lymph node;
        If (semi-mature output > mature output) Then
            cell context is assigned as 0;
        Else
            cell context is assigned as 1;
    End For
    Get MCAV for current Ag;
End While
Get MCAV mean;
If (MCAVmean > cDCAthreshold) Then
    Print "Malware PE";
Else
    Print "Benign PE";
```

C. deterministic Dendritic Cell Algorithm (dDCA1 & dDCA2)

A simplified and more predictable version of DCA which is called deterministic DCA (dDCA). Since its original inception, two major improvements are proposed for DCA namely antigen multiplier and time-windows for the purpose of optimization, they having the same effect on the DCA. [25][26]. The new variation of DCA, called dDCA, has following enhanced features:

- Three input signal categories are reduced to two, i.e. danger and safe signal;
- Random migration threshold is replaced with uniform distribution of lifespan values in a population;
- Dedicated storage and sampling of antigens is replaced with sampling of all antigens by DCs;
- Instead of forming a sampling pool, the signals' data is processed by all DCs. As a result, output signals are calculated once for population of DCs;
- Only one factor ($\acute{K}$) is calculated for each DC to arrive at a context. Negative values of $\acute{K}$ reflect a benign context and positive values indicate a malicious context.

Signal processing is simplified by reducing the number of input signals and using a weight assigning scheme. Two outputs are calculated:
(1) accumulation of signals (CSM),
(2) score ($\acute{K}$), to which the threshold is applied for classification.
The new signal processing procedure is shown in Equations 8 and 9, where S and D is the input value for the safe and danger [27].

$$\mathrm{CSM} = \mathrm{S} + \mathrm{D} \quad (8)$$

$$\acute{K} = \mathrm{D} - 2\mathrm{S} \quad (9)$$

IPEMDS use dDCA with changes suit its application and called it here dDCA1, and present another dDCA called it dDCA2 differ from the first one in the place where to count number of mature DC and the no need to store Ags and count them later, so MCAV will differ in the method of its calculation. The dDCA2 present promising results as will be see later. The two algorithm state in Algorithm (3) with markers determine which steps used in dDCA1 and which in dDCA2 to simplify comparison between them.

Algorithm 3: dDCA1 & dDCA2 Algorithm for Malware Detection.

```
Input: Ag with two signals (DS, SS),
Output: Benign or Malware,
Initialize: AgMultiplier, PopDCsize, iDCLifespan, dDCA1threshold
For (i to AgMultiplier) Do
    Copy Ag;
End For
For (iDC in PopDCsize) Do  /* Initialize iDC*/
    Initialize iDC: RandomLifeSpan, CSM, K, storeAg;
End For
While (AgMultiplier) Do
    Get CSM;
    Get K;
    For (iDC in PopDCsize) Do
        While (iDCLifespan > 0) Do
            get antigen;
```


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```
            store antigen; /* dDCA1*/
            Get iDC.K;
            iDCLifespan —;
        End While
        cell location update to lymph node;
        If (iDC.K < 0) Then
            cell context is assigned as 0;
        Else
            cell context is assigned as 1;
        Count no. of Mature cell; /* dDCA1*/
        Count no. of Stored Ag; /* dDCA1*/
    End For
    Get MCAV for current Ag; /* dDCA1*/
    Count no. of Mature cell; /* dDCA2*/
End While
Get MCAV mean;
If (MCAVmean > dDCA1threshold) Then
    Print "Malware PE";
Else
    Print "Benign PE";
```

The steps of *APIs Sequences Scan & DCAs* (*Second line of Defense*) can be summarized by the following :

1) Get the Packed status for the current suspicious PE file.
2) Get heuristic count for the current suspicious PE file.
3) Read *PeHsequences* profile.
4) Read suspicious file's DLLs APIs.
5) Find Maximum match for APIs and DLLs between current suspicious PE file and any one of Benign PE files in PeH.
6) If found in step 5, calculate and record the following: *MaxMatchSeq, MaxNotMatchSeq, MaxMatchDLL, MaxNotMatchDLL, MaxMatchAPI,* and *MaxNotMatchAPI.*
7) Create a danger Antigen and set it signals as follow:
   a. Ag.name = suspicious file name;
   b. Ag.PAMP = *heuristcount* + *PackedPE* + *MaxNotMatchDLL*;
   c. Ag.DS = (MaxNotMatchSeq + MaxNotMatchAPI)/2;
   d. Ag.SS = (*MaxMatchSeq* + *MaxMatchAPI* + *MaxMatchDLL*) / 3;
   e. Ag.InfSig = heuristcount + PackedPE;
   f. Ag.MCAV = 0;
8) Get Ag.MCAV = cDCA(Ag); Get Ag.MCAV = dDCA1(Ag); Get Ag.MCAV = dDCA2(Ag);
9) The final decision is what two of the three algorithms agreement on it Benign or Malware.

XII. IPEMDS Properties

Figure 2 shows the overall diagram of IPEMDS. The special properties of IPEMDS are:

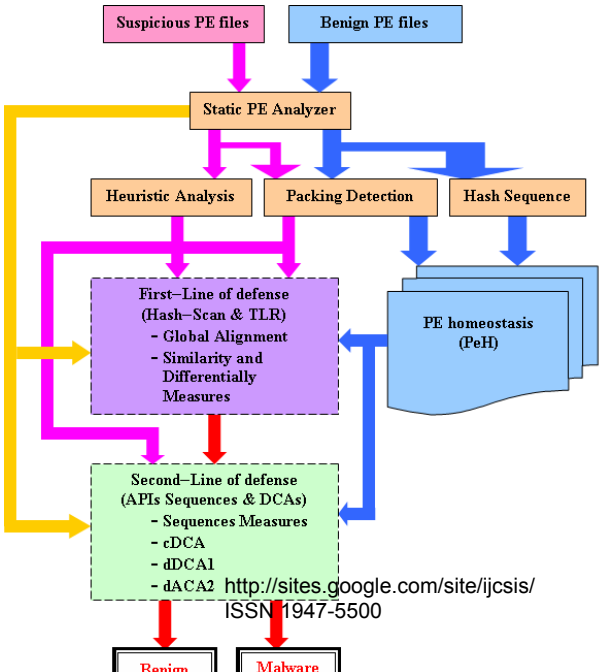
- It only depend on Benign PE executable files to built its knowledge as PE Homeostatic (PeH), and use it to diagnose whether any new PE executable is Benign or Malware.
- The performance can be improved more by careful selection of Benign PE executable files varied.
- It characterizes by the flexibility, because of it can detect any type of Win32 Malwares.
- In comparison to the small knowledge that the IPEMDS has, it obtain high Detection rate and very low false alarm, and this performance is promising to be better.
- No need to training period, it only extract some special information from a finite number of Benign PE executable files.
- It depend on Danger theory which is a second generation of Immune System theories to form two layers of defense.
- The speed of the system to detect is acceptable, in comparison with common Antivirus.
- The system permit to delete all PeH contents to built another new one, this feature benefit in case of install a new Benign executable files to operating system, although it is unlikely that the IPEMDS will detect it as Malware.
- The number of Benign executable files selected to built a PeH are incomparable to the large number of Benign executable files in personal computer system. Here the selection done on 300 from 5228 Benign files.
- The experimental results in next section show the important of the two lines in IPEMDS, this fact return to sensitivity of first line to recognize new Benign files where the second line recognize the Malware. So gathering them together give us the optimal results wish high detection rate (0.98) and low false alarm rate (0.11).
- The IPEMDS implemented using C# language.

XIII. Experimental Results

The IPEMDS depend on the standard performance measures: Detection Rate (TPR) and False Alarm Rate (TNR).

Several series of experiments are done to test IPEMDS performance, as follow:

1) Implement the IPEMDS on Malware dataset to compute the Detection Rate for each line alone and for both lines represented by the IPEMDS as shown in table 3. Note that each set of malwares have different types belong to the same malware class, for example Trojan contain: Agent, AddShare, AddUser, Adex, Adut, Affc, Adder, ect.
2) Implement the IPEMDS on new Benign dataset to compute the False Alarm Rate as shown in table 4.
3) Table 5, and figure 4 show a comparison between the used algorithms in the number of malwares they can detect.



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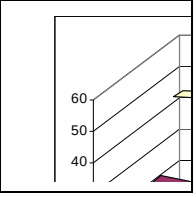

TABLE 3: SHOW THE DETECTION RATE OF EACH LINE ALONE AND FOR THE ALL IPEMDS.

Malware–Name	Size	TPR of First–Line	TPR of Second–Line	TPR of all IPEMDS
Backdoor–set1	50	0.48	1	1
Backdoor–set2	50	0.3	0.98	0.98
Worm.Bagle	50	0.88	0.92	1
Worm.Mydoom	51	0.76	1	1
Trojan–set1	60	0.48	0.98	0.97
Trojan–set2	60	0.27	0.93	0.93
TPR–Average	321	0.53	0.968	0.98

TABLE 4: SHOW THE FALSE ALARM RATE OF EACH LINE ALONE AND FOR THE ALL IPEMDS.

Benign–sets	Size	TNR of First–Line	TNR of Second–Line	TNR of all IPEMDS
1	50	0.08	0.68	0.08
2	50	0.08	0.78	0.08
3	50	0.16	0.78	0.16
4	50	0.18	0.72	0.18
5	50	0.12	0.72	0.1
6	50	0.06	0.64	0.06
Average	300	0.113	0.72	0.11

Table 5: Show number of malwares detected by each algorithm alone.

Malware–Name	Size	TLR	cDCA	dDCA1	dDCA2
Backdoor–set1	50	24	27	49	50
Backdoor–set2	50	14	23	48	48
Worm.Bagle	50	44	21	46	50
Worm.Mydoom	51	38	18	50	50
Trojan–set1	60	29	31	58	60
Trojan–set2	60	14	35	54	54
Sum	321	136	155	305	312

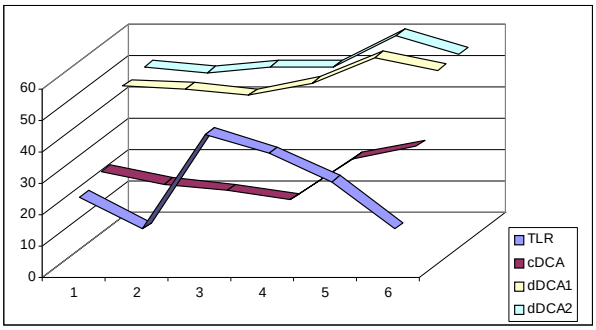

Fig 4: Detection Malware curve comparing for four algorithm (TLR, cDCA, dDCA1, dDCA2)

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Innovative Approach in Zero Tree Wavelet method

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Abstract:

Image Compression is just used everywhere. All the images you get on the Internet and web pages are compressed, typically in the JPEG or GIF formats, most modems use compression, HDTV will be compressed using MPEG-2 and several file systems automatically compress files when stored and the rest of us do it by hand. Compression is that the algorithms used in the real world make heavy use of a wide set of algorithmic tools, hash tables, including sorting, dictionary and FFTs. Furthermore, algorithms with strong theoretical foundations and implementation play a critical role in real-time applications because many of compression algorithmic models available, where in some of the algorithms will only be standing in the field. In this paper we are concentrating about zero tree wavelet method and proposed an enhancing approach in zero tree wavelet method.

Keywords:

Introduction:

Computer graphics applications, particularly those generating digital photographs and other complex color images, can generate very large file sizes. Issues of storage space, and the need to rapidly transmit image data across networks and over the Internet, has led to the development of a range of image compression techniques in order to reduce the physical size of files. Every compression techniques are independent of specific file formats, indeed, many formats support a number of several compression types. They are an essential part of digital image creation, transmission and storage Most algorithms are particularly suited to specific environment and these will be understood if they are used effectively. For example, is more efficient at compressing monochrome images, whilst others yield better results with complex color images.

Image compression algorithms fall into two main categories:

- Lossy compression, which achieves its effect at the cost of a loss in image quality by removing some image information.
- Lossless compression techniques, which reduce size whilst preserving all of the original image information and without degrading the quality of the image.

Lossy compression techniques should be treated with caution. If images are repeatedly migrated over time between different lossy formats, the image quality will be increasingly degraded at each stage. However, in some circumstances the use of lossy compression may be required, for example, to enable very large volumes of high-quality color images to be managed economically. In such circumstances, visually-lossless compression should be used, which only removes image information which is invisible to the human eye at normal magnification.

Some compression algorithms are patented and may only be used under license. Others have been developed as open standards. This can be an important consideration in terms of both creation costs and long-term sustainability.

Earlier works:

In our earlier work we worked with the RLE algorithm. RLE is a very simple form of data compression in sequences in which the

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same data value occurs in many consecutive data elements that are stored as a single data value and counted, rather than as the original run. This is useful on data that contains many such runs, for example, relatively simple graphic images such as icons, line drawings, and animations. It is not useful with files that don't have many runs as it could potentially file size is increase.Normally encoding algorithms are very complex to understand. There are numbers of algorithms available for encoding the schemes. Among that run length encoding algorithm is easy one to understand there are varieties of methods available to encode the long runs. The following diagram shows these methods. In our earlier example we gave text based. In this paper we are going to implement this technique into the image. Run length algorithm produce better result in text but not all type of images. Now we are trying to incorporate this technique into RGB color image. RGB color image always have three layers like Red, Green, Blue. In every layer have its own byte values. If the color of the image or color of the pixel values same with the neighbor pixel then run length will same. Now we can apply run length algorithm into the image.

Algorithm Procedure:

1. Input Image
2. Layer Separation
3. RLE encoding apply into byte level
4. Assign alpha index value in run length.
5. Link list data structure for organizing the RGB.
6. Store data structure top of image
7. Decoding.

In step one input image will take for the image compression. Even the image itself there are variety of forms available. Like plain image patterned image highly patterned image etc. if the image is plain then RLE works much efficient and good. In case the image is patterned every compression algorithm works slight dull.
Then input image will transformed into collection of pixels. In every pixel have three layers like red, green, blue. In every layer having color ratio between 0 to 255. Actually it will in binary form for our understanding we convert into integers then apply our RLE schemes.
Now we take a sample byte input of the images like
77 77 77 87 87 87 87 22 22 22 11 11 44 44 44 44 44 65 65
After encoding this series converted into like this
377, 487, 322,211, 544, 265

If we store this value in direct manner inside the pixel it will take long bytes. To overcome this problem we go for data structure methods index table data dictionary and linked list. We just assign the alpha index to every runs. For example
M-377
N-487
O-322
P-211
Q-544
R-265

After assign the alpha index we have to form the linked list data structure for the pixel. In this there are four fields

1. Alpha Index
2. Data dictionary
3. Header
4. Link

Linked list is stored in the top of picture so that we can retrieve the needed information or part of information in an effective manner. We have compared EARLE with many compression algorithms. The result analysis shows that EARLE performed good, compared with other algorithms. In appendix1 and appendix2 Sample Images and comparison ratio will be explained. (refer the Appendix column)

Decompression is always the reverse process of encoding. First take the linked list index it will give the alpha index value from which we can get the run lengths. Using header field we can get the basic information of the pixel. In data dictionary we get more information about the pixels. We can also access the part of picture information

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Proposed Method (NAGA):

The embedded zerotree wavelet algorithms (EZW) is a simple, yet remarkable significant image compression algorithm, This algorithm mainly focuses mainly on bits. In the bit, streams are generated in order of importance and some mathematical calculation which gives fully embedded code. Using an embedded coding algorithm, an encoder can terminate the encoding at any point thereby allowing a target rate or target range metric did not met. From the given bit stream, the decoder can start the decoding process at any point in the bit stream and can produce exactly the same image that would have been encoded at the bit rate corresponding to the truncated stream. In addition to producing a fully embedded bit stream, EZW consistently produces compression results that are competitive with virtually all known compression algorithms.

Algorithm:

- Image Read
- Gray Scale conversion
- Wavelet transformations apply.
- Find the coefficients in dominant and sub ordinate pass.
- Form matrix using coefficients
- Allocate the priority index values based on the threshold (T) value.
- Update the data dictionary
- Stop when final threshold reach
- Compression achieved
- Decoding.

A wavelet coefficient *C* is said to be inconsistent with respect to a given threshold *T* if |C|<*T*. The zero tree is based on the hypothesis that if a wavelet coefficient is inconsistent with respect to the given threshold, then all wavelet coefficients of the same direction or orientation in the same spatial location at the finer scale are said to be insignificant with respect to the same threshold (T). More specifically, in a hierarchical sub band system with the exception of the highest frequency sub bands, ever coefficient at a given scale can be related to a set of coefficients at the next finer scale of similar orientation. The coefficient at the range is called the parent and all coefficients corresponding to the same spatial location at the next finer scale of similar orientation are called children. Similar, we can define the concepts descendants and ancestors

Given a threshold *T* to determine whether or not a coefficient is significant, a coefficient *x* is said to be an element of a zero treefor the threshold *T* if itself and all of its descendents are insignificant with respect to the threshold *T*. Therefore, given a threshold, any wavelet coefficient could be represented in one of the four data types: zero tree root (ZRT), isolated zero (IZ), positive significant (POS) and negative significant (NEG).

The dominant pass finds out the pixel values above a certain threshold and the subordinate pass quantizes all significant pixel values found in this and all previous dominant passes previous. A dominant pass ensures all trees for significant pixel values with respect to a certain threshold. The initial threshold is chosen to be one-half of the maximum magnitude of all pixel values. Consequent dominant pass thresholds are always one –half of the previous pass threshold.

When an insignificant pixel value is found, and a check of all it's children reveals that they too are insignificant, then it is possible to encode that pixel and all it's children with one symbol, a zero tree root, in place of a symbol for that pixel and a symbol for each of that pixel's children, thus achieving compression. Pixel values found to be significant in the dominant pass are encoded with the symbol positive, for a value greater than zero, or negative, for a value less than zero, then those pixel values are added to a subordinate list for quantization, and the pixel value in the sub band is then set to zero for the next dominant pass. Pixel values are found to be insignificant in the dominant pass but with significant children are coded as isolated zeros.

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So, the dominant passes map pixel values to a four symbol alphabet which can then be further encoded by using an adaptive arithmetic coder.

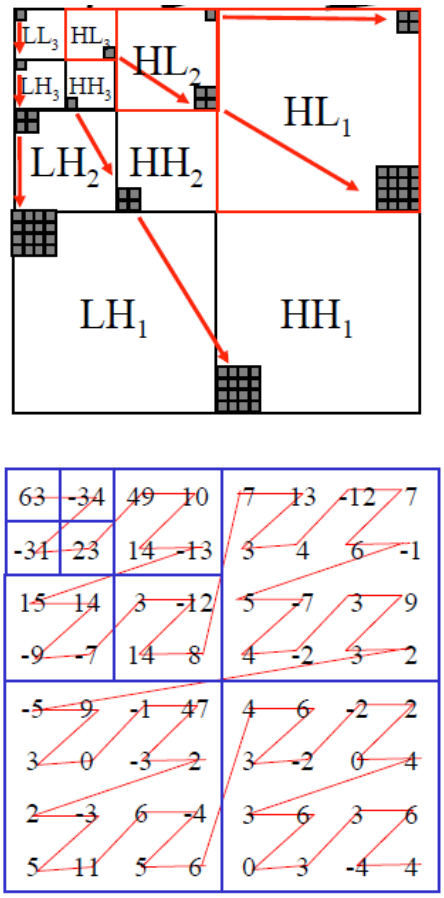

Figure: Coefficients are coded in a zerotree structure and scanned in a left-to-right order.

After each dominant pass, a subordinate pass is then performed on the subordinate list which contains all pixel values previously found to be significant. In the subordinate pass we are introducing the new label allocation scheme based on the threshold convergence. For example if the subordinate phase meets the nearest value of threshold value then we can allocate the higher priority of the symbol or else we can allocate some lower value symbol based on the degradation of threshold value**.**Since the initial threshold is one-half of the maximum magnitude of all pixel values for the first dominant pass then in the first subordinate pass only two ranges are specified in which a significant pixel value could lie: the upper half of the range between the maximum pixel value and the initial threshold.

A pixel value in the upper half of the range gets coded with the high priority symbol like a pixel value in the lower half gets coded with the low priority symbol. A pixel value found to be in a particular range is quantized from the decoder's viewpoint, to the middle point of that range. Upon subsequent subordinate passes the threshold has been cut in half and so there are twice as many ranges as the last subordinate pass plus two new ranges corresponding to the new lower threshold. In every cutting we will allocate the new priority symbols based on the threshold convergence we will allocate the new symbols. Allocating the new symbols doesn't matter but we have to maintain the data dictionary about the coding. That should be available in the starting pixels of the image. If the group of coded letter available then decoder will identify the some compression scheme present there. By reading the subordinate symbol from the dictionary corresponding to a significant pixel and knowing the threshold, the decoder is able to determine the range in which the pixel lies and reconstructs the pixel value to the midpoint of that range.

Conclusion:

In this paper we have provided an enhanced approach of zero tree wavelet method using priority index method. In our earlier work we have taken run length encoding scheme for our implementation. We have taken comparative analysis over EARLE work and the result is positive manner. We made this effort which will be useful for the people in their further research.

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Appendix:1

Images	Before Compression	Compressed Image	After Decompression
Stars			
Design			

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Nature			

Appendix:II

File Name	Size	TIFF	GIF	EARLE	NAGA
Stars	2232 kb	74%	73%	80%	84%
Design	1232kb	71%	75%	83%	87%
Nature	80kb	65%	81%	81%	84%

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STX Scheme for Reducing Latency with Centralized Matching Algorithms

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ABSTRACT- This research work is motivated by the need to achieve low latency in an input-queued centrally-scheduled cell switch for high-performance computing applications; specifically, the aim is to reduce the latency incurred between a request and response arrival of the corresponding grant. The minimum latency in switches with centralized scheduling comprises two components, namely, the *control-path latency and the data-path latency,* which in a practical high-capacity, distributed switch implementation can be far greater than the cell duration. We introduce a *speculative transmission scheme* to significantly reduce the average control-path latency by allowing cells to proceed without waiting for a grant, under certain conditions. It operates in conjunction with any centralized matching algorithm to achieve a high maximum utilization. Using this model, performance measures such as the mean delay and the rate of successful speculative transmissions are derived.

Keywords: speculative transmissions (STX), collisions, crossbar switch, cache table, control-path latency.

I. INTRODUCTION

A KEY component of massively parallel computing systems is the interconnection network (ICTN). To achieve a good system balance between computation and Communication, the ICTN must provide low latency, high bandwidth, low error rates, and scalability to high node counts (thousands), with low latency being the most important requirement. Although optics holds a strong promise towards fulfilling these requirements, a number of technical and economic challenges remain. Corning Inc. and IBM are jointly developing a demonstrator system to solve the technical issues and map a path towards commercialization.

II.SPECULATIVE TRANSMISSION SCHEMEARCHITECTURE:

Our objective is to eliminate the control-path latency in the absence of contention. To this end, we introduce a speculative transmission (STX) scheme. The principle behind STX is related to that of the original ALOHA and Ethernet protocols: Senders compete for a resource without perior scheduling. If there is a collision, the losing sender(s) must retry their data transmissions in a different time slot. However, the efficiency of ALOHA-like protocols is very poor (18.4% for pure ALOHA and 36.8% for slotted ALOHA because under heavy load many collisions occur, reducing the effective throughput. Therefore, we propose a novel method to combine scheduled and speculative (non-scheduled) transmissions in a crossbar switch. The objective is to achieve reduced latency at low utilization owing to the speculative mode of operation and achieve high maximum throughput owing to the scheduled mode of operation.

Crossbar switch area, latency, and power is computed using manual floor planning, standard cell selection, and wiring estimation. Taking into account output driver capacitance and switch wiring capacitance by annotating specific nets, virology synthesis is then performed for the remaining router logic structures. Estimated frequency parameters come from this virology delay coupled with timing models for the other structures. Finally, with energy and delay models for all router components, cycle-accurate C++ simulation model is complemented with necessary event counters to form an accurate power model.

The main contribution of this work is a hybrid crossbar scheduling scheme that combines *scheduled* and *speculative* modes of operation, such that at low utilization most cells can precede speculatively without waiting for a grant, thus achieving a latency reduction of up to 50%. In contrast, on demand protocols attempt to discover a route only when a

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route is needed. To reduce the overhead and the latency of initiating a route discovery for each packet, on-demand routing protocols use route Caches. Due to mobility, cached routes easily become stale.

Using stale routes causes packet losses, and increases latency and overhead. We investigate how to make on-demand routing protocols adapt quickly to topology changes. This problem is important because such protocols use route caches to make routing decisions; it is challenging because topology changes are frequent**.**

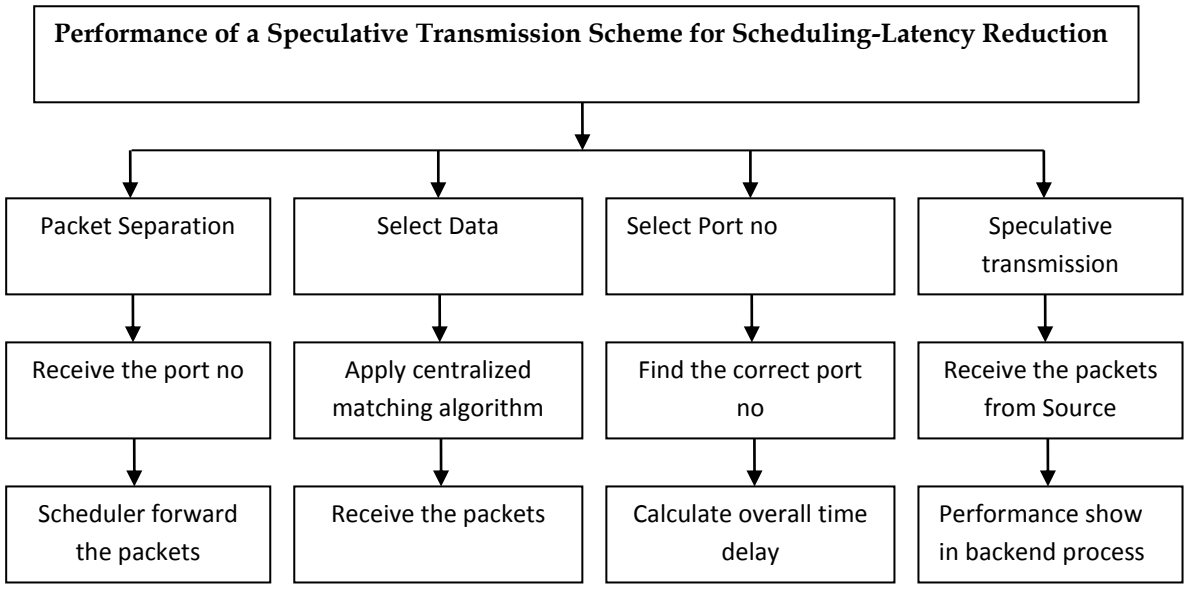

Fig.1 Speculative Transmission Scheme for Scheduling-Latency Reduction

We propose proactively disseminating the broken link information to the nodes that have that link in their caches. Proactive cache updating is key to making route caches adapt quickly to topology changes. It is also important to inform only the nodes that have cached a broken link to avoid unnecessary overhead. Thus, when a link failure is detected, our goal is to notify all reachable nodes that have cached the link about the link failure.

II.CACHE TABLE

It was shown that no single cache size provides the best performance for all mobility scenarios. Thus, we can design a cache table that has no capacity limit. The cache size increases as new routes are discovered and decreases as stale routes are removed.

There are four fields in a cache table entry:

1. ***Route***: It stores the links starting from the current node to a destination or from a source to a destination.

2. ***Source Destination***: It is the source and destination pair.

3. ***Data Packets***: It records whether the current node has forwarded 0, 1, or 2 data packets. It is 0 initially, incremented

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to 1 when the node forwards the first data packet, and incremented to 2 when it forwards the second data packet.

4. ***Reply Record***: This field may contain multiple entries and has no capacity limit. A *Reply Record* entry has two fields: the neighbor to which a ROUTE REPLY is forwarded and the route starting from the current node to a destination.

Route	S-D	DP	ReplyRecord
CDE	*A E*	0	*B ← CDE*

Fig 2- Example of Cache Table

A.DETAILS OF ALGORITHM

The Distributed Cache Update Algorithm

We present the distributed cache update algorithm. We define a broken link as *forward* or *backward* link. A broken link is a *forward* link for a route if the flow using the Route crosses the link in the same direction as the flow detecting the link failure; otherwise, it is a*Backward*link. For these two types of links, the operation of the algorithm is symmetric. On-demand Route Maintenance results in delayed awareness of mobility, because a node is not notified when a cached route breaks until it uses the route to send packets.

We classify a cached route into three types:

1. ***pre-active***, if a route has not been used;
2. ***active***, if a route is being used;
3. ***Post-active***, if a route was used before but now is not.

It is not necessary to detect whether a route is active or post-active, but these terms help clarify the cache staleness issue. Stale pre-active and post-active routes will not be detected until they are used. Due to the use of responding to ROUTE REQUESTS with cached routes, stale routes may be quickly propagated to the caches of other nodes. Thus, pre-active and post-active routes are important sources of cache staleness.

1) Detailed Description: The algorithm starts either when a node detects a link failure or when It receives a notification. In either case, the algorithm generates a *notification list*, which is a list of neighborhood nodes that need to be notified. Each entry in this list includes a node and a cached route to reach that node. A notification will be sent as a ROUTE ERROR.When a node detects a link failure; the algorithm checks each entry of the node's cache. If a route contains a *forward* link;

The algorithm does the following steps:

1. If *Data Packets* is 0, indicating that the route is pre-active, then no downstream node needs to be notified because the downstream nodes did not cache the link when forwarding a ROUTE REPLY.

2. If *DataPackets*is 1 or 2, then the upstream nodes need to be notified, because at least one data packet has reached the node and hence the Upstream nodes have cached the broken link. The Algorithm adds the upstream neighbor to the notification list.

3. If *DataPackets*is 2, or if *DataPackets*is 1 and the route being examined is different from the source route in the packet, then the downstream nodes need to be notified, because at least one data packet has traversed the route and hence the downstream nodes have cached the link.

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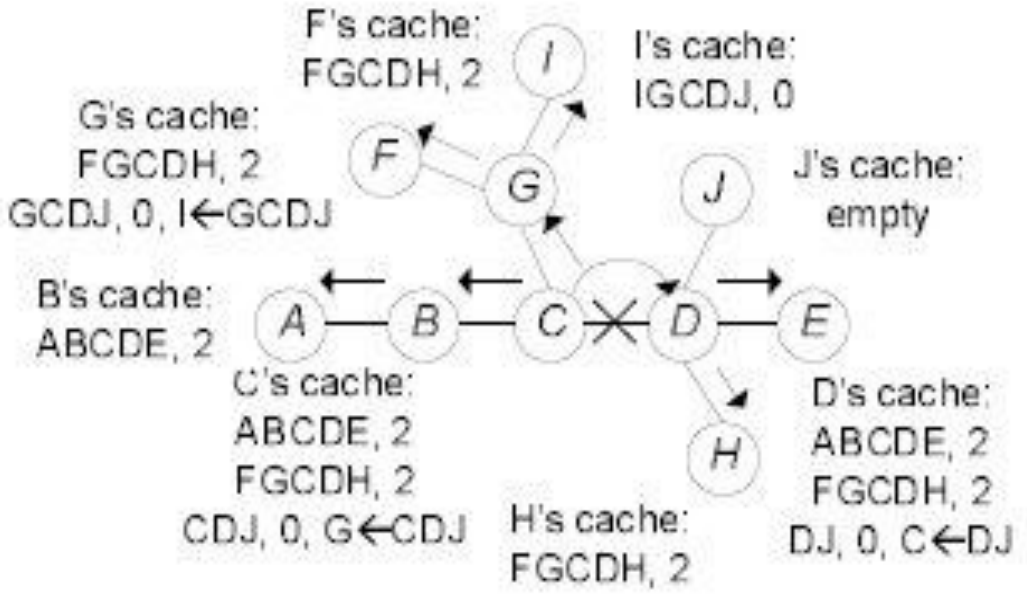

Fig 3 – Example of Distributed Cache Updating

B.PSEUDO CODE

Pseudo Code for the Distributed Adaptive Cache Update Algorithm

Algorithm: *cache Update*

Input: ID *from*, ID *to*, PACKET *p*, **Boolean** *detect by me*, **Boolean** *continue to notify*

/* If *p* is a ROUTE ERROR and *p*: *src*= *from* and *net ID*= *tell ID*, then *continue to notify* is set **TRUE**. */

Output: **vector** <Notify Entry*>*notify List*

1 **for** each entry *e* 2 *cacheTable***do**

2 **if** link (*from*; *to*) 2 *e*: *route then*

3 *has broken link:* =**TRUE**;

4 *directions:* =*forward*

5 **elseif**link (*to*; *from*) 2 *e*: *route then*

6 *has broken link:* =**TRUE**;

7 *directions:* =*backward*

8 **else** *has broken link:* =**FALSE**;

9 **if** *has broken link* **then**

10 *position:* =*Index* (*e*: *route*; *from*);

11 **if** *detect by me* **then**

12 **if** *direction* = *forward* **then**

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13 **if** (*e*: *DP*= 1 **or** *e*: *DP* = 2) **and** (**not** *is First Node* (*e*: *route; net ID*)) **then**

14*notifyList*:=*notify List* [f (*route* [*position*□1];

(Net *ID* jje: *route* [*position*□1]))g

15 **if** *e*: *DP*= 2 **or** (*e*: *DP*= 1 **and**

(**not** (*p* is a data packet **and** (*p*: *src Route*= *e*: *route*))))**Then**

16& 17*routeToUse*= /0;

18 Try to find a shortest cached route to *n*;

19 **if** such a route is found **then**

20 *found Route*: = the found route;

21 **if** *routeToUse*= /0 **or j** *found Route* j<j *routeToUse* j **then**

22 *routeToUse*: = *found Route*;

23 *tell ID*: =*n*

24 if *routeToUse*6= /0 then

25 *notify List*: =*notify List*[f(*tell ID*; *routeToUse*)g

26 else if *direction* = *backward* then

27 if not *is Last Node* (*e*: *route*; *net ID*) then

28 *notify List*: =*notify List* [f(*route*[*position*+1]; (*net ID* jje:*route*[*position*+1]))g

29 *routeToUse*= /0;

30 **for** each node *n* 2 *fe*: *route* [*position*□1]; *e*: *route* [0] g **do**

31 Try to find a shortest route to *n* in the cache table;

32 **if** such a route is found **then**

33 *found Route*: = the found route;

34 **if** *routeToUse*= /0 **or** j *found Route* j<j routeToUse j **then**

35 *routeToUse*: =*found Route*;

36 *tell ID*: =*n*

37 **if** *routeToUse*6= /0 **then**

38 *notify List*: =*notify List* [f (*tell ID*; *routeToUse*) g

39 **else** /* the node receives a notification.*/

40 *indexes: =Index* (*e*: *route*; *net ID*);

41 **if** *direction* = *forward* **and** *index* <*position* **and**

(**NotisFirstNode** (*e*: *route*; *net ID*)) **then**

42*notifyList*:=*notify List* [f (*route* [*index*□1]; (*ne tID*jje: *route* [*index*□1])) g

43 **if** *direction* = *backward* **and** *index* >*position* **and**

(**NotisLastNode** (*e*: *route*; *net ID*)) **then**

44 *notify List*: =*notify List* [f (*route* [*index*+1]; (*tID*jje: *route* [*index*+1]))g

45 **if** (*e*: *DP*= 1 **or** *e*: *DP* = 2) **and** ((*direction* = *forward* **and** *index* >*position*)

Or (*direction* = *backward* **and** *index* <*position*)) **then**

46 **if** *continue to notify* **then**

47 **if** (*direction* = *forward* **and** *net ID*= *to* **and**

(**not** *isLastNode* (*e*: *route*; *net ID*))) **or**(*direction* = *backward* **and**

IsFirstNode (*e*: *route*; *net ID*) **and** (**not** *net ID*= *to*)) **then**

48 *notify List*: =*notify List* [f (*route* [*index*+1]; (*netID*jje: *route* [*index*+1]))g

49 **if** (*direction* = *forward* **and** *isLastNode* (*e*: *route*; *net ID*) **and**

(**not** *net ID*= *to*)) **Or** (*direction* = *backward* **and**

Net ID= *to* **and** (**not** *isFirstNode* (*e*: *route*; *net ID*))) **then**

50 *notify List*: =*notify List* [f (*e*: *route* [*index*□1]; (*netID*jje: *route* [*index*□1])) g

51 **if not** (*net ID*= *to* **or** (*direction* = *forward* **and** *isLastNode* (*e*: *route*; *net ID*))

Or (*direction* = *backward* **and** *isFirstNode* (*e*: *route*; *net ID*))) **then**

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52 *notify List*: =*notify List* [f (*route* [*index*+1]; (*netID*jje: *route* [*index*+1])) g;

Pseudo Code for the Distributed Adaptive Cache Update Algorithm

(11-25 forward link) (26-38 backward link)

If a route contains a *backward* link (lines: 26–38), which means the link to the previous hop in the route is broken, the algorithm adds the downstream neighbor to the notification list. Since the node has forwarded at least one data packet using the route, the downstream nodes have cached that link. The upstream nodes also need to be notified. The algorithm searches the cache to find a shortest route to reach one of the upstream nodes. If it finds such a route, it adds that upstream node to the notification list.

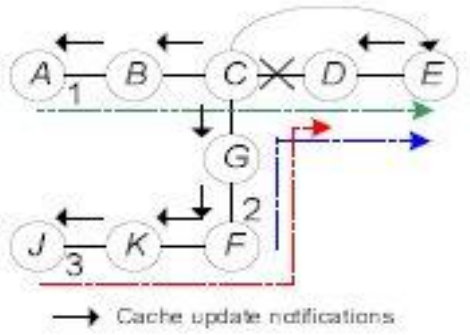

Fig 4 – How the algorithm operates based on the *Reply Record* field

1. If the link is a *forward* link, and the node is upstream to it but not the source node, then the algorithm adds the upstream neighbor to the notification list. If the link is a *backward* link, and the node is downstream to it but not the destination, then the algorithm adds the downstream neighbor to the notification list.

2. If the link is a *forward* link, and the node is downstream to it and receives a notification from the upstream endpoint of the broken link then there are three cases:

(1) If the node is the other endpoint of the link, then the algorithm adds its downstream neighbor to the notification list; (2) If the node is the destination, then the algorithm adds its upstream neighbor to the notification list; (3) Otherwise,

When a node detects a link failure, the algorithm does the above operation to add the closest upstream and/or downstream nodes to the notification list. If a node learns through a notification that a link is broken, it is responsible for notifying its upstream and/or downstream neighbors.

The algorithm determines the neighbors to be notified based on the position of the node in a route and whether the link is a *forward* or a *backward* link (lines: 39–53):

the algorithm adds both the upstream and downstream neighbors to the notification list.

3. If the link is a *backward* link, and the node is upstream to it and receives a notification from the downstream endpoint of the broken link, then there are three cases: (1) If the node is the other endpoint of the link, then the algorithm adds its upstream neighbor to the notification list; (2) If the node is the source, then the algorithm adds its downstream neighbor to the notification list; (3) Otherwise, the algorithm adds both the upstream and downstream neighbors to the notification list.

After adding the upstream and/or downstream neighbors to the notification list, the algorithm checks the *ReplyRecord*field. If an entry contains a broken link, the algorithm adds the neighbor that learned the link to the notification list (lines: 54–58). The algorithm then removes the cache table entry containing the broken link (line: 59). If a node detects a link failure when attempting to send a ROUTE REPLY, the algorithm removes the corresponding *ReplyRecord*entry (lines: 61–63). Finally, the algorithm removes duplicate nodes from the notification list. Duplicate nodes may occur in the list when the node is on multiple routes containing a broken link. The algorithm also removes the node that is the source node of a notification, since the algorithm adds both upstream and downstream neighbors to the notification list for the node that receives a notification from its upstream or downstream neighbour (lines: 51–53).

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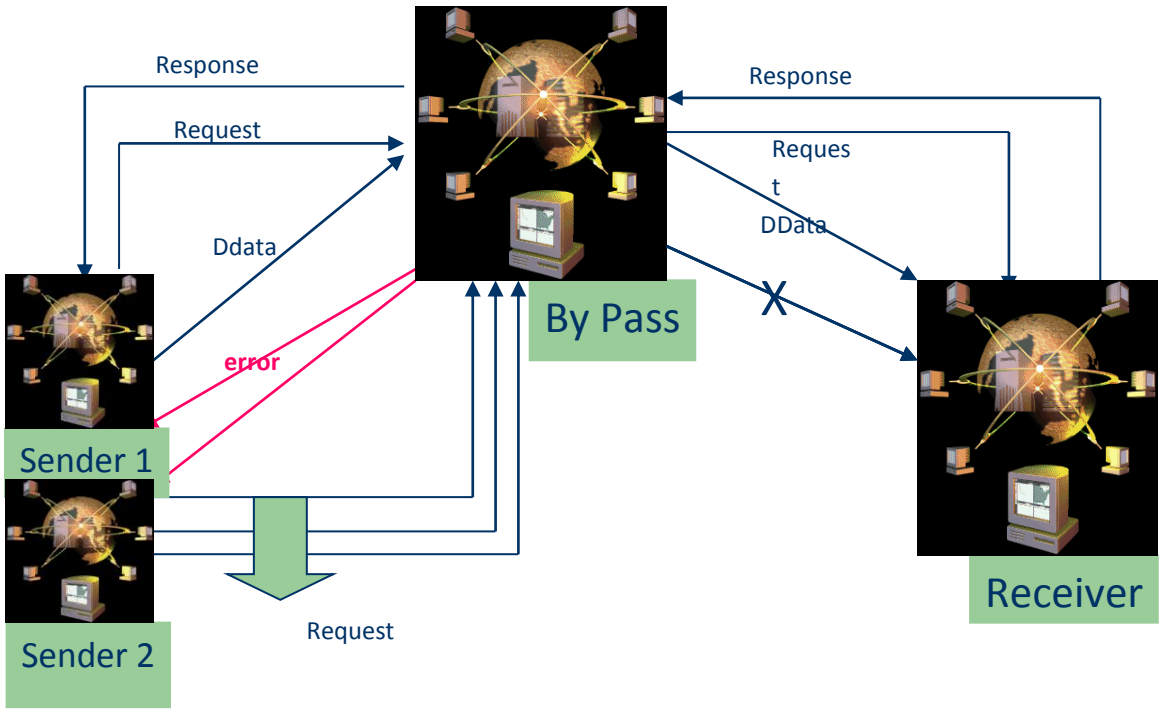

Fig 5 -Distributed cache updating for the dynamic source routing protocol

IV.RELATED WORK

There are alternative ways to avoid the scheduling latency .issue described above. The main options are: 1) bring the scheduler closer to the adapters; 2) use provisioning (circuit switching); 3) use a buffered switch core; or 4) eliminate the scheduler altogether. Although one can attempt to locate the scheduler as close to the adapters as possible, a certain distance determined by the system packaging limitations and requirements will remain. Although the RTT (round-trip time) can be minimized, the fundamental problem of non-negligible RTTs remains valid. One can also do without cell-level allocation and rely on provisioning to resolve contention. Of course, this approach has several well-known drawbacks, such as a lack of flexibility, inefficient use of resources, and long set-up times when a new connection is needed, which make this approach unattractive for parallel computer interconnects. An alternative approach is to provide buffers in the switch core and employ some form of link-level flow control (e.g. Credits) to manage them. As long as an adapter has credits, it can send immediately without having to go through a centralized scheduling process. However, as optical buffering technology is currently neither practically nor economically feasible and the key objective of OSMOSIS is to demonstrate the use of optics, this is not an option.

The last alternative is the load-balanced Birkhoff–von-Neumann switch .which eliminates the scheduler entirely. It consists of a distribution and a routing stage, with a set of buffers at the inputs of the second stage. Both stages are reconfigured periodically according to a sequence of permutation matrices. The first stage *uniformizes*the traffic regardless of destination and the second stage performs the

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actual switching. Its main advantage is that, despite being crossbar-based, no centralized scheduler is required. Although this architecture has been shown to have 100% throughput under a technical condition on the traffic, it incurs a worst-case latency.

A.PERFORMANCE OF A GENERAL PREFETCH SCHEME

A majority of Web servers and clients use the Hypertext Transfer Protocol (HTTP) which has several cache control features. The basic cache mechanism in HTTP/1.1uses the origin server-specified expiration timesandvalidators, as described below the "expiration" caching mechanism is to expect that origin servers will use the "Expires header" (or the max-age directive of the Cache-Control header) to assign future explicit expiration times to responses. Before the expiration time is reached the document is not likely to change. If the origin servers do not provide explicit expiration times, a HTTP cache can use other header values (such as the Last-Modified time) to estimate a plausible expiration time. The Last-Modified entity-header field value is often used as a cache "validator". When an origin server generates a full response, it attaches the validator to the response, which is kept with the cache entry. When a cache finds that a cached entry that a client is requesting has already expired, it makes a conditional request that includes the associated validator to the origin server. The origin server responds with a short code "Not Modified" (no entity-body) to validate that the cached entry is still usable if the entity has not been modified since the Last-Modified time; otherwise, it returns a full response including entity-body. Thus, it avoids transmitting the full response if the validator matches, and avoid an extra round trip if it does not match. In order to determine whether a cached entry is fresh, a cache needs to know if its *current age* has exceeded its *freshness lifetime*. The *current age* is an estimate of the time elapsed since the response was generated at the origin server. The *freshness lifetime* is the length of time between the generation of a response and its expiration time. HTTP/1.1 requires the origin server to send a *Date* header with every response, giving the time when the response was generated. The expiration judgement is performed in the cache when a cached entry is requested by a client:

entry_is_fresh= (freshness *lifetime>current age*) (1)

If the cached entry is fresh, then the cache sends the entry to the client; otherwise, it sends a conditional request with associated validator to the origin server. The validation check is performed in the origin server:

Not Modified= (Validator= *Last_Modified time)* (2)

The caching in HTTP/1.1 is shown in Fig. 1, where *Expiration time* is the time at which the origin server intends that an entity. Should no longer.bereturned by a cache without further validation *Current age* is the time since the response was sent by, or successfully validated with,. Origin server *freshness lifetime* is the length of time between the Generation of a response and its expiration time.

Validator is a protocol element (e.g., an entity tag or a Last-Modified time that is used to find out whether a cache entry is an equivalent copy of an entity.

Date is the value of the origin server's Date: header.

Now is the current (local) time at the host performing the calculation.*request_time*is the (local) time when the cache made the request that resulted in his cached response *response_time* is the (local) time when the cache received the response.

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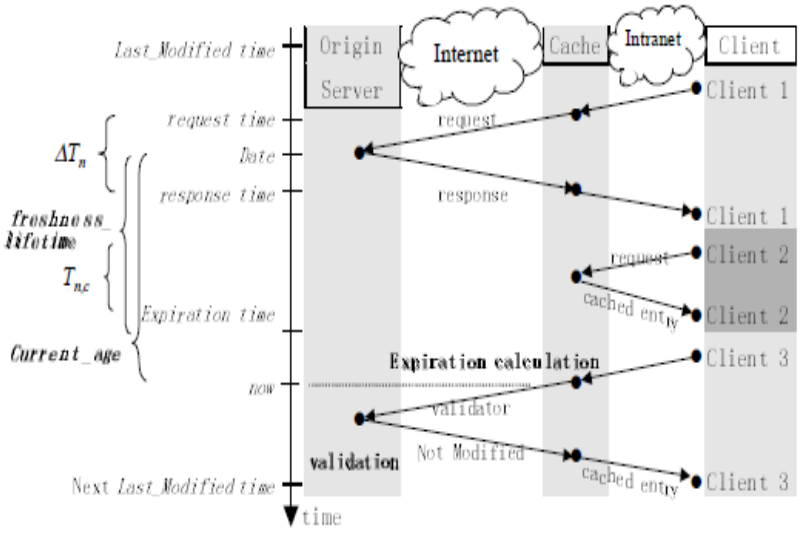

Fig. 1. Caching in HTTP/1.1

Based on the HTTP/1.1 caching mechanism, we build an analysis model of caching, as shown in Fig. 2. Document n is modified in its origin server with cycle m*n*. The first request from a client to the cache in a given cycle can not be satisfied by the cache (i.e., "miss" a fresh copy) and must fetch a copy of the document from the origin server. The consequent requests in the cycle are satisfied by the cache with the

Cached copy (i.e., "hit" its fresh copy). If a request arrives at the cache between the expiration time and the end of the cycle, the cache must validate the cached copy before using it. The inter-arrival time of requests to document n is governed by a distribution *fn*(*t*). Because origin servers specify the expiration time based on its estimation or schedule to the next modification time (i.e., the end of the current modification cycle), the interval between the expiration time and the end of the cycle may have a stochastic or deterministic distribution. For reduction of access traffic, origin servers intend to reduce the interval. Now we define the variables required in the following analysis (see TABLE I). In the definition of the variables, we assume the total rate *R* of access traffic to the Internet from a given Intranet is finite given by:

$$R = \sum_{n=1}^{N} R_n \ , \qquad (3)$$

.

and the ratio

$$\gamma_n = R_n / R \qquad (4)$$

Represents the probability of access to document n, *n*=1… *N*.

We assume that the inter-arrival time of requests to document n is exponentially distributed:

$$f_n(t) = R_n e^{-R_n t}, \qquad n=1, 2, ..., N. \qquad (5)$$

Then the probability g_n that there is at least one request to document n during a given modification cycle is given by

$$g_n = 1 - e^{-R_n H_n}, \qquad n=1, 2, ..., N. \qquad (6)$$

Suppose we observe *k* modification cycles. Then there will be on the average *kgn*such cycles in which at least one request is made to document n. The first request in a given cycle will miss a fresh copy of the document and must fetch it from the origin server. The consequent requests in the cycle use the cached copy.

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$$p_n = 1 - \frac{kg_n}{k\mu_n R_n} = 1 - \frac{g_n}{\mu_n R_n} \qquad (7)$$

n during the *k* cycles, *n*=1, 2,…, *N*.

Among the hit requests, there are some requests may arrive during the interval between the expiration time and the end of the cycle. They require the cache to validate the cached copy. Since the response with special code "Not Modified" is a short message, the transmission time is small. For simplicity, we omit this delay or assume this delay is included in the average delay *Tn, c* when a valid copy of the document is found in the cache. Now we derive general expressions for the average latency and hit probability of a generic prefetch scheme. Due to the limitation of the cache capacity, any prefetch scheme cannot cache all documents. Suppose that *r* documents are prefetched to the cache. By "prefetch" we mean the action that a proxy Web server takes by automatically caching and updating the *r* documents once they have expired, and this action is not driven by the client requests. Therefore, the average latency *L* for a prefetch scheme is given by

$$L = \sum_{n=r+1}^{N} \gamma_n \left[p_n T_{n,c} + (1 - p_n) T_{n,s} \right] + \sum_{n=1}^{r} \gamma_n T_{n,c}$$
$$= \sum_{n=1}^{N} \gamma_n \left[p_n T_{n,c} + (1 - p_n) T_{n,s} \right] - \sum_{n=1}^{r} \eta_n , \qquad (8)$$

Where g*n* is the access probability given by (4), *pn* is the hit rate given by (7), *Tn, c* is the response time from the cache, *Tn,s* is the response time from the origin server, and h*n* is defined by

$$\eta_n = \gamma_n (1 - p_n) \Delta T_n , \quad n = 1, \ldots, N \qquad (9)$$

As is seen from (8), the average latency consists of two terms: the first term is solely determined by the document access rates {*Rn*}, modification cycles {m*n*} and response times { Tn , *c*, *Tn, s*}, and is independent of a specific choice of prefetch scheme, which is the latency of a "no-prefetch "cache scheme (i.e., the conventional caching). This reduction is determined by the number *r* and the selection of *r* prefetch documents and so depends on the specific prefetchscheme. The total hit probability is given by

$$P = \left(\sum_{n=r+1}^{N} R_n p_n + \sum_{n=1}^{r} R_n \right) \Big/ R = \sum_{n=1}^{N} \gamma_n p_n + \sum_{n=1}^{r} \varphi_n , \qquad (10)$$

Where *Rn* is the access rate to document n, *R* is the total access rate, g*n* is the access probability given by (4), and j*n* is defined by

$$\varphi_n = \gamma_n (1 - p_n) , \quad n = 1, 2, \ldots, N. \qquad (11)$$

Now we proceed to derive expressions for the required cache capacity and bandwidth. Whenever a request misses a "fresh" copy of document n in the cache, the cache must fetch the current version of the document from the origin server. Thus, the fetching rate for document n in the cache is (1-*pn*)*Rn*.

The freshness lifetime of the document will be m*n*-*t*1, where t1 is the origin server's "*Date*" in terms of HTTP/1.1, i.e., the time of the first request since the present modification cycle has started. Thus, the average freshness lifetime of the document is given by

$$\int_0^{\mu_n} (\mu_n - t_1) f_n(t_1) dt_1 \Big/ \int_0^{\mu_n} f_n(t_1) dt_1 = \frac{\mu_n}{g_n} - \frac{1}{R_n} , \qquad (12)$$

Where *fn*(*t*) is given by (5), and *gn* is given by (6). The fetched document will be expectedly stored in the cache for the interval of the average freshness lifetime. In a prefetching scheme, the selected *r* documents are prefetched into the cache, while the other requested documents are dynamically stored in the cache as is done in the ordinary cache scheme. Therefore, the required cache capacity *C* is

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$$C = \sum_{n=r+1}^{N} s_n R_n (1-p_n)\left(\frac{\mu_n}{g_n} - \frac{1}{R_n}\right) + \sum_{n=1}^{r} s_n$$

$$= \sum_{n=1}^{N} s_n p_n + \sum_{n=1}^{r} s_n (1-p_n), \qquad (13)$$

The total transmission rate required for transmitting documents from the origin servers to the cache should be

$$B = \sum_{n=r+1} R_n (1-p_n) s_n + \sum_{n=1} s_n / \mu_n$$

$$= \sum_{n=1}^{N} g_n \frac{s_n}{\mu_n} + \sum_{n=1}^{r} (1-g_n)\frac{s_n}{\mu_n}, \qquad (14)$$

Thus, the improvement in the average latency and the hit probability is achieved at the expense of increased bandwidth usage.

V. CONCLUSION

This work is motivated by the need to achieve low latency in an input-queued centrally-scheduled cell switch for high- Performance computing applications; specifically, the aim is to reduce the latency incurred between issuance of a request and arrival of the corresponding grant.

The proposed solution features a combination of speculative and scheduled transmission modes, coupling the advantages Of uncoordinated transmission, that is not having to wait for a grant, hence low latency, with those of coordinated transmission, which is high maximum utilization.

VI. FUTURE ENHANCEMENTS

In Future I will transfer the images and video files from one end to another end.

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Adjusted Probabilistic based route discovery process in mobile ad hoc networks

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Abstract **- An ad hoc wireless network consists of set of mobile nodes connected without any central administration. Path finding processes in on-demand route discovery methods in mobile ad hoc networks (MANETs) use flooding. Source mobile node simply broadcast route request (RREQ) packet to its neighbour node and once again the neighbour node rebroadcast RREQ to its neighbour until unless route to a particular destination is found. The excessive RREQ packet can lead collision problem and consume more bandwidth in the network and decrease network performance. This paper proposed new probabilistic based route discovery method to reduce number of RREQ packet generated by the mobile nodes during the path finding process. In this paper exhibits an Ad Hoc on demand distance vector Routing protocol (AODV)[1] using in simulation based on our new probabilistic method route discovery processes. When we compare the modified AODV with traditional AODV, the simulation results shows significant improvement in the terms of routing overhead and end-to-end delay.**

Keywords: MANET, AODV, broadcast.

I. INTRODUCTION

Ad hoc wireless network utilize multi-hop nature and operating without the support of any fixed infrastructure. Hence this type of network called infrastructure less network. The absence of any central coordinator the routing protocol makes routing is very difficult. The path setup between two nodes is completed by the help of intermediate node. The routing is responsibilities of routing protocol, which include exchanging the route information, finding good path to a destination based on good routing metrics such as hop length, minimum power and life time of the links; collecting information about the path breaks; restoration of broken path with short processing power and bandwidth; and utilizing minimum bandwidth. The routing protocols faces many challenges such as mobility, bandwidth constraints, error-prone and shared channel, location dependent contention etc,. The major needed of routing protocol in ad hoc wireless networks are minimum route acquisition, quick route reconfiguration, loop free routing, distributed routing approach, minimum control overhead, scalability, quality of service, time sensitive traffic, security and privacy.

The major challenge in MANET is multi-hop behavior. For Ad hoc network several routing protocols have been proposed. These protocols classified into three categories such as proactive or table driven routing protocols, reactive or on demand routing protocols and hybrid routing protocols. The table–driven routing protocols, all nodes keep the network topology information in the form of routing tables by periodically exchanging information. Routing information is flooded in whole network. If node require route to destination, it runs path finding algorithm to find the route. For example destination sequenced distance vector routing protocols (DSDV), Wireless routing protocols (WRP), Cluster Head Gateway Switch routing protocols (CGSR) are working under proactive routing. Reactive routing protocols do not maintain topology information, whenever the source node required route it initiates path finding process. These protocols do not exchange routing information periodically. For example Ad hoc on demand distance vector routing protocol (AODV),Temporally ordered routing algorithm (TORA),Location aided routing (LAR) and dynamic source routing protocols (DSR) are coming under reactive protocols. Hybrid routing protocols has the best features of proactive and reactive routing protocols. For example zone routing protocols (ZRP), Core extraction distributed ad hoc routing protocols (CEDAR) coming under hybrid category.

In on demand distance vector routing protocol, the source node initiates RREQ packet and broadcast to its neighbors. The broadcasting is referred as flooding. For example the source S may initiate a destination search using RREQ packet. This packet contains location of S, destination ID and some control bits. If destination not reaches the intermediate node receives RREQ packet and rebroadcast to its entire neighbor until the destination found. The blind flooding causes unnecessary collision and bandwidth waste. For this problem some optimization techniques applied. The flooding can be classified into simple or blind flooding, probability based flooding, area based flooding and neighbor knowledge methods. The neighbor knowledge based flooding further classified into clustering based flooding, selecting forwarding neighbors and internal node based flooding.

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A straightforward flooding is very costly and will result serious redundancy, contention and collision. They identified this broadcast storm problem. Recently, probabilistic broadcast schemes for MANETs have been suggested [2,3] for broadcast storm problem associated with the simple flooding. In the probabilistic scheme, each node rebroadcast received RREQ packet with given fixed probability p. This method reduces the routing overhead. This paper introduce new route discovery algorithm using probabilistic based broadcast in route discovery process. For our evaluation we used regulated probabilistic based route discovery in AODV protocol. It helps reduce the overhead of the route discovery process while maintaining a comparable performance in terms of reachability, saved rebroadcasts as achieved by conventional AODV. In this paper section 2 shows related work, section 3 shows the implemented regulated probabilistic route discovery process; section 4 shows performance evaluation of implemented route discovery process and section 5 conclusions about this paper and future direction.

II. RELATED WORK

There has been a lot of research work towards the communication overhead associated with the dissemination of RREQ packets for route discovery and maintenance processes in MANETs [4]. In blind flooding, every node in the Ad Hoc network retransmits a message to its neighbours upon receiving it for the first time. This type of flooding is very simple and easy to implement, it can be very costly and may lead to a serious problem, often known as the broadcast storm problem [5] that is characterized by high redundant packet retransmissions, network contention and collision. The Paper [6] have studied the flooding protocol and their experimentally study indicated that rebroadcast could provide at most 61% additional coverage of the original area and only 41% additional coverage on average over that already covered by the previous broadcast transmission. Therefore, the authors conclude that rebroadcasts are very costly and should be used with caution.

The paper [5] has proposed the broadcasting techniques into the following four categories; simple flooding, probability-based, area-based, and neighbour knowledge schemes. In the flooding scheme, every node retransmits to its neighbours as a response to every newly received packet. The probability-based scheme is a one of the way of controlling broadcast message floods[9], where each node received broadcast message and rebroadcasts with a predefined probability *p*. Obviously when *p* = 1 this scheme resembles simple (blind) flooding. In the area based scheme, a node determines whether to rebroadcast a packet or not by calculating and using its additional coverage area [8]. Of these, of interest in this study is the probabilistic scheme family of variants. In this category of broadcasting techniques, a mobile node rebroadcasts packets according to a certain probability.

In paper [7] have described a probabilistic scheme where the probability *p* of a node retransmitting a message is computed from the local density *n* (i.e. the number of neighbours) and a fixed value *k* for the efficiency parameter to achieve the reachability of the broadcast. This model has the disadvantage of being locally uniform. Indeed, each node of a given area receives a broadcast and determines the probability according to a constant efficiency parameter (to achieve some reachability) and from the local density .

The paper [2-3] has also described a dynamic probabilistic scheme, which uses a combination of probabilistic and counter-based approaches. This scheme dynamically adjusts the rebroadcast probability p at every mobile host according to the value of the packet counters. The value of a packet counter does not necessarily correspond to the exact number of neighbors from the current host, since some of its neighbours may have suppressed their rebroadcasts according to their local rebroadcast probability. On the other hand, the decision to rebroadcast is made after a random delay, which increases latency.

The dynamic probabilistic broadcast schemes forwarding RREQ packets based on dynamically adjusted by the local topology information. Topology information is obtained by proactive exchange of "HELLO" packets between neighbours to construct a one-hope neighbour list at every host. The adjusted probabilistic flooding scheme is a combination of the probabilistic and knowledge-based approaches. For both approaches presented in [2,3], respectively, there is an extra overhead, i.e. before calculating the probability, average number of neighbour nodes should be known in advance.

With the broadcasting methods described above, the simplest one is flooding, which also produces the highest number of redundant rebroadcasts. The probabilistic approaches reduce the number of rebroadcasts at the expense of reachability[10,11]. Counter-based algorithms have better reachability and throughput, but suffer from relatively longer delay. Area-based algorithms need support from GPS or other location devices, and the neighbour-knowledge-based approaches require the ex- change of neighbourhood information with hosts. In this paper, we propose a new probabilistic approach that dynamically fine-tunes the rebroadcast probability for routing request packets (RREQs) according to the number of its neighbour nodes to yield higher throughput, higher saved rebroadcast, better reachability, and lower rout request. The details of the proposed approach are described in the following section.

III. PROBABILISTIC FLOODING

The probabilistic based flooding scheme is an alternative method to simple flooding to find destination node. This is like to simple flooding, except that nodes only rebroadcast with a predetermined probability. It is used to reduce redundancy to improve the broadcast storm problem. Every neighbor may rebroadcast the packet exactly one time based on some random condition. This continues until all reachable network nodes have received the packet. If the probability is 100%, this is

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equivalent to flooding. In probabilistic based flooding scheme, if node receiving a broadcast message, the node rebroadcast with a pre-determined probability of p. All nodes have the same probability to rebroadcast the message, regardless of its number of neighbours. In dense networks, many nodes share equivalent transmission ranges. These probabilities control the frequency of rebroadcasts and thus might save network resources without affecting delivery ratios. In sparse networks having less shared coverage, thus some nodes may not receive all the broadcast packets unless the probability parameter is high. So if the rebroadcast probability p is set to a smaller value, reachability will be poor. On the other hand, if x is set to a larger value, many redundant rebroadcasts will be generated. The rebroadcast probability must be high at the hosts in sparser areas and low at the hosts in denser areas. To calculate of density areas requires mobile hosts to periodically exchange "HELLO" messages between neighbours to construct a 1-hop neighbour list at each host. A more number of neighbours involve that the host is in a dense area, at the same time as a low number of neighbors involve that the host is situated in a sparser area. So, based on the number of neighbors, we should increase and decrease the rebroadcast probability value based on the sparse and dense network.

This kind of variation causes a dynamic stability between rebroadcast probabilities. The probabilities at the stability states should lead to best solutions in broadcast mechanism. In this paper we used simple adaptation algorithm. The simple introduction of the regulated probabilistic flooding algorithm is explained in Algorithm 1 working as follows. An intermediate node X hearing a broadcast message *m*, the node X rebroadcasts this message according to a probability; if the broadcast message is received for the first time, and the number of neighbours of node X is less than average number of neighbours, the node has to set high rebroadcast probability p. If the node has very few neighbour nodes that is average number of nodes/2 then set high rebroadcast probability $p=1$ (Simple flooding). If node X has more nighbours then set low rebroadcast probability p.

The regulated rebroadcast probability for probabilistic broadcasting algorithm for each node is briefly presented in Algorithm 1.

Algorithm 1 The regulated probabilistic flooding algorithm

Neighbor node receiving a broadcast packet *m* at node X

Avg is average number of neighbor (threshold value)

get degree n of a node X (number of neighbors)

if packet received for the first time **then**

if $n < Avg$ **then**

if n<Avg /2 **then**

node X has very few number of neighbors

set rebroadcast probability p=1 /* Simple flooding */

endif

node X has less number of neighbors

set high rebroadcast probability $p = p1$

else

node X has more number of neighbors

set low rebroadcast probability $p = p2$

end if

end if

generate a random number R over [0, 1]

if $R < p$ **then**

rebroadcast message

else

drop message

end if

Our algorithm is a dynamic nature approaches. It dynamically regulated the rebroadcast probability p at each mobile host according to the value of the local number of neighbours. The value of p changes when the host moves to a different neighbourhood. In a sparser area, the rebroadcast probability is larger or simple flooding and in denser area, the probability is lower. Compared with the probabilistic approach where p is fixed, our algorithm achieves higher saved rebroadcast. Also, the decision to rebroadcast is made immediately after receiving a packet in our algorithm without any delay.

We present an estimate of the average number of neighbours as the basis for the selection of the value of p. Let A be the area of an ad hoc network, N be the number of mobile hosts in the network. The average number of neighbour can be obtained as shown below.

$$Avg = (N - 1)*0.7*(\pi r^2 / A)$$

IV. PERFORMANCE EVALUATION

The performance of our regulated probability algorithm has been evaluated against the fixed rebroadcast probability and regular flooding scheme. All three methods have implemented in the AODV protocol. The metrics for comparison include the saved rebroadcasts (SRB) and reachability. For this evaluation we used GloMoSim network simulator to conduct experiments to measure the performance of probabilistic flooding. In original AODV protocol uses simple flooding to broadcast routing requests to identify the destination system. In this paper we have implemented two AODV differences: one using adjusted probabilistic method with Fixed Probability, and the other using our adjusted probabilistic algorithm. The main aim of this research is to reduce the number of rebroadcasts packets during route discovery processes, it reducing the network traffic, decrease packet collision and increase the overall network performance.

Since this probabilistic based approach does not fit on all scenarios, there is a small chance that the route requests cannot

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reach the destination. During this situation it is necessary to re-generate the route request if the previous route request failed to reach the destination. The AODV protocol uses flooding in the route discovery process, which means that all route requests will reach their destinations if the network is not partitioned. Based on this observation, our algorithm must perform better than AODV in dense networks.

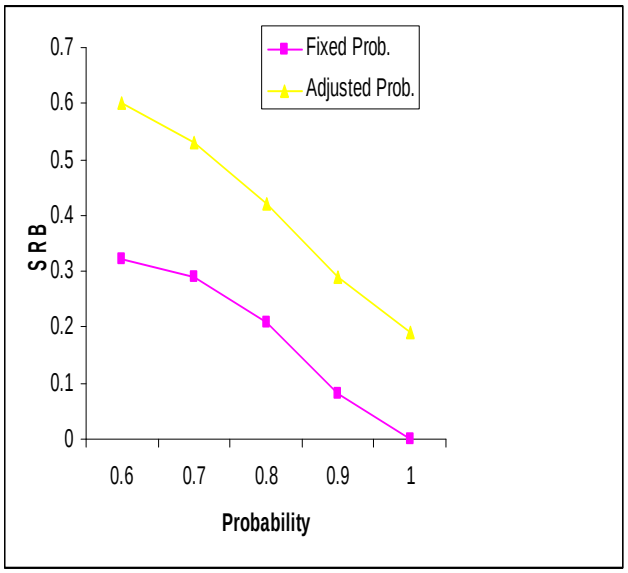

Figure 1: SRB Vs rebroadcast probability with node speed 10m/s

Table 1: Parameters used in simulation

Simulation parameter	Value
Simulator	GloMoSim v2.03
Network range	600 m x 600 m
Transmission range	250 m
Mobile nodes	25,50,75,100
Mobility	Random waypoint model
Band width	2Mbps
Packet size	512 bytes
Packet rate	10 packet per second
Simulation time	900 s

The simulation network considered for the performance analysis of the rebroadcast probability Vs network density, the nodes from 25 to 100 nodes placed randomly on 600 x 600m area, with each node in communication transmitting within 250 meter radius and the network having bandwidth of 2Mbps. The random waypoint model is used to simulate 25 mobility patterns with retransmission probabilities ranging from 0.5 to percent with 0.1 percent increment per experiment.

The random waypoint model considers nodes that follow a motion-pause recurring mobility state. Each node at the beginning of the simulation remains stationary for some pause time seconds, then chooses a random destination and starts moving towards it with speed selected from a uniform distribution. After the node reaches that destination, it again stands still for a pause time interval and picks up a new destination and speed. This cycle repeats until the simulation terminates. The maximum speed of 10 m/sec and pause times of 0 seconds are considered for the purposes of this study. The simulation parameters are summarised in Table 1.

The performance of broadcast protocols can be measured in the terms of message re-transmissions with respect to the number of nodes in the network. In this work, we use rebroadcast savings, which is a complementary measure and is precisely defined below. The next important metric is reachability, which is defined in terms of the ratio of nodes that received the broadcast message out of all the nodes in the network. The formal definitions of these two metrics are given as follows .

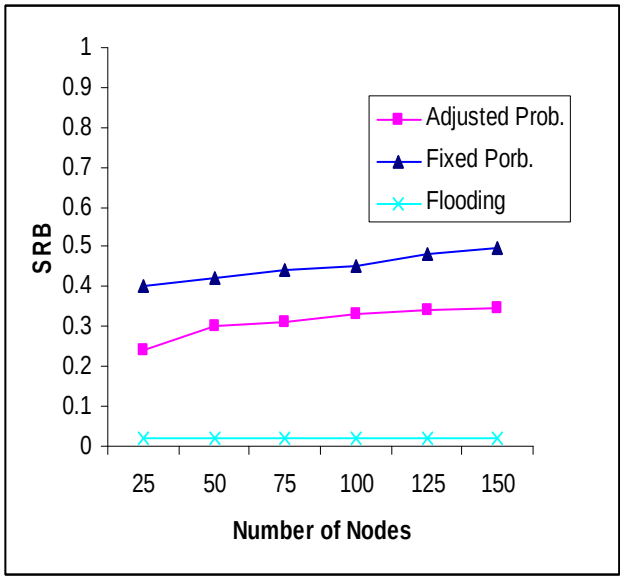

Figure 2: SRB of three broadcast schemes vs network density with node speed of 10m/s

Saved ReBroadcasts (SRB) : Let *r* be the number of nodes that received the broadcast message and let and *t* be the number of nodes that actually transmitted the message. Saved rebroadcast is then defined by $(rt)/r$.

Reachability (RE) : is the percentage of nodes that received the broadcast message to the total number of nodes in the network. For meaningful information, the total number of nodes should include those nodes that are part of a connected component in the network. For disconnected networks this measure should be applied to each of the components separately.

In this experiment we have compared the saved broadcast (SRB) in fixed probability and our adjusted probabilistic algorithm. Figure 1 shows that our algorithm can significantly reduce SRB with rebroadcast probabilities ranging from 0.5 to 1.0 percent with 0.1 percent increment per trial for a network of 50 nodes and maximum speed 20 m/s and 0 pause time. Figure 2 shows the SRB of the fixed probabilistic scheme against our

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adjusted probabilistic algorithm. The SRB of adjusted probabilistic is 40% in low-density networks (25 nodes) and 50% in high-density networks (150 nodes).

The SRB of the fixed probabilistic scheme with the probability assigned to 0.7 in any density of network is around 28-33%. Figure 3 shows that reachability increases when network density increases, regardless of what kind of the algorithm is used. The simple flooding method has the best performance in reachability, as expected. The performance of adjusted probabilistic algorithm shows that the reachability is above 95% in any density of the network. In all network densities, the reachability of our algorithm performs better than the probabilistic scheme when probability Is set to 0.7. In higher density networks, i.e. for 120 hosts and above, the reachability of our approach and flooding are evenly matched, with both performing very adequately (close to 100%). We have noted that the extra redundancy of RREQ transmissions is what results in more contention and collisions. Considering all the previous results, the adjusted probabilistic-enabled AODV is shown to improve AODV performance in all aspects for scenarios with low mobility.

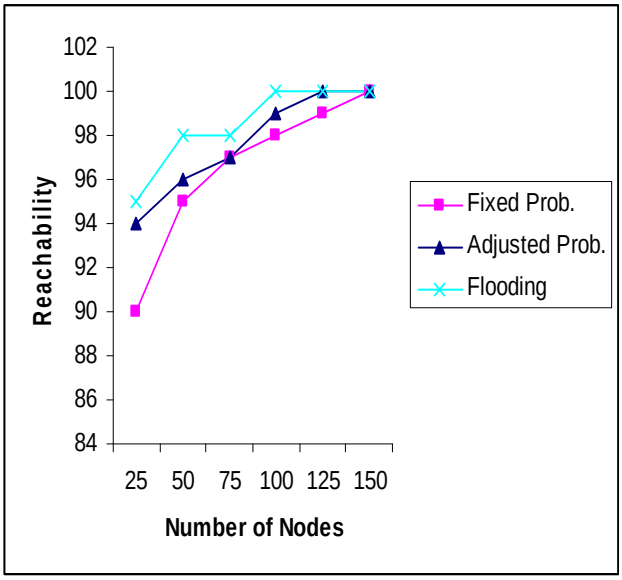

Figure 3: Reachability of three broadcast algorithms

V. CONCLUSIONS

Normally AODV uses simple flooding at the time of route discovery process. This paper we discussed the performance of adjusted probabilistic flooding on the AODV protocol, in order to increase saved rebroadcasts of route requests. This algorithm determines the rebroadcast probability based on number of neighbour host or network density. To improve the saved rebroadcasts, the rebroadcast probability of low density nodes is increased while that of high density nodes is decreased. If you compare adjusted probabilistic flooding with simple flooding, our simulation results shows during high mobility and density network, the adjusted probabilistic flooding algorithm can improve the saved broadcast up to 45% without affecting reachability. We have planned to evaluate the performance of adjusted probabilistic flooding on other on demand distance vector routing protocols such as Dynamic Source Routing (DSR) algorithm.

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A Novel Hybrid Intelligent Model for Classification and Pattern Recognition Problems

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Abstract-- **In this paper, a new hybrid intelligent model comprising a cluster allocation and adaptation component is developed for solving classification and pattern recognition problems. Its computation ability has been verified through various benchmark problems and biometric applications. The proposed model consists of two components: cluster distribution and adaptation. In first module, mean patterns are distributed in to the number of clusters based on the evolutionary fuzzy clustering, which is the basis for network structure selection in next module. In second module, training & subsequent generalization is performed by the syndicate neural networks (SNN). The Number of SNNs required in the second module will be same as the number of clusters. Where as, each network contains as many output neurons as the maximum number of members assigned to each cluster. The proposed novel fusion of evolutionary fuzzy clustering with neural network yields superior performance in classification and pattern recognition problems. Performance evaluation has been carried out over wide spectrum of benchmark problems and real life biometric recognition problems. Experimental results demonstrate the efficacy of the methodology over existing ones.**

Keywords- Hybrid Intelligence; Evolutionary Fuzzy Clustering; Syndicate Neural Network.

I. INTRODUCTION

Computational Intelligence is the emerging field rigorously applied for various classification and pattern recognition problems. An efficient synergism of evolutionary computation, fuzzy logic and neural network can lead to the development of computationally efficient and performance rich system. Computational intelligence based methods have been well applied for efficient solution of various real world problems [1]-[3] over the last decades. In the recent past, these techniques are also widely applied for biometric applications [4]-[6]. The strength and effectiveness of these techniques have been described in various literatures [7]-[10]. Hybrid intelligent system, the combination of evolutionary, fuzzy and neural paradigm into a single system, van be used for pattern recognition and classification applications. Fuzzy clustering plays an important role in various classification problems while introduction of evolutionary algorithms in fuzzy clustering provides a better optimization with various aspects of clustering [11]. Fuzzy clustering has proven its comparatively better ability for various classification problems [12] over the traditional clustering techniques. Some variants of fuzzy clustering have been well introduced for various classification problems dealing with noise [13]. Combining fuzzy clustering with evolutionary computation is quite efficient for solving classification and recognition problems [11], [14]. There exist many variants of evolutionary fuzzy clustering techniques [11], but still some of them techniques yield poor classification accuracy because of unsupervised nature. On the other hand, robust performance and quick convergence of artificial neural network with small complexity are vital for its wide applications [3] [7] [15]. The clever choice in the defining the structure of network make it computational more efficient and also over come from the general problems of neural networks. There is no general methodology exists for selection of the best neural network structures however it also depends on kind of the problem itself. Therefore, we have proposed a hybrid intelligent model containing two modules; in which one decide the structure of syndicated neural network in the second module.

The proposed model consists of two components: cluster distribution and adaptation module. In first module, mean patterns are distributed in to the number of clusters based on the evolutionary fuzzy clustering, which is the basis for network structure selection in next module. The proposed evolutionary fuzzy c-mean clustering is further generalized with the Minkowski distance matrices to provide flexibility in clustering with respect to their shapes [11]. This is named as EFC-MD. In second module, training & subsequent generalization is performed by the syndicate neural networks (SNN). The number of SNNs required in the second module will be same as the number of clusters generated in first module. Where as, each network contains as many output neurons as the maximum number of members assigned to each cluster. The proposed novel fusion of evolutionary fuzzy clustering with neural network, termed as EFC-MD-SNN, yields superior performance in classification and pattern recognition problems. The most widely used training algorithm, the error back propagation learning algorithm, is considered for the training in the adaptation module. Performance evaluation has been carried out over wide spectrum of benchmark problems and real life biometric recognition problems. Experimental results demonstrate the efficacy of the methodology over

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existing ones. Impact of varying number of clusters and number of members is also investigated.

Rest of the paper is organized as following- Section II presents the mathematical background and design of the hybrid intelligent model. It also elaborates the two basic functionary components of the proposed model. In order to estimate the strength and effectiveness of proposed model, the number of benchmark problems of various fields has been considered in Section III. Section IV is devoted for performance evaluation of the proposed hybrid model in biometric applications. The section V presents the inferences and discussions over the effect of various parameters considered in model. Finally Section VI concludes the paper.

II. HYBRID INTELLIGENT MODEL

This section describes the novel combination and co-ordination of three major paradigm of computational intelligence, viz evolutionary, fuzzy and neural, into single system, whose intelligent behavior is demonstrated in next section. The proposed hybrid intelligent model incorporates the fusion of two basic activities: cluster allocation and adaptation. The general structure of the proposed model is presented in fig. 1. It consists of cluster allocation module and adaptation module. First module involves the distribution of mean patterns into the number of clusters. The proposed mechanism for cluster allocation is fuzzy c-means (FCM) clustering along with evolutionary search. The different runs of conventional FCM clustering generate different partitioning [11]. Therefore, evolutionary search is combined with conventional FCM for finding the optimal partitioning among number of runs of FCM clustering. The proposed evolutionary fuzzy c-mean (EFC) clustering is further generalized with Minkowski distance matrices and named as EFC-MD. The Minkowski distance yields variable cluster shapes while conventional Euclidian distance restricts to spherical cluster shape [11]. The outcome of this module is the fuzzy distribution of mean patterns into number of clusters. These clusters decide the structure of syndicate neural network (SNN) in adaptation module. This module is devoted for learning process in the model for patterns generated in previous module. This module is also responsible for performing the generalization with data not used in training (test data), hence yields classification/recognition results to user. In adaptation module, the number of SNNs is same as the number of clusters generated by first module, while the number of output neurons in each SNN is same as the maximum number of cluster members (MCM). The number of hidden neurons in the network is contingent upon the problem considered. Learning in model is performed by back propagation algorithm with momentum. The maximum value among the maxima of outputs of each SNN determines the class of corresponding or recognized patterns.

A. Cluster Allocation

This module yields the basic distribution of patterns of training dataset into the number of clusters with proposed EFC-MD. Mean patterns are computed for each class by taking average of the number of samples per class selected for training. First part of this module is involved for the distribution of mean patterns into the number of clusters while second part performs the assignment of maximum number cluster member (MCM) in cluster allocation module. The evolutionary search is applied only for finding the optimal partitioning. It is to important to mention here that we execute EFC-MD algorithm for different number of clusters in order to access the impact of varying number of clusters on accuracy.

1) Allocation of mean patterns into clusters (*EFC-MD*)

Let considered training set consists of N classes and each class possesses *S* patterns. Let x_{jk} is the j^{th} pattern of the k^{th} class, where $1 \le j \le S$ and $1 \le k \le N$. The mean vector for *each* class is

$$\overline{x}_k = \left(\frac{\sum_{j=1}^{s} x_{jk}}{S} \right)$$

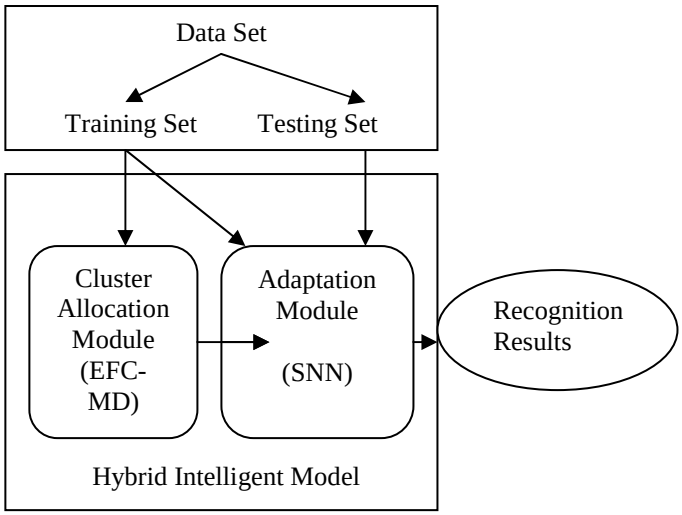

Figure 1. The Proposed Model

Let X= { $\overline{x}_1, \overline{x}_2, \overline{x}_3, \ldots\ldots\overline{x}_N$ } be the mean patterns of *N* classes, where each $\overline{x}_k \in X$ contains *q*-attribute values. EFC clustering algorithm divides N datasets into fuzzy partition matrix U (size C×N) containing C clusters. The

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membership function in *U* is defined as μ_{ik} which satisfies the following constraints –

$$\mu_{ik} \in [0,1] \quad , \quad 1 \le i \le C \quad \text{and} \quad 1 \le k \le N \qquad (1)$$

$$0 < \sum_{k=1}^{N} \mu_{ik} < N \qquad (2)$$

$$0 < \sum_{i=1}^{C} \mu_{ik} = 1, \qquad 2 \le C \le N \qquad (3)$$

In EFC clustering, each chromosome contains a sequence of attribute values representing a cluster. Let Θ_{ki} is a chromosome, defined as

Θ_{ki} = {1|0 if k^{th} data set belongs to i^{th} cluster, otherwise}

Where $1 \le i \le C$ and $1 \le k \le N$

Initially C clusters are encoded in each chromosome and population is initialized randomly. Therefore, in each run different initial population is generated. Optimization of fuzzy partition matrix *U* is made more general, when it is associated with Minkiwiski distance measure. Objective function of the evolutionary fuzzy c-mean clustering with Minkowski distance (EFC-MD) possesses a generalization parameter '*p*' whose variations produce different shapes of clusters. The Objective function for EFC-MD is defined as follows :

$$J(\mu,O) = \sum_{k=1}^{N} \sum_{i-1}^{C} (\mu_{ik})^m d^{2\beta}(\bar{x}_{k,} O_i) \qquad (4)$$

Where $d^{\beta}(\bar{x}_{k,} O_i) = \left(\sum_{j=1}^{n} \| \bar{x}_{kj} - O_{ij} \|^p \right)^{\beta / p}$,

$0 < \beta \le 1$ and $1 \le p < \infty$

The fuzzifier *m* is a weighting exponent, which determines the degree of fuzziness. In general, the values of *m* lie between one and infinity which greatly influence the performance of Fuzzy C-mean clustering (FCM) algorithm [29]. When *m* approaches to infinity, the solution will be the center of gravity of whole dataset and when *m*=1 it behaves like classical c-means. Interval (1, 3] is the best choice of *m*, however *m=2* is mostly used in literature. Therefore selection of suitable fuzzifier *m* is very important for implementation of FCM. In [29], it has been shown that a proper weighting exponent value depends on data itself. Main motivation behind considering Minkowski distance is to give freedom to the proposed algorithm for generating variable shapes of the clusters which is not possible with Euclidian distance measure. The exact nature of the shapes of clusters to be generated (which may be boxes, ellipsoids, spheres and others [11]), depend on the values of generalization parameter '*p*'. Selection of this distance measure does not only tend the shape of cluster spherical, which is often in Euclidian distance.

The fitness function '*f*' is a criterion to determine the best partitioning in evolutionary search, which is selected same as in [19] and its value is inversely proportional to the Xie Beni index (XB). Higher value of '*f*' gives survival to the fittest population and best population is selected among the various off-springs generated on different runs. EFC-MD algorithm runs through the necessary conditions for minimizing the objective function with the iterative update of following centre of the clusters and member function:

$$O_i = \frac{\sum_{k=1}^{N} \mu_{ik}{}^m \bar{x}_k}{\sum_{k=1}^{N} \mu_{ik}{}^m} \qquad (5)$$

$$\mu_{ik} = \frac{d(\bar{x}_k, O_i)^{\frac{1}{m-1}}}{\sum_{j=1}^{C} d(\bar{x}_k, O_i)^{\frac{1}{m-1}}} \qquad i = 1,2.....,C \qquad (6)$$

Let $J(\mu,O)^{(t)}$ is the objective function at t^{th} iteration then The EFC-MD algorithm terminates when

$$\| J(\mu,O)^{(t+1)} - J(\mu,O)^{(t)} \| < \Im \, , \qquad (7)$$

Where, $\Im$ is a threshold. Initially, partition matrix *U* is initialized randomly. Let $U^{(0)}, U^{(1)}, ...U^{(l)}$ be the *l* populations generated by the *l* runs of this algorithm. Best *U* is selected based on highest value of the fitness function '*f*', which then generate the new off-springs by choosing this *U* as parent. Thus repetitive execution of this algorithm produces best partitioning among the various populations generated by different runs.

2) Fixed member allocation

In conventional FCM, the size of each cluster varies with number of members. In order to avoid this variability and to cope up with the associated syndicate neural network (SNN) of the developed hybrid intelligent model, we need to obtain a uniform structure of all clusters. This process involves the allocation of fixed number of elements in each cluster, for which we select a fixed number of top membership grade elements into clusters. The maximum number of top membership grade elements assigned to the cluster is named as maximum cluster member (MCM). This parameter also plays an important role in selecting the number of output neurons in SNN and accuracy of the system. In empirical evaluation of the proposed model, we performed experiments with varying number of MCM along with number of clusters and report the case which yield reasonably good performance.

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B. Adaptation

This module performs two functions, learning and classification/recognition. The main function of this module is to train the allocated training patterns using syndicate neural network (SNN), containing only one hidden layer, with back propagation learning algorithm. Recognition of test patterns is performed by trained SNNs. For training, a three layer neural network is considered in each SNN. The number of output neurons in a SNN is same as the number of MCM, while the number of SNNs involved with this adaptation module is equal to the number of clusters. The mean patterns are distributed into each SNN as allocated by the cluster allocation module. After that, training patterns are entered in each SNN for learning.

For testing, feature vectors of unknown patterns are fed into the SNN. Let $Op(M_1), Op(M_2),...., Op(M_c)$ be the maximum output of SNNs $M_1, M_2,...., M_c$ respectively. Let $\Phi = \underset{i=1}{\overset{C}{MAX}}(Op_{x_k}(M_i))$ where $Op_{x_k}(M_i)$ is the maximum outcome of the i^{th} syndicate network corresponding to the x_k pattern. A pattern is identified by corresponding member of cluster for which maximum value of Φ is obtained.

III. Performance Evaluation Using Benchmark Datasets

In order to evaluate the performance of proposed model, we have used a wide range of benchmark problems and biometric problems. This section first presents the performance of the proposed model over standard dataset like wine, SPECTF Heart and MONK dataset. In second phase of experiments, we have considered two standard biometric datasets, AT & T bell lab face and AR face dataset. Comparative analysis of EFC-MD-SNN is done with conventional FCM, EFC-MD, conventional neural network (MLP) and other strategies presented in different other refereed journal papers. This analysis is clearly demonstrated through different measures, tables and graphs.

A. Wine Dataset Problem

The wine data set is the outcome of the chemical analysis of wine based on 13 constituents varies in three different kinds of wine classes [19]. There are total of 178 data values of all three classes. In this experiment, we considered 58% of data for training and rest 42 % data for testing. Here, EFC-MD employs *p=4* instead for Euclidian equivalent value (*p=2*) and we get 97.33% testing accuracy. Experiments were performed by varying the number of clusters (C) and MCM. Table I presents the comparative performance of FCM, EFC-MD, MLP and EFC-MD-SNN. The neural networks consider same number of hidden neurons and learning cycles. The 99.03% testing accuracy is achieved at C=2 and MCM=2 with smallest possible neural network structure.

TABLE I. Comparision of Accuracy for Wine Dataset

Method	Accuracy (%)	
	Training Set	**Test Set**
FCM	54.66	55.33
EFC-MD	97.08	97.33
MLP	100	94.3
EFC-MD-SNN	**100**	**99.03**

B. SPECTF Heart Dataset Problem

This data set [17] is based on cardiac single proton emission computed tomography (SPECT) images. Each patient is classified into two categories normal and abnormal. Dataset contains 267 instances each of them having 44 attributes. In [17], it is recommended to take 80 instances for training and 187 instances for testing out of 267 instances. The comparative analysis of CLIP3 [20], EFC-MD, MLP and EFC-MD-SNN is given in Table II. For EFC-MD, again yield best results and it is achieved when generalization parameter '*p*' for Minkowski distance *is p=4*.

TABLE II. Comparision of Classification Accuracy for Spectf Heart Dataset Problem

Method	Accuracy (%)	
	Training Set	**Test Set**
CLIP3	--	77
FCM	100	67.91
EFC-MD	100	85.56
MLP	100	86.63
EFC-MD-SNN	**100**	**89.3**

We get 89.3% accuracy at C=2, MCM=2. Fusion of EFC-MD with SNN again outperforms as compared with EFC-MD and MLP.

C. MONK Data Problem

The MONK problem was the basis of the first international comparison of learning algorithms. There are three MONK problems. The third MONK problem with a random noise added to the data is used in this paper. This dataset consists of 554 patterns with seven features, and these patterns are assigned to two classes. Training and testing set considered here is same as used in [13]. Among 122 training patterns, 60 patterns belonging to the positive class and rest 62 belong to the negative class. The testing set consists of 432 patterns in which 228 patterns belonging to the positive class and 204 patterns belonging to the negative class. Here, EFC-MD performs better for p=2. The experiments were also performed with varying number of C and MCM. We obtained 98.15% accuracy at C=2, MCM=3 with smallest possible SNN (10 hidden neurons) at MSE=0.00098. Our method performs better than SVM [13]

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and KFCM-FSVM technique described in [13], as shown in table III.

TABLE III. COMPARISION OF ACCURACY FOR MONK DATASET

Method	Accuracy (%)	
	Training Set	Test Set
SVM	--	97.68
KFCM-FSVM	--	97.68
FCM	81.9	83.33
EFC-MD	100	96.29
MLP	100	96.99
EFCMD-SNN	**100**	**98.15**

IV. PERFORMANCE EVALUATION USING BIOMETRIC DATASETS

This section presents the performance evaluation of proposed EFC-MD-SNN model for biometric standard datasets. The feature extraction and dimensionality reduction of data set is performed with Principal component analysis followed by fisher linear discriminant (PCA-FLD) [8]. PCA is more suitable in applications where images slightly vary from one another. Whereas, its performance is not well when major variations are involved in images such as occlusion and noise. In experiments, we also observed that when PCA is combined with FLD yield very good results.

A. AT & T Bell Face Dataset

The AT & T Laboratories face database [16] contains 400 face images from 40 individuals captured over the span of a 2-year period from subjects aged between 18 and 81. There are 10 different images of each person with variations in pose, scale, orientation and expression, as shown in fig 2. We use randomly chosen 200 images for training which contains 5 images per person and rest 200 images for testing. Extraction of dominant feature vectors of the faces for training is done with PCA+FLD. In Training set, the mean vector is calculated as the average of five images; thus we get 40 mean vectors which are distributed into the varying number of clusters in cluster allocation module. This is done using EFC-MD technique which minimizes the objective function in each run of algorithm. Plot between number of iterations and objective function for single run of EFC-MD is shown in fig. 3, which indicates the convergence of objective function for AT & T face and AR face dataset. It is worth to mention here that proposed hybrid intelligent system with EFC-MD has clearly demonstrated the effect of variation of 'p' in this experiment. Along with variation in C and MCM, we obtained best accuracy of 97%, when $p = 2$. But, accuracy up to 99.5% has been achieved at p = 4.

Figure 2. AT & T bell Face dataset

A cluster allocation table shows the cluster allocation of mean patterns of training set which is genereated by the first module of the model. Allocation table for A T & T face dataset is shown in fig. 6. Each row provides the information for corrosponding cluster while columns correspond to the member of clusters. Entrty in each cell of this table shows the pattern number. This table is constructed for the C=10 and MCM=10.

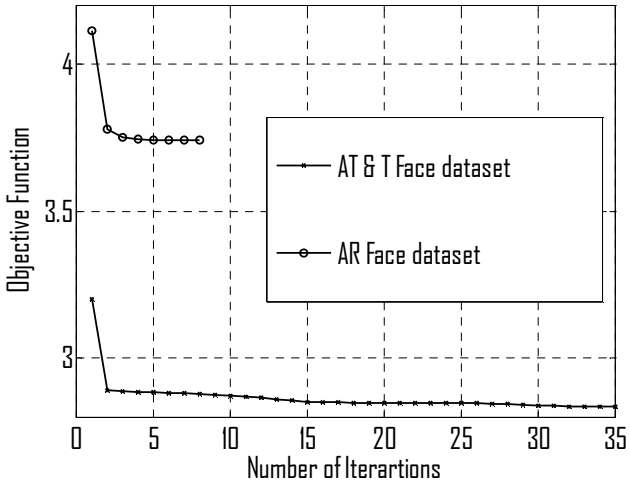

Figure 3. Plot between objective function and number of iterations.

In the next phase, the adaptation module of proposed model trained according to the cluster distribution of training set. On increasing the number of hidden neurons in SNN from 5 onward, we observe increase in accuracy upto 10 neurons. After that no further improvement is observed. The adaptation module is run upto 20,000 learning cycles in all experiment. When the effect of variations in C & MCM is critically analyzed, we conclude that the best result have been obtained at C=10 and MCM= 10. A comparision of proposed technique among with other recent researches of smilar methodologis is summarized in table IV for this dataset.

TABLE IV. COMPARISION WITH RECENT METHODS FOR AT & T FACE

Method	Testing Accuracy
DFLDA [25]	96.2
NFL[26]	96.875
RBFNN[8]	98.08
Multiple classifier[27]	97.1
Combined framework[28]	97.65
Fuzzy MLP[1]	97.87
EFC-MD-SNN	99.5

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B. AR Face Dataset

AR Face data consists of more than 4000 color images of 126 individuals taken in two sessions separated by two weeks [21]. These images include more facial variations, including illumination change, facial disguises and expressions as compared to the AT & T bell lab face dataset. We select a subset containing 30 male and 30 female subjects. For each subject, 14 images having variations in facial expressions and illumination (fig. 4) have been selected; Where seven images from session 1 is used for training and seven images from session 2 is used for testing. The images are cropped with dimension 241×293 and converted into gray scale. Cluster allocation table is shown in fig. 7 is constructed for C=12 and MCM= 12. Effect of varying parameters is shown in table V. We achieved 91.19% accuracy at C=12 and MCM=12 with 0.0054 MSE. The table VI presents the comparison of proposed strategy with some other. It again reveals superiority of our method among them.

TABLE V. ACTUAL OUTPUTS FOR AR FACE DATASET

C	MCM	Learning Cycles	MSE	Accuracy (%)	
				Training Set	Test Set
8	10	16000	0.0228	96.42	90.47
10	12	20000	0.0063	97.14	90.71
12	12	24000	0.0054	**97.61**	**91.19**
14	12	28000	0.0071	95.23	87.38

TABLE VI. COMPARISION OF CLASSIFICATION ACCURACY FOR AR FACE DATASET

Method	Accuracy with test set
Nearest Neighbour [27]	89.7%
Nearest subspace [28]	90.3%
EFC-MD-SNN	**91.19%**

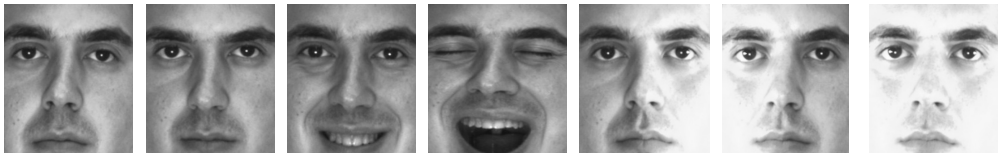
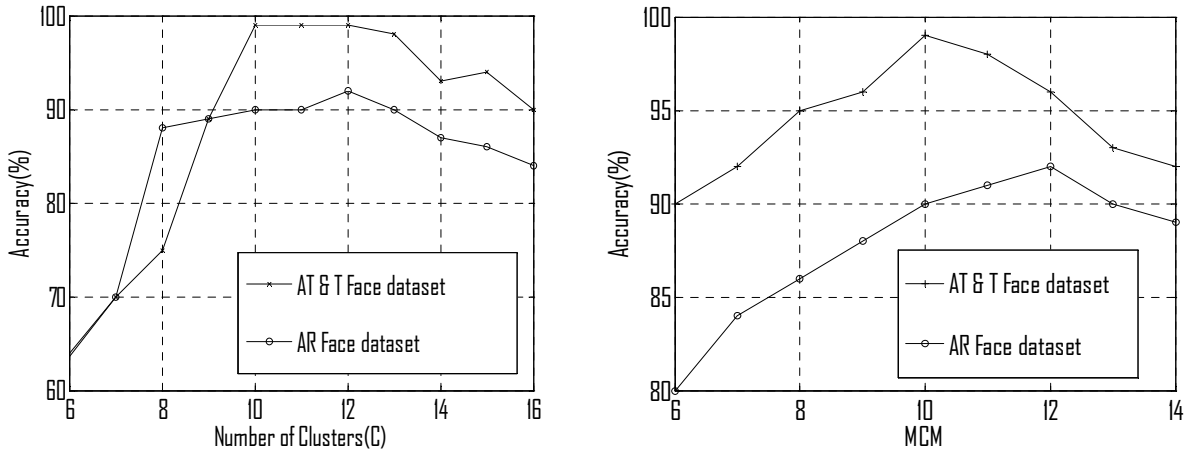


Figure 4. AR Face sample images of training set showing variations in expression and illumination.



(a) (b)

Figure 5. Impact of various parameters on accuracy a) by varying *C* (b) varying MCM.

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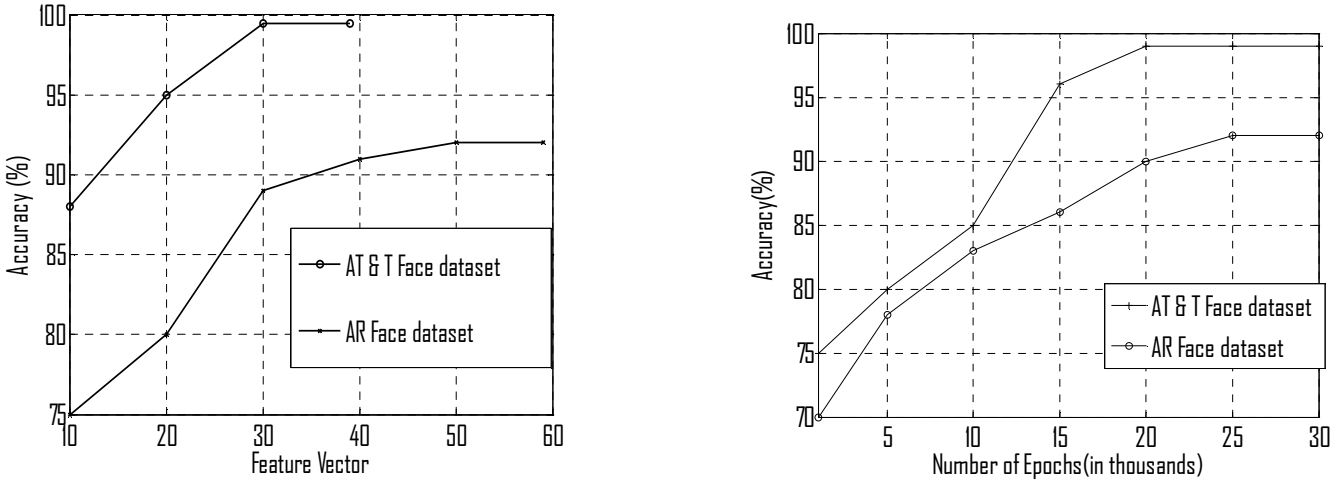
1	3	5	6	7	11	13	25	33	39
1	8	18	23	29	30	34	37	38	39
4	9	10	16	19	20	21	22	24	27
9	11	12	14	15	16	17	19	31	35
2	4	9	10	16	21	22	27	28	40
2	4	9	10	16	19	20	21	22	24
8	13	14	18	25	29	31	34	35	39
1	3	5	6	7	13	14	15	18	28
3	9	10	11	12	17	19	30	31	35
1	5	6	7	8	13	23	25	26	29

Figure 6. Cluster allocation table for AT & T Face datset in which each row representing a cluster and number of columns corresponding to MCM.

6	8	12	16	17	25	36	46	47	49	54	57
3	5	9	10	11	18	19	20	22	23	42	48
6	8	12	16	17	25	36	40	47	51	57	60
6	8	12	16	17	25	36	40	47	51	57	60
2	3	9	14	19	26	30	31	51	53	59	1
3	5	9	10	11	18	19	20	22	29	48	52
6	8	12	14	16	17	25	40	46	49	51	54
1	16	18	20	21	28	33	37	38	44	45	55
3	5	6	8	9	10	11	12	16	17	42	49
3	5	9	11	18	19	20	23	24	27	30	32
3	5	9	10	11	18	19	20	22	23	42	48
4	7	13	15	16	28	33	35	37	41	44	45

Figure 7. Cluster allocation table for A R Face datset in which each row representing a cluster and number of columns corresponding to MCM.



(a) (b)

Figure 8. Plot : (a) between number of feature vector and accuracy (b) between number of learning cycles and accuracy

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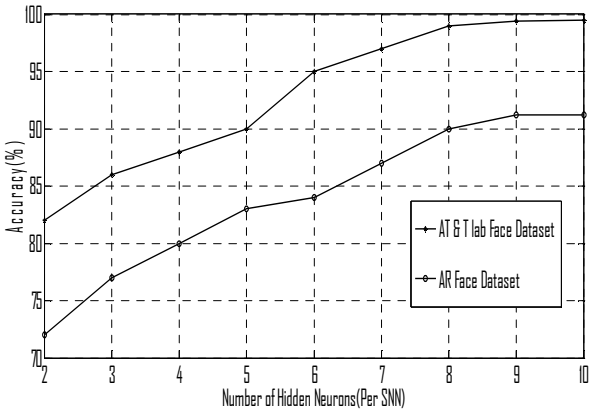

Figure 9. Plot between Number of hidden neurons versus accuracy.

V. INFERENCES FOR BIOMETRIC APPLICATION OF MODEL

In order to evaluate the performance of proposed intelligent system, the experiments are again performed with varying values of C and MCM for both image datasets. Fig. 5, graphically presents the effect of these variations keeping 10 neurons in hidden layer of SNN. C=10 and C=12 are the best choices for AT & T face dataset while best accuracy is obtained in case of AR database when C=12. MCM value is kept 10 in both cases. On increasing the value of C above this, the detoriation in model performance is observed.

Fig.5 (b) shows the variation effect of MCM keeping C=12. We observe that best accuracy is achieved at MCM=10 and MCM =12 for AT & T face and AR face dataset respectively. When we increase the MCM, it means that there is increase in fuzziness, up to some extent the increase in fuzziness enhances the performance, but after that it degrades performance. It has been also observed that the most suitable value of MCM is close to C in our experiments. Selection of number of feature vectors also plays an important role in performance (fig 8 (a)). For AT & T face dataset, maximum accuracy is obtained when 30 features are selected while in case of AR face dataset 50 features are required for best performance. Plot between iterations versus accuracy has been shown in fig 8(b). The reasonably good accuracy is achieved when adaptation module of proposed hybrid intelligent model is run on average 20,000 and 24,000 learning cycles for two face datasets respectively. Variation in number of hidden neurons also plays crucial role in whole SNN design. Effect of varying number of hidden neurons per SNN is shown in fig 9. Selecting less than 8 neurons degrades the performance of the proposed model while going beyond 10 neurons per SNN do not yield any significant improvement in accuracy keeping constant number of learning cycles mentioned above.

VI. CONCLUSION

This paper proposes a novel hybrid intelligent model based on the evolutionary fuzzy clustering with Minkowiski distance (EFC-MD) and syndicate neural network (SNN). A novel synergism of all three paradigms evolved a model which demonstrated superiority not only in benchmark problems but also in biometric dataset considered for real life applications. EFC-MD provide a optimal partitioning containing general shape cluster, whereby this patterns information is processed by SNN to yield competitive result of biometric applications. In biometric face recognition problems dealing with variations such as pose, illumination and expression, our method outperformed over the existing techniques. In this paper, we also reported the variation in number of clusters and MCM and observed that on increasing the number of clusters and MCM, the performance increases up to some extent then start decreasing. In most of the examples presented in this paper, we observed that best accuracy is achieved when number of members in a cluster (MCM) and number of clusters (C) are nearly comparable.

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Image Watermarking Based on Simplified Significant Wavelet Tree Quantization

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***Abstract*—This paper proposes an image watermarking scheme using wavelet tree quantization. The proposed approach embeds a watermark with visual recognizable patterns, such as binary or gray, in images by modifying the frequency part of the images. In the proposed approach, an original image is decomposed into wavelet coefficients. Then, image watermarking scheme based on the Simplified Significant Wavelet Tree (SSWT) is used to achieve the robustness of the watermarking. Unlike other watermarking techniques that use a single casting energy, SSWT adopts adaptive casting energy in different resolutions. The wavelet coefficients of the host image are grouped into wavelet trees and each watermark bit is embedded using trees. The trees are so quantized that they exhibit a large enough statistical difference, which will later be used for watermark extraction. Each watermark bit is embedded in all frequency bands, which renders the mark more resistant to attacks that remove certain frequency components. The performance of the proposed watermarking is robust to a variety of signal distortions, such as image cropping, adding noise, and filtering, and compression attacks.**

Keywords-Simplified Significant Wavelet Tree, Wavelet Tree, watermarking, DWT.

I. INTRODUCTION

Due to the open environment of Internet downloading, copyright protection introduces a new set of challenging problems regarding security and illegal distribution of privately owned images. One potential solution for declaring the ownership of the images is to use watermarks [1-3]. The Watermarking techniques apply minor modifications to the original data in a perceptually invisible or almost invisible manner with the modifications bearing the watermark information. By detecting the existence of these modifications, we can prove the ownership and even trace an illegal copy source [8].

Hsu and Wu [10] embedded the watermarks with visually recognizable patterns in the images. The embedding positions were selectively modifying the middle frequency of DCT of the images. The embedding and extracting methods of the DCT-based approaches have been described [10], [21], [22]. On the other hand, several methods [11-14], [16-20] used the discrete wavelet transform (DWT) to hide data to the frequency domain to provide extra robustness against attacks. Wang and Lin [9] proposed a wavelet tree quantization for copyright protection watermarking. The wavelet coefficients are grouped into a predefined structure called super tree. Watermark bits are also embedded by quantizing super tree and the resulting difference between quantized and unquantized trees will later be used for watermark extraction. One famous wavelet image/video coding, embedded zero tree wavelet (EZW) coding [15], has the potential to play an important role in upcoming image/video compression standards, such as JPEG2000 and MPEG4 due to its excellent performance in compression.

In most previously proposed wavelet-based watermarking techniques the watermark is easily detected by employing detection theory. To over come this, the present paper, we propose a Watermarking based On Simplified Significant Wavelet Tree Quantization approach by adding visually recognizable images to the coefficients in all high frequency bands at all the level of the DWT of an image. In this process, we can identify the groups which are SSWT quantized during watermark insertion process. We then select the SSWT non-quantized groups and SSWT quantize them to remove the watermark. Our experimental results show that the proposed watermarking approaches is very robust to image compression and complicated image distortions.

The present paper extends the study on wavelet trees and developed new concepts based on wavelet tree data structures to address the problem of (1) obtaining the best image quality for a given bit rate, and (2) to render the watermark more resistant to frequency based attacks, i.e., to achieve high robustness. This problem is important in many applications, particularly for progressive transmission, image browsing, multimedia applications and compatible transcoding in a digital hierarchy of multiple bit rates. It is also applicable to transmit over a noisy channel in the sense that the ordering of the bits in the order of importance leads naturally to prioritization for the purpose of layered protection schemes.

The remaining sections of this paper are organized as follows. Basic concepts about DWT and Wavelet tree are described in Section 2. Section 3 describes the watermark embedding approach and the extraction method. In Section4, the experimental results are shown. The conclusions of our study are stated in Section 5.

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II. BASIC CONCEPTS

A. Wavelet theory and multiresolution analysis

One of the oldest problems in statistics and signal processing is how to choose the size of an analysis window, block size, or record length of data so that statistics computed within that window provide good models of the signal behavior within that window. The choice of an analysis window involves in trading the ability to analyze "anamolies", or signal behavior that is more localized in the time or space domain and tends to be wide band in the frequency domain, from "trends", or signal behavior that is more localized in frequency but persists over a large number of lags in the time domain. To model data as being generated by random processes so that computed statistics become meaningful, stationary and argotic assumptions are usually required which tend to obscure the contribution of anomalies.

The main contribution of wavelet theory and multiresolution analysis is that it provides an elegant framework in which both anomalies and trends can be analyzed on an equal footing. Wavelets provide a signal representation in which some of the coefficients represent long data lags corresponding to a narrow band, low frequency range, and some of the coefficients represent short data lags corresponding to a wide band, high frequency range. Using the concept of scale, data representing a continuous tradeoff between time (or space in the case of images) and frequency is available.

In image processing, most of the image area typically represents spatial "trends", or areas of high statistical spatial correlation. However "anomalies", such as edges or object boundaries, take on a perceptual significance that is far greater than their numerical energy contribution to an image. Traditional transform coders, such as those using DCT, decompose images into a representation in which each coefficient corresponds to a fixed size spatial area and a fixed frequency bandwidth, where the bandwidth and spatial area are effectively the same for all coefficients in the representation. Edge information tends to disperse so that many non zero coefficients are required to represent edges with good fidelity. However, since the edges represent relatively insignificant energy with respect to the entire image, traditional transform coders, such as those using the DCT, have been fairly successful at medium and high bit rates. At extremely low bit rates, however, traditional transform coding techniques, such as JPEG, tend to allocate too many bits to the "trends", and have few bits left over to represent "anomalies", as a result, blocking artifacts often result.

After an in depth study on the above the present thesis found that wavelet techniques show promising results at extremely low bit rates because trends, anomalies and information at all "scale", in between are available. A major difficulty is that fine detail coefficients representing possible anomalies constitute the largest number of coefficients. To overcome this, the proposed SSWT, of the present work made an effective use of the multiresolution representation in which much of the information is contained in representing the position of those few coefficients corresponding to significant anomalies.

B. Wavelet trees

To improve the compression of significance maps of wavelet coefficients, two new data structures called SSWT is proposed in this paper. A parent child relationship can be defined between wavelet coefficients at different scales corresponding to the same location. Except the highest frequency subbands (i.e., HL_1, LH_1, and HH_1), every coefficient at a given scale can be related to a set of coefficients at the next finer scale of similar orientation. The coefficient at the coarse scale is called the parent, and all coefficients corresponding to the same spatial location at the next finer scale of similar orientation are called children. For a given parent, the set of all coefficients at all finer scales of similar orientation corresponding to the same location are called descendants. Similarly, for a given child, the set of coefficients at all coarser scales of similar orientation corresponding to the same location are called ancestors. The fourth level wavelet decomposition is shown in Figure 1. The parent child dependencies are shown in Figure 2. Note that in Figure 2 the arrow points from the subband of the parents to the subband of the children. The lowest frequency subband is the top left and the highest frequency subband is at the bottom right. In this section, coefficients with local information in the subbands are chosen as the target coefficients to be cast. The coefficients selection approach of the proposed SSWT is derived from EZW, and the basic definitions are given as follows.

Definition 1: A wavelet coefficient $x_n(i,j) \in D$ is a parent of $x_{n-1}(p,q)$, where D is a subband labeled HL_n, LH_n, HH_n, $p=i*2-1|i*2, q=j*2-1|j*2, n>1, i>1$, and $j>1$. [6] represented the EZW algorithm for image compression using the zerotree of wavelet coefficients. The zerotree is defined as follows. Given an amplitude threshold value T, if a wavelet coefficient $|x(i,j)|$satisfies $|x(i,j)| < T$, then the $|x(i,j)|$ is said to be insignificant over a given threshold value T. If a coefficient and all of its descendants are insignificant over T, then the set of these wavelet coefficients are called as zerotrees for the threshold value T. An element of a zerotree for threshold value T is a zerotree root if it is not the descendant of a previously found zerotree root for the threshold value T. The zerotree is based on the hypothesis that if a wavelet coefficient at a coarse scale is insignificant with respect to a given threshold value T, then all wavelet coefficients of the same orientation in the same spatial location at finer scales are likely to be insignificant with respect to T [6].

Definition 2: If a wavelet coefficient $x_n(i,j)$ at the coarsest scale and its descendents $x_{n-k}(p,q)$ satisfy $|x_n(i,j)| < T$, $|x_{n-k}(p,q)| < T$ for a given threshold T, then they are called wavelet zero trees, where $1<k<n$.

Definition 3: If a wavelet coefficient $x_n(i,j)$ at the coarsest scale satisfy $|x_n(i,j)| > T$ for a given threshold T, then $x_n(i,j)$ is called a significant coefficient [6].

Definition 4: If a wavelet coefficient $x_n(i,j) \in D$ at the coarsest scale is a parent of $x_{n-1}(p,q)$, where D is a subband labeled HL_n, LH_n, HH_n satisfy $|x_n(i,j)| > T_1$, $|x_{n-1}(p,q)| > T_2$ for a given threshold T_1, T_2 then $x_n(i,j)$ and its children are called Qualified Significant Wavelet Tree (QSWT) . The present study based on the above definitions derived new definition on wavelet tree.

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C. Features of the proposed SSWT

The Simplified Significant Wavelet Tree (SSWT) uses a DWT, which provide a compact multiresolution representation of the image.

- The SSWT coding provides a compact multiresolution representation of significant maps, which are binary maps indicating the positions of the significant coefficients. The proposed approaches allow the successful prediction of insignificant coefficients across scales to be efficiently represented as part of exponentially growing trees.
- Successive approximation is used in the SSWT which provides a compact multi precision representation of the significant coefficients and facilitates the embedding algorithm.
- The SSWT uses a prioritization protocol whereby the ordering of importance is determined, in order, by the precision, magnitude, scale and spatial location of the wavelet coefficients. Note in particular, the larger coefficients are deemed more important than smaller coefficients regardless of their scale.

III. PROPOSED SSWT SCHEME

Definition of proposed SSWT : If any wavelet coefficient $x_n(i,j) \in D$ (other than finest scale wavelet coefficient or the leaf node) which is a parent of some $x_{n-1}(p,q)$, where D is a subband labeled HL_n, LH_n, HH_n, satisfy $|x_n(i,j)| > T_1$ or $|x_{n-1}(i,j)| > T_2$ or $|x_{n-2}(i,j)| > T_3$ or $|x_{n-3}(i,j)| > T_4$ or $|x_{n-k}(i,j)| > T_k$ for a given threshold $T_1,T_2,T_3,T_4 \ldots T_k$ then $x_n(i,j)$ and all of its children other than the finest scale wavelet coefficient or the leaf node are called Simplified Significant Wavelet Tree (SSWT).

The host image of size n by n is transformed into wavelet coefficients using the L level DWT. With L level decomposition, one can have L×3+1 frequency bands. The proposed scheme is experimented with four levels as shown in Figure 1, when L = 4, the lowest frequency subband is located in the top left (i.e., the LL_4 subband), the highest frequency subband is at the bottom right (i.e., the HH_1 subband). The relationship between these frequency bands from the blocks of variable size can be seen as a parent child relationship. With the exception of the lowest frequency subband LL_4, the parent child relationship can be connected between these sub nodes to form a wavelet tree. If the root consists of more than one node, then an image will have many wavelet trees as explained below.

A wavelet tree descending from a coefficient in subband HH_4 of SSWT is shown in Figure 3. With the exception of the lowest frequency subband, all parents have four children. For the lowest frequency subband, the parent child relationship is defined such that each parent node has three children in the SSWT. In the proposed SSWT approaches the scanning of the coefficients is performed in such a way that no child node is scanned before its parent. For an N scale transform, the scan begins at the lowest frequency subband, denoted as LL_N, and scans sub ands HL_N, LH_N and HH_N, at which point it moves on to the scale N-1, etc. Each coefficient within a given coarser subband is scanned before any coefficient in the next finer subband in the proposed SSWT scheme.

In the proposed approaches of SSWT a higher level subband (e.g., the HL_4 subband) is more significant than a lower level subband (e.g., the HL_2 subband). The proposed SSWT is not considering the LL_4 subband as a root to embed a watermark, since LL_4 is a low frequency band, which contains important information about an image. The coefficients are grouped according to wavelet trees except the coefficients of LL band (A4,4). Therefore the coefficients in subband A4,1, A4,2, A4,3 forms as roots of wavelet tree. By using a four level wavelet transform image of a 512×512, at the fourth level, the subbands, A4,1, A4,2, A4,3 have 32^2 coefficients, and there are total $3\times32^2 = 3072$ trees in SSWT. Each tree consists of 1+4+16+64 = 85 coefficients as shown in Figure 2. The coefficients are in the order of parent to children.

For an image of size N × N at the level two there are $(N/4)^2$ coefficients and there are a total of $3\times (N/4)^2$ trees in the SSWT. For an image of size N × N at the level four there will be $(N/24)^2$ coefficients and there are a total of $3\times(N/24)^2$ trees. In the same way for a level L, for an image of size N × N, there are $(N/24)^2$ coefficients and there are a total of $3\times (N/24)^2$ trees in the SSWT. For coefficients in the subbands of the same level, a novel raster scanning order is proposed in SSWT as shown in Figure 3. The j^{th} coefficient of a tree is denoted by x (j), $1 \le j \le 85$.

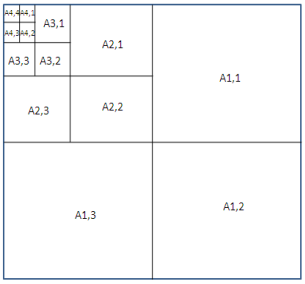


Figure1. Wavelet decomposition and its subbands

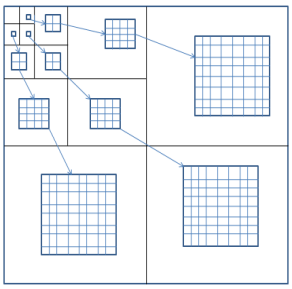
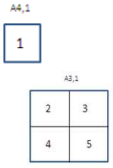


Figure2. Tree structure of wavelet coefficients and parent child relationship of SSWT



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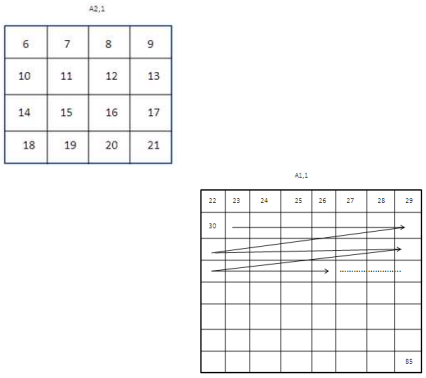

Figure 3. The 85 wavelet coefficients of a four level wavelet tree for a original image of size 512 × 512 and ordering of coefficients from coarser scale to finer scale of SSWT

A. Watermark insertion process of SSWT

The present thesis adopted various preprocessing steps as described in the previous chapter for selecting significant subbands of SSWT. Preprocessing steps enhances the quality, better illumination, contrast and sharpening of image. By this confidentiality, quality, data integrity and robustness of the image are improved. The various preprocessing equations on mean, median, mode, variance and Standard Variation (SD) are given in the Equation 1 to 5 respectively.

$$Mean = \text{int}\left(\frac{\sum_{i=0}^{z-1}\sum_{j=0}^{z-1} P(i,j)}{z}\right) \quad (1)$$

$$Median = middlevalu\ e\left\{ASC\left(\forall_{i=0}^{z-1}\ \forall_{j=0}^{z-1}\ P(i,j)\right)\right\} \quad (2)$$

$$Mode = \text{mod}\ value\left(\forall_{i=0}^{z-1}\ \forall_{j=0}^{z-1}\ P(i,j)\right) \quad (3)$$

$$Variance = \text{int}\left(\frac{\sum_{i=0}^{z-1}\sum_{j=0}^{z-1} P(i,j)}{z} - \frac{\sum_{i=0}^{z-1}\sum_{j=0}^{z-1} (P(i,j))^2}{z}\right) \quad (4)$$

$$SD = \left(\frac{\sum_{i=0}^{z-1}\sum_{j=0}^{z-1} P(i,j)}{z} - \frac{\sum_{i=0}^{z-1}\sum_{j=0}^{z-1} (P(i,j))^2}{z}\right)^{1/2} \quad (5)$$

The watermark bit is embedded according to the ordered coefficients. In this scheme the watermark bit is inserted in the 6th LSB or 7th LSB if the coefficient of the pixel value is even or odd respectively. After embedding the watermark bits in the 85 coefficients as explained above, the next subband is chosen and the same process is repeated until the entire watermark bits are embedded.

B. Watermark extraction process of SSWT

For extraction of the watermark the proposed method initially transform the watermarked image into four levels of DWT. Then, wavelets trees are created as explained above and rearrange them into 3072 trees. From these trees, based on the preprocessing method significant SSWT are identified and watermark bits are extracted until eight consecutive zeros in the 7th LSB and eight consecutive ones in the 6th LSB are reached.

IV. EXPERIMENTAL RESULTS

The proposed SSWT scheme is experimented on the cover images Lena, Baboon, Peppers, Barbara, Monalisa, Lake, Cameraman and child of size 512×512, as shown in Figure 4. The Haar wavelet transform is used in the proposed scheme. The watermark considered for the experiments are logo SRRF GIET of size 32×32 as shown in Figure 5. In the proposed scheme the preprocessing step mean is applied as threshold. However any preprocessing method can be applied. The watermark is inserted in the selected locations by using the above method.

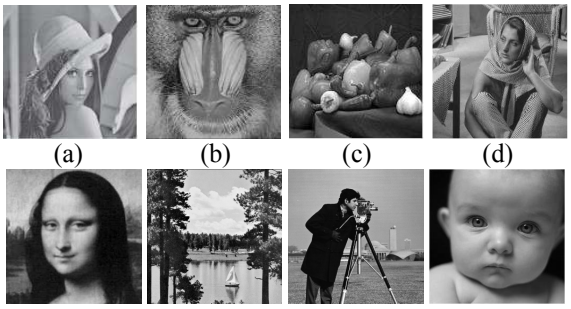

Figure 4. Original images (a) Lena (b) Baboon (c) Peppers (d) Barbara (e) Monalisa (f) Lake (e) Cameraman (h) Child

(a)

Figure5. Watermark Image (a) Logo SRRF GIET

Table 1 indicates the PSNR and NCC values for the proposed SSWT scheme. PSNR values of Table 1 ranges from 38 dB to 39 dB for the considered 8 images for SSWT, which means the watermark is almost imperceptible. In Figure 6 shows the watermarked images for the proposed scheme.

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(e) (f) (g) (h)

Figure 6. Watermarked images (a) Lena (b) Baboon (c) Peppers (d) Barbara (e) Monalisa (f) Lake (e) Cameraman (h) Child

TABLE I. PSNR AND NCC VALUES FOR SSWT SCHEME

S. No	Image	SSWT	
		PSNR	NCC
1	Lena	38.26	0.847
2	Baboon	38.08	0.889
3	Pepper	38.28	0.918
4	Barbara	39.52	0.967
5	Monalisa	38.44	0.946
6	Lake	38.96	0.895
7	Cameraman	39.56	0.848
8	Child	38.52	0.859

The proposed SSWT scheme on Haar wavelets are also tested with various attacks such as JPEG compression with different ratios (90%, 80%, 70% and 60%), Gaussian noise with different ratios (10%, 15%, 20% and 25%), cropping with different ratios (5%, 10% ,15% and 20%) and Median filter with different size (2×2, 3×3, 4×4, 5×5), to test the robustness. Table 2 shows the PSNR and NCC values with various attacks on the considered images. From the Table 2, it is clearly evident that the proposed scheme is having a very good PSNR for all the images even after attacks. The experimental results demonstrate that the correlation coefficient‘s value is above 0.7. The NCC value of Table 2 clearly indicates the quality of the watermark image is not degraded for all the attacks. The table also indicates the robustness is not degraded for the proposed scheme with attacks.

Table 3 compares the PSNR values after inserting the watermark without attacks by the proposed SSWT scheme with various other existing methods [4, 5]. Table 2 clearly indicates the SSWT outperform the other existing methods. A graph is also plotted in Figure 7 which indicates the comparison of the proposed SSWT scheme with various other methods.

TABLE II. PSNR AND NCC RESULTS OF VARIOUS ATTACKS ON LENA IMAGE USING SSWT SCHEME

Attacks		SSWT	
		PSNR	NCC
JPEG Compression	90%	37.25	0.911
	80%	34.46	0.832
	70%	30.64	0.795
	60%	29.81	0.668
Filtering	2×2	37.93	0.913
	3×3	37.44	0.891
	4×4	36.14	0.799
	5×5	34.9	0.743
Adding Gaussian Noise	10%	37.1	0.932
	15%	35.61	0.879
	20%	33.8	0.775
	25%	31.66	0.711
Cropping	5%	33.28	0.865
	10%	31.83	0.812
	15%	29.32	0.765
	20%	27.67	0.624

TABLE III. COMPARISON OF THE PROPOSED SSWT SCHEME WITH OTHER METHODS

Test images	LIU Hui and HU Yu-ping method	Prayoth Kumsawat et.al method	Proposed SSWT method
	PSNR(dB)		
Lena	38.20	38.00	38.36
Baboon	38.01	37.70	38.08
Pepper	38.11	38.01	38.28
Barbara	38.27	38.16	39.52
Monalisa	37.99	37.89	38.44
Lake	38.23	38.09	38.96
Cameraman	38.12	38.12	39.56
Child	38.25	38.01	38.52

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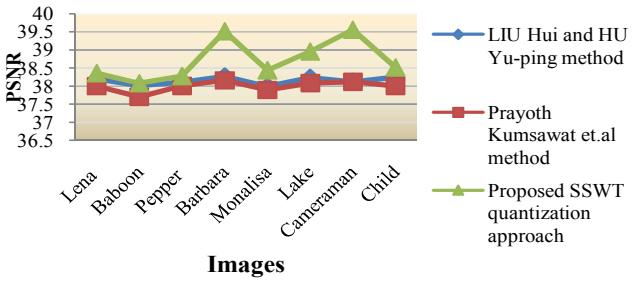

Figure 7. Comparison of proposed SSWT scheme with other method

V. CONCLUSION

The present paper demonstrated a novel scheme called SSWT which is the extensions of zero wavelet trees. In the proposed schemes each watermark bit is embedded in various frequency bands and the information of the watermark bit is spread throughout large spatial regions. While the proposed watermarking schemes achieve high perceptual quality of the watermarked image for human eyes, it possesses high performance of robustness to various malicious manipulations including median filtering, low pass filtering, image rescaling, image cropping, JPEG, and JPEG2000 compression. Even the proposed scheme is implemented to provide that the value of NCC of the extracted watermark is as high as 0.9 while the watermarked image is attacked by the JPEG compression with a quality factor as low as 40%. In addition to copyright protection, the proposed watermarking schemes can also be applied to data hiding or image authentication. The proposed approaches are hierarchical and have multiresolution characteristics. In the proposed approaches, the embedded watermark is hard to detect by human visual perceptivity. The approaches match the upcoming image/video compression standards.

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Speech Recognition using Transform Method

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***Abstract*— This paper presents a novel method for isolated English word recognition based on transform method. This isolated word recognition method consists of two phases, feature extraction phase and recognition phase. In feature extraction, discrete Fourier transform and discrete cosine transform is used for extracting the features of speech samples and feature vector of different dimensions is obtained. In Recognition phase, Euclidean distance is calculated between test sample feature vector and all reference speech samples. Speech sample with minimum average distance is selected. For testing, 30 different words are used, spoken by male and female both, 25 utterances of each word are recorded. Results are compared with different feature vector dimensions. Experimental results showed that the maximum recognition rate of 94% is obtained.**

Keywords- Isolated word Recognition, Feature Extraction, Discrete Fourier Transform (DFT), Discrete Cosine transform (DCT), Euclidean distance.

I. INTRODUCTION

In this technological era, information technology continues making more impact on many aspects of our daily lives, however, the problems of communication between human beings and information processing machines become increasingly important. So far, such communication has been done almost entirely by means of keyboards and screens, but there are substantial disadvantages of this method for many applications. Speech is considered as the most widely used and natural means of communication between humans, and it is an obvious substitute for such means of keyboards and screens in the communication process. However, this deceptively simple means of exchanging information is, in fact, extremely complicated. Although the application of speech in the man-machine interface is growing rapidly, in their present forms machine capabilities for generating and interpreting speech are still incomplete and imperfect [1].

This research is concerned with speech recognition technology, which is part of speech and signal processing, as well as human computer interaction (HCI). Speech recognition is highly demanded and has many useful applications. This research simulates speech recognition technology used in telephone machine operators, when speech recognition technology is not currently commonly being used by traditional telephone operators. Through this research, a new simulation system or telephone operator is introduced that incorporates various components of Artificial Intelligence (AI), natural language processing, speech recognition technology and human computer interaction fundamentals [2].

The goal of speech recognition system is to map the acoustical signal to a string of words. The recognition of speech is of paramount importance in applications where Speech is the desirable input. As it allows natural interactions between man and machine without the use of a keyboard, this mode of input is increasingly gaining acceptance. The speech recognition systems acquire speech through a microphone and convert the speech to recognize the uttered text [3].

Speech recognition also defined as the technology by which sounds, words or phrases spoken by humans are converted into electrical signals, and these signals are transformed into coding patterns that can be identified by a computer. Based on this identification, the computer usually takes some actions. Speech recognition also refers to the ability of a machine or computer program to receive and interpret spoken commands and act upon those commands. An automated speech recognition system, using a microphone or a telephone as an input device, converts a person's speech into digital code by comparing the electrical patterns produced by the speaker's voice with a set of pre-recorded patterns stored in the database [4 – 5].

In recent years, automatic speech recognition has reached very high levels of performance, with word-error rates dropping by a factor of five in the past five years. This current state of performance is largely due to improvements in the algorithms and techniques that are used in this field. As a result, the accuracy level of Automated Speech Recognition (ASR) systems is improved especially when using a combination of various algorithms and feature extraction techniques [6].

There are various features extraction techniques, including Linear Predictive Coding (LPC), Perceptual Linear Prediction (PLP) and Mel- Frequency Cepstral Coefficient (MFCC) [9]. The most common operations required for front-end (features extraction) techniques [7]. Those operations include; sampling with a preferred sampling rate between 16000 to 22000 times a second for speech processing corresponding to 16 kHz to 22 kHz. After the sampling, pre-emphasis is performed followed

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by windowing, frequency warping, adding the first and second derivative coefficients to the static feature coefficients in order to enhance the performance of the speech recognition system, and lastly is the cepstral liftering, which is used to rescale the cepstral coefficients to have similar magnitudes. The most prevalent and dominant method used to extract spectral features is calculating Mel- Frequency Cepstral Coefficients (MFCC). MFCCs are one of the most popular feature extraction techniques used in speech recognition based on frequency domain using the Mel scale which is based on the human ear scale. MFCCs being considered as frequency domain features are much more accurate than time domain features [9].

This paper presents a Speech Recognition technique using transform method, in this method Fourier transform is used for feature extraction and Euclidean distance is used for feature matching. For speech recognition testing, thirty different computer related words spoken by different persons including male and female both are used.

II. Speech Recognition process

Speech recognition in computer domain involves various steps. The steps required to make computers perform speech recognition are: Voice recording, feature extraction, and recognition with the help of knowledge models. Feature extraction in automated speech recognition (ASR) systems is the computation of a sequence of feature vectors which provides a compact representation of the given speech signal. Feature training is a process of enrolling or registering a new speech sample of a distinct word to the identification system database by constructing a model of the word based on the features extracted from the word's speech samples.

Feature matching/testing is a process of computing a matching score, which is the measure of Similarity of the features extracted from the unknown word and the stored word models in the Database. The unknown word is identified by having the minimum matching score in the database.

The matching of an unknown word is performed by measuring the Euclidean distance between the feature vectors of the unknown word to the model of the known words in the Database. The word with the smallest average minimum distance is picked as shown in the equation below,

$$d(x, y) = \sqrt{\sum_{i=1}^{D} (x_i - y_i)^2} \quad (1)$$

Where xi is i [th] input features vector, yi is i [th] features vector in the database, and d is the distance between xi and yi.

III. Speech Recognition Using Transform Method

This method involves a frame-based analysis of a speech signal where the speech signal is broken down into a sequence of frames. Each frame undergoes a sinusoidal transform (Fast Fourier Transform) in order to obtain certain parameters, which then undergoes filtering and decorrelation. The result is a sequence of feature vectors describing useful logarithmically compressed amplitude and simplified frequency information .

The following steps are used for feature extraction for transform method of speech recognition.

- *Frame Blocking:* Framing focuses on the process of segmenting the speech sample obtained from the analog to digital conversion into small frames with time length in the range of 10ms to 40ms. In this step the continuous speech signal is blocked into frames of *N* samples, with adjacent frames being separated by *M* (*M* < *N*). The first frame consists of the first *N* samples. The second frame begins *M* samples after the first frame, and overlaps it by *N* - *M* samples. Similarly, the third frame begins 2*M* samples after the first frame (or *M* samples after the second frame) and overlaps it by *N* - 2*M* samples. This process continues until all the speech is accounted for within one or more frames. The goal of the overlapping scheme is to smooth the transition from frame to frame. Typical values for *N* and *M* are *N* = 256 (which is equivalent to ~ 16 msec windowing and facilitate the fast radix-2 FFT) and *M*=100. Fig. 1 shows the segmented speech sample with frame size 256 samples [10].

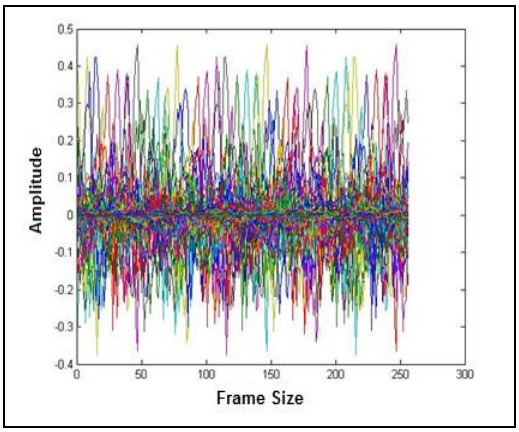

Figure 1 Segmented Speech Signal (Frame Size = 256 samples)

- *Windowing:* The next step in the processing is to window each individual frame so as to minimize the signal discontinuities at the beginning and end of each frame. The concept here is to minimize the spectral distortion by using the window to taper the signal to zero at the beginning and end of each frame. Windowing is very necessary to work with short term or frames of the speech signal. This is to select a portion of the speech signal that can be reasonably assumed to be stationary speech signal. It is performed in order to avoid any unnatural discontinuities in the speech segment and distortion in the underlying spectrum, in order to ensure that all parts of

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the speech signal are recovered and possible gaps between frames are eliminated [11].

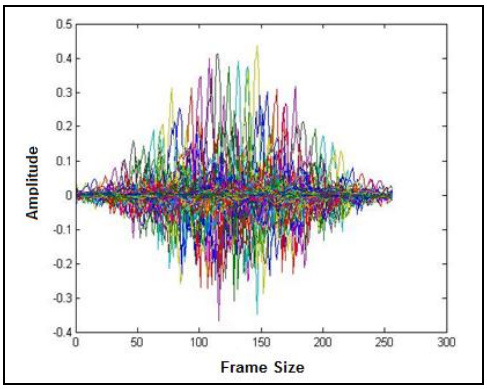

Figure 2 Windowed Speech Segment

The most commonly used window shape is the hamming window; Fig 2. Shows the windowed speech sample. Equation of Hamming window is

$$w(n) = 0.54 - 0.46\cos\left(\frac{2\pi n}{N-1}\right), \quad 0 \le n \le N-1 \tag{2}$$

- *Fast Fourier Transform (FFT):* Fourier series enable a periodic function to be represented as a sum of sinusoids and converts a speech signal from the time domain to the frequency domain. Fast Fourier Transform, which converts each frame of *N* samples from the time domain into the frequency domain. The FFT is a fast algorithm to implement the Discrete Fourier Transform (DFT) which is defined on the set of *N* samples X_n as follow:

$$X_n = \sum_{k=0}^{N-1} x_k e^{-2\pi j k n / N}, \qquad n = 0,1,2,\ldots,N-1 \tag{3}$$

The result after this step is often referred to as Power spectrum or periodogram. Fig 3 shows the power spectrum of word 'One', this diagram shows the output of FFT transform on frequency and time scale. The red color shows the most of the energy present between 0.8 and 1.2 sec.

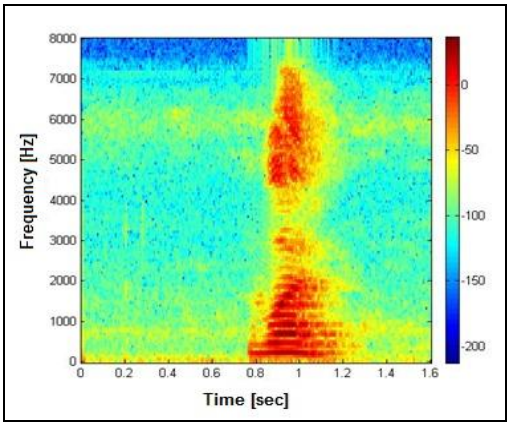

Figure 3 Power Spectrum of word 'ONE'

- Discrete Cosine Transform (DCT): In this final step, spectrum is converted back to time. The result is called the cepstrum coefficients. The cepstral representation of the speech spectrum provides a good representation of the local spectral properties of the signal for the given frame analysis. Because the Mel spectrum coefficients are real numbers, we can convert them to the time domain using the Discrete Cosine Transform (DCT). The formula is,

$$\tilde{c}_n = \sum_{k=1}^{K} (\log \tilde{S}_k) \cos\left[n\left(k - \frac{1}{2}\right)\frac{\pi}{K}\right], \qquad n = 1,2,\ldots,K \tag{4}$$

By applying the procedure described above, for each speech frame of around 16msec with overlap, a set of cepstrum coefficients is computed. These are result of a cosine transform of the logarithm of the short-term power spectrum. This set of coefficients is called a feature vector. Feature Vector of 8, 16 and 20 dimension is computed [12].

IV. Implementation Steps for Feature Extraction, Training and Matching

1. The speech signal is stored in the form of wave files and is read.

2. The speech signal is blocked into frames of N samples, with adjacent frames being separated by M samples. Frame blocking is carried out to reduce the mean squared prediction error over a short segment of speech wave form. In our case, N = 256 and M = 100.

3. All the frames are stored in matrix M1.

4. Hamming window is applied on each individual frame so as to minimize the signal discontinuities at the beginning and end of each frame.

5. Matrix M1 is transformed into new matrix M2, where the column vectors of M2 are the original frame vectors transformed by the hamming window.

6. Discrete Fourier Transform is applied on matrix M2, and M2 is transformed in new matrix M3 where column vectors of M3 are DFTs of the column vectors of M2.

7. Discrete cosine transform is applied on DFT output to convert back into time domain, and stored in a new matrix and used as a feature vector matrix for feature matching phase.

8. For feature training, feature vectors of all the reference speech samples are calculated using transform method.

9. For feature matching unknown word is selected from database as test sample.

10. Feature vector is calculated for this test sample.

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11. The Euclidean distance is calculated between test samples and all reference speech samples.
12. Speech sample with minimum average distance is selected.

VI. RESULTS

Database of speech samples is prepared; the speech samples used in this project are recorded using Windows Sound Recorder 2010, 9.0.1. For each word, twenty five utterances from different speakers are collected, samples are taken from each speaker in two sessions so that training model and testing data can be created. Ten, five, three samples from each word are used for training phase and remaining fifteen, ten are used for testing phase. Table I shows the database description for speech recognition. The samples are collected from eight different speakers, including male and female both so that speaker independent speech recognition can be done.

Table I. Database Description

Parameter	Sample characteristics
Language	English
No. of Speakers	10 (5 Male, 5 Female)
Sampling frequency, quantization	16000 Hz, 16 bits
Average duration of training and testing utterance	1 – 2 sec
Total number of words	30
Number of sample utterances per word	25
Total number of utterances in database.	30*25 = 750.

The performance of speech is evaluated in terms of recognition rate, the following recognition measure for computing the recognition rate,

$$\text{Recognition rate} = \frac{\text{(Number of successful detection of word)}}{\text{(Number of words in testing set)}} \quad (5)$$

Table II shows the matching rate of 15 test samples for 05, 10 reference samples of each word, for feature vector dimension 16. Here matching rate is calculated out of 15 samples for each word using equation (5). Total 450 test samples are used and each test sample is compared with 150 and 300 different

Table II. Matching Rate (%) for 15 test samples of each word, feature vector size - 16

WORD	Matching Rate (%)	
	05 Reference Samples	10 Reference Samples
ONE	93.33	93.33
TWO	73.33	73.33
THREE	100	100
FOUR	60	60
FIVE	93.33	93.33
SIX	100	100
SEVEN	100	100
EIGHT	100	100
NINE	100	100
TEN	100	100
EXCELLENT	100	100
WALK	100	100
GOOD	100	100
GO	73.33	93.33
LIFT	100	100
UP	93.33	73.33
DOWN	80	100
THROW	66.66	100
STOP	73.33	80
CATCH	100	100
WELCOME	100	100
ENTER	100	100
AMAZING	66.66	100
BEAUTIFUL	100	100
SHUTDOWN	80	80
SHIFT	100	100
PRINT	100	100
COPY	100	100
PASTE	100	100
EXIT	100	100
Total Matches out of 450	413	427
Avg Matching Rate (%)	91.77	94.88

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Table III. Comparison of Matching (%) of 450 test samples for different feature vector size

No of Reference Samples for each word	Feature Vector Dimension					
	08		16		20	
	Matches	%	Matches	%	Matches	%
05	409	90.88	413	**91.77**	402	89.33
10	418	92.88	427	**94.88**	408	90.66

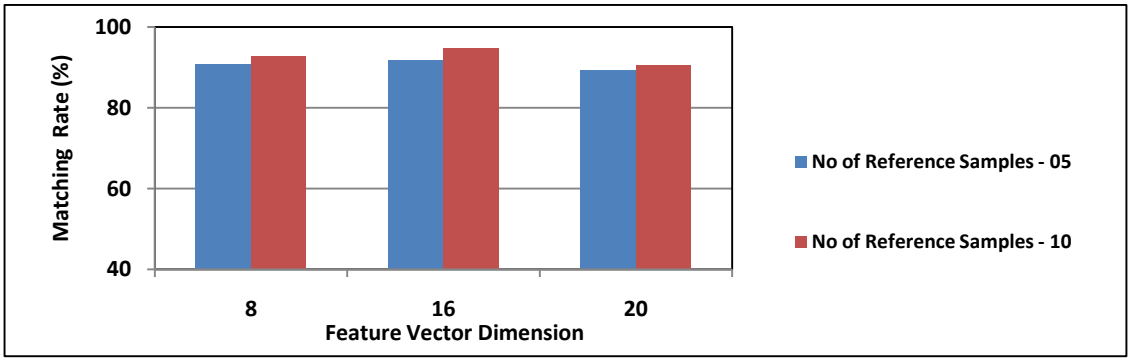

Figure 4 Feature vector Dimension Vs Matching Rate (%) of 450 test samples.

Speech samples. In this case also for most of the words 100% matching rate is obtained. Maximum matching rate is observed, when ten reference samples of each word are used. Shaded cells shows the maximum matching rate of 90% and above, for 5 reference samples, maximum average matching rate of 91.77% and for 10 reference samples, maximum average matching rate of 94.88% is observed. Table III shows the comparison of Matching (%) out of 450 test samples for different no of reference samples for each word, for feature vector dimension 8, 16 and 20. For five reference samples for each word, the matching accuracy is 90%, 91% and 89% for 8, 16 and 20 feature vector dimension respectively. Similarly for ten reference samples for each word, the matching accuracy is 92%, 94% and 90% for 8, 16 and 20 feature vector dimensions respectively. In both the cases, maximum matching accuracy is obtained in 16 feature vector dimension. Fig 4 shows the same results in graphical format.

VII. Conclusion

In this paper, Speaker independent isolated word recognition technique using Transform method is presented. The results were found to be satisfactory of vocabulary of English words. In Transform method, speech samples are converted into frequency domain using fast Fourier transform and maximum accuracy of 94% is obtained.

Different recognition rate is obtained for all words, because of different phonemes are used for different words. The maximum recognition rate is obtained for transform method for words like, Two, Three, Walk, Excellent etc. The words 'Go', 'Throw' have the same vowel part and differ only in their unvoiced beginnings and endings, so these two words are mostly misinterpreted with each other.

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Mobile Scientific Calculator

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***Abstract*-The mobile and wireless industry is entering an exciting time. Demand for mobile technology is growing at a tremendous rate. Corporations are deploying mobile applications that provide substantial business benefits, and consumers are readily adopting mobile data applications.**

We present scientific application for mobile phone in steps of software engineering project starting from *data gathering, data analysis, designing, coding, packaging, testing and deploying*, Mobile Scientific Calculator (MSC) enable user to compute any mathematical operation by using this application in mobile phone without needing to use the calculator. Scientific calculator offers three keys the four mathematic operations, the four systems of digits and offering many of functions such as angles functions, power, factorial and other functions. Scientific calculator is suitable for many mobile phones which don't have scientific calculator in its applications, it provide simple design for dealing with its functions for all users. It operated on more than one mobile phone model.

Keywords - mobile application, scientific calculator.

I. INTRODUCTION

Scientific calculator is an important and necessary application for all student or any person work in scientific work field, more operations are difficult to computed it by using normal calculator which is available in all mobile phone devices and designed for computing simple mathematical operations such as addition, subtraction, multiplication and division, so needing for scientific calculator increase when dealing with mathematical computation operations with pure mathematical values.

More of mathematic operations that the student needing it the scientific calculator offer it for student such as four numeric systems, mathematic operations, factorial, mod, power, square, etc. all of these functions and operations the mobile scientific calculator executes it in any type of the four numeric systems, this facilitates us the operation of conversion digits to decimal system for solving and reconversion the result to the specific system.

Scientific calculator is not available in all mobile models, so MSC can install in mobile which do not have scientific calculator such as Nokia models or Samsung models.

II. RELATED WORKS

Some related works used the scientific calculator Jairus P. Ochanda and Francis C. Indoshi [1] which show benefits of using scientific calculator in teaching and learning in secondary school education. Other related works showed the effectiveness of using calculator in classroom for computing certain results Christina L. Sheets [2], but this calculator was not scientific calculator. Helmut Dersch [3] designed a symbolic calculator written for mobile phones and PDAs. It solves and manipulates equations, handles basic calculus problems, and provides a few more typical functions of computer algebra systems with no support of the forth numeric systems.

Also there is another related work for using scientific calculator in mobile such as Xici Wang [4] which designed a portable digital laboratory. It collected data from a sensor, and send data to a computer or a Graphing Calculator (GC), with the Data Streamer software, this work using scientific calculator in mobile with computer availability.

III. DATA GATHERING STEP

In this level information about designing user's interfaces , converting algorithms among numeric systems and other mathematic function algorithms.

IV. DATA ANALYSIS STEP

After gathering information and requirements in the previous step the analysis was started which showed that a necessary requirements for scientific calculator application were designing simple interfaces for user including buttons for input mathematic operations, special buttons for input numeric system and other buttons for deleting with monitor for digits representation.

MSC is supported the following operations :

- Mathematic operations (sum, sub, mult, div).
- Factorial.
- Power.
- Mod.
- Square.
- Pi, which equal to 3.14.
- Other functions (sin, cos, tan).

In addition to the above operations there are alerts messages when error occur such as division by zero, out of range and power to real number.

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V. DESIGNING STEP

In this step the design of program was achieved according to the data flow diagram as following :

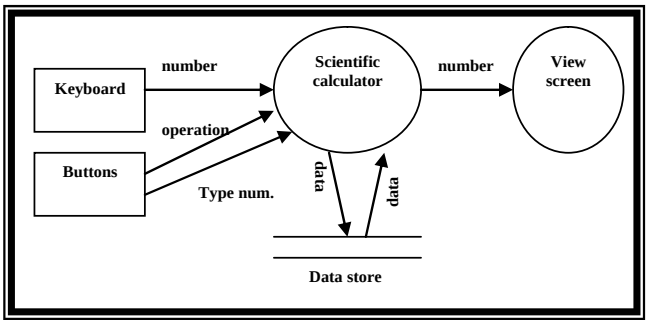

Figure (1) First Level Mobile Scientific Calculator DFD

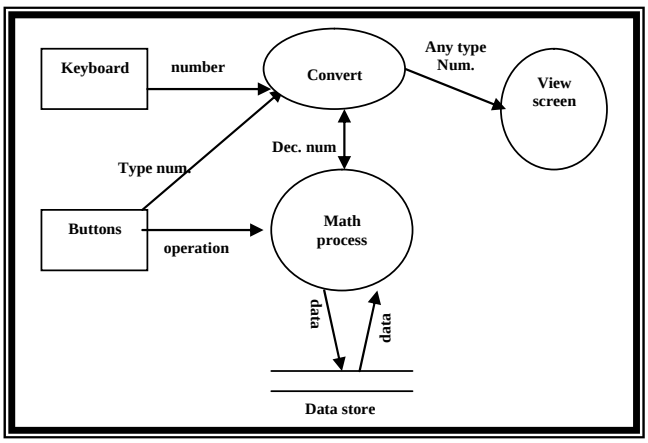

Figure (2) Second Level Mobile Scientific Calculator DFD

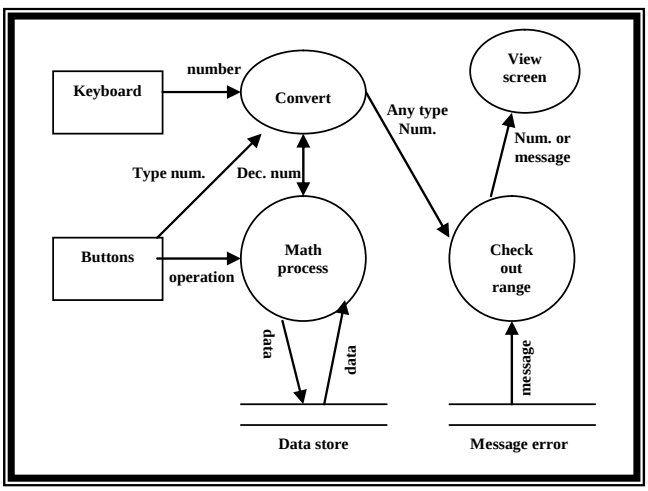

Figure (3) Third Level Mobile Scientific Calculator DFD

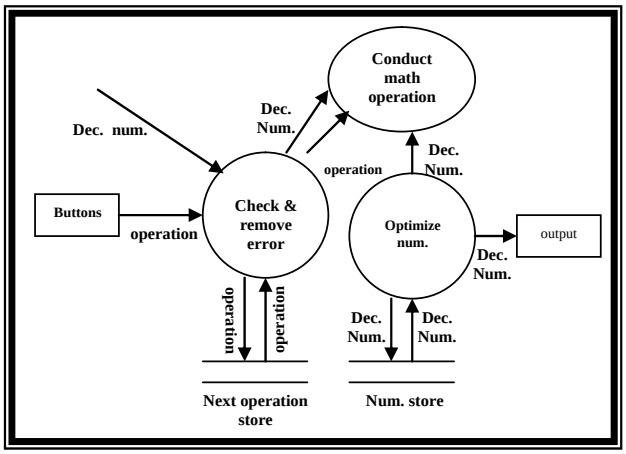

Figure (4) Forth Level Mobile Scientific Calculator [Math Process] DFD

The interface of (MSC) was designing by using graphics (canvas) as show in the following :

Figure (5) MSC Interface

VI. CODING STEP

The source code of MSC was written by using J2ME.

VII. Compilation and precertification step

This step was completed after coding step with assurance of completing all source code steps. The compilation was achieved on Connected Limited Device Configuration (CLDC 1.0 &CLDC 1.1) platform with Mobile Information Device Profile (MIDP 2.0).

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VIII. PACKAGING STEP

The execution of this step was achieved after executing of code in developing environment, then all packages and necessary files of mobile were packaged as well as the special information of application together in one package.

IX. TESTING STEP

The application was tested on developing environment as following :

The main interface

Inter the first digit

Operation choice

Inter the second digit

The result

Using Hex

Figure (6) Mobile Scientific Calculator Interfaces

X. DEPLOYING STEP

After testing the application in emulator the application was deployed on mobiles with different models. The deployment of MSC was achieved on MIDP 2.0 with CLDC 1.1.

XI. SCIENTIFIC CALCULATOR EVALUATION

We performed a simple study for (51) students in 1 st, 2 nd and 4 th classes of software engineering department in February of 2012 about the using of scientific calculator in their exam, the total number of students was (51) students which contained (21) students in 1 st calss, (10) students in 2 nd class and (20) students in 4 th classes the results of evaluation are shown in the following figure :

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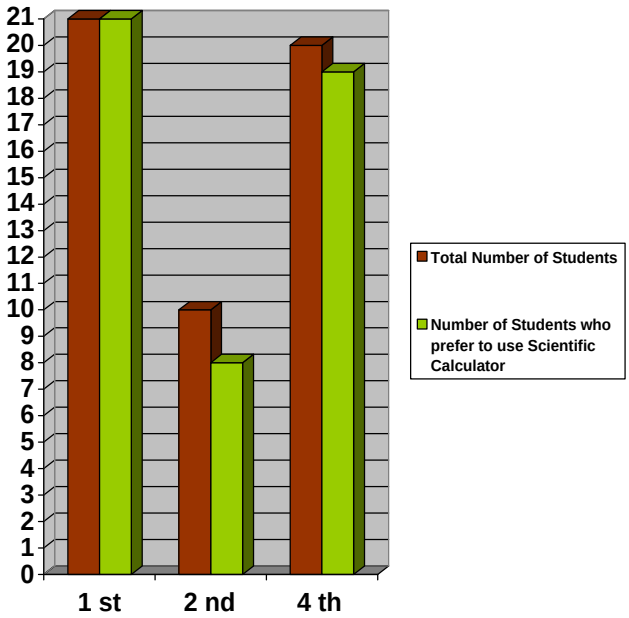

Figure (7) Scientific Calculator Evaluation

XII. CONCLUSIONS

The MSC help every student for performing many operations. Every student who have mobile will do not need to carry scientific calculator after installing the MSC on (his or her) mobile. So the MSC reduces devices that the student must carried it such as scientific calculator specifically.

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Association Rule Mining with Hybrid- Dimension Datasets

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***Abstract*— Hybrid dimension association rules mining algorithm satisfies the definite condition on the basis of multidimensional transaction database. Boolean Matrix based approach has been employed to generate frequent item sets in multidimensional transaction databases. When using this algorithm first time, it scans the database once and will generate the association rules. Apriori property is used in algorithm to prune the item sets. It is not necessary to scan the database again; it uses Boolean logical operations to generate the association rules.**

***Keywords*—Association Rule, Hybrid dimensional association rule, relational calculus, multidimensional transaction database.**

I. Introduction

For mining association rule in transactional or relational database in data mining till now we have used different approaches. Apriori algorithm is costly to handle a huge number of candidate sets and it requires multiple scans for the database which is a tedious job. However, in situations with a large number of frequent patterns, long patterns, or quite low minimum support thresholds, an Apriori*i*-like algorithm may suffer from some above problems and it is used for only single dimensional mining. Although an FP-tree is rather compact, its construction needs two scans of a transaction database, which may represent a nontrivial overhead [3].

Finding frequent patterns plays an important role in data mining and knowledge discovery techniques. Association rule describes correlation between data items in large databases or datasets. The first and foremost algorithm to find frequent pattern was presented by R. Agrawal et al. in 1993. Presented, frequent pattern tree approach, for mining association rules without candidate generation. The candidate generation and test methodology, called Apriori techniques was the first technique to compute frequent patterns based on the Apriori principle and anti-monotone property. The Apriori technique finds the frequent pattern of length k from the set of already generated candidate patterns of length k-1. This algorithm requires multiple database scans and large amount of memory to handle the candidate patterns when the number of potential frequent pattern is reasonably large. In the past two decades, large numbers of research studies have been published presenting new algorithms or extending existing algorithms to solve frequent pattern mining problem more effectively and efficiently. But all the above-mentioned studies are well suitable for single-dimensional transactional databases.

II. Association Rules

Definition 1: Let I = {i1, i2, i3,… in} be a set of items. D is a database of transactions. Each transaction T is a set of items and has an identifier called TID. Each $T \subseteq I$.

Definition 2: Association rule is the implication of the form $A \Rightarrow B$, where A and B are item sets which satisfies $A \subseteq I$, $B \subseteq I$ and $A \cap B = \varphi$.

Definition 3: The strength of an association rule can be measured in terms of its Support and Confidence.

The support supp(X) of an item set X is defined as the proportion of transactions in the data set which contain the item set.

The confidence of a rule is defined

$Conf(X \Rightarrow Y) = supp(X \cup Y)/supp(X)$.

Definition 4: Boolean Matrix: is a matrix with element ‘0’ or ‘1’.

Definition5: The Boolean AND operation is defined as follows: 0.0=0 0.1=0 1.0=0 1.1=1. Where logical implication is denoted by ‘.’ or AND

There are different methods for generating frequent item sets and association rule mining.

Some of them are as follows:-

A. Apriori Algorithm

The classical Apriori algorithm employs an iterative method to find all the frequent item-sets. First, the frequent 1-item sets L_1 is found according to the user-specified minimum support threshold, and then the L_1 is used to find frequent 2-iemsets L_2, and so on, until there is no new frequent item sets could be found. After finding all the frequent item sets using Apriori, we could generate the corresponding association rules [5]. Apriori employs an iterative approach known as a level-wise search, where k-item sets are used to explore (k+1)-item sets. Apriori principle: If an item set is frequent, then all of its subsets must also be frequent. It works in two steps-Join Step: Ck is generated by joining $L_{k-1}$with itself. Prune Step: Any (k-1)-item set that is not frequent cannot be a subset of a frequent k-item set.

Apriori Algorithm is the simple Single-dimensional mining algorithm.

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B. Sampling Algorithm

The main idea for the sampling algorithm is to select small sample one that fits in the main memory of the database of transactions and to determine the frequent item sets from that sample. If those frequent item sets form a superset of frequent item sets for the entire database, then we can determine the real frequent item sets by scanning the remainder of the database in order to compute exact support values for the superset item sets. A superset of frequent item sets can usually be found from by using for eg.Apriori algorithm with a lowered minimum support.

C. Partition Algorithm

In this algorithm if we are given a database with a small number of potential large item sets say a few thousands, then support for them can be tested in one scan by using a partitioning technique. Partitioning divides the database into non-overlapping subsets; these are individually considered as separate databases and all large item sets for that partition called local frequent item sets, are generated in one pass. The Apriori algorithm can then be used efficiently on each partition if it fits entirely in main memory. Partitions are chosen in such a way that each partition can be accommodated in main memory.

D. FP-growth algorithm

FP-growth algorithm is an efficient method of mining all frequent item sets without candidate's generation. The algorithm mine the frequent item sets by using a divide-and-conquer strategy as follows: FP-growth first compresses the database representing frequent item set into a frequent-pattern tree, or FP-tree, which retains the item set association information as well. The next step is to divide a compressed database into set of conditional databases (a special kind of projected database), each associated with one frequent item. Finally, mine each such database separately. Particularly, the construction of FP-tree and the mining of FP-tree are the main steps in FP-growth algorithm.

In reality, for example, along with items purchased in sales transactional databases, other related information like quantity purchased, price, branch location etc are stored. Additional related information regarding the customers who purchased the items, such as customer age, occupation, credit rating, income, and address also stored in the database. Frequent item sets along with other relevant information will be helpful in high-level decision-making. This leads to the challenging mining task of multilevel and multidimensional association rule mining. In recent years, there has been lot of interest in mining databases with multidimensional data values.

III. Conditional –Hybrid dimensional association Rule Mining

Thus here I present mining conditional hybrid-dimensional association rules. Based on these marking, either it does intra-dimensional join or inter-dimensional join.

To solve these problems for founding frequent item sets we have proposed this algorithm. It mines hybrid dimension

Association rules not only from single-dimensional as well as multidimensional database. It meets the definite condition to generate conditional hybrid dimensional association rules, from multidimensional transactional database. It scans database only once which makes easy to find large frequent patterns. It does not generate the candidate item sets as we generate in Apriori algorithm, rather it uses Boolean vector "relational calculus" to generate frequent item sets. I take multidimensional datasets with five attribute as input and apply on Hybrid-dimensional association algorithm rule to generate association rule using Boolean matrix. I use backend sql server and front end jdk1.5 version.

Methodology used in this project:-

- Transforming the multidimensional transaction database into two Boolean matrices one for subordinate attributes (Am*p) and one for main attribute (Am*q).
- Generating the set of frequent 1-itemset L_{A1} (from the subordinate attributes matrix) and L_{B1} (from the main attribute matrix).
- Pruning the Boolean matrices.
- Perform AND operations to generate 2-itemsets: $L_{A1} \bowtie L_{B1}$ and $L_{A1} \bowtie L_{A1}$ for inter-dimension join and $L_{B1} \bowtie L_{B1}$ for intra-dimension join.
- Repeat the process to generate (k+1)-item sets from Lk.

Transforming the multidimensional transaction database into Boolean matrix

Generating the frequent 1-itemset L_1

Pruning the Boolean matrix

Generating the set of frequent k-item sets L_k

The generation of frequent item sets is the core of all the association rules mining algorithms. Previous studies on mining multi-dimensional association rules we focused on finding non-repetitive predicate multi- dimensional rules. We integrate the single-dimensional mining and no repetitive predicate multi-dimensional mining, and present a method for mining hybrid-dimensional association rules using Boolean Matrix.

A. The join process

There are two steps in generation of the frequent item sets and frequent predicate sets. The two steps are *joining* and *pruning*.

(1) The join generating candidate 2-itemsets C2; we find frequent 1-itemsest based on each attribute, at the same time we mark items belong to every main attribute. So it will be clear that the marked items are the items of main attribute and unmarked items are the subordinate items. When we search for ***C2,*** if both of the two joining items are marked items, we call the function for intra-dimensional join between the items as well as inter-dimensional join, but only proceed with inter-dimensional join on the other occasions.

(2) The join on other occasions when we generate frequent item sets directly according to the join mode of the Apriori, it would occur intradimensional join as well as inter-dimensional join. But there are some restrictions to the generation of intradimensional join and inter-dimensional join. Therefore we make the following modifications to the joining step of the Apriori. We assume that items within transaction

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and item-set are sorted in lexicographic order. We could take two steps to find L_k

• Distinguish the intra-dimensional join and inter-dimensional join; If all the items within the two (k-1) item-sets belong to the main attribute; we proceed with intra-dimensional join, and proceed with inter-dimensional join on other occasions.

• Implement join $\boldsymbol{L_{k-1} \bowtie L_{k-1}}$, and choose the corresponding joining condition according to the characteristic of the join (intra-dimensional join or inter-dimensional join)

B. The conditional restriction in hybrid-dimension

Association rules

First the frequent item-sets are obtained, and then we generate the hybrid-dimension association rules from the frequent item-sets. In the process of generating frequent item-sets, we make both intra-dimensional join and inter-dimensional join, as well as the conditional restrictions while proceeding with join, all of the frequent item-sets have such a character: the values within main attribute field occur many times, while the values within subordinate attribute fields occur only once. Thus, the rules generated by the algorithm may include many predicates, or include the same predicate. So the hybrid dimension association rules are formed [1].

IV. ALGORITHM

The algorithm consists of following steps:

1. Transforming the multidimensional transaction database into two Boolean matrices one for subordinate attributes (Am*p) and one for main attribute (Am*q).
2. Generating the set of frequent 1-itemset L_{A1} (from the subordinate attributes matrix) and L_{B1} (from the main attribute matrix).
3. Pruning the Boolean matrices.
4. Perform AND operations to generate 2-itemsets:
L_{A1}join L_{B1} and L_{A1} join L_{A1} for inter-dimension join
And L_{B1}join L_{B1} for intra-dimension join.
5. Repeat the process to generate (k+1)-item-sets from L_k.

- Transforming the multidimensional transaction database into Boolean matrix
- Generating the frequent 1-itemset L_1
- Pruning the Boolean matrix
- Generating the set of frequent k-item sets L_k

We integrate the single-dimensional mining and no repetitive predicate multi- dimensional mining, and present a method for mining hybrid- dimensional association rules using Boolean Matrix. Let a multi-dimensional transaction database Order, which includes two subordinate attributes Age and Income and one main attribute rdered_items as given in table I. In order to simplify the implement process, we pre-processed some attributes before algorithm executes, shown below in table II and table III.

The multidimensional transaction table Order is transformed into two Boolean Matrices: Am*p as subordinate attributes matrix and Bm*q as main attribute matrix. Which are as given below: Let the minimum support is 0.4; m=10 is the number of transactions.

TABLE I

ORDER

ID	Age	Income	Ordered_items
1	31..40	6780	I1, I2, I5
2	31..40	7800	I1, I2
3	31..40	9500	I1,I2,I5
4	21..30	4850	I2, I4
5	41..30	7700	I1, I3
6	31..40	8650	I1, I2, I4
7	31..50	3500	I1, I3, I5
8	21..30	4600	I2, I5
9	21..30	3950	I1, I2, I3
10	21..40	5400	I3, I4

TABLE III

MAPPING AGE

Interval	Name
21..30	y
31..40	m
41..50	s

TABLE III

MAPPING INCOME

Interval	Name
4000-6000	l
6000-10,000	h

TABLE IIIV

ORDER SETS

ID	Age	Income	Ordered_items
1	M	H	I1, I2, I5
2	M	H	I1, I2
3	M	H	I1,I2,I5
4	Y	L	I2, I4
5	S	H	I1, I3
6	M	H	I1, I2, I4
7	M	L	I1, I3, I5
8	Y	L	I2, I5
9	Y	L	I1, I2, I3
10	Y	L	I3, I4

Therefore min_sup_num=10. We compute the sum of the elements value of each column in the Boolean matrix A_{10*5} and B_{10*5} set of frequent 1-itemset is:

L_{A1} = {{y},{m},{h},{l}}, L_{B1} ={{I1},{I2},{I3},{I5}} smaller than the minimum support number [7]. Now we perform the 'AND' operation to join L_{A1} and L_{B1} (according to the type of join) to generate L_2. The possible 2-itemsets are: Inter-dimensional join ($L_{A1} \bowtie L_{B1}$ and $L_{A1} \bowtie L_{A1}$): It is performed by AND operation among the columns of Matrix A_{m*p} AND B_{m*q} and A_{m*p} AND A_{m*p}. Intra-dimensional join ($L_{B1} \bowtie L_{B1}$): It is performed by AND operation among the columns of Matrix B_{m*p} AND $B_{m*q.}$ The possible 2-itemsetsfrom$L_{A1}$and$L_{B1}$are:(y,l),(m,h),(h,1),(h,2),(h,3),(h,5),(l, 1),(l,2),(l,3),(l,5),(y,1),(y,2),(y,3),(y,5),(m,1),(m,2),(m,3),(m,5) ,(I1,I2),(I1,I3),(I1,I5),(I2,I3),(I2,I5),(I3,I5).After performing 'AND' operation to get the support numbers of these

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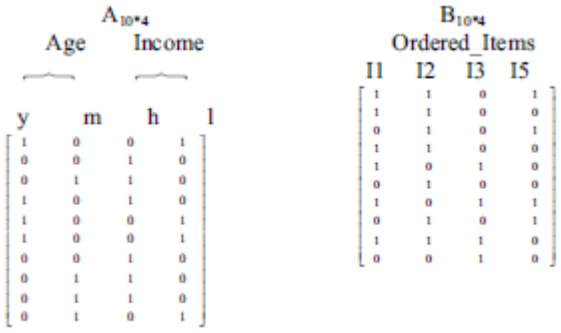
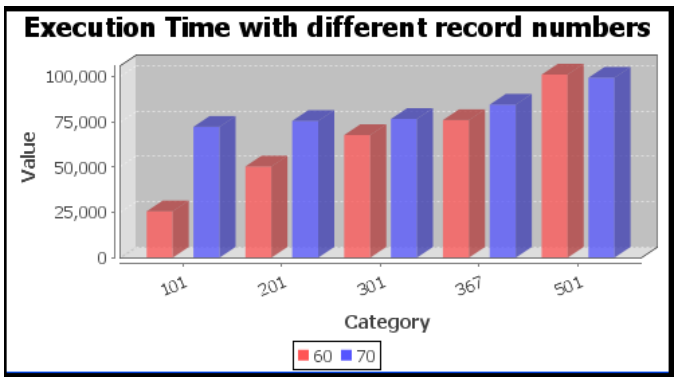
mentioned item sets the Boolean matrices A_{10*18} and B_{10*6} are generated. Now again we compute the sum of the columns of matricesA_{10*18} and B_{10*6}. And prune the columns of the 2-itemsets those are not frequent. Same process will be repeated till for next higher item sets.



We can generate such a hybrid-dimension association rule: $m \cap h \cap I1 \Rightarrow I\,2$ (Support=40% and Confidence=100%)

V. EXPERIMENT

To test whether the proposed method is fast, expansible And effective our experiments are made on machine with Intel(R) Core 2Duo, 1.5GHz and 1GB memory. The Operating system is Windows XP. We use a database that has 500 records and 13 attributes, which have 2~8 different value. Time value for execution is given in millisecond.



VI. RESULT AND DISCUSSION

The confidence of association rules has a specific meaning: When the antecedent of the rule is satisfied, the consequent of the rule will have *c%* (here c refers to the confidence of the rule) possibility of being satisfied. In association rules, only in the antecedent part of multidimensional association rules include several predictions at the same time. We can say that the result of prediction on multidimensional association rules is better and more precise than on single dimensional Associatio rules. For example, TABLEI presents a multidimensional transaction database ***Order.*** If we make a single dimensional association analysis on the predicate ***Ordered_items,*** which presents itemsets.A in transaction, the result of analysis will only include the relevance of ***Order*** itemsets.A. But, if we make a hybrid dimension association analysis, the result of analyzing not only includes the relevance of ***Order*** itemsets.A, but also includes the relevance of customers' information, e.g.: ***Age, Income.*** Thus when we proceed with predictions on the product order of customers' by means of the result of association analysis, obviously, the conditions included in the antecedent of multidimensional association rules is more abundant, and will bring better prediction result.

VII. CONCLUSION

The proposed algorithm uses input datasets and meets the definite condition to generate conditional-hybrid dimensional association rules, from multidimensional transactional database. The main features are: it scans the database only once, it does not generate the candidate item sets, and it uses the "relational calculus" to generate frequent item sets. It stores data in the form of bits, so it needs less memory space and can be applied to large relational databases.

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Computing the Efficiency of Decision-Making Units with FuzzyData Using Ideal and Anti-Ideal DecisionMaking Units

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Abstract:

Data Envelopment Analysis (DEA) is a non-parametrical method for evaluating the efficiency of Decision Making Units (DMU) using mathematical programming. There are several methods for analyzing the efficiency of Decision Making Units, among which are Charnes Cooper Rodes (CCR) and Banker Charnes Cooper (BCC), which compute the efficiency of Decision Making Units using the linear programming or Wang's method which evaluates the efficiency of Decision Making Units using Ideal Decision Making Unit (IDMU) and Anti-Ideal Decision Making Unit (ADMU) and ultimately performs the ranking of units. All these calculations occur when all data, that is the inputs and the outputs of Decision Making Units, are positive and crisp data. Now this question arises: if the data are Symmetric Triangular Fuzzy Number, how will be the method of computing the efficiency of Decision Making Units? In thisarticle, wewill introducea method for evaluating the efficiency of Decision Making Units and also rank them using Ideal and Anti-ideal Decision-Making Units with FuzzyData. Finally, a numerical example is proposed to display the application of this method.

Key words:
Data Envelopment Analysis (DEA), Ideal Decision Making Unit (IDMU), Anti Ideal Decision Making Unit (ADMU), relative closeness (RC), Ranking

1. Introduction:

Data Envelopment Analysis (DEA), developed by Charnes, Cooper [1], usually evaluates decision making units (DMUs) from the angle of the best possible relative efficiency. If a DMU is evaluated to have the best possible relative efficiency of unity, then it is said to be DEA efficient;otherwise it is said to be DEAinefficient. DEA efficient DMUs are always thought to perform better than DEA inefficient DMUs. If a DEA efficient DMU, however, also has a poorer relative efficiency than a DEA inefficient DMU,when they are both evaluated from the angle of the worst possible relative efficiency, can we still say that DEA efficient DMU performs better than the DEA inefficient DMU? It is obvious that the answer is negative. Then, there must be a method to combine the best and the worst relative efficienciesto give a general assessment of each DMU. Entani [2] considers the efficiency of DEA from both optimistic and pessimistic viewpoints. Wang [3], in 2006, evaluated the efficiency of DEA using ideal and anti-ideal decision-making units.

DUG HUN HONG, in 2006, surveyed the minimum and maximum operators for fuzzy numbers.The first paper on fuzzy DEA was written by Sengupta[5]in 1992.Fuzzy DEA models can represent real world problems more realistically than the conventional DEA models.InLertworasirikul'sbook [6] in 2002; several methods have been offered for solving the fuzzy CCR model.We can consider two approaches for solving fuzzy CCR. The first one defuzzifies the fuzzy CCR model and changes it into the equivalent crisp model and the second one uses $\alpha - levels$ tocreate interval valued linear programming that solves the fuzzy DEA by parametric programming.Tananka, Entani, Maeda [7], formulated two DEA models:one model that gives upperlimit (best case) efficiency and one model that gives lowerlimit (worst case) efficiency. With

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defuzzification approach we first defuzzify the fuzzy inputs and outputs into crisp values, and then solve the resulting crisp model using an LP solver. There are several methods such as: "COA" ,"max-min" ,"MOM", "max- max"methods; these methods are used for trapezoidal and triangular membership functions.Liu [8] also studied fuzzy DEA models. The idea of his development is the same as that proposed by Entani, Tanaka and Maeda. It falls into the category of parametric programming.

In this article, ideal and anti-ideal decision-making units have been introduced. One evaluates DMUs with fuzzy data from the viewpoint of the best possible relative efficiency, and the otherevaluates themfrom the view point of the worst relative efficiency. These two relative efficiencies combine to form RC index which expresses the relative closeness of the units to the ideal decision-making unit. All of the data of the decision-making units are fuzzy with symmetrical triangular membership function. At each $\alpha - level$ the fuzzy inputs and outputs correspond to intervals,[L,U], which we will try to evaluate the efficiency of units using appropriate $\alpha - levels$ .An interval-valued linear programming model is created by using these input and output intervals and we will try to evaluate the efficiency of units with fuzzydatausing ideal anti-ideal units and also evaluate the ranking of units through different $\alpha - levels$.

2. Fuzzy DEA models using ideal and anti-ideal decision making units

Assume that there are n decision-making units (DMUs) to be evaluated, each DMU with m inputs and s outputs. We denote the inputs and outputs of $(DMU_j)\ j = 1,2,\dots,n$ with $\tilde{x}_{ij}\ , i = 1,2,..,m$ and $\tilde{y}_{rj}\ , r = 1,2,\dots,s$which all of the inputs and outputs arefuzzysymmetrical triangularnumbers and positive. At each $\alpha - level$, the fuzzy inputs and fuzzy outputs correspond to intervals, [L, U], on the membership function, in which at each $\alpha - level$ L and U represent the lower and higher band of thedata. By using these inputs and outputs an interval linear programming model iscreated. The ideal decision-making unitwhich will be represented by IDMU and the anti-ideal decision-making unit which will be represented by ADMU are defined as follows:

Definition1: The ideal decision making unit (IDMU) is a virtual decision-making unit that has the least input and the most output. The anti-ideal decision making unit (ADMU) is a virtual decision-making unit that has the most input and the least output.

The ith input of DMU_j is $\tilde{x}_{ij\ ,i=1,2,..,m}$ $_{j=1,2,\dots,n}$ that for different $\alpha - levels$ can be defined as $(\tilde{x}_{ij})^{\alpha} = \left(\tilde{x}^{L}_{ij}(\alpha), \tilde{x}^{U}_{ij}(\alpha)\right) i = 1,2,\dots,m,\ j = 1,2,\dots,n$. Similarly, the rth output of DMU_j for different $\alpha - levels$ is $(\tilde{y}_{rj})^{\alpha} = \left(\tilde{y}^{L}_{rj}(\alpha), \tilde{y}^{U}_{rj}(\alpha)\right) r = 1,2,\dots,s$ .According to the definition1 for each $\alpha - level$ we consider $(\tilde{x}_i^{min})^{\alpha}, i = 1,2,\dots,m$, $(\tilde{y}_r^{max})^{\alpha}, r = 1,2,\dots,s$ respectively as the inputs and the outputs of the ideal decision-making unit (IDMU) and $(\tilde{x}_i^{max})^{\alpha}, i = 1,2,\dots,m\ and\ (\tilde{y}_r^{min})^{\alpha},\ r = 1,2,\dots,s$ as the inputs and the outputs of anti-ideal decision-making unit(ADMU) which defined as follows:

$$(\tilde{x}_i^{min})^{\alpha} = \left(\min\left\{\tilde{x}^{L}_{ij}(\alpha)\right\}_{j=1,\dots,n}, \min\left\{\tilde{x}^{U}_{ij}(\alpha)\right\}_{j=1,\dots,n}\right)$$
$$i = 1,2,\dots,m$$

$$(\tilde{x}_i^{max})^{\alpha} = \left(\max\left\{\tilde{x}^{L}_{ij}(\alpha)\right\}_{j=1,\dots,n}, \max\left\{\tilde{x}^{U}_{ij}(\alpha)\right\}_{j=1,\dots,n}\right)$$
$$i = 1,2,\dots,m$$

$$(\tilde{y}_r^{min})^{\alpha} = \left(\min\left\{\tilde{y}^{L}_{rj}(\alpha)\right\}_{j=1,\dots,n}, \min\left\{\tilde{y}^{U}_{rj}(\alpha)\right\}_{j=1,\dots,n}\right)$$
$$r = 1,2,\dots,s$$

$$(\tilde{y}_r^{max})^{\alpha} = \left(\max\left\{\tilde{y}^{L}_{rj}(\alpha)\right\}_{j=1,\dots,n}, \max\left\{\tilde{y}^{U}_{rj}(\alpha)\right\}_{j=1,\dots,n}\right)$$
$$r = 1,2,\dots,s$$

We can show the relative efficiency of ideal decision-making unit with θ_{IDMU} . It is clear that the ideal decision-making unit must have the best (i.e. the highest) efficiency. According to the definition of the relative efficiency, the efficiency valuefor different $\alpha - levels$ by using "Best-Best", "Worst-Worst", "Best-Worst", "Worst-Best" methods, can be obtained by solving these models:

$$Max \quad \theta_{IDMU}^{B-B} = \sum_{r=1}^{s} u_r (\tilde{y}_r^{max})_{\alpha}^{U}$$

$$s.t \quad \sum_{i=1}^{m} v_i\ (\tilde{x}_i^{min})_{\alpha}^{L} = 1 \quad (1.1)$$

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$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_{\alpha}^{U} - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_{\alpha}^{L} \le 0$$

$$j = 1,2,\dots,n$$

$$u_r \ge 0\,, v_i \ge 0\ \forall i\,, r$$

And,

$$Max \quad \theta_{IDMU}^{W-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_{\alpha}^{L}$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{min})_{\alpha}^{U} = 1 \quad (1.2)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_{\alpha}^{L} - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_{\alpha}^{U} \le 0$$

$$j = 1,2,\dots,n$$

$$u_r \ge 0\,, v_i \ge 0 \quad \forall i\,, r$$

And,

$$Max \quad \theta_{IDMU}^{B-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_{\alpha}^{U}$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{min})_{\alpha}^{L} = 1 \quad (1.3)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_{\alpha}^{L} - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_{\alpha}^{U} \le 0$$

$$j = 1,2,\dots,n$$

$$u_r \ge 0\,, v_i \ge 0 \quad \forall i\,, r$$

And,

$$Max \quad \theta_{IDMU}^{W-B} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_{\alpha}^{L}$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{min})_{\alpha}^{U} = 1 \quad (1.4)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_{\alpha}^{U} - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_{\alpha}^{L} \le 0$$

$$j = 1,2,\dots,n$$

$$u_r \ge 0\,, v_i \ge 0 \quad \forall i\,, r$$

The abovementioned models are linear programming problems in which $u_r$andv_i are the decision variables and $(\tilde{.})_{\alpha}^{U}$, $(\tilde{.})_{\alpha}^{L}$ are the column vector of the maximum and minimum values of the corresponding fuzzy sets achieved at the given $\alpha - level$ respectively. The hypothesis In "Best-Best" method is that: at each $\alpha - level$,the smallest inputs and the largest outputs are used for every DMU and in the "Worst-Worst" method at each $\alpha - level$,the largest inputs and the smallest outputs are used for every DMU.In "Best-Worst" method from the input and output intervals at each $-level$, the smallest inputs and the largest outputs are used for DMU_o ,while the largest inputs and smallest outputs are used for all other DMUs.In "Worst-Best" method from the input and output intervals at each $\alpha - level$,the largest inputs and smallest outputs are used for DMU_o, while the smallest inputs and largest outputs are used for all other DMUs.

We consider $\theta_{IDMU}^{B-B^*}$, $\theta_{IDMU}^{W-W^*}$, $\theta_{IDMU}^{B-W^*}$, $\theta_{IDMU}^{W-B^*}$ respectively as the optimal solutions of (1.1),(1.2),(1.3),(1.4) models (the best efficiency). Since there is the possibility that the abovementioned models could have multiple optimal solutions, we consider the following models for computing the efficiency of DMU_o ,on the condition that the relative efficiency of the ideal decision-making unit (IDMU) remains unchanged , utilizing "Best-Best"," Worst-Worst" , "Best-Worst" , "Worst-Best"methods at each $\alpha - level$:

$$Max \quad \theta_o^{B-B} = \sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_{\alpha}^{U}$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_{\alpha}^{L} = 1$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_{\alpha}^{U} - \sum_{i=1}^{m} v_i(\theta_{IDMU}^{B-B^*}\,(\tilde{x}_i^{min})_{\alpha}^{L}) = 0 \quad (2.1)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_{\alpha}^{U} - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_{\alpha}^{L} \le 0$$

$$j = 1,2,\dots,n$$

$$u_r\,, v_i \ge 0 \quad \forall i, r$$

$$Max \quad \theta_o^{W-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_{\alpha}^{L}$$

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$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_\alpha^U = 1$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_\alpha^L - \sum_{i=1}^{m} v_i(\theta_{IDMU}^{W-W^*}\,(\tilde{x}_i^{min})_\alpha^U) = 0 \quad (2.2)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^U \le 0$$

$$j = 1,2,\dots,n$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

$$Max \quad \theta_o^{B-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_\alpha^U$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_\alpha^L = 1$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_\alpha^U - \sum_{i=1}^{m} v_i(\theta_{IDMU}^{B-W^*}\,(\tilde{x}_i^{min})_\alpha^L) = 0 \quad (2.3)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^U \le 0$$

$$j = 1,2,\dots,n, j \ne o$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_\alpha^U - \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_\alpha^L \le 0$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

$$Max \quad \theta_o^{W-B} = \sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_\alpha^L$$

$$s.t \quad \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_\alpha^U = 1$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_r^{max})_\alpha^L - \sum_{i=1}^{m} v_i(\theta_{IDMU}^{W-B^*}\,(\tilde{x}_i^{min})_\alpha^U) = 0 \quad (2.4)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^U - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^L \le 0$$

$$j = 1,2,\dots,n, j \ne o$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{ro})_\alpha^L - \sum_{i=1}^{m} v_i\,(\tilde{x}_{io})_\alpha^U \le 0$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

In the above models, DMU_o has been the analyzed decision-making unit and $\theta_{IDMU}^{B-B^*}, \theta_{IDMU}^{W-W^*}, \theta_{IDMU}^{B-W^*}, \theta_{IDMU}^{W-B^*}$ are the optimal solutions of the(1.1),(1.2),(1.3),(1.4) models respectively.

Similarly, we can define the efficiency of anti-ideal decision-making unit ($ADMU$). It is clear that the efficiency of ADMU is worse (lower) than other decision-making units. We have the following linear programming models:

$$Min \quad \varphi_{ADMU}^{B-B} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{min})_\alpha^U$$

$$s.t \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{max})_\alpha^L = 1 \quad (3.1)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^U - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^L \ge 0 j = 1,2,\dots,n$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

And,

$$Min \quad \varphi_{ADMU}^{W-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{min})_\alpha^L$$

$$s.t \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{max})_\alpha^U = 1 \quad (3.2)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^U \ge 0 j = 1,2,\dots,n$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

And,

$$Min \quad \varphi_{ADMU}^{B-W} = \sum_{r=1}^{s} u_r\,(\tilde{y}_r^{min})_\alpha^U$$

$$s.t \sum_{i=1}^{m} v_i\,(\tilde{x}_i^{max})_\alpha^L = 1 \quad (3.3)$$

$$\sum_{r=1}^{s} u_r\,(\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i\,(\tilde{x}_{ij})_\alpha^U \ge 0 j = 1,2,\dots,n$$

$$u_r, v_i \ge 0 \qquad \forall i,r$$

And,

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$$Min \quad \varphi_{ADMU}^{W-B} = \sum_{r=1}^{s} u_r \, (\tilde{y}_r^{min})_\alpha^L$$

$$s.t \sum_{i=1}^{m} v_i \, (\tilde{x}_i^{max})_\alpha^U = 1 \qquad (3.4)$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{rj})_\alpha^U - \sum_{i=1}^{m} v_i \, (\tilde{x}_{ij})_\alpha^L \geq 0 j = 1,2,\dots,n$$

$$u_r \, , v_i \geq 0 \qquad \forall i, r$$

Let's $\varphi_{ADMU}^{B-B^*}$, $\varphi_{ADMU}^{W-W^*}$, $\varphi_{ADMU}^{B-W^*}$, $\varphi_{ADMU}^{W-B^*}$ are the optimal solutions for ADMU (the worst efficiency) with "Best-Best", "Worst-Worst","Best-Worst" ,"Worst-Best" methods through different $\alpha - levels$. Now we can consider the following linear programming models for determining the worst efficiency for DMU_o, on the condition that the efficiency of the anti-ideal decision-making unit (ADMU) remains unchanged, By using "Best-Best", "Worst-Worst","Best-Worst", "Worst-Best" methods at each $\alpha - level$ we have:

$$Min \quad \varphi_o^{B-B} = \sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^U$$

$$s.t \quad \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^L = 1$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_r^{min})_\alpha^U - \sum_{i=1}^{m} v_i \, (\varphi_{ADMU}^{B-B^*} \, (\tilde{x}_i^{max})_\alpha^L) = 0 \quad (4.1)$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{rj})_\alpha^U - \sum_{i=1}^{m} v_i \, (\tilde{x}_{ij})_\alpha^L \geq 0 \qquad j = 1,2,\dots,n$$

$$u_r \, , v_i \geq 0 \qquad \forall i, r$$

And,

$$Min \quad \varphi_o^{W-W} = \sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^L$$

$$s.t \quad \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^U = 1$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_r^{min})_\alpha^L - \sum_{i=1}^{m} v_i \, (\varphi_{ADMU}^{W-W^*} \, (\tilde{x}_i^{max})_\alpha^U) = 0 \quad (4.2)$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i \, (\tilde{x}_{ij})_\alpha^U \geq 0 \qquad j = 1,2,\dots,n$$

$$u_r \, , v_i \geq 0 \qquad \forall i, r$$

And,

$$Min \quad \varphi_o^{B-W} = \sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^U$$

$$s.t \quad \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^L = 1$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_r^{min})_\alpha^U - \sum_{i=1}^{m} v_i \, (\varphi_{ADMU}^{B-W^*} \, (\tilde{x}_i^{max})_\alpha^L) = 0 \quad (4.3)$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{rj})_\alpha^L - \sum_{i=1}^{m} v_i \, (\tilde{x}_{ij})_\alpha^U \geq 0 \quad j = 1,2,\dots,n \, , j \neq o$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^U - \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^L \geq 0$$

$$u_r \, , v_i \geq 0 \qquad \forall i, r$$

And,

$$Min \quad \varphi_o^{W-B} = \sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^L$$

$$s.t \quad \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^U = 1$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_r^{min})_\alpha^L - \sum_{i=1}^{m} v_i \, (\varphi_{ADMU}^{W-B^*} \, (\tilde{x}_i^{max})_\alpha^U) = 0 \qquad (4.4)$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{rj})_\alpha^U - \sum_{i=1}^{m} v_i \, (\tilde{x}_{ij})_\alpha^L \geq 0 \quad j = 1,2,\dots,n \, , j \neq o$$

$$\sum_{r=1}^{s} u_r \, (\tilde{y}_{ro})_\alpha^L - \sum_{i=1}^{m} v_i \, (\tilde{x}_{io})_\alpha^U \geq 0$$

$$u_r \, , v_i \geq 0 \qquad \forall i, r$$

Let's $\theta_o^{B-B^*}, \theta_o^{W-W^*}, \theta_o^{B-W^*}, \theta_o^{W-B^*}$ be the optimal solutions of (2.1),(2.2),(2.3),(2.4) problems respectively, and also $\varphi_o^{B-B^*}, \varphi_o^{W-W^*}, \varphi_o^{B-W^*}, \varphi_o^{W-B^*}$ be the optimal solutions of (4.1),(4.2),(4.3),(4.4) problems respectively, which are representative of the best and the worst relative efficiency ofDMU_o.

It is clear that the problems (1.1) to (1.4) and the problems (2.1) to (2.4) which are dependent on the ideal decision-making unit, evaluate the best relative efficiency of the ideal decision-making unit ($IDMU$)

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and the other decision-making units ($DMUs$), Also the problems (3.1) to (3.4) and (4.1) to (4.4), which are dependent on the anti-ideal decision-making unit ($ADMU$),evaluate the worst relative efficiency of the anti-ideal decision-making unit ($ADMU$) and the other decision-making units($DMUs$).

Definition 2: Suppose that $\theta_{IDMU}^{B-B^*}, \theta_{IDMU}^{W-W^*}, \theta_{IDMU}^{B-W^*}$ and $\theta_{IDMU}^{W-B^*}$ are the best relative efficiency for IDMU with four abovementioned methods and $\theta_o^{B-B^*}, \theta_o^{W-W^*}, \theta_o^{B-W^*}$ and $\theta_o^{W-B^*}$ are the best relative efficiency for DMU_o withthese methods, and $\varphi_{ADMU}^{B-B^*}, \varphi_{ADMU}^{W-W^*}, \varphi_{ADMU}^{B-W^*}$ and $\varphi_{ADMU}^{W-B^*}$ are also the worst relative efficiency for ADMU with 4 abovementioned methods and $\varphi_o^{W-B^*}, \varphi_o^{B-W^*}, \varphi_o^{W-W^*}, \varphi_o^{B-B^*}$ are the worst relative efficiency for DMU with these method. Then, the relative closeness (RC) of DMU_o to IDMU with 4 mentioned methods is defined as follows:

$$RC_o^{B-B} = \frac{\varphi_o^{B-B^*} - \varphi_{ADMU}^{B-B^*}}{(\varphi_o^{B-B^*} - \varphi_{ADMU}^{B-B^*}) + (\theta_{IDMU}^{B-B^*} - \theta_o^{B-B^*})} \quad (5.1)$$

$$RC_o^{W-W} = \frac{\varphi_o^{W-W^*} - \varphi_{ADMU}^{W-W^*}}{(\varphi_o^{W-W^*} - \varphi_{ADMU}^{W-W^*}) + (\theta_{IDMU}^{W-W^*} - \theta_o^{W-W^*})} \quad (5.2)$$

$$RC_o^{B-W} = \frac{\varphi_o^{B-W^*} - \varphi_{ADMU}^{B-W^*}}{(\varphi_o^{B-W^*} - \varphi_{ADMU}^{B-W^*}) + (\theta_{IDMU}^{B-W^*} - \theta_o^{B-W^*})} \quad (5.3)$$

$$RC_o^{W-B} = \frac{\varphi_o^{W-B^*} - \varphi_{ADMU}^{W-B^*}}{(\varphi_o^{W-B^*} - \varphi_{ADMU}^{W-B^*}) + (\theta_{IDMU}^{W-B^*} - \theta_o^{W-B^*})} \quad (5.4)$$

It is clear that the greatest difference between $\varphi_o^{B-B^*}$ and $\varphi_{ADMU}^{B-B^*}$ ، $\varphi_o^{W-W^*}$ and $\varphi_{ADMU}^{W-W^*}$ ، $\varphi_o^{B-W^*}$ and $\varphi_{ADMU}^{B-W^*}$ ، $\varphi_o^{W-B^*}$ and $\varphi_{ADMU}^{W-B^*}$ and the lowest difference between $\theta_o^{B-B^*}$ and $\theta_{IDMU}^{B-B^*}$ ، $\theta_o^{W-W^*}$ and $\theta_{IDMU}^{W-W^*}$ ، $\theta_o^{B-W^*}$ and $\theta_{IDMU}^{B-W^*}$ ، $\theta_o^{W-B^*}$ and $\theta_{IDMU}^{W-B^*}$ displays the better performance of DMU_o. Therefore, the bigger RC value with the 4 aforementioned methods represents the better performance of DMU_o. Since the RC index integrates both the best and the worst possible relative efficiencies of each DMU, it can be regarded as a general ranking of DMUs.

3. An applied example

Suppose 5 decision-making units with two fuzzy inputs and outputs as shown in table 1, all of which have symmetrical triangular membership functions. The membership functions are denoted by (c, d) where c is the center and d is the spread of the membership functions.

DMU (j)	1	2	3	4	5
Input 1	(4.0,0.5)	(2.9,0.0)	(4.9,0.5)	(4.1,0.7)	(6.5,0.6)
Input 2	(2.1,0.2)	(1.5,0.1)	(2.6,0.4)	(2.3,0.1)	(4.1,0.5)
Output 1	(2.6,0.2)	(2.2,0.0)	(3.2,0.5)	(2.9,0.4)	(5.1,0.7)
Output 2	(4.1,0.3)	(3.5,0.2)	(5.1,0.8)	(5.7,0.2)	(7.4,0.9)

Table 1.Decision Making Units with fuzzy inputs and outputs

Through different $\alpha - levels$, such as $\alpha = 0,0.25,0.5,0.75,1$, we calculate the efficiency and the ranking of units using "Best-Best" ," Worst-Worst"," Best-Worst"," Worst-Best" methods. Tables from 2 to 5 includes 5 columns, the first section of which represents the efficiency of decision-making units through different $\alpha - levels$ with input-oriented CCR model using the aforementioned methods and the second column of the tables,the row related to IDMU represent the efficiency of the ideal decision-making unit through different $\alpha - levels$ depending on the method chosen using (1.1) or (1.2) or (1.3) or (1.4) models , and the other rows except the row related to ADMU, represent the efficiency of decision-making units through different $\alpha - levels$, depending on the method chosen using (2.1) or (2.2) or (2.3) or (2.4) models.The third column of the tables, the row related to ADMU represents the efficiency of the anti-ideal decision-making unit through different $\alpha - levels$ depending on the method chosen, utilizing (3.1) or (3.2) or (3.3) or (3.4) models, and the other rows, except the row related to IDMU, represent the efficiency of decision-making units through different $\alpha - levels$, depending on the method chosen using (4.1) or (4.2) or (4.3) or (4.4) models.The 4th section of the tables indicate RC index which represents the relative closeness of the evaluated decision-making unit to ideal decision making unit through different$\alpha - levels$, depending on the method chosen using (5.1) or (5.2) or (5.3) or (5.4) models, and finally The last section of the tables represents the ranking of decision-making units through

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different $\alpha - levels$ by using RC indexand " Best-Best", "Worst-Worst", "Best-Worst" and "Worst-Best"methods.

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Table2: Efficiency and RC values for the 5 DMUs with "Best-Best" method for different $\alpha - levels$

Best-Best	CCR efficiency					CCR/IDMU efficiency					CCR/ADMU efficiency					RC					RANK				
α	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
DMU1	0.899	0.919	0.909	0.887	0.855	0.877	0.865	0.909	0.887	0.855	1	1	1	1	1.005	0.269	0.258	0.269	0.275	0.280	5	5	5	5	4
DMU 2	0.985	1	1	1	1	0.934	۰/۹۹۳	1	1	1	1.065	1.094	1.123	1.153	1.191	0.298	0.304	0.322	0.341	0.364	3	2	1	1	1
DMU 3	1	1	0.958	0.907	0.861	1	1	0.958	0.907	0.857	1.141	1.102	1.064	1.028	1	0.332	0.307	0.296	0.287	0.279	1	1	3	3	5
DMU 4	1	1	1	1	1	0.893	0.925	0.963	0.953	0.921	1.019	1.036	1.020	1.02	1.025	0.278	0.276	0.283	0.291	0.297	4	4	4	2	3
DMU 5	1	1	1	1	1	0.959	0.971	1	0.89	1	1.092	1.07	1.048	1.026	1	0.310	0.293	0.297	0.284	0.3	2	3	2	4	2
IDMU	-	-	-	-	-	2.463	2.54	2.477	2.398	2.318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ADMU	-	-	-	-	-	-	-	-	-	-	0.415	0.419	0.423	0.428	0.436	-	-	-	-	-	-	-	-	-	-

Table3: Efficiency and RC values for the 5 DMUs with "Worst-Worst" method for different $\alpha - levels$

Worst-Worst	CCR efficiency					CCR/IDMU efficiency					CCR/ADMU efficiency					RC					RANK				
α	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
DMU1	0.788	0.800	0.813	0.826	0.855	0.759	0.738	0.801	0.822	0.855	1.154	1.112	1.074	1.038	1.005	0.343	0.316	0.306	0.292	0.280	3	3	3	3	4
DMU 2	1	1	1	1	1	1	1	1	1	1	1.455	1.395	1.329	1.260	1.191	0.487	0.456	0.425	0.394	0.364	1	1	1	1	1
DMU 3	0.699	0.734	0.772	0.814	0.861	0.659	0.697	0.755	0.786	0.857	1	0.999	1	0.999	1	0.269	0.269	0.273	0.272	0.279	5	5	5	4	5
DMU 4	1	1	1	1	1	0.758	0.741	0.810	0.830	0.921	1.511	1.353	1.228	1.129	1.025	0.447	0.392	0.359	0.324	0.297	2	2	2	2	3
DMU 5	0.817	0.868	0.921	0.976	1	0.817	0.732	0.921	0.783	1	1	0.999	1	0.996	1	0.295	0.274	0.298	0.271	0.3	4	4	4	5	2
IDMU	-	-	-	-	-	2	2.08	2.159	2.239	2.318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ADMU	-	-	-	-	-	-	-	-	-	-	0.506	0.491	0.474	0.455	0.436	-	-	-	-	-	-	-	-	-	-

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Table 4: Efficiency and RC values for the 5 DMUs with "Best-Worst" method for different $\alpha - levels$

Best-Worst	CCR efficiency					CCR/IDMU efficiency					CCR/ADMU efficiency					RC					RANK				
α	'	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
DMU1	1	1	0.963	0.904	0.855	1	1	0.951	0.896	0.855	1.637	1.447	1.281	1.135	1.005	0.322	0.315	0.303	0.291	0.280	4	3	5	4	4
DMU 2	1	1	1	1	1	1	1	1	1	'	1.746	1.584	1.439	1.310	1.191	0.346	0.349	0.352	0.358	0.364	2	1	1	1	1
DMU 3	1	1	1	0.932	0.861	1	1	1	0.922	0.857	1.583	1.417	1.263	1.123	1	0.310	0.308	0.304	0.290	0.279	5	4	4	5	5
DMU 4	1	1	1	1	1	1	1	0.971	0.914	0.921	1.666	1.475	1.307	1.158	1.025	0.329	0.322	0.313	0.300	0.297	3	2	3	3	3
DMU 5	1	1	1	1	1	1	1	0.997	0.92	1	1.79	1.340	1.343	1.164	1	0.356	0.287	0.327	0.303	0.3	1	5	2	2	2
IDMU	-	-	-	-	-	3.013	2.826	2.648	2.479	2.318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ADMU	-	-	-	-	-	-	-	-	-	-	0.679	0.606	0.542	0.486	0.436	-	-	-	-	-	-	-	-	-	-

Table 5: Efficiency and RC values for the 5 DMUs with "Worst-Best" method for different $\alpha - levels$

Worst-Best	CCR efficiency					CCR/IDMU efficiency					CCR/ADMU efficiency					RC					RANK				
α	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
DMU1	0.624	0.702	0.758	0.807	0.855	0.624	0.702	0.758	0.807	0.855	0.711	0.775	0.844	0.917	1.005	0.277	0.268	0.266	0.269	0.280	3	3	4	4	4
DMU 2	0.836	0.908	0.990	1	1	0.836	0.908	0.972	1	1	0.891	0.966	1.041	1.113	1.191	0.410	0.39	0.38	0.371	0.364	1	1	1	1	1
DMU 3	0.571	0.642	0.716	0.791	0.861	0.565	0.641	0.714	0.788	0.857	0.617	0.697	0.786	0.883	1	0.217	0/222	0.235	0.253	0.279	5	5	5	5	5
DMU 4	0.855	0.943	1	1	1	0.620	0.706	0.771	0.839	0.921	0.990	1	1	1.010	1.025	0.393	0.358	0.327	0.308	0.297	2	2	3	2	3
DMU 5	0.638	0.735	0.845	0.969	1	0.638	0.722	0.825	0.963	1	0.611	0.689	1	0.868	1	0.225	0.230	0.336	0.272	0.3	4	4	2	3	2
IDMU	-	-	-	-	-	1.672	1.889	2.066	2.208	2.318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ADMU	-	-	-	-	-	-	-	-	-	-	0.310	0.340	0.371	0.402	0.436	-	-	-	-	-	-	-	-	-	-

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4.Conclusion

In this article ,the method of defining ideal and anti-ideal decision-making units when the data are fuzzy numbers and also an RC index , which represents the relative closeness of the evaluated decision-makiong unit to the ideal decision-making unit, were introduced. Considering different $\alpha-$ levels and Worst-Best, Best-Worst, Worst-Worst and Best- Best methods, we can defuzzify, fuzzy models and compute the efficiency of decision-making units considering ideal and anti-ideal decision-making units and rank decision-making units with fuzzy data by calculating the RC index.

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Variation of Boyer-Moore String Matching Algorithm: A Comparative Analysis

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Abstract- **String matching plays an important role in field of Computer Science and there are many algorithm of String matching, the important aspect is that which algorithm is to be used in which condition. BM(Boyer-Moore) algorithm is standard benchmark of string matching algorithm so here we explain the BM(Boyer-Moore) algorithm and then explain its improvement as BMH (Boyer-Moore-Horspool), BMHS (Boyer-Moore-Horspool-Sundays), BMHS2 (Boyer-Moore-Horspool-Sundays 2), improved BMHS(improved Boyer-Moore-Horspool-Sundays) ,BMI (Boyer-Moore improvement) and CBM (composite Boyer-Moore).And also analyze and compare them using a example and find which one is better in which conditions.**

Keywords-String Matching: BM; BMH; BMHS; BMHS2; improved BMHS; BMI; CBM

I. INTRODUCTION

In computer science, the Boyer-Moore string search algorithm is a particularly efficient string searching algorithm, and it has been the standard benchmark for the practical string search literature.

It was developed by Bob Boyer and J Strother Moore in 1977. The algorithm preprocesses the pattern string that is being searched in text string. [5]

Before BM algorithm was proposed, the direction of character comparison was consistent to the moving direction of the pattern i.e. both are from left to the right. But in BM the direction of character comparison is different from the moving direction of the pattern i.e. from right to left in pattern.[4]

After BM algorithm was proposed there were some algorithms are proposed to improve it. In 1980, Horspool simplified BM algorithm and proposed BMH algorithm Although it only used the information of the table Right, BMH algorithm acquired no bad efficiency. In 1990 Sunday proposed BMHS algorithm that improved the BMH algorithm.[6]

In 2010, Lin quan Xie, Xiao ming liu proposed BMHS2, which is strictly based on the analysis of BMHS algorithm to improve is in the match fails, the text string matches last bit characters to participate in the next match, a character string in the case appear to increase the last bit character and appear in the character string matching the first characters of a position if there is consideration.[3]

In 2010 BMI algorithm is proposed by Jingbo Yuan, Jisen Zheng, Shunli Ding which is improvement of BM algorithm. The BMI algorithm combines with the good-suffix function and the advantages of BMH and BMHS.At the same time the BMI algorithm also takes into account the singleness and combination features of the Next-Character and the Last- Character. [8, 9]

There are two important factors which influence the efficiency and speed of pattern matching and they are the cost to find the mismatching character in the text string and the shift distance to right.On basis of the two factors, an improved algorithm called Improved BMHS algorithm which is given by Yuting Han, Guoai Xu in 2010. [7]

Another improved algorithm called composite Boyer-Moore was proposed in 2010 by Zhengda Xiong. The key issue of the composite Boyer-Moore algorithm is how to utilize the history comparison information achieved at previous iteration. So a new concept of two-dimensional table Jump[*m*][*m*] is introduced.[4]

II. BM ALGORITHM

The BM algorithm scans the characters of the pattern from right to left beginning with the rightmost one and performs the comparisons from right to left. In case of a mismatch (or a complete match of the whole pattern) it uses two pre-computed functions to shift the window to the right. These two shift functions are called the good-suffix shift (also called matching shift and the bad-character shift (also called the occurrence shift).

Assume that a mismatch occurs between the character $P[i] = b$ of the pattern and the character $T[i+j] = a$ of the text during an attempt at position j. Then, $P[i+1 .. m-1] = T[i+j+1 .. j+m-1] = u$ and $P[i] \neq T[i+j]$.The good-suffix shift consists in aligning the segment $T[i+j+1 .. j+m-1] = P[i+1 .. m-1]$ with its rightmost occurrence in P that is preceded by a character different from $P[i]$.

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BM algorithm will carry through shift computing as follow.

(1) good-suffix function

The algorithm looks up string *u* leader character is not *b* in *P* from right to left. If there exist such segment, shift right *P* to get a new attempt window. If there exists no such segment, the shift consists in aligning the longest suffix *v* of *T[i+j+1 .. j+m- 1]* with a matching prefix of *P*.

(2) bad-char function

The bad-character shift consists in aligning the text character *T [i+j]* with its rightmost occurrence in *P [0 ... m-2*].

If *T[i+j]* does not occur in the pattern *P*, no occurrence of *P* in *T* can include *T[i+j]*, and the left end of the window is aligned with the character immediately after *T[i+j]*, namely *T[i+j+1]*

BM algorithm uses good-suffix function and bad-char function to calculate the new comparing position, shifting rightward *P* by taking maximum of these two values. [1]

Practice shows that BM Algorithm is fast in the case of larger alphabet. In preprocessing phase, time and space complexity is *O (m+* ů*)*, where ů is the size of the finite character set relevant with pattern and text. In searching phase time complexity is in *O (mn)*. There are *3n* text character comparisons in the worst case when searching for a non periodic pattern. Under best performance time complexity is *O (n/m)*. Under the worst time complexity is *O (mn)*. [1]

Advantages

- The both good-suffix and bad-char combined provides a good shift value as maximum of two is taken as shift value.

Disadvantages

- The preprocessing of good-suffix is complex to implement and understand.
- Bad-char of mismatch character may give small shift, if mismatch after many matches.

***Example*:** We have a text string ñ*STRINGMATCHINGISTOFINDTHEPATTERN*ò. And a pattern ñ*PATTERN*ò which is to find in a text string, so we apply all above algorithm as discussed below to solve this example. Example of BM is *shown in Table 1.*

TABLE 1.BM Example (5 Shift and 13 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																									
2								P	A	T	T	E	R	N																		
3															P	A	T	T	E	R	N											
4																						P	A	T	T	E	R	N				
5																									P	A	T	T	E	R	N	
6																										P	A	T	T	E	R	N

III. IMPROVEMENT OF BM ALGORITHM

A. *BMH Algorithm*

The preprocessing of good suffix is hard to be understood and implemented; BMH algorithm only uses the bad characters shift. In BMH algorithm, no matter the location of mismatching, the distance of shift to right is determined by the character in the text string which is aligned to the last one of pattern string.[7]

In preprocessing phase, time complexity is*O*(*m+ s*). In searching phase, time complexity is *O*(*mn*). In the best performance, time complexity is *O*(*n /m*). Practical applications show that BMH algorithm is much more efficient than BM algorithm. [2] [10]

Example: shown in Table 2.

Advantages

- The concept of Good-suffix is removed so easy to implement.
- In case of mismatch ,the shift value is determined by the bad char value of last character instead of character that caused mismatch so more jump is archived using bad char than in BM.

Disadvantages

- The removal of good-suffix sometime may not give shift as much as in BM.

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TABLE 2.BMH Example (5 Shift and 13 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																										
2								P	A	T	T	E	R	N																			
3															P	A	T	T	E	R	N											
4																						P	A	T	T	E	R	N				
5																									P	A	T	T	E	R	N	
6																										P	A	T	T	E	R	N

B. BMHS Algorithm

The core idea is in the calculation of Bad char function; consider the situation of the next character, namely the use of the next character T[m] to determine the right offset. If the character does not appear in the matching string is skip that step by pattern length + 1; otherwise, the mobile step= match strings in the far right of the character to the end of the range+1.In the matching process, the mode string must not be asked to compare, it does not match is found, the algorithm can skip as many characters to match the next step to improve the matching efficiency. [3]

BMHS algorithm worst case time complexity is O (mn), the best case time complexity is O (n/m+1). For a short pattern string matching problem, the algorithm is faster. [3]

Example: shown in Table 3

Advantages

- In BMH the maximum shift achieved is equal to pattern length but in BMHS the maximum shift that can be achieved is equal to one more than pattern length.

Disadvantages

- Suppose last character is not in pattern but next-to-last character is in pattern so In state of mismatch less shift is achieved as compared to BMH.

TABLE 3.BMHS Example (4 Shift and 13 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																										
2							P	A	T	T	E	R	N																				
3															P	A	T	T	E	R	N											
4																							P	A	T	T	E	R	N			
5																										P	A	T	T	E	R	N

C. BMHS2 Algorithm

The idea of algorithm is when mismatch occur at any position then the Right Shift value is determined by Next-to-Last character and Last character of Text corresponding to Pattern that is T[i+m] and T[i+m-1] where m is length of Pattern.

Now matching start from Last character of Pattern, if mismatch at any position than consider Next-to-Last character (T[i+m]) of Text and find its position in pattern

(1) If not in pattern than right shift by m+1.
(2) If occur at first position than right shift by m.
(3) If occur other than first position than shift calculated is X than
   - Consider Last character of Text corresponding to pattern and calculate shift, if shift calculated by this is X than shift by X.
   - Otherwise shift by m+1.

BMHS2 algorithm worst case time complexity is O(mn), the best case time complexity is O(n),where n is length of text and the maximum moving distance of m+1. [3]

Example: shown in Table 4

Advantages

- This algorithm considers last character and next-to-last character both so it combined advantages of both BMH and BMHS.

Disadvantages

- Searching overhead increases as we have to take care of two characters for calculation of shift.

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TABLE 4.BMHS2 Example (4 Shift and 11 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																										
2									P	A	T	T	E	R	N																		
3																	P	A	T	T	E	R	N									
4																									P	A	T	T	E	R	N	
5																										P	A	T	T	E	R	N

D. Improved BMHS Algorithm

The improved algorithm uses the comparative order from right to left. Supposing that the pattern string P0P1é P_{M-1} aligns with the part of the text string T_{k-m+1} é T_{k-1} T_k.

The preprocessing phase is as follows: construct the array *Skip*[*x*] according to the bad-character rules, in the conditions of $x \in \times$. In addition, improved algorithm needs to construct *Num*[*y*] which records the times of each character appearing in the pattern string.

The searching phase is as follows: compare the character *Pm-1* with *T* k.

When mismatch occurs between P_{m-1} and T_k, calculate Skip $[T_{k+1}]$ and *Skip* $[T_{k+2}]$. If *Skip* $[T_{k+1}]$ is equal with one, the pattern string will shift one point to right. Otherwise, the movement will be determined by the larger one between Skip $[T_{k+1}]$ and *Skip* $[T_{k+2}]$.

When P_{m-1} and T_k match successfully, compare the character P_{m-2} with character T_{k-1}. If the match is successful, continue to comparing P_{m-3} and T_{k-2}, P_{m-4} and T_{k-3}, and so on, until the text string is matched completely. If mismatch occurs at P_{m-4} Í T_{k-3}, calculate Skip $[T_{k+1}]$ and *Skip* $[T_{k+2}]$. If *Skip* $[T_{k+1}]$ is equal with one, check Num $[P_{m-3}]$ whether it is equal with one, if *Num* $[P_{m-3}]$ is equal with one, change *Skip* $[T_{k+1}]$ to m+1. Then compare between *Skip* $[T_{k+1}]$ and *Skip* $[T_{k+2}]$, select the larger one as the movement of the Pattern shift. [2]

In preprocessing phase, time complexity is *O* (*m*+ *s*). In searching phase, if the successful match takes place in *Ti,* it is compared (i-1)*m times before successful matching, and m times during article i time of comparison. So it is compared i*m times.

The time complexity is *O* (*mn*). In the best case, if successful match takes place in *Ti,* it is compared *i* /(*m*+2) times before successful matching, and m times during article i time of comparison. So it is compared m+*i* / (*m*+2) times. The best time complexity is *O* (*n* /*m*+2). [2]
Example: shown in Table 5

Advantages

- Maximum shift that can be achieved using this algorithm is pattern length + 2.

Disadvantages

- Calculation of shift using Next-to-Last and Next-to-Next-to-Last character increase searching over head and for that preprocessing of Num[ ] is done which increases preprocessing overhead.

TABLE 5.Improved BMHS Example (4 Shift and 12 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																										
2							P	A	T	T	E	R	N																				
3																P	A	T	T	E	R	N										
4																									P	A	T	T	E	R	N	
5																										P	A	T	T	E	R	N

E. BMI Algorithm

The BMI algorithm combines with the good-suffix function and the advantages of BMH and BMHS [8][9]. At the same time the BMI algorithm also takes into account the singleness and combination features of the *Next-Character* and the *Last- Character.*

The basic idea behind the algorithm is to achieve the maximum shift distance in the event of a mismatch. Assume that now *P [0]…P[m-1]* correspond to *T[i]…T[i+m-1]* during the attempt. If a mismatch occurs, the shift right position will be calculated with function *Onechar(x)* and *TwoChar(x)* as following formula (1) and (2).[1]

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$$\text{OneChar(X)} = \begin{cases} -1 & \text{Character } x \text{ not in pattern} \\ j & \text{the rightmost position of character } x \text{ in pattern} \end{cases} \quad (1)$$

$$\text{TwoChar(X)} = \begin{cases} -1 & \text{two characters } T[j+m-1]x \text{ not in pattern} \\ j & \text{the rightmost position of characters } T[j+m-1]x \text{ in pattern} \end{cases} \quad (2)$$

Define: The *Last-Character* refers to the rightmost character of each attempting window in text *T*. The *Next-Character* refers to the first character on right side of attempting window in text *T*.

Now if m comparisons have completed and $T_iT_{i+1}...T_{i+m-1}=P_1P_2...P_{m-1}$, the matching is successful. If $(P_j=a) \neq (T_{i+j}=b)$ in *(m-j)*-th comparison, the BMI algorithm calculates the jump shift as below methods. Denote $T_{i+j+1}T_{i+j+2}...T_{i+m-1}=P_{j+1}P_{j+2}...P_{m-1}=u$ *and* $T_{i+j}\neq P_j$.

(1)Calculate the jump shift using the *Last-Character d* in pattern and *OneChar* function. The algorithm looks up the position of the first occurrence of the *Last-Character d* from right to left in $P_0P_1...P_{m-2}$. If found the position, the pattern *P* right shifts to align with character *d*. If not found the position, the pattern *P* right shifts to align with right side of character d. Then the algorithm begins to compare in new attempt window.

(2)Calculate the jump shift using the *Next-Character c* and *OneChar* function. The algorithm look up the position of the first occurrence of *Next-Character c* from right to left in *P0P1…Pm-1*. If found the position, the pattern *P* right shifts to align with character *c*. If not found the position, the pattern *P* right shifts to align with right side of character *c*. Then the algorithm begins to compare in new attempt window.

(3)Calculate the jump shift using the Last-Character d, the Next-Character c and TwoChar function. Denote X as the combination of character b and c, that is, X=bc. The algorithm look up the position of the first occurrence of X from right to left in P0P1é Pm-1. If found the position, the pattern P right shifts to align with character b. If not found the position, the pattern P right shifts to align with right side of character *b*. Then the algorithm begins to compare in new attempt window.

In the case of mismatch, the BMI algorithm combines three different shift functions to optimize the number of characters that can be skipped during the skip process.

If the *Last-Character d* is matching with the rightmost character of Pattern, the algorithm calculates the jump shift using above three methods and takes the maximum value of its results as final jump shift. If failed, the algorithm calculates the jump shift using above method (1) and method (2) and takes the maximum value as final jump shift. [1]

Under best performance the time complexity of BM and BMH algorithm all are *O(n/m)*, the time complexity of BMHS and BMI algorithm all are *O(n/m+1)*, but the average time complexity of BMI algorithm is better. [1]

Example: shown in Table 6

Advantages

- BMI uses last character, Next-to-Last character and combination of these two characters for calculation of shift means BMI Takes advantages of BMH, BMHS and good-suffix feature of BM for combination of last character and Next-to-Last character.

Disadvantages

- In calculation of shift using three different methods and taking maximum of these increases overhead in searching.

TABLE 6.BMI Example (4 Shift and 11 Comparisons)

	S	T	R	I	N	G	M	A	T	C	H	I	N	G	I	S	T	O	F	I	N	D	T	H	E	P	A	T	T	E	R	N
1	P	A	T	T	E	R	N																									
2								P	A	T	T	E	R	N																		
3																P	A	T	T	E	R	N										
4																							P	A	T	T	E	R	N			
5																										P	A	T	T	E	R	N

F. CBM Algorithm

The key issue of the CBM algorithm is how to utilize the history comparison information achieved at previous iteration. So we construct a two-dimensional table Jump[*m*][*m*]. Jump[*i*][*j*] denotes the shift distance of pattern P, when the mismatch at previous iteration appears at p[*i*], and the mismatch at current iteration appears at p[*j*]. This table is only related to pattern P. Once Jump[*m*][*m*] is constructed, it can be utilized for searching P in different texts.

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The comparison principle of algorithm CBM is shown in Figure 1. Suppose P is at place P_0 at previous iteration, and the mismatch appears at index *i* of P_0; and suppose P is at place P_1 at current iteration, the mismatch appears at index *j* of P_1; then P_2, P's new position, must meet following conditions: its substring at B matches with P_1's substring at B; its character at *b* does not match P_1's character at *j*; its substring at A matches P_0's substring at A; and its character at *a* does not matches with P_1's character at *i*. Above four matching conditions make a large shift distance Jump[*i*][*j*] for pattern P.[4]

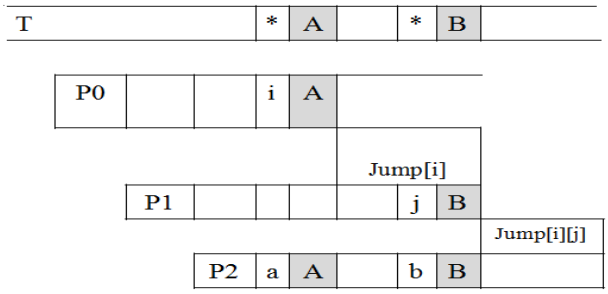

Figure1.Working principle of CBM

In the procedure, the initial values of Jump[*i*][*j*] is set to Jump[*j*] for every *i*. Then the values increased gradually by test, until it satisfies above four matching conditions. After generating table Jump[m][m], the specific matching process is similar to the BM algorithm.

In the case of small alphabet and long pattern, values in Jump[m][m] that is close to the right column are usually larger than the corresponding values in Jump[m], and the matching efficiency are improved. Binary searching in Computer Science and DNA sequence tests in genetic engineering are such kind of applications. [4]

IV. COMPARISON AND ANALYSIS

BMH algorithm is more efficient when last character does not occur in pattern. BMHS is more effective than BMH when last character occur in pattern but next to last character does not occur in pattern. Improved BMHS algorithm is efficient when next to last character and next to next to last character does not occur in pattern. BMHS2 perform better when next to last character does not occur in pattern or occur at first position in pattern. BMI algorithm perform better when Next to Last character does not occur in pattern; Or when Last character does not occur in pattern; Or when combination of Last character with Next to Last character does not occur in pattern. CBM is effective in case of small alphabet and long pattern such as Binary Searching.

Analysis Based on Example:

- In our example BM and BMH performance was equal as SHIFT=5 and Comparison=13.
- In case of BMHS SHIFT decreases to 4 but Comparison remains to 13, so we can't say that BMHS always perform better than BMH, it totally depends on Input.
- Improved BMHS performance is better than BM, BMH and BMHS as SHIFT=4 and Comparison=12.
- Performance of BMI and BMHS2 is even better than Improved BMHS as SHIFT=4 and Comparison=11.
- In example performance of BMI and BMHS2 is equal but we also can't say that there performance remains always same, it is also depends on Input.

Table 7.Comparison

Para.\Algo.	BM	BMH	BMHS	Improved BMHS	BMHS2	BMI
SHIFT	5	5	4	4	4	4
COMPARISION	13	13	13	12	11	11
BEST-CASE TIME COMPLEXITY	O(n/m)	O(n/m)	O(n/m+1)	O(n/m+2)	O(n/m+1)	O(n/m+1)
WORST-CASE TIME COMPLEXITY	O(mn)	O(mn)	O(mn)	O(mn)	O(mn)	O(mn)

Analysis Based on Experiment:
Experimental Environment
Processor: i7
RAM: 8 GB
OS: windows 7
Language: visual C++ runs on visual studios 2008

Experimental Data
Text File: of size 2, 68,196 KB in which large number of occurrence of pattern.
Pattern of length 15

Experiment

In the experiment we have search a pattern in text and calculated number of comparison which is how many times we compare pattern character with text character and search time is also calculated in milliseconds. The results as search time and number of comparison, corresponding to different algorithm are shown in table 8.

TABLE 8: Experimental Results

S.N.	Para\Algo	No. of Comparison	Search Time (millisec.)
1	BM	26112769	108
2	BMH	26220229	110
3	BMHS	26041122	120
4	Improved BMHS	20238289	104
5	BMI	20023363	92
6	BMHS2	19199507	73

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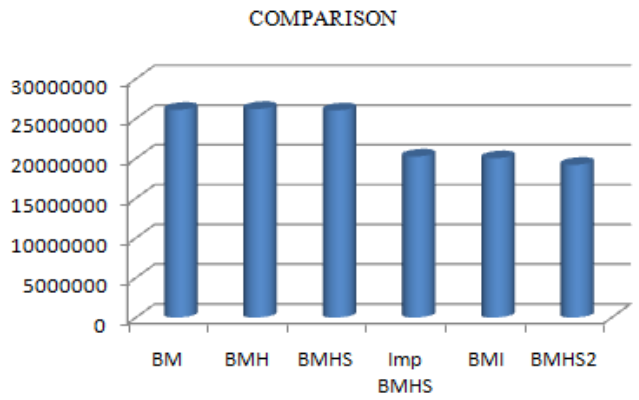
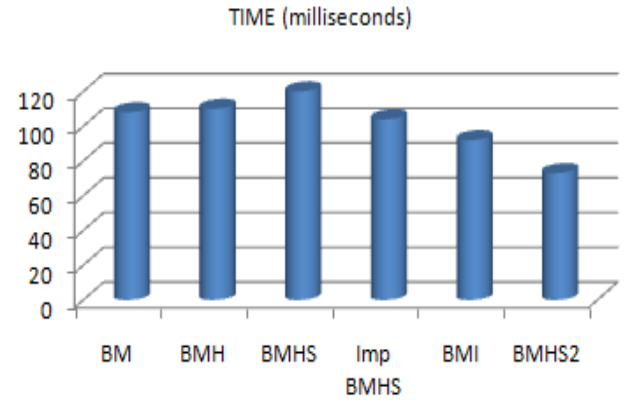
On the basis of experimental results we plot bar graphs for comparison and search time as shown in graph1 and graph2.



Graph1: Number of Comparison of Different Algorithm



Graph2: Searching Time of Different Algorithm

V. CONCLUSION

The comparison of BM and its relative algorithm is performed on the basis two factors; one is number of comparison performed and second is search time. In example and in experiment we present a comparison on the basis of number of comparison performed that performance of BM, BMH and BMHS are almost equal as number of comparison is almost same. Improved BMHS perform better than BMHS as number of comparison decreases.BMI and BMHS2 perform even better than Improved BMHS as number of Comparison decreases. In Experiment we also present a comparison on the basis of search time in which BM and BMH perform almost same but BMHS search time increases. Improved BMHS search time is less in comparison to BM, BMH and BMHS. In BMI searching is faster than above four and BMHS2 search time is even less than BMI. So finally we can say that BMHS2 is best of all six algorithms as search time and number of comparison both are less than in all other algorithm.

Composite Boyer-Moore algorithm is efficient in case of binary searching where small varieties of alphabet and long pattern.

The performance of algorithm depends on two factors, first on Input, number of inputs and type of inputs, Second is Methodology of algorithm, so there may be possible that some variation in performance occur as input changes.

VI. FUTURE WORK

The focus of future work is to improve existing algorithm and finding the efficient string searching algorithm so that searching speed can be increased and performance as well.

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Performance Evaluation of Speaker Identification using Spectrogram and Hartley Transform with Cropped Feature Vector

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***Abstract*— This paper presents a novel approach for speaker identification using spectrograms and Hartley transform. Performance of this approach is observed to be improving up to 88.34% as cropping of feature vector is done at the specific area of transformed spectrograms. Computational complexity of this technique is found to be same as the computational complexity of our previous work using DCT and spectrograms.**

Keywords-Speaker Identification, Hartley Transform, Spectrogram

I. INTRODUCTION *(HEADING 1)*

With extensive use of networks along with the computer systems, security of user's data has become a major issue in today's era. Various security measures are successfully used. Many more are under development and research to provide trustworthy systems. Biometrics is one of such security providing technique, wherein user is authenticated before allowing access to the information or resources. Face recognition, fingerprint recognition, iris recognition, palm print recognition, speaker identification are some the well known biometric techniques. All these techniques are using some physical or behavioral characteristic of human being and have its own pros and cons. Speaker identification is identifying a speaker based on the unique characteristics present in the speech signals [1]. In this paper, closed set text dependent speaker identification is considered. In the proposed method, speaker identification is carried out with spectrograms and Hartley transformation technique. This work is an extension to our previous work of Speaker Identification using the transforms such as DCT, WALSH and HAAR [2], [3], [4], [5]. Similar to these techniques, selection of cropped or partial feature vector is tried in the presented work using Hartley, to observe its effect on accuracy of the system. Selecting appropriate area for cropping the feature vector has been found interesting in Speaker Identification using Spectrogram and various transformation techniques.

The rest of the paper is organized as follows: In section 2 we present related work carried out in the field of speaker identification. In section 3, proposed approach and experimental work has been presented. Results are tabulated in section 4. Conclusion has been outlined in section 5.

II. RELATED WORK

There are many techniques used to parametrically represent a voice signal for speaker recognition task. Mel Frequency Cepstrum Coefficient is the most popular one. Davis and Mermelste in [6] have described the energy distribution of speech signal in a frequency field. Wang Yutai et. al. [7] has proposed a speaker recognition system based on dynamic MFCC parameters. This technique combines the speaker information obtained by MFCC with the pitch to dynamically construct a set of the Mel-filters. These Mel-filters are further used to extract the dynamic MFCC parameters which represent characteristics of speaker's identity. Another histogram based technique has been proposed by Sleit, Serhan and Nemir [8]. This histogram based speaker identification technique uses a reduced set of features generated using MFCC method. For these features, histograms are created using predefined interval length. These histograms are generated first for all data in feature set for every speaker. In second approach, histograms are generated for each feature column in feature set of each speaker. Vector Quantization (VQ) is yet another approach of feature extraction [9], [10], [11], [12]. In Vector Quantization based speaker recognition systems; each speaker is characterized with several prototypes known as code vectors [13]. Speaker recognition based on non-parametric vector quantization was proposed by Pati and Prasanna [14]. Another widely used method for feature extraction is use of linear Prediction Coefficients (LPC). LPCs capture the information about short time spectral envelope of speech. LPCs represent important speech characteristics such as formant speech frequency and bandwidth [15].

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III. PROPOSED TECHNIQUE

Before proceeding with the proposed algorithm, we would like to elaborate some observations on Hartley transform and its energy distribution.

As we know, DCT has the tendency to concentrate energy of an image or entropy of an image at the top left corner of an image. This makes us possible to crop the feature vector of an image as shown in Fig.1.

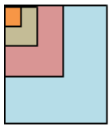

Figure 1. Cropping of feature vector in case of DCT on image

The outermost rectangle represents the feature vector without cropping. As we move towards the upper left corner we get cropped feature vectors of smaller sizes.

This however does not hold true for Hartley transform. If we crop the feature vector of Hartley transformed image to get the top left portion as feature vector, we end with a reduced accuracy for Speaker Identification.

Reason behind this is where Hartley transform tends to concentrate the entropy of an image. If we see the plot of energy of an image using DCT and Hartley respectively, we can easily find out the difference between energy concentrations areas in both the cases. In case of DCT, it is top left corner of an image as shown in Fig. 2.

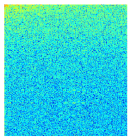

Figure 2. Energy distribution for DCT on one of the spectrogram from dataset

However, for Hartley, energy of an image is observed to be concentrated in four corners of an image as shown in Fig. 3.

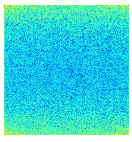

Figure 3. Energy distribution for Hartley on one of the spectrogram from dataset

Hence cropping the feature vector from Hartley transformed image makes sense to select the coefficients from four corners of a transformed image unlike DCT as shown in Fig. 4. The outer rectangle shows the full feature vector of an image. The rectangles with same color, at four corners show the cropped feature vectors. These four corners are then appended to form a cropped feature vector of an image. Fig. 5 shows energy distribution of such appended four corners.

Figure 4. Cropping of feature vector when Hartley transform is applied to an image

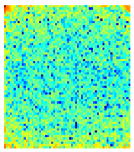

Figure 5. Energy distribution of cropped feature vector obtained by appending the four corners of Hartley transformed image

We now present the proposed technique after this sufficient elaboration.

The experimental work has been continued with the database of speakers used in our previous work [2], [3], [4], [5].

This database contains speech sentences recorded for 30 speakers. Each speaker has been recorded with six different sentences uttered at different times. Ten occurrences of each sentence were recorded in order to have sufficient training and testing set. In all, this results into collection of 1800 speech samples. The next step in the work is to convert these samples of continuous signals into image dataset by creating spectrogram from it preceded by some pre-processing. Hartley transform is then applied to this database containing 1800 spectrograms.

From the ten spectrograms for each speaker and for each sentence, eight spectrograms are randomly selected for training the system. Remaining two spectrograms are used for testing the accuracy of system. Thus training set consists of 1440 spectrograms and test set consists of 360 spectrograms. Algorithmic steps of the work carried out on these trainee images are given below:

Step 1: Resize the input trainee image to size 256*256.

Step 2: Apply Hartley transform to this resized image.

Step 3: Select four corners of size 2*2 each from the output obtained in step 2 and append them to form cropped feature vector of size 4*4.

Repeat steps 1 to 3 for each spectrogram in training set and also for various corner sizes such as 4, 8,10,16,32 and 64.

Similarly, for test images, following steps are performed.

Step 1: Resize the input test image to size 256*256.

Step 2: Apply Hartley transform to this resized image.

Step 3: Select four corners of size N*N each from the output obtained in step 2 and append them to form cropped feature vector of size 2N*2N.

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Step 4: Calculate the Euclidean Distance between test image and each of the trainee images of corresponding sentences.

Step 5: Trainee image with minimum Euclidean Distance is the spectrogram of identified speaker.

Repeat steps 1 to 5 for each spectrogram in test set and also for various corner sizes such as 2, 4, 8, 10, 12,16,20,32 and 64. Calculate accuracy of the system by taking the average of accuracy obtained for each sentence.

IV. RESULTS

Following Table I shows the accuracy obtained for various corner sizes cropped from the feature vector. These results are further categorized sentence wise. Average accuracy of all six sentences for a particular corner size gives the overall accuracy of the system.

It can be observed that maximum accuracy up to 90% is obtained for sentence s4, s5 and s6 with cropped corners of size 12*12 and hence for cropped feature vector of size 24*24.

TABLE I. ACCURACY OF THE SPEAKER IDENTIFICATION SYSTEM FOR CROPPED FEATURE OF VARIOUS SIZES OBTAINED BY APPLYING HARTLEY TRANSFORM

Corner size	S1	S2	S3	S4	S5	S6	Average Accuracy
2*2	53.33	56.67	53.33	56.67	53.33	53.33	54.44
4*4	70	76.67	73.33	80	75	78.33	75.55
6*6	80	83.33	88.33	83.33	86.67	86.67	85.05
8*8	85	88.33	86.67	86.67	91.67	90	88.05
10*10	86.67	88.33	85	86.67	90	88.33	87.5
12*12	86.67	86.67	86.67	90	90	90	88.34
16*16	88.33	86.67	85	86.67	85	90	86.94
20*20	88.33	88.33	85	83.33	85	88.33	86.39
32*32	80	80	78.33	85	81.67	88.33	82.22
64*64	78.33	75	80	78.33	81.67	81.67	79.17

V. CONCLUSION

From the experimental work carried out, it can be concluded that Hartley transform can be efficiently used for speaker identification similar to the DCT, Walsh and Haar transform. Accuracy of the system goes on increasing till a specific size of cropped feature vector. The computational complexity of Hartley transform is $2N^3$ multiplications and $2N^2(N-1)$ additions, where N*N is the size of an image. In our case, image is of size 256*256. This complexity is similar to the computational complexity of DCT on spectrograms for speaker identification. The only difference lying between two techniques is the area from where feature vector is cropped. This shows that Hartley transform can be effectively used for biometric technique like Speaker Identification.

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Normalized Cross- Correlation for Tracking Object and Updating the Template: Exploration with Extensive Dataset

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***Abstract*—Tracking is the process explicitly dedicated to estimate the path of the object as it moves along the region of scene in the image plane. In other words it is a strategy to detect and track moving object through a sequence of frames. Here an attempt to enable the Normalized Cross-Correlation strategy for both matching and updating the template for tracking the object in an outdoor environment is made. The proposed method explores to consume extensive bench mark dataset. The evolved system critically exhibits the capability to track an object or multiple objects genuinely under varied illumination conditions. Evidently, the outcome reveals the worthiness of the proposed developed novel system.**

Keywords- Object tracking, Normalized Cross-Correlation, Frame difference, Template updating.

I. INTRODUCTION

Object tracking is basically an attention drawing mechanism. It is also a process of establishing the correspondence to the objects in sequence of frames. Perhaps it unearths many applications but important among them are in video surveillance, monitoring the traffic and as a vision to the robot. There is no dearth of relevant literature in tracking object emerged in a moderate scene. It could be possible through spatial or appearance based model. Secondly several processes are evolved from frequency sphere. Further too hybrid approaches are celebrating effective performance. There are several approaches for tracking object in a scene that are Point tracking, Kernel tracking and silhouette tracking. Template matching is sub-class of Kernel tracking [8]. Some of the factors make object tracking complex due to change in color and illumination, noise in the images, abrupt motion of the objects and computational aspects for real-time processing [8]. Today the prime research in computer vision algorithm is detection and tracking of object. One such application is analysis of traffic scene. Thus vehicle detection is important for civilians as well as military usage especially in aerial and usual traffic scene since vehicles are vital part of human life.

This paper attempts to propose a system which tracks the object vigorously with the correlation between object and template. However it takes care of updating the template with the help of normalized cross-correlation. In order to emphasize the proposed process with the help of three building blocks, such as correlating the template and image is aspired which is motivated based on the correlation score. Secondly the frame differencing algorithm is employed to produce the motion regions. Finally, sub-images are cropped and stored via frames which are corresponding to motion regions. In the sequel, existing template will be correlated with sub-images and the best match will be replaced as a new template. This process is repeated for every fixed interval of frames. An experiment has been conducted exhaustively employing the benchmark datasets such as PETS 2001 (1, 2 and 3 clips) and VISOR(video for traffic surveillance clip) and their details are tabulated in the table- 1.

TABLE I. Showing the Dataset

Sr No	Dataset	# of frames	Contents	Camera
1	PETS 2001 (1)	2343	Human,Cars and People	Side fixed, Moving tree
2	PETS 2001 (2)	2240	Human,Cars and People	Top-Down fixed
3	PETS 2001 (3)	2688	Human,Cars and People	Side fixed
3	VISOR	1495	Human,Cars	Side fixed

This paper contents are arranged as follows. Section 2 deals with the related work. Section 3 emphasizes the proposed method. The experiment and results are discussed in section 4. Conclusion and future work portrayed in section 5.

II. COMPREHENSION OF RELATED WORK

In the work of [4] J.P. Lewis et al. encourages the potentiality of normalized cross-correlation based template matching in the spatial domain.

The author [1] Alan .J. Lipton et al. attempted to employ the combination of frame differencing and template matching to highlight the object in a scene. The template matching is guided by temporal differencing and image based correlation to make tracking process robust. Further the Impulse Response filter (IIR) is used to update the template, in other words it is known as adaptive template matching method. Researcher Hieu T. Nguyen et al. [2] tried to comprehend the tracking process for a rigid object through Kalman filter and

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consequently updating the template to adapt changing illumination and orientation of the object is achieved via an adaptive Kalman filter.

In the work of [6] Longin Jan Latecki et al. proposed strategy which is based on selective hypothesis tracking algorithm. It includes the motion regions, image alignment and minimum cost estimation to update the template dynamically. In other words minimum cost matching is established through association between the motion region and the aligned template. Thus motion vector is updated

Dynamic template matching and controlling the field of view of camera by PTZ was remarked by [5] Karan Gupta et al. using frame difference approach and choosing the proper threshold. This strategy basically tries to consider the instant updating the template although limited to a single object in a scene.

In the work of Xue mei et al. [9] used the probabilistic algorithm for tracking, which included template matching and incremental subspace update. The templates are modeled using mixed probabilities and updated based on considerably changes of the object appearance. The augmentation of the Kernel Gream matrix with a row and column yields the updation.

Jiyan pan et al. [11] gradual shifting away from the template in object tracking concept is well addressed through the template drift. In this work it is observed carefully that where template drifts occurs and consequently the template is updated. Kalman Appearance Filter [11] employed to update the template.

Wenhui Liao et al. [10] introduced a new method called Case Based Reasoning (CBR) to maintain accurate template of object automatically. In other words algorithm dynamically updates the case base (template). With this, real time face tracking is built to track the face robustly under different orientations and conditions.

The literature surveyed till this point has encouraged us to propose a system based on normalized cross-correlation to track the object and update the template.

Hence, we are proposing the template updating task with the combination of frame difference and normalized cross-correlation approach as a novel strategy. Perhaps it is expected to yield best possible outcomes. In other words this work tries to concentrate on the hybrid model for updating the template. Further proposed work ensures the tracking of single and multiple objects in a scene. On the other hand projected system addresses the limitations observed in the literature.

III. PROJECTED PROCESS

This section the dedicated to present a proposed work and aims to track the object and update the template. The simplified block diagram of a general system is shown in Figure.1

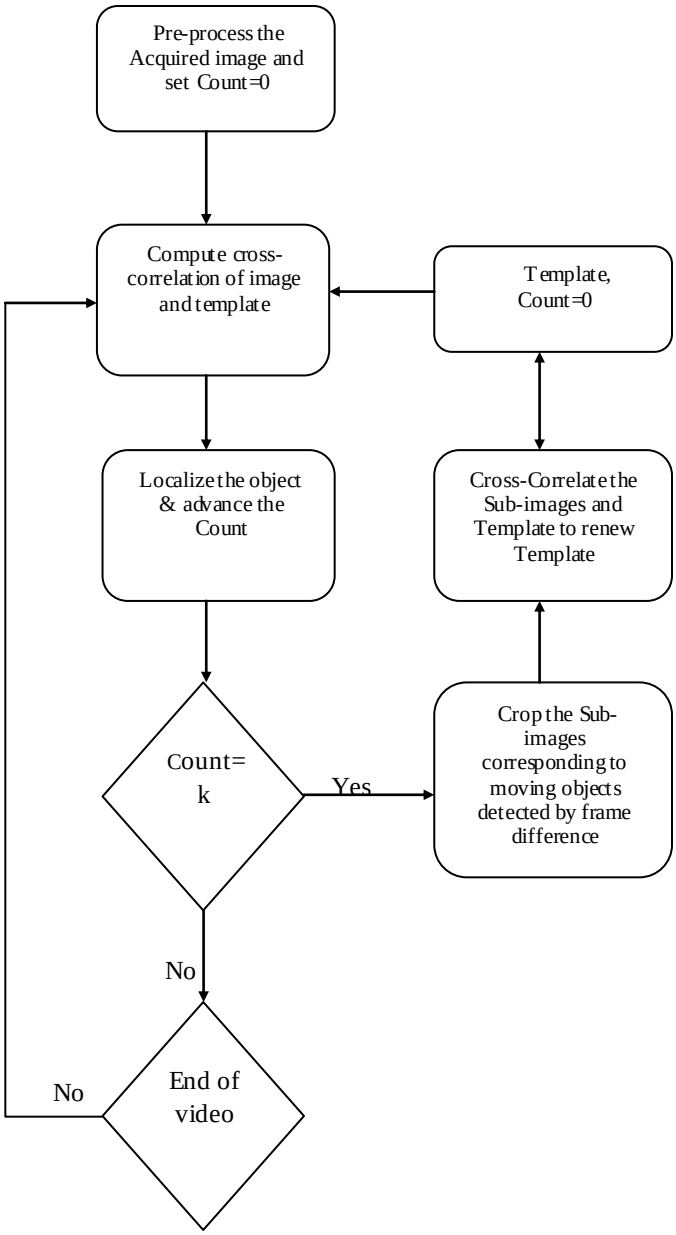

Figure 1: Proposed system

The computation of normalized cross-correlation involves through the following mathematical expression displayed in equations 1, 2 and 3. Subsequently determine the location

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where the maximum value of correlation score occurs and corresponding location is the best match. Thus it gives the evidence to put the bounding box over the object.

$$d^2_{f,t}(u,v) = \sum_{x,y}[f(x,y) - t(x-u, y-v)]^2 \qquad (1)$$

Where f (x, y) – is the image, t(x-u, y-v) is template positioned upon u & v.

$d^2_{f,t}(u,v)$ is a squared Euclidean distance and summation is done over x and y.

$$d^2_{f,t}(u,v) = \sum_{x,y}[f^2(x,y) - 2f(x,y)t(x-u,y-v) + t^2(x-u, y-v)]$$

If the terms $\sum f^2(x,y)$ and $\sum t^2(x\text{-}u, y\text{-}v)$ are treated as constants. The approximate equation called as cross-correlation is.

$$C(u,v) = \sum_{x,y} f(x,y)\, t(x-u, y-v) \qquad (2)$$

It is used as a measuring unit of similarity between the image and the template.

The difficulties are noticed such as image energy which causes correlation score minimum, sorting of C(u,v) depends on template size, change in illuminations not affecting the equation (2) are eliminated through a process of normalization. Therefore the normalized cross-correlation (γ) expressed through equation 3 as follows.

$$\gamma(u,v) = \frac{\sum_{x,y}[f(x,y) - \bar{f}_{u,v}][t(x-u,y-v) - \bar{t}]}{\{\sum_{x,y}[f(x,y) - \bar{f}_{u,v}]^2 \sum_{x,y}[t(x-u,y-v) - \bar{t}]^2\}^{0.5}} \qquad (3)$$

Where $\bar{f}_{u,v}$ and $\bar{t}$ are means of image and template respectively.

Further the necessity of template updating as we discussed and same is achieved through the equation 4. In order to obtain the absolute value of moving object by frame differencing below equation is exploited.

$$D = |(fm) - (fm-1)|$$

$$P(i,j) = \begin{cases} f(i,j) & D \geq T \\ 0 & D < T \end{cases} \qquad (4)$$

In view of obtaining the binary form from the difference image by selecting suitable threshold and post-process it in the later stage using the morphological operations. Then, connected component helps to label the moving objects. In the sequel the centroids of moving objects are estimated.

The proposed strategy encourages to mound the cropped sub-images with the help of centroid followed by process of computation of cross-correlation score between the template and sub-images. Therefore the best match will be the new template and process of updating is repeated for k- interval of frames. As it is empirically observed by the proposed experiment, the value of the k reflects with the dataset. It is portrayed in the plot shown in figure 2. This entire process is illustrated in subsequent section through two phases. First algorithm is predominantly exhibit object tracking task and second one dedicates to update the template in turn which supports and provide enhanced knowledge to track the object

.

Algorithm-I

1. Renovate input video into frames.
2. To obtain noise free frame, median filter is employed.
3. Initialize with template.
4. Read the r^{th} frame and the template, compute the correlation score. Put the bounding box over the object for the best match.
5. Generating and updating the template after every fixed interval of frames using Algorithm-II .
6. Step ***4*** and ***5*** are repeated for ***n*** frames

Algorithm-II

Generate and update the template after every fixed interval

1. Initialization of count through ***k***- interval of frames.
2. Get absolute value by subtracting m^{th} frame from $(m\text{-}1)^{th}$ frame.
3. Using threshold, the difference image is converted to binary form
4. The moving objects are labeled using connected component analysis.
5. Determine the Centroids of moving objects.
6. Cropped sub-images corresponding to centroids are stored.
7. Declare a new template using correlation between the template and the sub-images

IV RESULTS AND EXPERIMENTS

We have conducted experiments to corroborate the performance efficacy of the normalized cross-correlation approach. The computational aspects of the evolved method turn out to be polynomial and its order is O ($\mathbf{n^6}$). The same is tested over the available machine Pentium(R) Dual-core CPU, T4200 @ 2.00 GHz and 2.83 GB of RAM of 1.20 GHz.

The experiment is conducted on the PETS2001 (Video clips 1,2 and 3 clips) and VISOR video dataset (Video for traffic surveillance clip) for the different bunch of frames which includes different objects. Individual objects are tracked using respective templates, few of them are selected to experiment are tabulated in the TABLE VI. Single object as

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small as 50 pixels is tracked efficiently. Template update is done empirically for every ***k*** frames which yields better performance. In the experiment environment ***k*** predominantly represents template updating at interval of frames and also known as updating frequency. This is summarized further through the TABLE II to TABLE V and Figure 2. Here we have noticed some of the interesting observations which made us keen upon further exploration in the future work

It is observed that updating template at every alternate frame becomes computationally expensive. On the other hand updating after many frames will fail the tracking. Hence it is empirically chosen a suitable update frequency as *k* because of the stability. It is also further noticed by experimentation, that the tracking performance is directly proportional to the size of template. In other words larger the template, tracking is better. The proposed system has robustly performed over the different set of frames comprising different objects and varied illumination conditions. It is revealed in the TABLE VI that displayed the mis- tracking rate is minimal. The tracking results can be observed from the Figure 5 (a), (b), (c) and (d) are human, car (dark), car (white) and people respectively

TABLE II. Showing the effect of template updating upon tracking for PETS2001 (1) with 52 frames.

Sl. No	Updating frequency	No. of updates	tracking	Mis-tracking
1	1	52	52	0
2	2	26	14	38
3	5	10	46	6
4	6	8	49	3
5	10	5	10	42
6	15	3	15	37
7	20	2	20	32
8	25	2	25	27

TABLE III. Showing the effect of template updating upon tracking for PETS2001 (2) with 70 frames.

Sl. No	Updating frequency	No. of updates	tracking	Mis-tracking
1	1	70	30	40
2	2	35	60	10
3	5	14	52	18
4	6	11	48	22
5	8	8	61	09
6	10	7	60	10
7	15	5	43	27
8	20	3	20	50
9	25	2	50	20

TABLE IV. Showing the effect of template updating upon tracking for PETS 2001 (3) with 52 frames.

Sl. No	Updating frequency	No. of updates	tracking	Mis-tracking
1	1	52	52	0
2	2	26	14	38
3	5	10	46	6
4	6	8	49	3
5	10	5	10	42
6	15	3	15	37
7	20	2	20	32
8	25	2	25	27

TABLE V. Showing the effect of template updating upon tracking for VISOR with 23 frames.

Sl. No	Updating frequency	No. of updates	tracking	Mis-tracking
1	1	23	23	0
2	2	11	20	3
3	5	4	20	3
4	6	3	20	3
5	9	2	23	0
5	10	2	20	3
6	15	1	15	87
7	20	1	20	3
8	25	1	0	23

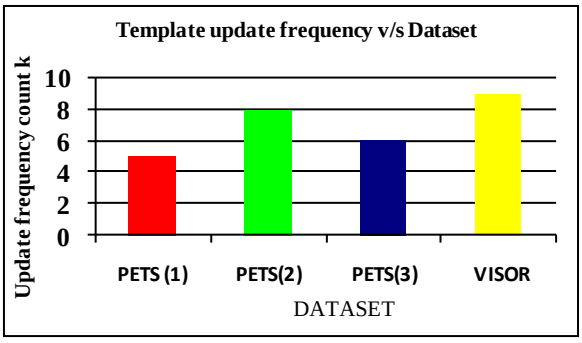

Figure- 2: Shows the variations of update frequency with Dataset

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Frame-1

Frame-100

Figure 3 (a)

Frame-5

Frame-99

Figure 3 (b)

Frame-1

Frame-35

Figure 3 (c)

Frame-2

Frame-68

Figure 3 (d)

Figure 3 PETS2001 (1)

Frame-1

Frame-100

Figure 4 (a)

Frame-1

Frame-35

Figure 4 (b)

Frame-8

Frame-69

Figure 4 (c)

Frame-7

Frame-94

Figure 4 (d)

Figure 4 PETS2001 (2)

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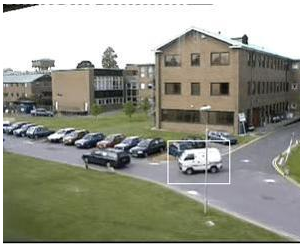
Frame-468

Frame-540

Figure 5 (a)



Frame-2575

Frame-2665

Figure 5 (b)

Frame-830

Frame-875

Figure 5 (c)

Frame-340

Frame-430

Figure 5 (d)

Figure 5 PETS2001 (3)

Frame-10

Frame-60

Figure 6 (a)

Frame-8

Frame-24

Figure 6 (b)

Frame-10

Frame-10

Figure 6 (c)

Frame-13

Frame-28

Figure 6 (d)

Figure 6 VISOR (video for traffic surveillance)

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Table VI- Object tracking on PETS 2001(3) video. The details like type and number of Objects and number of frames and tracking and mis-tracking.

Sl. No	Scene Objects	Objects	Templates	Frames	Tracked	Mis tracked
1	Human	1	Humn	90	90	0
2	Human & Car	2	Car	90	89	1
3	Car & Car	2	Car (whit)	90	90	0
4	Human, Car & People	3	People	45	45	0

V CONCLUSION AND FUTURE WORK

In this paper it is established through normalized cross-correlation feature to track multiple objects. This procedure being able to track object as small 50 pixels and update frequency is empirically decided as *k* frames. It is observed that larger the template, tracking is better on the contrary poor tracking. Experimental results on PETS 2001 and VISOR video dataset reveal that the approach is capable of spotting and tracking the object correctly. The future work can be focused to track the object for different set of videos and handle the partial and full occlusions. Hence many future avenues can be thought of based on the success reported in this paper.

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Mining Education Data to Predict Student's Retention: A comparative Study

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***Abstract*— The main objective of higher education is to provide quality education to students. One way to achieve highest level of quality in higher education system is by discovering knowledge for prediction regarding enrolment of students in a course. This paper presents a data mining project to generate predictive models for student retention management. Given new records of incoming students, these predictive models can produce short accurate prediction lists identifying students who tend to need the support from the student retention program most. This paper examines the quality of the predictive models generated by the machine learning algorithms. The results show that some of the machines learning algorithms are able to establish effective predictive models from the existing student retention data.**

***Keywords*— Data Mining, Machine Learning Algorithms, Retention Management, Predictive Models**

I. INTRODUCTION

Student retention is a challenging task in higher education [1] and it is reported that about one fourth of students dropped college after their first year [1-3]. Recent study results show that intervention programs can have significant effects on retention, especially for the first year. To effectively utilize the limited support resources for the intervention programs, it is desirable to identify in advance students who tend to need the support most. In this paper, we describe the experiments and the results from a data mining techniques for the students of MCA department to assist the student retention program on campus. The development of machine learning algorithms in recent years has enabled a large number of successful data mining projects in various application domains in science, engineering, and business [4, 5]. In our study, we apply machine learning algorithms to analyze and extract information from existing student data to establish predictive models. The predictive models are then used to identify among new incoming first year students those who are most likely to benefit from the support of the student retention program.

Prediction models that include all personal, social, psychological and other environmental variables are necessitated for the effective prediction of the retention rate of the students. The retention of students with high accuracy is beneficial for identify the students with low academic achievements initially. It is required that the identified students can be assisted more by the teacher so that their performance is improved in future.

In this connection, the objectives of the present investigation were framed so as to assist the low academic achievers in higher education and they are:

a) Generation of a data source of predictive variables.
b) Identification of different factors, which affects a student's retention rate.
c) Construction of a prediction model using different classification data mining techniques on the basis of identified predictive variables, and
d) Validation of the developed model for higher education students studying in Indian Universities or Institutions.

II. BACKGROUND AND RELATED WORK

The most commonly cited model of retention studies is one developed by Tinto [2]. According to Tinto's Model, withdrawal process depends on how students interact with the social and academic environment of the institution.

Kember [6] describes in an Open distance learning context, researchers tend to place more emphasis on the influence of external environment, such as student's occupation and support from their family, while the concept of social integration into an Open distance learning institution's cultural fabric, is given less weight.

A number of Open Distance Learning institutions have carried out dropout studies. Some notable studies have been undertaken by the British Open University (Ashby [7]; Kennedy & Powell [8]). Different models have been used by these researchers to describe the factors found to influence student achievement, course completion rates, and withdrawal, along with the relationships between variable factors.

Pandey and Pal [9] conducted study on the student performance based by selecting 600 students from different colleges of Dr. R. M. L. Awadh University, Faizabad, India. By means of Bayes Classification on category, language and background qualification, it was found that whether new comer students will performer or not.

Hijazi and Naqvi [10] conducted as study on the student performance by selecting a sample of 300 students (225 males, 75 females). The hypothesis that was stated as "Student's attitude towards attendance in class, hours spent in study on daily basis after college, students' family income, students' mother's age and mother's education are significantly related with student performance" was framed. By means of simple linear regression analysis, it was found that the factors like mother's education and student's family income were highly correlated with the student academic performance.

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Khan [11] conducted a performance study on 400 students with a main objective to establish the prognostic value of different measures of cognition, personality and demographic variables for success at higher secondary level in science stream. It was found that girls with high socio-economic status had relatively higher academic achievement in science stream and boys with low socio-economic status had relatively higher academic achievement in general.

Al-Radaideh, et al [12] applied a decision tree model to predict the final grade of students who studied the C++ course in Yarmouk University, Jordan in the year 2005. Three different classification methods namely ID3, C4.5, and the NaïveBayes were used. The outcome of their results indicated that Decision Tree model had better prediction than other models.

Pandey and Pal [13] conducted study on the student performance based by selecting 60 students from a degree college of Dr. R. M. L. Awadh University, Faizabad, India. By means of association rule they find the interestingness of student in opting class teaching language.

Ayesha, Mustafa, Sattar and Khan [14] describe the use of k-means clustering algorithm to predict student's learning activities. The information generated after the implementation of data mining technique may be helpful for instructor as well as for students.

Baradwaj and Pal [21] obtained the university students data like attendance, class test, seminar and assignment marks from the students' previous database, to predict the performance at the end of the semester.

Bray [15], in his study on private tutoring and its implications, observed that the percentage of students receiving private tutoring in India was relatively higher than in Malaysia, Singapore, Japan, China and Sri Lanka. It was also observed that there was an enhancement of academic performance with the intensity of private tutoring and this variation of intensity of private tutoring depends on the collective factor namely socio-economic conditions.

Bhardwaj and Pal [16] conducted study on the student performance based by selecting 300 students from 5 different degree college conducting BCA course of Dr. R. M. L. Awadh University, Faizabad, India. By means of Bayesian classification method on 17 attributes, it was found that the factors like students' grade in senior secondary exam, living location, medium of teaching, mother's qualification, students other habit, family annual income and student's family status were highly correlated with the student academic performance.

Yadav, Bhardwaj and Pal [17] obtained the university students data like attendance, class test, seminar and assignment marks from the students' database, to predict the performance at the end of the semester using three algorithms ID3, C4.5 and CART and shows that CART is the best algorithm for classification of data.

III. DECISION TREE INTRODUCTION

A decision tree is a flow-chart-like tree structure, where each internal node is denoted by rectangles, and leaf nodes are denoted by ovals. All internal nodes have two or more child nodes. All internal nodes contain splits, which test the value of an expression of the attributes. Arcs from an internal node to its children are labeled with distinct outcomes of the test. Each leaf node has a class label associated with it.

The decision tree classifier has two phases [4]:

i) Growth phase or Build phase.

ii) Pruning phase.

The tree is built in the first phase by recursively splitting the training set based on local optimal criteria until all or most of the records belonging to each of the partitions bearing the same class label. The tree may overfit the data.

The pruning phase handles the problem of over fitting the data in the decision tree. The prune phase generalizes the tree by removing the noise and outliers. The accuracy of the classification increases in the pruning phase.

Pruning phase accesses only the fully grown tree. The growth phase requires multiple passes over the training data. The time needed for pruning the decision tree is very less compared to build the decision tree.

A. ID3 (Iterative Dichotomise 3)

This is a decision tree algorithm introduced in 1986 by Quinlan Ross [18]. It is based on Hunts algorithm. The tree is constructed in two phases. The two phases are tree building and pruning.

ID3 uses information gain measure to choose the splitting attribute. It only accepts categorical attributes in building a tree model. It does not give accurate result when there is noise. To remove the noise pre-processing technique has to be used.

To build decision tree, information gain is calculated for each and every attribute and select the attribute with the highest information gain to designate as a root node. Label the attribute as a root node and the possible values of the attribute are represented as arcs. Then all possible outcome instances are tested to check whether they are falling under the same class or not. If all the instances are falling under the same class, the node is represented with single class name, otherwise choose the splitting attribute to classify the instances.

Continuous attributes can be handled using the ID3 algorithm by discretizing or directly, by considering the values to find the best split point by taking a threshold on the attribute values. ID3 does not support pruning.

B. C4.5

This algorithm is a successor to ID3 developed by Quinlan Ross [18]. It is also based on Hunt's algorithm.C4.5 handles both categorical and continuous attributes to build a decision tree. In order to handle continuous attributes, C4.5 splits the attribute values into two partitions based on the selected threshold such that all the values above the threshold as one child and the remaining as another child. It also handles missing attribute values. C4.5 uses Gain Ratio as an attribute selection measure to build a decision tree. It removes the biasness of information gain when there are many outcome values of an attribute.

At first, calculate the gain ratio of each attribute. The root node will be the attribute whose gain ratio is maximum.

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C4.5 uses pessimistic pruning to remove unnecessary branches in the decision tree to improve the accuracy of classification.

C. ADT (Alternating Decision Tree)

ADTrees were introduced by Yoav Freund and Llew Mason [19]. However, the algorithm as presented had several typographical errors. Clarifications and optimizations were later presented by Bernhard Pfahringer, Geoffrey Holmes and Richard Kirkby [20].

An alternating decision tree consists of decision nodes and prediction nodes. Decision nodes specify a predicate condition. Prediction nodes contain a single number. ADTrees always have prediction nodes as both root and leaves. An instance is classified by an ADTree by following all paths for which all decision nodes are true and summing any prediction nodes that are traversed. This is different from binary classification trees such as CART (Classification and regression tree) or C4.5 in which an instance follows only one path through the tree.

The original authors list three potential levels of interpretation for the set of attributes identified by an ADTree:

- Individual nodes can be evaluated for their own predictive ability.
- Sets of nodes on the same path may be interpreted as having a joint effect
- The tree can be interpreted as a whole.

IV. Data Mining Process

Knowing the reasons for dropout of student can help the teachers and administrators to take necessary actions so that the success percentage can be improved. The data is collected from Department of MCA of V. B. S. Purvanchal University, Jaunpur, India. The raw data set is a collection of 432 records accumulated over a period of twelve years regarding the basic information of first year students and whether they continued to enroll after the first year. The MCA department has been started in the year 1997 and 12 batches have completed their study. In the raw data set, 398 of the students continued to enroll after their first year while 34 of them dropped out by the end of the first year.

A. Data Preparations

Data of 432 students of the Department of MCA, VBS Purvanchal University, Jaunpur is collected who get admission from 1997-2000 batch to 2009-2012 batch. The data was collected through the enrolment form filled by the student at the time of admission. The student enter their demographic data (category, gender etc), past performance data (SSC or 10th marks, HSC or 10 + 2 exam marks and Graduation Marks etc.), address and contact number.

B. Data selection and transformation

In this step only those fields were selected which were required for data mining. A few derived variables were selected. While some of the information for the variables was extracted from the database. All the predictor and response variables which were derived from the database are given in Table I for reference.

TABLE I: STUDENT RELATED VARIABLES

Variables	Description	Possible Values
Sex	Students Sex	{Male, Female}
Cat	Students category	{General, OBC, SC, ST}
GSS	Students grade in Senior Secondary education	{O – 90% -100%, A – 80% - 89%, B – 70% - 79%, C – 60% - 69%, D – 50% - 59%, E – 40% - 49%, F - < 40%}
GMSS	Students grade in Math at Senior Secondary education	{O – 90% -100%, A – 80% - 89%, B – 70% - 79%, C – 60% - 69%, D – 50% - 59%, E – 40% - 49%, F - < 40%, Not Applicable}
GS	Graduation Stream	{BA with Math, B.A. without Math, BSc. With Math, B.Sc. without Math, B.Com, BCA, BBA, B.Tech}
GOG	Grade obtained in Graduation	{First ≥ 60% Second ≥ 45 & <60% Third ≥ 36 & < 45%}
MED	Medium of Teaching in Graduation	{Hindi, English, Regional}
CL	College Location	{Rural, Urban}
ATYPE	Admission Type	{UPSEE, Direct}
RET	Retention: Continue to enroll or not after one year	{0, 1}

The domain values for some of the variables were defined for the present investigations are as follows:

- **Cat** – From ancient time Indians are divided in many categories. These factors play a direct and indirect role in the daily lives including the education of young people. Admission process in India also includes different percentage of seats reserved for different categories. In terms of social status, the Indian population is grouped into four categories: General, Other Backward Class (OBC), Scheduled Castes (SC) and Scheduled Tribes (ST). Possible values are General, OBC, SC and ST.
- **GSS** - Students grade in Senior Secondary education. Students who are in state board appear for five subjects each carry 100 marks. Grade are assigned to all students using following mapping O – 90% to 100%, A – 80% - 89%, B – 70% - 79%, C – 60% - 69%, D – 50% - 59%, E – 40% - 49%, and F - < 40%.
- **GMSS** – Student Grade in Mathematics at Senior Secondary education. Grade in mathematics at 10+2 level are assigned to all students using following mapping O – 90% to 100%, A – 80% - 89%, B – 70% - 79%, C – 60% - 69%, D – 50% - 59%, E – 40% - 49%, and F - < 40%. If student has not the mathematics at 10 + 2 level then assign Not-Applicable.
- **GS** – Graduation Stream. MCA admission is open for all stream students, therefore, Graduation Stream is split into following classes BA with Math, B.A. without Math, B.Sc. with Math, B.Sc. without Math, B.Com, BCA, BBA, B.Tech.
- **GOG** – Grade Obtained in Graduation. Marks/Grade obtained in graduation. It is also split into four class

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values: First – ≥60% , Second – ≥45% and <60%, Third – ≥36% and < 45%.

- **Med** – This paper study covers only the degree colleges and institutions of Uttar Pradesh state of India. Here, medium of instructions are Hindi or English or Regional.
- **ATYPE** - The admission type which may be through Uttar Pradesh State Entrance Examination (UPSEE) or direct admission through University procedure.
- **RET** – Retention. Whether the student continue or not after one year. Possible values are 1 if student continues study and 0 if student dropped the study after one year.

A. Implementation of Mining Model

Weka is open source software that implements a large collection of machine leaning algorithms and is widely used in data mining applications. From the above data, ret.arff file was created. This file was loaded into WEKA explorer. The classify panel enables the user to apply classification and regression algorithms to the resulting dataset, to estimate the accuracy of the resulting predictive model, and to visualize erroneous predictions, or the model itself. There are 16 decision tree algorithms like ID3, J48, ADT etc. implemented in WEKA. The algorithm used for classification is ID3, C4.5 and ADT. Under the "Test options", the 10-fold cross-validation is selected as our evaluation approach. Since there is no separate evaluation data set, this is necessary to get a reasonable idea of accuracy of the generated model. The model is generated in the form of decision tree. These predictive models provide ways to predict whether a new student will continue to enroll or not after one year.

B. Results and Discussion

The three decision trees as examples of predictive models obtained from the retention data set by three machine learning algorithms: the ID3 decision tree algorithm, the C4.5 decision tree algorithm and the alternative decision tree (ADT) algorithm. For example, consider a new case with a student having graduation with B.Sc. (GS= B.Sc. with Math), and graduation grade is First (GOG = First), category is General (Cat = General) and get admission from UPSEE (ATYPE = UPSEE). For both the ID3 decision tree and the C4.5 decision tree, we need to start from the root to find a unique path leading to a prediction leaf node. In both trees, we find a unique path of length 1 immediately leading us from the root to a leaf node labeled 1, predicting continued enrollment the next year.

```
: -0.506
|  (1)GSS = A: -1.261
|  (1)GSS != A: 0.389
|  (2)MED = Hindi: 0.263
|  |  (4)GOG = Second: 0.433
|  |  |  (7)GMSS = A: -0.512
|  |  |  (7)GMSS != A: 0.476
|  |  |  |  (10)GSS = A: -0.372
|  |  |  |  (10)GSS != A: 0.564
|  |  (4)GOG != Second: -0.485
|  |  |  (8)GSS = C: 0.438
|  |  |  (8)GSS != C: -0.614
|  (2)MED = English: -0.372
|  |  (3)GMSS = C: -0.756
|  |  (3)GMSS != C: 0.23
|  |  |  (5)GS = B.A.  without maths: 0.507
|  |  |  |  (9)Cat = OBC: -0.412
|  |  |  |  (9)Cat != OBC: 0.603
|  |  |  (5)GS != B.A.  without maths: -0.384
|  |  |  |  (6)GSS = 0: 0.533
|  |  |  |  (6)GSS != 0: -0.653
```

Figure 1: AD Tree.

On the other hand, for the alternative decision tree (ADT tree) as shown in fig. 1, we may have multiple paths from the root to the leaves that are consistent with data and we need to sum up all the numbers appearing on these paths to see whether it is positive or negative. In this particular case, we find three paths leading from the root to leaves. Summing up all the numerical numbers appearing on these paths, we have a positive value 0.483+0.15-0.218+0.125+0.036=0.576, and that leads to the prediction of continued enrolment too. These decision trees also provide interesting insights into hidden patterns in the student retention data set. For example, both the ADT tree and the C4.5 decision tree show that Graduate Stream (GS) is a very relevant factor.

The Table II shows the accuracy of ID3, C4.5 and CART algorithms for classification applied on the above data sets using 10-fold cross validation is observed as follows:

TABLE II: CLASSIFIERS ACCURACY

Algorithm	Correctly Classified Instances	Incorrectly Classified Instances
ID3	72.093%	11.627%
C4.5	74.416%	25.581 %
ADT	72.093%	27.907%

Table II shows that a C4.5 technique has highest accuracy of 74.416% compared to other methods. ID3 and ADT algorithms also showed an acceptable level of accuracy.

The Table III shows the time complexity in seconds of various classifiers to build the model for training data.

TABLE III: EXECUTION TIME TO BUILD THE MODEL

Algorithm	Execution Time (Sec)
ID3	0.12
C4.5	0.08
ADT	0.06

Table IV below shows the three machine learning algorithms that produce predictive models with the best precision values in our experiments, together with the corresponding recall values. For these algorithms, the best precision values (ranging from around 68.2% to 82.8%) are almost all accomplished when learning from the data set, with recall values ranging from 6.4% to 11.4%.

The alternative decision tree (ADT) learning algorithm is the best precision performer we have seen so far, capable of reaching a precision rate of 82.8% and a recall rate of 11.4% without a sign of over-fitting. In other words, given a collection of 1000 new first year students with around 250 would-be drop-out cases embedded in the list (assuming a drop-out rate of 25%), the ADT tree algorithm is likely to produce a list of around 37 students and among them about 31 are actual would-be drop-out cases.

TABLE IV: CLASSIFIERS ACCURACY

Algorithm	Precision values	Recall values
ID3	68.2%	06..4%
C4.5	70.4%	09.6 %
ADT	82.8%	11.4%

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V. CONCLUSIONS

One of the data mining techniques i.e., classification is an interesting topic to the researchers as it is accurately and efficiently classifies the data for knowledge discovery. Decision trees are so popular because they produce classification rules that are easy to interpret than other classification methods. Frequently used decision tree classifiers are studied and the experiments are conducted to find the best classifier for retention data to predict the student's drop-out possibility. Machine learning algorithms such as the alternative decision tree (ADT) learning algorithm can learn effective predictive models from the student retention data accumulated from the previous years. The empirical results show that we can produce short but accurate prediction list for the student retention purpose by applying the predictive models to the records of incoming new students. This study will also work to identify those students which needed special attention to reduce drop-out rate.

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Factors Affecting Information Communication Technology Acceptance in Public Organizations in Saudi Arabia

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Abstract- Recent developments in information communication technology (ICT) have heightened the need of more study in this topic. There is a real risk of the acceptance of ICT by some and not others contributing to the rejection. The paper approaches the technology acceptance from the perspective of administration by examining the use of ICT and e-services in the public environment. The theoretical framework variables of the technology acceptance model (TAM) are examined. The study also investigated the effect of the model of organization readiness to change (MORC) Individual Differences "recipients' beliefs" as external variables, in addition subjective norm and volunteer as the mediating . the study tested the current usage as mediating variable between ICT believes and attitude behaviour. Most studies in ICT have been carried out in private sectors in Saudi Arabia. The survey instrument uses to collect the data is a self administrated questioner developed based on the technology acceptance questioner as used by Davis and Venkatesh. The research population is Saudi workers in public organization. The research tool is structure equation modelling (SEM), which required a minimum sample of 200 respondents.

Key words: Technology Acceptance model; Information Communication Technology; ICT Usage, Public organization; structural equation modelling; Saudi Arabia and developing countries.

I. INTRODUCTION

ICT is a critical means for achievement in private and public sectors together, but ensuring ICT acceptance is very difficult assignment for the organization given the barriers will face the project. However, this rapid change is having a serious effect on ICT project success rate and created problems threaten the organization existence [1]. The benefits and the problems associated with ICT implementation and adoption needs exploring.

This study is an investigation of Saudi public worker behaviour. Besides that the study investigates the actual behaviour; worker behaviour and acceptance behaviour of Saudi workers who use ICT. Then, analyze the relationship between social demographics, worker behaviour, and acceptance behaviour of public workers. Lastly, this study also examines the intention to use and willingness to continue use ICT.

II. RESEARCH PROBLEM

In general, There is increasing concern that most organizations, despite its extent, have not been able to recognize the complete merits brought by ICTs [2]. In order to realize the full advantages of ICT solutions, organizations need to identify the factors affecting ICT acceptance [3] [4] [5]. In addition, the failure rate in the implementation of technology calls for a better understanding of the process [6] [7] [8].

The wide investment in technology infrastructure is support to ICT program. Yet; considering organizations are

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investing in technology projects at an alarming rate, and the failure rate associated with this investment call for the need to investigate on this issue is even more critical Krigsman [9] affirms the worldwide cost of information technology projects failure over $6.2 trillion. Recent developments in public technology have heightened the need for study of the technology adoption factors. It is becoming increasingly difficult to ignore the factors cause the adoption failures in the public organization and the low production of the civil workers [10].

Although ICT acceptance is rarely the motivation for public workers in Saudi Arabia, it is an essential activity for many workers. However, little is known about public worker's behaviours and their preferences. This study will investigate acceptance factors of public workers and will profile worker preferences. Organizations that target ICT can benefit from the understanding of employee's behaviour, and can gain advantages over those organizations that are less knowledgeable about their user.

Many researchers [11] [12] [13] [14] have argued research on how organizations manage problems associated with technology and e-services acceptance needs to be undertaken before the association between the factors affecting the technology acceptance, use and finally, the adoption of the e-services. A commonly observed phenomenon, in e-services acceptance and adoption in Saudi Arabia and developing countries, is that Saudis seems apprehensive to accept technology [15]. Some studies had an emphasis for the need of direct measure of the effect the social norm and culture on the acceptance and the adoption of e-transactions in governments organizations in Saudi Arabia [12] [16]. Richardson states one of the main streams of research is the explanation and prediction of ICT adoption in the developing countries [17].

Turner, Kitchenham, Brereton, Charters [18] and Budgen [18] said that TAM proposed in 1989 as a means of predicting technology usage, is the superlative tool that demonstrates technology acceptance [19]. Dasgupta, Granger and Teo and McGarry emphasis that many TAM studies generate diverse hint's base on the empirical facts, Inconsistent finding's overflow in terms of the direction and the scale of the assassination between TAM variables [20]. Other studies showed unreliable associations. Teo [21] and Ahmad et al,. [5] argued that using predicted use as an alternative of actual use of ICT is deteriorating TAM studies.

Lee, Kazor and Larsen [22] and Yousafzai, Foxall and Pallister [23] conducted a meta-analysis of TAM and found that one of the major problems with TAM research was that scholars were performing replication studies that provide very little incremental advancement to the literature. Researchers were not really expanding TAM. Lee et al,. [22] noted that many scholars felt that the concept of a "cumulative tradition" was carried too far in all the repetitious studies of TAM, because the model had become an inhibitor of more advanced theories of ICT use.

Acceptance of technology innovations for communication needs and factors that influence the acceptance, and adoption have been studied for decades. The theoretical frameworks that were used to inform the studies include the diffusion of innovation theory, the expectancy-value model, and the technology acceptance model. The word 'acceptance' has been used by different authors in different meanings and context. As a matter of fact, the expression does not have any unique or specific description in literature. TAM has defined acceptance as user's decision about how and when to use technology [24].

The theory of planned behaviour Ajzen [25] which developed out of the theory of reasoned action Ajzen and Fishbein [26]; Fishbein and Ajzen [27] [28], the model of readiness for organizational change (MROC) Holt, Armenakis, Feild and Harris [29] and TAM Davis, Bagozzi, and Warshaw [30] provide the foundation of the model which is integrated in this dissertation into the proposed theoretical model.

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The study of people's behaviour to ICT application has been a vital issue in ICT study in ICT research since the 1980s. The theoretical foundation for the study of whether a person is willing to use a technology comes from research on adoption and diffusion [31]. Research in this area has continued to develop over the decades producing other theories including the theory of planned behaviour Mathieson [32] [33], social cognitive theory [34]and TAM [35] [24] [30] [36].

TPB has been used successfully for prediction purposes in various research areas, including the use of structured interview techniques for selection purposes, the forecast of managers' personal motivation to enhance their own proficiencies after receiving feedback, readiness for organizational change Jimmieson, Peach and White [37] technology adoption, intent toward participating in a participation program [38].

The stated purpose of TAM is to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" [35]. It assumes rationality within the decision-making process. Studies have provided empirical support for TAM [39]. TAM also compares favourably with other technology acceptance theories [32]. Taylor and Todd [33] affirm that TAM customarily annotates about forty percent of the discrepancy in a persons' intentions to employ the ICT and the true usage of it.

TAM proposes that the technology use is motivated by persons' attitude toward using the it, which is a function of their beliefs about using the technology and an evaluation of the value of actually using it. This stands on "the cost-benefit paradigm from behavioural decision theory" [24] p:321, which state that a person behaviour is based on his or her self-tradeoffs between the effort to performance a work and the cost of this action. Therefore, TAM emphasizes that human will use a technology if the reimbursement of doing so overshadowed the effort required to use it [24].

Among the behaviours commonly measured are: system usage [40], and user satisfaction [41]. Some researchers have studied both of these dimensions as a composite [42]. User satisfaction actually represents a cognitive and affective outcome that is less tangible in terms of classification as behaviour. Al-Gahtani and King [43] came up to the conclusion that ICT usage is an accurate measurement of ICT acceptance.

The intention to use ICT depend on the behaviour of actual use of it, since individuals, perform as they planned to, so long as they have control over their actions. Sequentially, the attitude to use ICT applications depend on the behavioural intentions to use it. Following the logic of the TRA framework, users' attitudes are determined by beliefs about the system and about the consequences of using it.

The model of readiness for organizational change suggests that (intended and unintended) behavioural outcomes are due to intentions (and reactions) concerning those behaviours. Researchers have previously argued that a positive and favourable view toward organizational change, based on the degree workers believe a change is likely to contain positive beneficial implications for them, and the organization will lead to better reactions to change [44]. In turn, these intentions and reactions are linked with the attitude called readiness for change, which has been defined in numerous ways [29]. This attitude is, in turn, believed to be due to various change-related beliefs.

Several attempts have been made to define change recipients' beliefs [29]. In addition, these change recipients' beliefs are related to various antecedents that fit within the aforementioned typology. Subjective norms play a crucial role. The proposition that subjective norms help predict intentions relating to supporting

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organizational change comes from the suggestion that collective influence will create a load among workers who directs them to support change. Researchers have suggested that practitioners should take advantage of the group culture in organizations as a device for creating roots and union that can influence and inform one another about a change in order to generate support and produce shared significance throughout the period of change [45].

In addition, there are three relevant behavioural beliefs originate from the literature that having an impact on the attitudes, subjective norms, and perceived behavioural control [25]. These beliefs are: (a) affect approaches towards the perception of behaviour, (b) regular assumptions that consist of the fundamental components of these non-objective standards, and (c) control faiths that provide the basis for perceived behavioural control.

TPB suggests, subjective norm is the antecedent generally associated with social pressure. It reflects " the individual's perception of social support or opposition to his performance of the behaviour [27]." Normative beliefs and motivation are the two elements subjective norms. Normative beliefs are the individual's perceptions that certain people want them to perform the behaviour. The individual's compliance represents the relative importance of the referent person to the individual. This element of behavioural intentions is determined by the extent to which the individual believes others who are considered significant times the individual's desire to comply with the wishes and desires of those significant others who desire the behaviour.

Lin and Lee [46] reported the results for a study which described the knowledge sharing behaviour of employees due to social pressure created by senior managers. The study found that opinions of peers were more likely to influence the decisions made by senior managers with respect to knowledge sharing behaviour. The study's results demonstrated that the main agents of overall company-wide knowledge sharing behaviour were through the boosting and expression of faith of senior managers. The positivity of their attitudes, through encouragement and perceived behavioural control greatly influenced intentions to advocate knowledge sharing.

Perceived ease of use (PEU) is described as "the degree to which a person believes that using a particular system would be free of effort" [24] p:320. The construct reflects the amount of effort that would be required, relative to the people perceived capabilities, in terms of being able to use the technology to accomplish the intended functions.

A theoretical model put forth by Venkatesh [40] found a number of control-intrinsic motivation-related and emotion-related determinants for PEU. Control was divided into perceptions of internal control (computer self-efficacy) and perceptions of external control (facilitating conditions). Intrinsic motivation was conceptualized as computer playfulness, while emotion was conceptualized as computer anxiety. Thus, computer self-efficacy, facilitating conditions, computer playfulness, and computer anxiety were system independent variables.

The variables were examined, and were found to play a very important role in shaping PEU beliefs related to the new system. The influence of these determinants was reduced over time due to growing experience with the system. Venkatesh put forth that objective usability, perceptions of external control (facilitating conditions) over system use, and perceived enjoyment would have a stronger influence on PEU during continuance.

Perceived usefulness (PU) has been defined as "the degree to which a person believes that using a particular system would enhance his/her job performance" [24] p:320. The construct reflects an employee's level of conviction that a particular system will increase their work performance [35]. The PEU and PU relationship may be reduced over time [47].

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The quality of the output, particularly the more precise and up-to-date the information provided, the greater the PU. In addition, the greater the ease of ICT accessibility, comprehension, and analysis, the greater is the PU [48]. Goodwin [49] opined that perceived usefulness depends on the usability and the counting use of the technology, represented by PEU. Mathieson [32] and Szajna [47] reported that PEU accounts for a significant portion of the variance in PU. In TAM II, Hence according to Venkatesh and Davis [36] "PU's significant antecedents have included subjective norm, image, job relevance, output quality, and result demonstrability." Li [50] discusses ICT adoption from the effects of the group. Herding occurs when an organization adopts an ICT based on a "me too" attitude. In many cases, the adoption of technology is in response to not being left behind, the "herding effect." The herding effect results when the first bureau adopts a technology, and subsequent users adopt the technology in order to minimize the risk of choosing an alternative technology. In situations of incompatible ICT about technologies, committing to a technology is more advantageous to the agency earlier rather than later, due to the commitment power when the choice is irreversible [51].

This herding behaviour may appear because of information flow, which occurs when individuals of sound minds begin to ignore their own findings and instead continue in the footsteps of previous decision makers [50]. In addition to informational cascading, Li [50] also notes that positive network feedback can cause leading technology to grow more dominant. They usually result in positive network externalities that make an ICT adopter's return positively correlated with the number of adopters who have already committed themselves to the same technology. Therefore, herding is rewarded by increasing the payoffs of those ICT adopters who associated themselves with the majority.

As technology advances, organizations adopt newer tasks. This can result to the change of the nature of work in the organization. For instance, tasks that were done manually are now done automatically with the aid of machines. Most organizations increase the readiness to change because the nature of work is changing [52] [53] [54].

Madsen, Miller and John [55] define change as a transition from a stage to another, and that existing structures are broken down to create new ones. According to Armenakis et al,. [44], there are certain features of a positive work environment; which generally tend to include both workplace as well as individuals. These thus encourage positive behaviours and attitudes for the organizational readiness for change.

One of the most significant current discussions in commitment to change is work-related attitudes and behaviours. Perceived risk and habit is an important component in the resistance to user resistance to a new technology [56]. In addition, Mowday, Steers and Porter [57] argued that a relationship exists between job nature and affective organization commitment, is described as the motivation and desire of an employee to not only continue working for an organization but also work to his full potential to help achieve the said organizations' goals [57] p:225.

As already discussed, technological advancements lead to the need for change in the organization. Technology also influences the nature of work, for instance, from manual to automatic tasks. Adopting new technologies is mandatory for improved performance and retaining a competitive advantage for the organization [58]. However, the organizational readiness for change will depend on first, the availability of resources to adapt new technologies; and second the employees' ability to coexist with the introduced technology [59]. New technologies necessitate the need for knowledge, skills, and expertise on how to use them. When employees are unfamiliar with the new technology, intimidation may occur, and hence resistance towards change.

The organizational readiness to change can therefore be achieved depending on

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how the organizational people are introduced to the new technology. This requires training, which not only acts as an instrument towards empowering the people with the knowledge and skills for the technology, but also motivates employees in their work. Training is one way in which the needs of personal development for the employees are met, and in turn benefits the organization with improved performance. Therefore, training increase the organizational readiness for change, as the employees are empowered towards the acquisition of newer tasks. On the other hand, lack of training reduces the organizational readiness for change and instead increases resistance to change. Resistance to change in organizations at the moment is associated with reduced business development. It has been suggested that commitment to change is dependent of the job redesign and empowerment [60].

For performance improvement, a lot of key factors come into play, for instance the leadership style, the motivation that employees get, and how the goals and values of the organizational culture are implemented. This means that dissatisfaction in performance is greatly contributed by the perception that the employees have towards the organizational structure, and the management models. Supervisory models influence the effort that the employees are willing to put in the work for the benefit of the organization in terms of performance. Dissatisfaction in performance also results from external factors such as competition. The biggest problem often facing public organization when it comes to evaluation knows what to evaluate. It is much more important to measure outcomes rather than inputs or outputs [61]. Winslow and Bramer [62] state that depict a model for human performance where optimum performance lies in the middle of three intersecting circles of ability, context, and motivation. A considerable of the study done by Burke and Litwin [63] a strong relationship between performance and organization change has been confirmed, moreover, have argued that numerous studies [64]; [65] have attempted to explain the impact of reword, nature of work, the needs of an individual and the values he places on motivation as well as satisfaction with job on the work performance and organization change.

With regard to computer usage, Straub [66] says that if an individual can effectively communicate electronically with the clients, it thus reflects a high level of capability on part of the individual. An effective employee, hence, believes that he or she can assess the usefulness of the computer-mediated work environment, thus bringing out positive changes in his or her behavioural intention and use of the technology. More importantly, employee's computer self-efficacy is determined by experience, observation, social persuasion, and affective arousal. Therefore, one's computer self efficacy, being changeable in nature, could be enhanced through intervention, which may include specifically designed training [67] [5].

The satisfaction on the new tool depends on the performance of this new instrument [68]. In a study done by Floh and Treiblmaier [69] identified that satisfaction which represented by the management performance is a very important attribute of technology adoption.

Researchers tried to look into various elements linked to this and have developed outlooks in terms of the affective, cognitive and behavioural reactions that different people exhibit to technology along with outlining how different elements impact the individuals to produce these reactions. No theoretical framework has been more successful as TAM [35].

On the other hand, defence mechanisms are typically utilized without any active knowledge on part of the person in question, when confronted with danger to one's spirituality [70] [71], therefore, the relationships between the research variables were hypothesized Figure 1:

- H_1: Attitude to change negatively and directly influences Behavioural intention (BI) to use.

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- H_{1a}: Subjective norms mediate the relationship between Attitude to change and BI.
- H_{1b}: Perceived voluntariness mediate the relationship between Attitude to change and BI.
- H_2: Usage "performance" positively and directly influences the intention to change.
- H_{2a}: Training mediates the relationship between usage and attitude to change.
- H_{2b}: The nature of work mediates the relationship between usage and attitude to change.
- H_3: Usage mediates the relationship between Perceived usefulness and attitude.
- H_4: Perceived ease of use positively and directly influences Perceived usefulness.
- H_{4a}: Usage mediates the relationship between Perceived ease of use and attitude.
- H_{5a}: Principal Support positively and directly influences perceived ease of use.
- H_{5b}: Principal Support positively and directly influences perceived usefulness.
- H_{6a}: Valence negatively and directly influences perceived usefulness.
- H_{6b}: Valence negatively and directly influences perceived ease of use.
- H_{7a}: Appropriateness positively and directly influences perceived ease of use.
- H_{7b}: Appropriateness positively and directly influences perceived usefulness.

ICT acceptance is rarely the motivation for public workers in Saudi Arabia; it is an essential activity for many workers. However, little is known about public worker's behaviours and their preferences to use ICT. This study will investigate acceptance factors of public worker and will profile worker preferences. Organizations that target ICT can benefit from the understanding of employee's behaviour, and can gain advantages over those organizations that are less knowledgeable about their user.

The study aims to answer the main research question "what factors affect employee behaviour to accept and adopt ICT in the Saudi public industries?" and to what extend the performance affect the ICT acceptance and adoption.

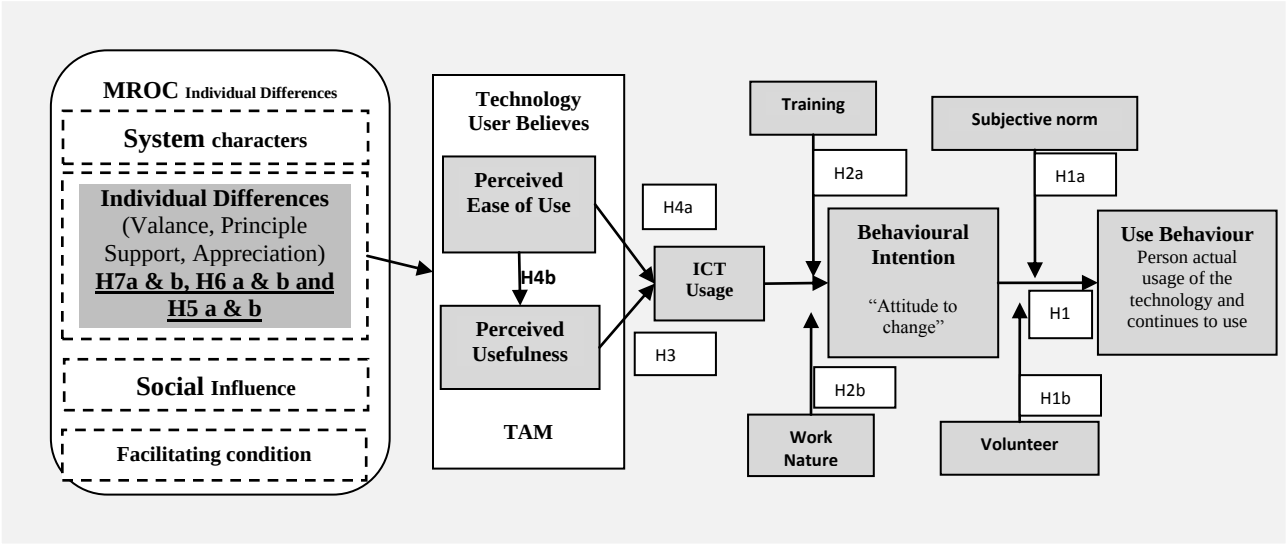

Figure -1 The Research model

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III. METHODOLOGY AND FRAMEWORK

For this paper, the MROC presented by Holt and colleagues [29] was combined with components of TAM III [72], the third iteration of TAM [24]. The theoretical framework proposed specifies potential relationships among variables from both TAM and the model of organizational readiness of change with other factors from the literature subjective norm and volunteer Figure 1. For the theoretical model, the MROC serves as the template and technology acceptance variables are included into the model. The change-related beliefs chosen for this research consist of nine interrelated variables. The three beliefs referred to as the organizational change recipients' beliefs (OCRBs) include: appropriateness, "is this the right change"; principal support, "has everyone bought into making the change happen"; valence, "what is in it for me" and commitment to change [73] [53]. In addition to the three change-related beliefs, the four primary beliefs of TAM, seeming easiness in terms of the usage, seeming usability, are also taken into account.

In addition to four factors which are nature of work, training, perceived voluntariness and subjective norm as moderators. These variables are not explained in this section since each one is focused on in greater detail in the sections that follow within this literature review. It is proposed that these beliefs are the result of sense making as it concerns any number of antecedents that could be related to the organizational change involving technology.

Finally, current usage the discrepancy between the desired and the current performance levels can trigger the call for change in the organizations. Specifically, if the current performance is faced with perceived dissatisfaction, the organizational construct suggests that changes occur in the organization [59]. Yousafzai, et al,. [23] argue that the variance in the type of method, subject, technology and utilization are typically prone to moderating the links that have been hypothesized.

IV. PARTICIPANTS AND PROCEDURES

Participants were 757 employees who are working at public organization in Saudi Arabia. A letter of consent was obtained, and the questionnaires were issued. The participants in this study were 100% male, majorities 46% of them are graduated. The age group between 30- 34 is the majorities of the respondents. The survey would be highly influenced by supervisors with income between SR 6000 -7999. Most of the respondents have no training and almost 20% of the trainees got their training in the department for less than one week.

Before issuing the questionnaire, a brief explanation (verbal introduction) about the purpose of visit, objective of the study and how to fill the questionnaire were all instructed to the employees. Questionnaire was translated to Arabic and back translated again to English. All the questionnaires were issued, filled and collected on the day of the visit or sent by mail. After that the questionnaires, data was typed in manually into excel file, then transfer to PASW 18.0 file format and coded.

A. Data analysis

The research at hand makes use of structural equation modelling (SEM), in order to construct a framework that showcases the links in terms of the four variables that have been included in this research. These variables include intent to use, behaviour towards using technology, seeming utility, and seeming easiness in terms of use. Data was gathered via a survey questionnaire which consisted of queries regarding respondents attribute and various things for every single one of the four variables included in the research. SEM was picked up for the research and not a regression analysis. This is because it as a parallel analysis running which allows an assessment of links in terms of the different variables included along with the errors and issues that every variable has, which are to be measured independently, and this is not possible with the regression analysis.

AMOS (Analysis of MOment Structures) was used as the data analysis tool. AMOS is the more recent analysis package which is user-friendly graphical interface, and it has gained popularity as a much more easy manner of adding specifications to structure dimensions. AMOS additionally has an interface an alternate option known as BASIC [74].

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The sample was a convenience sample of at least 200 of civic employees who work in western Saudi Arabia. A self-administered survey was used to collect data at Medina, Jeddah, and Yanbu. The study was conducted at different organization and ministries offices to reduce bias.

The instrument for data collection was developed based on the review of the literature on technology acceptance studies change behaviour and TAM I, TAM II and TAM III, Model of organization readiness of change.

Steps which involved SEM are as follows: Data was checked to see whether there was anything missing or left over. After this, the data was validated and discriminate and convergent validities of the information at hand was developed. After this the problems associated with SEM itself were looked into. For instance, in order to make sure that normality existed within the data, [74] suggested the view of kurtosis indices along with skews shouldn't go beyond the value of 10.0 and 3.0 respectively. For the results from SEM to be reliable it is important that the size of the sample be kept at 100-150 [75]. The size of the sample within the current study at hand has been kept at 429 in order to ensure that it fall within the specified requirements.

B. Result

The analyses within the current section are of a statistical nature and look into the descriptive statistics for the purpose of measuring objective and examining how valid the measurement is within the scope of the current study. Subsequent to this, the model is tested in terms of the various fit indices and previously developed hypotheses.

C. Descriptive Statistics

Table-1 contains all constructs for descriptive statistics. The means lie above 3.00; however, this is not true for the principle support which at 2.7 holds a different mean. Standard deviations lie within the range of 0.77-1.24; this shows that the mean has a relatively narrow spread around it. In terms of the Skew we can see that the index lies between -0.6 - 2.0, along with which the Kurtosis also exhibited an index which ranged from -0.1 – 4.6. The data is normal in terms of the SEM as per the recommendations put forth by [74].

Table -1 Descriptive Statistics of the Study Constructs

Variables	Item	Mean	ST.D	Skewness	Kurtosis
Principle support	4	2.68	0.77	-0.9	0.1
Motivation Valance	4	4.02	1.03	-0.6	-0.4
Appreciation	5	4.24	0.99	-1.3	-0.9
Perceive Ease of Use	4	4.22	1.09	-0.4	-1.1
Perceive Usefulness	5	4.05	0.82	-1.2	1.6
Attitude to change	4	3.70	0.80	-2.0	5.5
Subjective Norm	2	4.11	0.83	-2.0	4.6
Volunteer	4	3.81	1.00	-1.1	1.3
Behaviour Intention	5	3.90	1.08	-1.0	0.4

D. Convergent Validity

In assessing for convergent validity of the measurement items, the item reliability of each measure, composite reliability of each constructs, and the average variance extracted are examined. The item reliability of an item was assessed by its factor loading onto the underlying construct. In this study, the composite reliability was used instead of the Cronbach's alpha because the latter tends to understate reliability [75]. For composite reliability to be adequate, a value of 0.70 and higher was recommended [76]. The third indicator of convergent validity, average variance extracted, is a measure of the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error [77]. Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50. From Table-2, the average variance extracted and composite reliability met the recommended guidelines, indicating that the convergent validity for the proposed items and constructs in this study are adequate.

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Table – 2 Results for the Measurement Model

Latent Variables	Item	Factor loading	Ave. Variance extracted (> .50)*	Composite Reliability (> .70)*
Principle support	Ps1 Ps2 Ps3 Ps4	0.7 0.8 0.7 0.5	0.6	0.7
Motivation Valance	Mv1 Mv2 Mv3 Mv4	2.2 0.6 0.5 0.5	0.6	0.7
Appreciation	Ap1 Ap2 Ap3 Ap4 Ap5	1.8 0.8 0.8 0.7 0.6	0.7	0.7
Perceive Ease of Use	PEU1 PEU2 PEU3 PEU4	2.3 0.7 0.5 0.3	0.7	0.8
Perceive Usefulness	PU1 PU2 PU3 PU4 PU5	2.5 0.9 0.6 0.5 0.3	0.7	0.7
Attitude to Change	At1 At2 At3 At4	2.7 0.7 0.5 0.3	0.7	0.8
Subjective Norm	Sn1 Sn2	1.8 0.9	0.5	0.9
Volunteer	Vl1 Vl2 Vl3 Vl4	2.4 0.7 0.5 0.3	0.7	0.8
Behaviour Intention	Bi1 Bi2 Bi3 Bi4 Bi5	2.3 0.8 0.8 0.5 0.3	0.7	0.7

E. Test of the Measurement Model Fit

The model of the research has been developed through the structural equation modal approach. The AMOS was used to create it [78]. Numerous different indices have been implemented in this research. Hair et al. [75] was of the view that utilizing fit indices that stemmed from different sets was a good idea. The ones used were absolute fit indices and gauged the extent of the inconsistency in terms of the observed and implied covariance matrices. The (χ^2/df) statistic is used by researchers along with the SRMR, the standardized root mean residual, which is not used within this research. Parsimonious indices are closer to the indices that are absolute fit, however, they are different because they account for the complexity of the

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model. The RMSEA the room of mean square error of approximation is used in great quantities across the research spectrum as a parsimonious fit index and P-CLOSE.

The third table reveals the limit of what is acceptable as a fit along with the fit indices for the projected model for research within the study at hand. The values were up to the levels that were recommended in terms of the acceptable fit. In terms of the $\chi 2$ it was seen as highly sensitive to any augmentation in terms of the size of the sample along with the amount of variables that was to be examined [75]. This is the reason that the ratio of $\chi 2$ to its extent of liberty to be calculated (χ^2/df) was implemented, through a ratio of 3 or smaller, which was an indication that an acceptable fit existed in terms of the sample data, and the model developed through the hypothesis [79].

Table - 3 Fit Indices for the Research Model

Model Fit Indices	Value	Recommended Guide lines	References
(χ^2/df)	1.6	< 0.3	Kline and Littel 2010; Hair, 2010
CFI	0.9	> 0.9	McDonald and Ho, 2002; Hair, 2010
GFI	0.9	> 0.9	Klem, 2000; McDonald and Ho, 2002; Hair, 2010
REMSA	0.04	< 0.05	McDonald and Ho, 2002
PCLOSE	0.81	> 0.5	Klem, 2000; Hair, 2010

F. Test of Structural Model

Overall, eight hypotheses were supported by the data. At this point, of the assessment of the hypothesized path suggested in the structure model Figure 2, in this step of the procedure the researcher checks, whether the path coefficients are significant and the same direction assumes in the model. Also the mediators are inspected and evaluated in the same way based on the literature which the relationship has been constructed. Significantly, it is to check the affect of the new variables on the model. In general fifteen hypothesizes were recognized in the model for the study. Table-4 illustrates the standardized regression weight of the model hypothesizes in Figure 2.

Table-4 shows appreciation and motivation valance affected the PEF negatively, on the other hand, PS significantly affects the PEF positively. PU found to be predicted by appreciation and MV negatively, and positively with PS. Overall, PEF and PU have a significant direct positive relationship. PEU has a positive association with current usage which opposite to the association between PU and current usage. Current usage with the association to the intent of using along with the intent of using in link to BI was found has no effect or no significant effect. The mediators of the model were found to arbitrate the correlation.

Table- 4 Hypothesis Testing Results

Hypotheses	Path			Std Regr. weight	Result
$\mathbf{H_{7a}}$	PEU	←	Ap	-0.29	Not supported
$\mathbf{H_{7b}}$	PU	←	Ap	0.20	Supported
$\mathbf{H_{6b}}$	PEU	←	Mv	-0.78	Not supported
$\mathbf{H_{6a}}$	PU	←	Mv	0.36	Supported
$\mathbf{H_{5b}}$	PEU	←	PS	1.46	Supported
$\mathbf{H_{5a}}$	PU	←	PS	-0.83	Not supported

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H_4	PU	←	PEU	1.22	Supported
H_{4a}	Usage	←	PEU	-1.01	Not supported
H_3	Usage	←	PU	0.81	Supported
H_2	Att. B	←	Usage	-0.19	Not supported
H_{2a}	Att. B	←	Training	0.20	Supported
	Training	←	Usage		
H_{2b}	Att. B	←	Work	-0.02	Not supported
	Work	←	Usage		
H_1	B I	←	Att. B	0.03	Not supported
H_{1a}	B I	←	SN	0.31	Supported
	B I	←	Att. B		
H_{1b}	B I	←	Vol	0.68	Supported
	B I	←	Att. B		

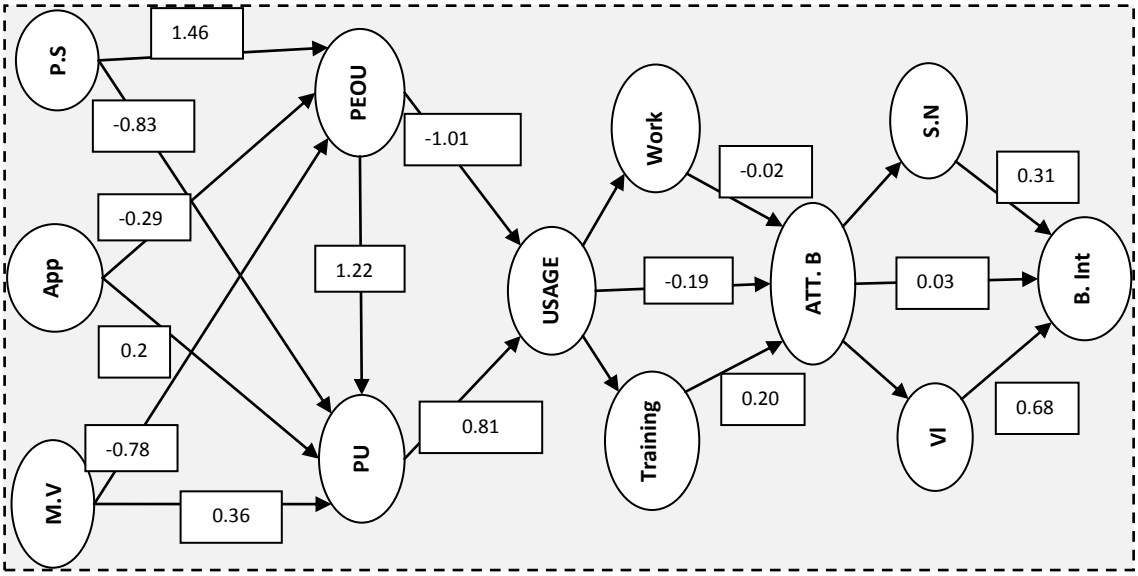

Figure -2 CFA Of the Research Model

V. DISCUSSION

This research was trying to: (1) forecast factors affecting ICT in clearing up the behaviour of accepting technology in a developing Arab nation, especially Saudi Arabia, (2) expand the TAM to expand on how ICT is used behaviour wise, along with (3) scrutinize the part played by norm, volunteer, training time and work type as mediators of the ICT acceptance and adoption in terms of elaborating on the behaviour linked with ICT utilization. For the purpose of addressing the objectives of the study the researcher has made used of a strategy for research as has been outlined in the upcoming seconds. The study worked by looking into how applicable antecedents of belief variables of (MORC) on TAM Technology user believes. Then the study examined the affect of current usage on TAM model. Finally, the study examined the influence of training and work type on the relationship between current usage and attitude behaviour. Moreover, the study explored the affect of norm and volunteer on the association between attitude behaviour and behaviour intention to use.

Andam, [80] proclaim that with the appreciation in ICT, in particular in public organization, it has a positive influence.

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Unexpectedly, the Table-4 shows the relationship between perceive ease of use, and appreciation is significantly negatively. This due to the motivation method explains how individuals' goals influence their efforts.

Davis [24]and Venkatesh [40] argue that appreciation is the increasing value of the use of ICT. As well, it is the ways individuals appreciate the use of ICT. After looking at the principal of appreciation, it is important to consider reviewing perceive usefulness. Perceive usefulness helps to determine the reason why people in an organization accept or reject information technology. Eventually, this research renders a similar result as Davis [24] and Venkatesh [40]claimed, Table-4 shows that appreciation has a direct positive relation with perceive usefulness.

The definition of valance is an individual strength of performance for a reward. Then expectance is the probabilities of a particular action leading to a desired reward instrumentality indicate individuals estimate that performance will result in achieving the reward. This means that if an individual has a particular goal to achieve, the individual must produce certain behaviour in order to achieve this goal. Individuals also need to weigh the like hood that various behaviours will help in achieving the desired goals. If it needs certain behaviour as an expectation of more success, individuals will, then prefer a new particular behaviour [81].

The table surprisingly shows direct positive relationship between motivation valances and perceive usefulness. For the purpose of developing better comprehension in terms of the issue of valance, the expectancy, describe at time it is the performance reward proverbially. The expectancy theory gives the probability the performance that will lead to a desired goal or outcome [82].

To some extent, motivation becomes valance, instrumentality and expectancy. The three factors in the expectancy model can exist in an infinite number of contributions depending on the range of valance and the degree of expectancy and instrumentality. The achievement of high positive valance comes out, when there is a combination that produces a high motivation. When the three values are high and produce a high motivation value, the valance will then be a positive value [83].

On evaluating valance as a way of motivating employees, the research found out that valance does not take in a specific means of motivation. There are various ways of motivation valance [84]. This means that motivation does not come from the activity alone, but from other external factors [85] [86]. This study supported the valance instrumentality expectance claim of the zero effects or negative effect as Table-4 illustrates the direct negative relationship between motivation valance and perceive ease of use.

Davis [24] and Venkatesh [40] notice after making a careful observation of both principal support and perceive ease of use, we can see that they are all deriving to the ICT implementation. There is an essence of improving the ICT systems in order to provide an ease to the users. With the ease, the organization finds that implementation of ICT is enhanced [40]. In fact, in this study the principle support has a direct significant positive effect on perceive ease of use as Table-4 shows. The relationship in this study is supported.

Researches affirm that there is the urge of learning the new ICT within the employees; yet, there is lack of commitment from the top management [87]. At such a situation, the management has not acknowledged the importance of ICT causing the organization member's reluctance as well. With the principal of support such, an organization requires to establish its weakness towards accepting the new information system in order to come up with good implementation of ICT [87].

Yet Table-4 shows that principle support is negatively affects the perceive usefulness, which confirm what Bjorn and Fathul [1] showed in their study that the lack of leaders or high officials support contributes to sixty per cent of e-government initiative's failure.

Perceive ease of use determines individual behaviour intention to use information technology. Perceive ease of use falls under a broad topic called TAM. This is a theoretical framework that outlines the manner in which users can acknowledge a particular technology. The theory goes on to state that

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the presentation of a new technology to the users, there are numerous elements that can impact their decision making process in terms of the time and manner of their usage [88].

PEU has shown a direct positive significant effect on perceived usefulness in many studies [89]. After all, this study came up with the same output of the old studies which is illustrated in Table-4. The level of significant of regression weight is very low.

Rogers confirmed that perceive ease of use is not only the perception of inform a system by people but also is the extent where the innovation has been seen by the user as easy to understand, use and learn [31]. In contrary, the study shows Table-4, the association between current usage "performances" and perceive ease of use, is direct negative relationship. This confirms the most recently study done by Nagli, Rahmat, Samsudin, Hamid, Ramli, MD Zaini and Jusoff [90] which confirm that perceive ease of use has no significant in today operation Table-4.

On the other hand, the table shows the relationship between perceive usefulness and usage is a direct positive relation, with high level of significant regression weight. The outcome of the study affirms the claim of Nagli et al,. [90] that perceive usefulness has a direct positive relationship with performance and current usage.

Part of the study is to provide how current usage positively affects the attitude to change. The increasing and continuous use of ICT affects the attitude to change positively.

Primarily, this study shows Table-4 that current performance is negatively affects the attitude behaviour with a very low level of significant. Due to Change management has become critical in the modern world of business. All organizations are looking forward to manage change in order to achieve their objectives. Even if change is important for the improvement of the organization performance, employees at time have resisted change. The reason of change resistance among the employees is the fear of losing their job positions. Not all organization members will take this positively.

Some organization members may not be computer literate and will think the introduction of computers will threaten their job since they can use the system [91]. Also Winters, Chudoba, and Gutek and Teo, Lee and Chai indicate that one's attitude has a considerable amount of impact in terms of being a forecaster of how some technology would be used if the user is given the liberty to choose if he should or shouldn't use computers [92] [93].

Management may not fully grasp the actual level of expertise required for organizational members use the technology effectively. As such, they often underestimate the training required and the time that it will take in implementing the new ICT [36].

The organization has to provide training to its employees about the use of information systems. Besides that, the organization as well is required to train the organization members about ICT at large. Given the opportunity to learn about information systems (IS) and ICT at large, the members will develop interest [5].

Attitude to change is not always positive. To the organization, change is something vital but the employee's change is a threat. Many at times the organizations may be glad to introduce change to their daily services activities but organization members will always be ready to resist the ICT applications. Theory of planned behaviour is significant for the understanding of these variables. Theory of planned behaviour specifies the natures of relation between believe and attitude. Individuals' evaluations of attitudes towards behaviour usually are determined by accessible believes about behaviour [94].

A belief is basically one's own concept of what will most likely going to happen i.e. a certain act or behaviour will lead to a specific result. To be specific, the assessment of a result is a part and parcel to the behaviour and is positively linked to someone's subjective likelihood that produces the outcome in question [27]. Davis confirmed the relation between attitude and behaviour intention as a direct positive relationship [24], this study did not confirm the hypotheses as the table shows positive non significant weight relationship with the level of significant is 0.7.

The stated purpose of TAM is to "provide an explanation of the determinants of computer acceptance that is general, capable

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of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" [35]. It assumes rationality within the decision-making process. Studies have provided empirical support for TAM [39].

Subjective Norm in relation to an innovation was hypothesized to influence significantly the user's behavioural intent to adopt the innovation. The study shows subjective norm mediates the relationship between attitude and behaviour intention, even though the influence is not significant p level is smaller than 0.08 as according to Hair [75].

Perceived voluntariness towards an innovation was hypothesized to influence significantly the user's behavioural intent to adopt that innovation. The table shows that volunteer mediate the relation between attitude and behaviour the direct path has weight 0.81, and P-level 0.3, which is significant to mediate the relationship according to Hair [75].

The table shows that training mediate the relationship between current usage and attitude behaviour the direct path is 0.14 for the relationship between training and attitude behaviour, and it is negative relation between usage and attitude behaviour. According to Hair [75] the value of a path must be greater than 0.08 in order to be significant. The study concludes that Table-4 the nature of work did not mediate the relationship between usage and attitude with a significant level of 0.9.

VI. IMPLICATION FOR THE THEORY

This study demonstrated association among TAM variables. Yet, It could be observed from the research analysis that ICT usage has affected the relationship between TAM variables.

Second, the research technology beliefs PEOU and PU have an opposite impact on the ICT usage. The PEOU has a direct negative effect on usage (-1.1). The PU effect on usage is -0.8. Therefore, PU is a deciding factor on ICT acceptance. What is less clear is if the current usage has a motivation effect on attitude behaviour due to a low level of usage and training.

Third, this study expands the understanding of TAM, and shows that it is very applicable to Arab countries (Saudi Arabia). However, this argument needs more investigation and examination.

Fourth, the research examined the relationship between TAM behavioural factors. The analysis revealed a prototype that is related to the Saudi public industries.

Fifth, Lin and Lee [46]mention that subjective norm moderate ICT acceptance. Also, Quaddus, Xu and Hoque [95] noted that that perceived volunteer influence the ICT usage. This study confirms this allegation and comes to similar result.

Sixth, this study found that training insignificantly increase employee readiness for change, this finding support Lan and Cayer [58] and Davis and Bostrom [96] argument with insignificant influence, due to 80 % of the respondents had no training.

Seventh, this research found that current usage has an insignificant negative impact on the attitude behaviour, which validate Management Hub argument that some of the employees are not familiar in using ICT and may think that such change may disturb their work.

Finally, work type did not moderate the relationship between usage and attitude behaviour, this contrasting Al-Adwani [56] and Modway, Steers and Porter [57] argument that a relationship exists between job nature and affective attitude to change.

VII. IMPLICATION FOR THE ORGANIZATION

The objectives of this investigation are knowledge the typologies of employees and their preferences of ICT acceptance and adoption. And to identify the factors behind the ICT acceptance and adoption failure. So that the public organizations have upper hand over ICT acceptance and adoption failure in the future.

In this part the study will provide some understanding of the obstacles to ICT adoption in GO's in Saudi Arabia. Seven important issues were identified in the survey's out-come given as follows: At the first, the most

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important concern for the public organization to deal with is had to do with the question of: will the worker be able to use the new system? Are they prepared to use it? Have they had the suitable training? The employee's willingness and the organizations' readiness were observed to be near to the ground in developing countries. These two issues impact significantly the ICT acceptance and soon after the adoption of ICT. The research instrument showed that approximately 80 % of the workers had no training.

Therefore, employees should be trained on the way the system works on the parts that are associated with their jobs. In a nutshell, achieving a close understanding into the how the whole system work is imperative than what the user needs as a part.

Second, the resistance of change issue, this matter related to the low e-readiness among employees. Research affirms that workers fail to use the new ICT system due to the lack of training, which cause workers to oppose the ICT applications. Consequently, providing a better solution for the ICT applications uses is a necessity to reduce the resistance.

Third issue is language barrier associated with the new technologies. According to the undersecretary of the Ministry of Commerce, language is an important barrier to any e-systems where the majority of people speak Arabic.

Fourth, skilled workers are required to level up the ICT Knowledge. According to the survey less educated workers have low ICT acceptance. It was also reported by the officials that absence of adequate know-how hinders governments to adopt and start ICT-based projects.

Fifth, Porter and Lawler [84] propose the construction of the job environment keeping in mind the objective of internal and external rewards to create fulfilment work and could be followed by the growth of the job, which will make the job more motivating. It is more interesting and thus become more satisfying fundamentally. Reward in the mean of high salary which, consequently provides the employees' a motivation to work.

Sixth, according to the top administrator of the Ministry of Civil Status, most of the users of e-government were females because of cultural issues in which women are expected by custom to stay at home. Due to their spending long time at home, they will likely use the e-services at home frequently for the convenient sake.

Lastly is the issue of leadership support. It was reported by the head of the information systems department at the Ministry of Finance that having leadership support plays an essential role in the execution and spreading of e-government. According to the official, there must be high priority for ICT, and it should be considered as the major contributor to economy otherwise any important development initiatives such as IT education will not be paid attention to. Leadership support has great influence on the allocation of resources for technology and e-government adoption. Furthermore, the undersecretary of the Ministry of Commerce also argued that leadership and top officials' commitment to ICT is also crucial. Such has the capability of affecting the allocated budget for ICT adoption and development in any organisation. However, the official stated that budgets cannot just be raised to bring about the increase in the awareness of ICT but some other institutions of government usually budgeted for ICT and have their top officials willing to work hard with their time and energy devoted to ICT. There are other organisations with low budget allocation to ICT while some such as Ministry of Education have a commitment to ICT.

VIII. LIMITATION AND FUTURE STUDY

The findings of this study have some important implications. One, TAM extended is very relevant to a non-western nation where there is changing degree of explanatory power. However, more studies are still required particularly when the explanatory power of the model employed is not as high as TAM.

There is still needs for more investigation of additional probable variables, which likely give high boast in analysing ICT in terms of the behaviour in different nations, apart from the west. Two, TAM extended or UTAUT model may be employed to analyse other behaviour of ICT. Three, the requirement for future inspection in terms of the part that experience plays when it comes to acceptance

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modelling for technology, and this was shown by the findings. Therefore, there is room for future research, particularly with respect to training and compensation. Also needed for future study is an intensive study of usage as a mediating variable. More research designs are likely to strengthen the insight into the aggregated model. A cross-section of people within the ICT in government organization usage context was investigated. Therefore, studies in the future might examine larger subsets of users in relation to pointing out the limitations and exceptions. Also recommended for future research is the longitudinal studies which examine the hypothesised associations as they were open for some time now. The inclusion of an additional group of antecedents which includes being educated about the system.

Lastly, findings suggest that the formation of positive attitude of ICT should occur before the adoption of technology and as a result, researcher should investigate the training effectiveness.

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Survey and selection of Energy Storage System for Low Power Embedded System

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***Abstract*— Energy storage for portable low power Embedded System is one of the biggest challenges for a long time operation in present research and application. These systems are designed to operate the lowest possible energy at micro-watt or Milli-Watt range and the power is supplied from a small primary or secondary cell. In this paper an extensive study and latest survey has been shown to estimate and select the right suitable energy storage device in theoretical aspects and also commercially available cells. The alternative Super-Capacitor based storage solution also has been described as ready reference to estimate the requirements with trade-offs between cost, size, weight and other parameters with feasibility aspects.**

***Keywords*— Low Power, Mathematical Modeling, Energy storage, Capacity, Form factor, Cost.**

I. INTRODUCTION

The embedded system device requires a tiny storage device with high specific capacity and long shelf life. The cost is an important parameter and the product should be readily available in the market, so that it can be replaced easily when required. Normally batteries are primarily considered for storing energy. In this paper different chemical compositions of primary and secondary batteries have been studied for different characteristics that make them suitable to be used for an embedded device. The parameters which form the basis of mathematical model are: specific capacity, specific weight and volume, nominal voltage, shelf life, re-chargeability and cost. This paper also highlights super capacitors that are emerging as energy storage system. Since, batteries have a limitation that they take a long time to recharge. Super capacitors, with engineering characteristics like very less charge time, good temperature range, capacitance in 1000F range, can become an alternative to the batteries.

II. CHEMICAL BATTERY & CHARACTERISTICS

An All the parameters in a storage system are compared with "capacity" of the storage system. There are the lists of comparison study of all major parameters for conventional battery/cell energy system.

A. Specific Cost

The prime interest of any storage system is the cost or the specific cost ($/Ah). Fig. 1 shows a comparison report based on commercially available batteries/cells. The result shows, the Zinc-air has the maximum cost per unit amount of energy where as the $ZnMnO_2$has the lowest cost per unit amount of energy. Hence, if the desired parameters are cost-effective device, the priority will be batteries based on $ZnMnO_2$. However, $ZnMnO_2$ is the primary cell. If we need to select Secondary battery, the best selection is Li $(CF)_n$.

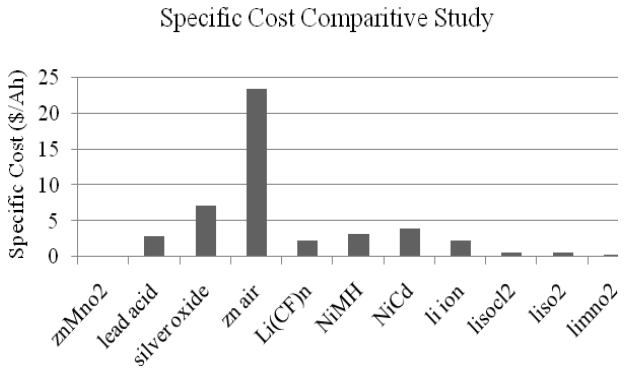

Fig.1 Specific cost of various chemical compositions of commercially available batteries

B. Specific Capacity

The specific capacity i.e. capacity per unit mass (Ah/Kg) is another important parameters based on which batteries are selected. In Fig. 2 the comparison report is highlighting this parameter for commercially available batteries/cells. As per the graph, the Zinc-air has the maximum capacity per unit mass of cell where as the lead acid the lowest capacity per unit mass of cell. Hence, if the desired parameter is high specific capacity device, the priority will be batteries based on Zinc-air. Since Zinc-air is the primary cell, so if we need to select Secondary battery then Li $(CF)_n$ would be the best.

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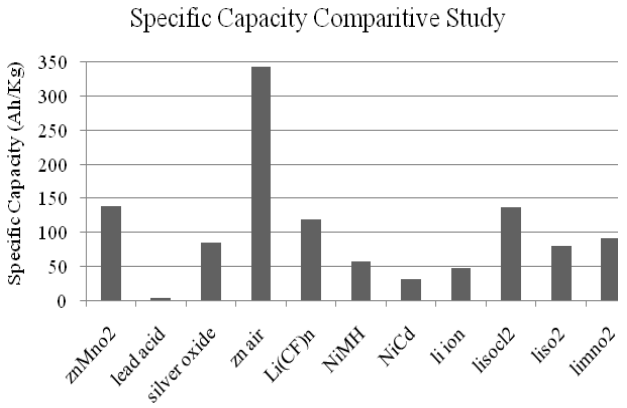

Fig.2 Specific capacity of various chemical compositions of commercially available batteries

C. Specific Weight

For portable devices, weight of battery plays a significant role. Here is a comparison report for specific weight i.e. weight per unit capacity (Kg/Ah). As appear from the graph, the lead acid battery has the maximum weight per unit amount of energy where as the Zinc-air has the lowest weight per unit amount of energy of the cell. So, if weight is the prime selection parameter then, the Zinc-air battery tops the list. Among secondary batteries $Li(CF)_n$ based batteries would be the best choice.

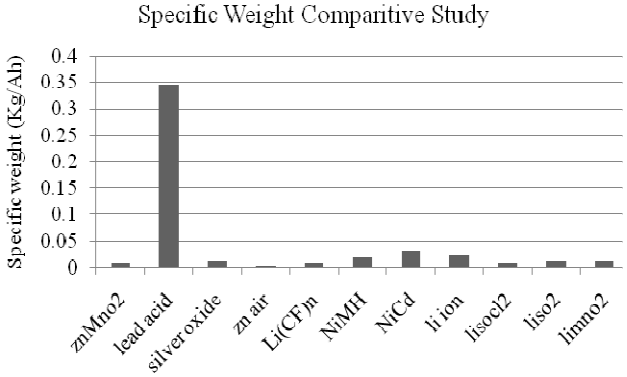

Fig.3 Specific weight of various chemical compositions of commercially available batteries

D. Specific Volume

Like weight, the unit volume is again a significant parameter for portable devices. The report compares different cells/batteries based on cell volume per unit amount of energy (cm^3/Ah). According to the report, the lead acid battery has the maximum volume per unit amount of energy where as the Zinc-air has the lowest volume per unit amount of energy. So, if volume is the major parameter for selection, then the Zinc-air battery should be selected. For secondary batteries $Li(CF)_n$ based batteries are best.

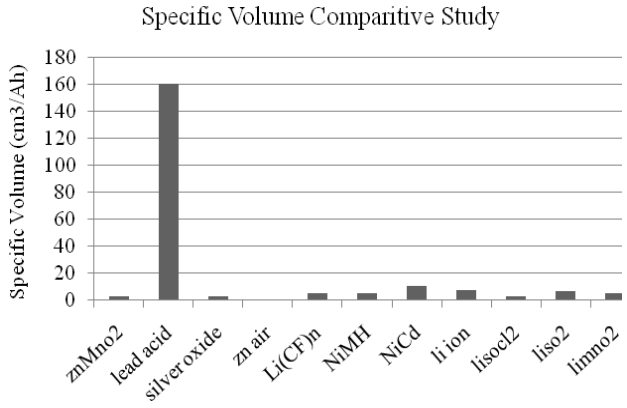

Fig.4 Specific volume of various chemical compositions of commercially available batteries

III. Super Capacitor an Alternative to Battery

The capacitance is measured in units called Farads of which the definition is: 1 Farad is the capacitance of a conductor, which has potential difference of 1 Volt when it carries a charge of 1 Coulomb. So,

$$Q = CV \qquad (1)$$

Where Q is the charge in coulombs, C is the capacitance in Farads and V is the voltage.

Also "Q" is also represented as:

$$Q = I \times t$$

Where Q is the charge in Coulombs, I is the current in Amps and t is the time in Seconds.

The battery capacity comes in Ampere-Hour unit.

$$1mAh = 3.6Q \qquad (2)$$

Using $eq^n(1)$ and $eq^n(2)$ the capacity offered by the super capacitors can be calculated. Also the charging time can also be calculated, assuming that capacitor is fully charge when it has acquired 90% of its operating voltage.

A. Capacity vs. Form Factor

The form factor i.e. the volume and weight of the energy storage system is the major parameter based on which comparison has been done. In fig. 5 the report displays the form factor based comparison for commercially available battery and capacitor. The result shows, that capacitors are bulky as compared to batteries offering similar capacity. So if form factor is the prime parameter then batteries are a better choice than capacitors.

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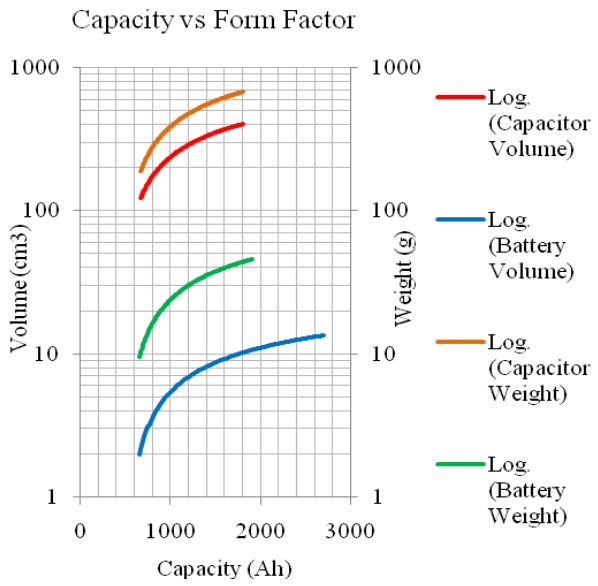

Fig.5 Capacity vs. form factor of various chemical compositions of commercially available batteries and capacitors

B. Capacity vs. charging time

The time taken to charge an energy storage device is again an important parameter. In fig. 6 the report shows the graphical comparison for the same. According to graph the time taken by a capacitor to get charged is vey less than a battery. So the application where charging time is the deciding factor, capacitors should be given preference to batteries.

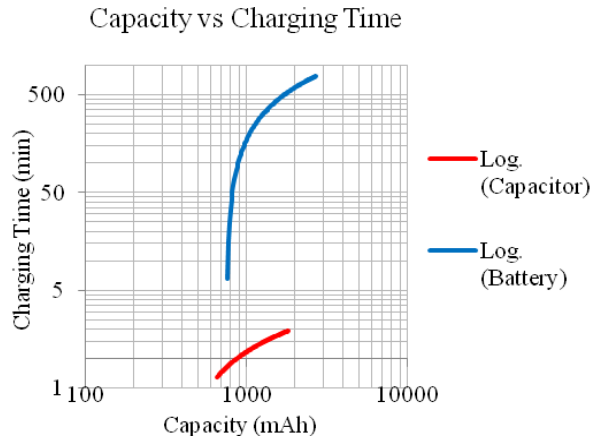

Fig.6 Capacity vs. charging time of various chemical compositions of commercially available batteries and capacitors

C. Capacity vs. cost

Cost is also a significant parameter for an energy storage device. The report compares both the energy storage systems based on cost factor. And as it's clear from the fig. 7 the capacitors are costlier than batteries. Thus, for low cost solutions batteries are more suitable than capacitors.

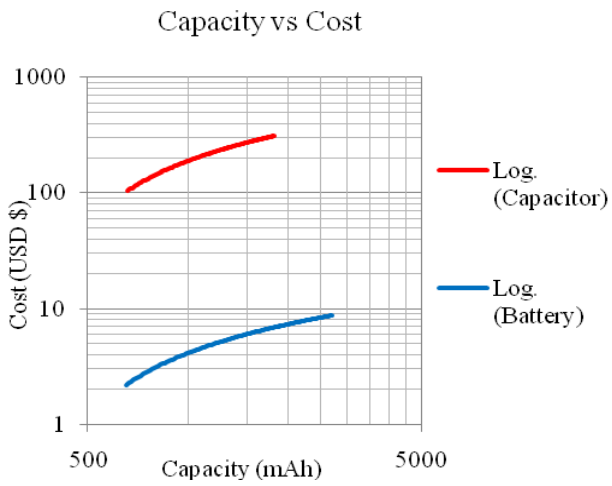

Fig.7 Capacity vs. cost of various chemical compositions of commercially available batteries and capacitors

IV. Conclusions

The comparative result is the formulated survey based data collected recent industry wide and it contains almost all major parameter to select a suitable storage unit following the most important parameters with its individual weight. The battery selection is totally arbitrary and fully depends on user and his choice. For example when Specific Capacity is the prime factor, Zn-Air is the most suitable battery where as, for costing point, $ZnMnO_2$ is the most suitable and for individual cell voltage, $LiSOCl_2$ is the most suitable selection. In some exceptional case, the appropriate solution may differ from study result: such as, Zinc-air battery which is very high at specific capacity point but may not be available at very high capacity size, on that situation, user must look forward to commercial availability of that choice or can shift to next priority as per the graphs shown.

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E-Health: The Use of Mobile Computing In The Health Sector of Nigeria

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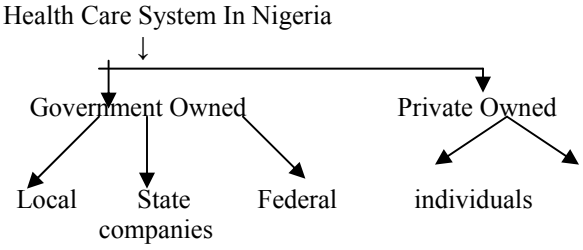
ABSTRACT: The health care system in Nigeria is nothing to write home about, this is due to the inadequate availability of medical and human resources. This inadequacy has led to enormous paper work, waste of time, life, and ineffective treatment procedures.
This study takes a look at the use of mobile technology devices such Personal Digital Assistants, cell phones, personal laptops, palm top etc for health care delivery in Nigeria. It proposes to look at how healthcare application will improve the healthcare services by providing spatially the link between patient and primary health care .This link will provide easy access to medical information at the points of health-care delivery within health care centers. An E- Health model can be designed to solve this problem, the central idea behind this model is to use web languages to describe a user's personal health environment and extend the web browser to use this document to support user mobility. This model enables users to access user-defined health environment from anywhere, at anytime and with any kind of Internet-connected computers. With the use Unified Modeling Language, mobile, and Java-based technologies for its development, E-Health is proposed to be a general solution to the current challenges in the health sector in Nigeria.

1. INTRODUCTION

It is often said that health is wealth; a nation with a good health care system is therefore blessed. Information and Communication Technology (ICT) has played a major role in the understanding of illness, its successful diagnosis and in the practice of medicine itself. The involvement of ICTs in health is commonly called e-health, it is essentially the use of ICTs in medicine for knowledge management and service delivery, a combination which can essentially improve the delivery of medical services and can by consequence improve health outcomes [9].
The World Health Organization [10] determines that there are five essential components to e-health: structural enhancement in the delivery of health services, engagement with stakeholders and the private sector in improving the availability and appropriateness of technologies, learning how to use the tools, creation of standardized norms and practices, and evaluation and monitoring of the application and impact of ICTs to health. E-health is therefore a model that functions as a network of experts and resources that are able to be mobilized within a wide range of distance. E-Health enhances the timeliness of emergency response, thus reducing mortality rate and hospital cost. Surveillance and information gathering systems that allow the recording and analysis of data on spread able diseases is an example of ICTs in this field and is essential in managing the safety of populations [3].

Nigeria is one of the developing countries of the world, located in West Africa. Although it is blessed with natural resources, its wealth is being misspent by its leaders and not spent on important sectors like health.
Sixty percentage of the health care delivery system in the country is delivered by the government and the remaining forty percent by private parastatals. The government owned health care system is divided into local government, state government and the federal government health care systems as shown in the figure below. The National Health Information System (NHIS) was proposed by Nigeria Ministry of Health, to perform the major reforms implemented under the Nigerian government health scheme.

Figure 1. [Health Care Structure in Nigeria.]



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Nigeria has been unable to enjoy the benefits of E-health because we lack the capacity to systematically evaluate developments in ICT, we lack standardized street addresses, and we are unable to create digital records and databases for tracking the spread of disease and lack access to online resources on treatment and diagnosis of illness, management tools and support for clinical care.

Mobile Computing is the use of portable devices to exploit the increasing processing power of consumers needs. E-Health (the use of mobile computing in the health sector) provides a perspective for exploring the relationship between people, their health and well-being through the use of mobile phones. It helps in improving the health- care services by providing the basic infrastructures needed in the sector. E-Health aims to improve healthcare services in Nigeria by developing a Secure Health Information Platform using latest Information Technologies. The spread of hand-held devices, new generation of programmable cellular phones and the availability of development environments for such devices have made possible the design and development of new kind of software that satisfies the users' needs about mobility support and personal information management. With the advancement of network technology these past years, the ability to connect different networks across different platforms has become a complex task. There have been many proposed solutions, some of it are J2SE™ and J2EE™, the J2ME™ platform which are Sun Microsystems technologies that provides a solution to bridge the communication gap between a PC and a mobile phone, technologies that directly transfers information without need for format conversion; J2ME is a technology for mobile devices .

An E-Health system is typically built of several technologies with all their different possibilities and limitations. There are many different technologies available and new technologies arrive continuously. J2ME™ is a new technology that has recently been introduced at the wireless market and many believe that J2ME™ will improve the diffusion of E-Health.

As mentioned above, E-health is one of the fundamental issues for E-commerce why this paper seeks to answers the following question:

"To what extent is J2ME™ suitable for the client technology in a successful E-Health system?"

To answer that question, the paper will initially describe the market, technologies and fundamental aspects of E-Health.

Furthermore the paper will describe a set of critical success factors (CSFs) and example of requirements. The CSFs shall outline the requirements from the market and describe the challenges of providing a *successful* mobile payment system.

On that basis the paper will analyze the J2ME™ technology as a building block of a E-Health system. Comparisons to existing systems and technologies are made during the analysis and the strengths and weaknesses of J2ME™ are described.

The expected conclusion will be an evaluation of the J2ME™ as a building block of E-Health, by describing a set of statements of what eventually needs to be done, to introduce successful E-Health systems with J2ME™.

2. Statement of the Problem

The main problem with the health care system in Nigeria is that most hospitals are still using the manual system to operate, this leads to enormous paper work and consequently, patients have to wait in long queues, while waiting some patients' health deteriorates and worse still, some die in the process. Furthermore, there are inadequate human and medical resources. Most hospitals have just two or at most three doctors attending to hundreds of patients and the hospitals are not properly equipped with necessary infrastructures. Besides, the doctors and nurses are not properly trained; they do not have the necessary information and knowledge to help improve the conditions of their patients. E-Health proposes to design a Healthcare application that will improve the healthcare services in Nigeria by providing a link between patient and primary health care. This link will provide easy access to medical information at the points of health-care delivery within health care centers. E-Health aims to improve healthcare services in Nigeria by developing a Secure Health Information Platform using latest Information Technologies.

3. REVIEW OF LITERATURE

Mobile computing has been used to solve a wide range of problems in fields like Banking, Geology, Law etc. In the medical field, many designs have been proposed and implemented. In turkey, a geographical information system was designed to improve the health care facilities of the country. GIS was used to map and analyze the geographical distributions of populations at risk, health outcomes, and risk factors in turkey. Research has shown that there is a Heartbeat programme in Jordan that allows medical experts to give advice to doctors in remote areas where no specialist is present, thus the patient doesn't have to think of looking for funds to travel and this has led to the reduction of unnecessary visits to the few heart specialist of the country and has helped saved millions of dollars for the health system in the country.

In addition, the Atraumatic Restorative Treatment (ART) approach was introduced in government dental clinics in Tanzania to help improve the health conditions in that field.

In Nigeria there is an on going research work aimed at presenting an integration of a fuzzy expert system and fuzzy association rule mining process to enhance the comprehensibility of an expert system in medical domain.

"Telehealth, electronic health records, computer-assisted prescription systems, accessing clinical databases and other

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aspects of e-health are transforming health today and hold even greater promise for the future" [7]. As the technologies continue to evolve and their use becomes more ubiquitous, the field of medicine will see further increases in its capabilities through enhanced "remote consultation, coordination, and diagnosis" [3].

This study, E-Health (the use of mobile computing in the health sector) proposes to solve some of the problems we are having in the health sector in Nigeria. The design and implementation a health care software technology will make health care in Nigeria very effective and efficient by helping to reduce time wasting while waiting to see the doctor and by providing the required information needed to solve the patients' problems. It will help increase the resources in the health sector and provide easy access to medical treatment.

4. METHODOLOGY

Software Platforms

The software running on mobile devices is similar to the better known software running on desktop computer. The software is built in a hierarchical fashion with operating systems, runtime systems and application. The SIM card plays a vital role in the software-hierarchy – design of handheld handsets. Mobile handsets can have two different types of operating systems (OS): Standardized OS or proprietary OS (called black boxes).Originally, all mobile handset's functionality was defined as a black box but as mobile handsets became more and more sophisticated, the black box opened up and became more similar to operating systems, allowing applications outside the black box to utilize the handset resources.

Examples of OS' for handset are Microsoft Mobile, Palm OS, Symbian etc. The common tasks of both types of operating systems are: process management, file system, graphical user interfaces, device drivers, networking and security.

JAVA

The main technology usually used in E-Health is java technology; it will be usually used as a building block for E-Health system. Java platform offers a runtime and programming environment to develop applications, and an increasing number of handsets are supporting the java technology. The Java 2 platform consists of three elements:

Java Programming language

Java Virtual Machine (JVM)

Application Programming Interfaces (APIs)

A program written in java goes through two steps in order to run on a hardware platform. First, the program has to be compiled into byte code and this is done by a java compiler. Then in order to run, an interpreter in the java virtual machine has to interpret the byte code into appropriate machine code. By having java virtual machines for different hardware platforms, the java programs do not have to consider the hardware platform it will run on, this will be taken care of by the java virtual machine. This is the idea behind java vision of "write once, run anywhere". The APIs are codes that is written and ready for reuse through a well define interface (graphical user interface).

The E-Health application is usually implemented in java, more specifically J2SE, J2ME, and J2EE to ensure portability. The Java Standard Edition (J2SE) contains the most commonly used set of classes without any added functionality. Mobile devices usually use a lighter version of Java called the Micro Edition (ME), this ensures full support of user mobility and provides a runtime environment for the java MIDlet. Java Enterprise Edition (J2EE) is the edition/technology of java used to ensure full support of user mobility via the web.

Java is usually used because it is user friendly (through the use of graphical user interface), it has a secure way of handling data (strong encryption, authentication and verification) and its universality.

ANALYSIS

The use cases are formal methodology means to show how the functionality the system offers meets some needs of the user. They are not meant to indicate how the communication between participants of the system is, but rather a tool to identify the functionality the different actors have to offer. There should be at least two actors in this thesis, a user (the client) and the application server. The user represents a user with an E-Health application enabled mobile phone or PC. The user can interact with the server who offers the required services.

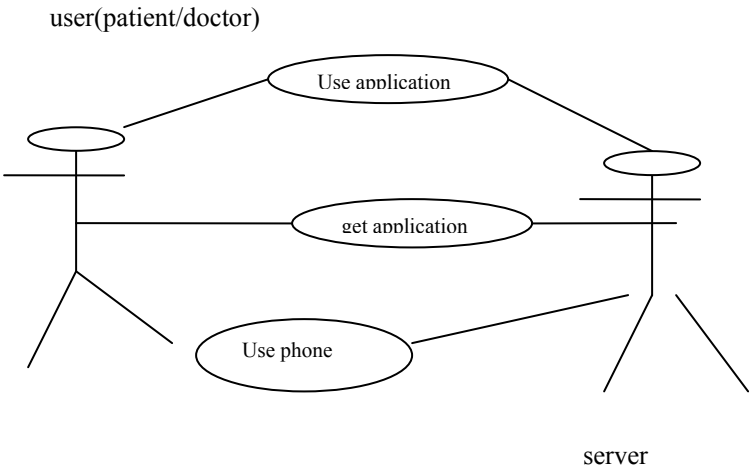

figure 2.[High level use cases].

4. MATERIALS AND METHODS

Project Description

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This paper provides users of J2ME, J2SE, J2EE enable applications the ability to seek medical attention via the mobile phone and the internet.

Description of Components
The E-Health has three key components with which to build upon and these include the following:

The mobile phone: this facet serves as the client; it is the medium in which transactions are been perform. J2ME (Java Micro Edition) is the edition / technology of java that is used in this facet to ensure full support of user mobility. Instead of a patient spending hours in a particular clinic waiting to be attended to, the patient simply uses his/her phone (in which the E-Health application has been enabled) and simply collects the necessary information he/she requires for the particular illness and goes to the chemist for drugs or books an appointment with the best doctors if need be.

The Central Database System: this is the second facet of this application and it acts as a crosslink for the other two facets of this application. The Database is necessary in this application since we will be dealing with records of various medical practitioners, hospitals, patients etc. and database serves as an efficient and effective way to keep and store records. We have various database systems in use today; we have Oracle, MySQL, MSSQL (which is windows based), JDB and so on. Oracle is the most compatible with java but it is meant for companies running large scale on line enterprise application and requires not less than 5g of RAM.
The Web Application Server: this facet serves as the server. When a patient sends a request to a particular clinic, the client (the phone sends the request to the Web application server).The Web application automatically checks the database to confirm the authenticity of the patient ‘s records in the clinic and automatically sends a respond either positive or negative to the client (phone). J2EE (Java Enterprise Edition) is the edition/technology of java that is used in this facet to ensure full support of user mobility via the web.

Netbeans IDE 6.0 is the platform in which the three facets of this application are interlinked and run.
The following steps are involved in a typical E-Health system:
An order is placed and sent to a particular clinic.
The Mobile Digital E- Health application is sent to the mobile phone.
The user receives the application and installs it on his/her phone.
The enabled phone is then used via the application installed on it to help solve health related problems.

Procurement and Deployment of Related Software

All of the needed software for development is easily obtainable throughout the Internet. There are mainly three items to download and install unto the system. Of course, it is understood that the system of development is a Windows XP system running on Intel Centrino technology

J2SE J2ME
The base developmental platform, J2SE can be obtained from Sun’s Java website, http://java.sun.com. The additional APIs for J2ME can also be downloaded from the same website. Programmers knowledgeable of Java can easily install these two development kits. It is recommended that all these are installed in a directory with no spaces. Development of the thesis used Java 2 SE 1.6 and Java Wireless Toolkit 2.5.2. Development in the toolkit is unique, as one can only create folders within the \WTK22\apps directory, as j2me requires specific folders and files that are automatically generated by the toolkit. (Ktoolbar application)

Netbeans
The Netbeans IDE 6.0 which is the platform in which the three facets of this application are interlinked and run. Netbeans IDE 6.0 can be easily downloaded in the internet.

MySQL
The Database is necessary in this application since we will be dealing with records of various custom, transactions, accounts etc. MySQL is used in this thesis as the database system because it economizes resources and easy to use.

5. RESULTS AND DISCUSSION

User mobility is another degree of mobility that is less pursued in the area of E-Health. This paper proposed a new computing model that tries to provide user mobility service to all applications through a system-level solution. This solution utilizes a platform-independent interface to fit a user’s personal computing environment on a platform-dependent middleware that provides two services to web-top applications.

6. CONCLUSION AND RECOMMENDATIONS

A system to support user mobility faces several challenges. First, a user’s personal computing environment must fit in a heterogeneous environment. Second, local resources on an E- Health System client must be integrated into the user’s computing environment to best support user. There are also security issues and adaptation issues. However, these two issues are not addressed in this thesis.
E-Health System model opens new opportunities for future work. The E-Health System, including a prototype could be developed in many aspects even within the definition in the thesis

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A Dynamic Cyber Terrorism Framework

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***Abstract*—Many nations all over the world have increased their dependency on cyberspace by maximizing the use of Information and Communication Technology (ICT). In this digital age, the concept of cyber terrorism or the use of cyberspace to carry out terrorist activities has emerged. Interestingly, there are many concepts of cyber terrorism provided by researchers, policy makers and individuals. This paper proposes a framework describing the core components of cyber terrorism. The authors have analyzed the data by using a grounded theory approach, in which the framework is drawn. The framework defines cyber terrorism from six perspectives: Target, motivation, method of attack, domain, action by perpetrator, and impact. In addition, the proposed framework provides a dynamic way in defining cyber terrorism as well as describing its influential considerations. Continued research in this area can be further conducted, which may lead to the development of strategic and technological framework to counter cyber terrorism.**

Keywords-component; Cyber Terrorism, Cyberspace, ICT, Terrorism

I. INTRODUCTION

Cyberspace and the Internet are at the center of modern life and have become an important medium for businesses, economics, politics and communities. Many nations all over the world have constantly increased their dependency on cyberspace by maximizing the use of Information and Communication Technology (ICT). ICT offers a double-edged sword. While development in the area of ICT allows for enormous gains in efficiency and productivity, it has also created opportunities for those with devious ambitions to cause harm [1]. At the same time, it can be a powerful tool for perpetrators such as extremists and terrorist groups to promote extremist ideologies and propaganda materials as well as to create public fear by damaging assets that are vital to national interest and security [2] [3]. The same technological advances that are benefiting the public at large are also increasing the arsenal of our adversaries.

Critical National Information Infrastructure (CNII) underlies the nation's economic, political, strategic and socio-economic activities [4]. Many stakeholders are concerned with terrorist attacks against critical infrastructures such as telecommunications, power distributions, transportation, financial services and essential public utility services. Terrorist cyber attacks on CNII is possible, where the motives, resources and willingness to conduct operations of different kinds against specific targets are fundamental [5]. If perpetrators follow the lead of hackers, theoretically they have the capability to use ICT to conduct cyber attacks against specific targets. Due to the fact that cyberspace has no boundaries, there is a possibility that the terrorists or terrorist groups may pursue cyber terrorism in conducting offensive attacks and supporting physical violence in the future [6].

II. CONCEPTS AND TERMS

A. Cyber Terrorism

War, crime and terrorism are traditional concepts that occur in the physical domain, the only new aspect is the "cyber" domain. Physical terrorism and cyber terrorism share the same basic elements i.e. sharing a common denominator – terrorism. Several researchers have argued that the underlying principles of terrorism behind the threat remain the same [6], and they have described terrorism activities in the cyber world as cyber terrorism [7].

It is noted that several definitions of terrorism have included targets directed at computer systems and its services that control a nation's energy facilities, water distributions, communication systems, and other critical infrastructures. Malaysia's Penal Code, Chapter VIA, Sections 130B – 130T comprises provisions dealing with terrorism [8]. Section 130B (2) (h) defines terrorism as an act or threat of action designed or intended to disrupt or seriously interfere with, any computer system or the provision of any services directly related to communications infrastructure, banking or financial services, utilities, transportation or other essential infrastructure. Australia's Security Legislation Amendment (Terrorism) Act 2002 defines terrorism, among others, as actions that seriously interfere, disrupt, or destroy, an electronic system including, but not limited to, an information system; a telecommunications system; a financial system; a system used for the delivery of essential government services; a system used for, or by, an essential public utility; or a system used for, or by, a transport system" [9].

The term cyber terrorism was first coined in the 1980s by Barry Collin [10], a senior research fellow at the Institute for Security and Intelligence in California. According to him, the convergence of the "virtual world" and "physical world" form the vehicle of cyber terrorism. Collin further clarifies that the

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virtual world is the place in which computer programs function and data moves whereas the physical world is the place in which we live and function. The growing convergence of the physical and virtual worlds is becoming more complex. Nowadays, ICT plays a major role in the convergence of these two worlds.

Denning [11] defines cyber terrorism as unlawful attacks and threats of attack against computers, networks and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Denning also clarifies that, "Further, to qualify as cyber terrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear. Attacks that lead to death or bodily injury, explosions, plane crashes, water contamination, or severe economic loss would be examples. Serious attacks against critical infrastructures could be acts of cyber terrorism, depending on their impact. Attacks that disrupt non-essential services, or that are mainly a costly nuisance, would not." Definition by Denning consists of several important components on the concept of cyber terrorism. First, it refers to unlawful attacks. Second, the attacks and threats of attacks against computers, networks and the information stored within them. Third, the purpose of (unlawful attacks) is intimidating or influencing a government or society to further political or social objectives. Fourth, the attack results in violence against persons or property, or at least causes enough harm to generate fear. Lastly, serious attacks against critical infrastructures could be acts of cyber terrorism.

Likewise, Lewis [12] defines cyber terrorism as the use of computer network tools to shut down critical national infrastructures (such as energy, transportation, government operations) or to coerce or intimidate a government or civilian population. Mantel [13] defines cyber terrorism as highly damaging computer attacks by private individuals designed to generate terror and fear to achieve political or social goals. Mshvidobadze [14] defines cyber terrorism as cyber acts designed to foment terror or demoralization among a target population for some purpose of the perpetrator, most likely this will be some kind of attack on critical infrastructure. Cyber terrorism should be involving computer technology and means as a weapon or target by terrorist groups or agents [15]. In the context of cyber terrorism, the above definitions suggest that critical infrastructure's computer system and civilian population would seem become attractive targets and contribute to the uniqueness of cyber terrorism. Here, the direct damage caused by the attack is to the critical infrastructure's computer system and civilian population.

The context of cyber terrorism seems to argue that this term comprises component of motivation such as political, social and belief. For example, Conway [16] describes that, in order to be labeled as cyber terrorism, the attacks must have a terrorist component, which is result in death and/or large scale destruction and politically motivated. Pollitt [17] defines cyber terrorism as the premeditated, politically motivated attack against information, computer systems, computer programs, and data which result in violence against non-combatants target by sub national groups or clandestine agents. Czerpak [18] argues that cyber terrorism is a politically driven attack perpetrated by the use of computers and telecommunications capabilities, which leads to death, bodily injury, explosions and severe economic loss. Nagpal [19] defines cyber terrorism as the premeditated use of disruptive activities, or the threat thereof, in cyber space, with the intention to further social, ideological, religious, political or similar objectives, or to intimidate any person in furtherance of such objectives.

Method of attack in cyber terrorism seems to use computer technology in carrying out the acts of terrorism. Beggs [20] defines cyber terrorism as the use of ICT to attack and control critical information systems with the intent to cause harm and spread fear to people, or at least with the anticipation of changing domestic, national, or international events. Similarly, Weimann [21] defines cyber terrorism as the use of computer network tools to harm or shut down critical national infrastructures (such as energy, transportation and government operations). CRS Report for Congress [22] defines cyber terrorism as the use of computer or weapons, or as targets, by politically motivated international, or sub-national groups, or clandestine agents who threaten or cause violence and fear in order to influence and audience, or cause a government to change its policies.

As defined by Denning, the action by perpetrator involves to unlawful attacks to the targeted audiences. This notion is supported by Ariely [23] where cyber terrorism is referred as the intentional use or threat of use, without legally recognized authority, of violence, disruption, or interference against cyber systems. The result would be in death or injury of a person or persons, substantially damage to physical property, civil disorder or significant economic harm. This understanding is in line with study conducted by Nelson et al. [24] which defined cyber terrorism as the unlawful destruction or disruption of digital property to intimidate or coerce governments or societies in the pursuit of goals that are political, religious or ideological.

Cyber terrorism can have critical impact to the targeted audiences such as to cause fear to anyone in the vicinity or result in violence, death and destruction. Stohl [25] argues that cyber terrorism includes some form of intimidate, coerce, influence as well as violence. He defines cyber terrorism as the purposeful act or the threat of the act of violence to create fear and/or compliant behavior in a victim and/or audience of the act or threat. In a report to the United Nation General Assembly First Committee on Disarmament and International Security, cyber terrorism is mentioned as actions conducted via computer network that may cause violence against or generate fear among people, or lead to serious destruction for political or social problem [26]. Ron Dick, Director of the US's National Infrastructure Protection Center (NIPC) defines cyber terrorism a criminal act perpetrated through computers resulting in violence, death and/or destruction, and creating terror for the purpose of coercing a government to change its policies (as cited in [27]). This definition perhaps is taken from the US Government's definition of terrorism with the inclusion of "computer" in the definition.

Kerr [28] believes that cyber terrorism should have three common elements: The use of violence, political objectives, and the purpose of showing fear within a target population.

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Ellsmore [29] says that cyber terrorism can be differentiated in terms of intent, outcome and the use of skills. Further analysis suggests that there are at least five elements which must be satisfied to construe cyber terrorism as described in Table I [30].

Table I: Elements of Cyber Terrorism (adapted from Yunos et al. [30])

Elements of Cyber Terrorism	• Politically-motivated cyber attacks that lead to death or bodily injury; • Cyber attacks that cause fear and/or physical harm through cyber attack techniques; • Serious attacks against critical information infrastructures such as financial, energy, transportation and government operations; • Attacks that disrupt non-essential services are not considered cyber terrorism; and • Attacks that are not primarily focused on monetary gain.

Based on the discussion above, there is no common agreement on the concept of cyber terrorism at the international front and among the researchers. While there are many definitions of cyber terrorism, these suggest a trend that further analysis of the phenomena could be further conducted. This is evidence as the study of this concept has been the focus of many policy makers and scholarly studies, but their standpoints and views vary. Due to multidimensional structures (or components) of cyber terrorism, we can say that the concept of cyber terrorism is a contested concept who interpret it differently by a number of parties. The context of cyber terrorism denotes different understandings and interpretations.

B. A Clear Line between Terms

When discussing cyber terrorism, there is always confusion between the term cyber terrorism with "cyber crimes" and "terrorist use of the Internet" [31]. However, these terms should not be mistaken as synonyms for cyber terrorism.

Cyber terrorism has become a buzzword and is often sensationalized in the media whereby reports of cyber crimes are posed as cyber terrorism [31]. Berner [32] argues terms such as "computer crime" or "economic espionage" must not be associated with the term cyber terrorism. In defining cyber terrorist and cyber crime activities, it is necessary to segment the motivation and action [33]. From the motivation perspective, cyber terrorism is clearly different, operating with a specific agenda to support their actions [34]. Cyber crime and cyber terrorism can be differentiated through financial or economic purposes [35] [36].

The United Nations categorized cyber crime as unauthorized access, damage to computer data or programs, sabotage to hinder the functioning of computer system or network, unauthorized interception of data to, from and within a system or network; and computer espionage [37]. From a legal perspective, cyber crimes and cyber terrorism are two different things. In the United States, The Computer Fraud and Abuse Act (18 USC: 1030) defines cyber crimes as unauthorized computer intrusions or misuse as unlawful activity [36]. Malaysia too has enacted the Computer Crimes Act 1997. The purpose of the Act is to provide offenses relating to the misuse of computers. Amongst other things, it also deals with unauthorized access to computer material, unauthorized access with intent to commit other offenses and unauthorized modification of computer contents [38]. From legal perspective, the definition of Malaysia's computer crimes in Computer Crimes Act 1997 and terrorism in Penal Code, Chapter VII A, Section 130B is different. These two concepts cover different areas. In the simplest terms, cyber terrorists' actions may cause prejudice to national security and public safety whereas cyber criminals' actions may cause prejudice to individuals or groups for the purpose of monetary gain.

Many studies have indicated that the Web 2.0 media such as interactive websites and blogs, social networking sites and discussion forums have been rapidly used by extremists as the medium to support their online activities [13]. However, it is important to note that cyber terrorism is different from terrorists' use of the Internet [31]. Taliharm [33] argues that cyber terrorism should not be confused with the use of illicit activities or Internet radicalization in cyberspace by the terrorist groups [33]. Taliharm [33] further argues that terrorists' use of the Internet is just action by certain individual or group to organize illicit activities by using the cyberspace.

Radicalization and extremism in cyberspace, however, can lead to terrorism [39]. Understanding online radicalization is one of the pillars of the fight against terrorism [21]. Perhaps the main concern is the potential for terrorists to use the Internet to inflict damage. The United Nations' report mentioned that the concern is to prevent moderates from becoming extremists, and extremists from becoming terrorists [40]. Threats from terrorism must be analyzed before they evolve into fully-fledged threats. Many of the actors in foiled plots have been discovered to have been radicalized online, on terrorists' and extremists' websites and chat rooms, amongst others, to provide information on weapons and explosives and facilitate large-scale recruitment efforts and propaganda [3].

C. Empirical Cyber Terrorism Frameworks

Based on literatures, there are several empirical frameworks on cyber terrorism proposed by researchers. Veerasamy proposed a conceptual framework outlining the aspect of cyber terrorism that addresses the operating forces, the techniques and the objectives [41]. The operating forces provide the context in which cyber terrorism is functioning, in which it describes the qualities of a cyber terrorist as well as the properties of cyber terrorism in general. The technique describes practical methods and classification descriptions of carrying out cyber terrorism via invasive or offensive computer and network security practices. The objectives are similar to the motivation, where the intent is to cause direct damage via malicious goals and support functions. The framework provides a high level overview and serves as a basis of considerations in the domain of cyber terrorism. However, the framework's attributes are not interactive and quite complex. The framework signifies that in order to consider cyber terrorism, at least one or more elements must be fulfilled. However, this is not accurate as cyber terrorism should be seen from a holistic perspective.

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Another framework on cyber terrorism, proposed by Heickero, illustrates the effects and consequences of cyber terrorism operation from actor-target-effect chain in an asymmetric context [5]. The model illustrates how cyber terrorism in different phases could plan and accomplish a cyber operation as well as the effects and consequences of the digital attack. Figure 1 provides an illustration of how cyber terrorism is conducted.

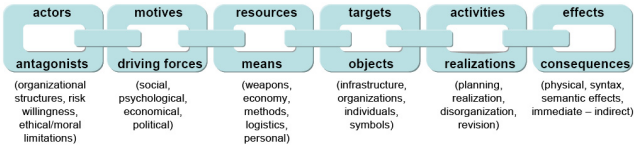

Figure 1. Actor-target-effect Chain (adapted from Heickero [5])

The framework provided by Heickero is more relevant in understanding the modus operandi of cyber terrorism, which provides an attribute-chain from one attribute to another. The framework consists of the actors which are antagonists; the driving forces behind motives are social, psychological, economical and political; usage of means such as weapons and economy (resources); targets are objects such as infrastructure, organizations and individual; activities in realizing their goals such as planning and disorganization; and effects or consequences such as physical effect and syntax effect.

Gordon and Ford [42] viewed cyber terrorism from the following perspectives; people (or groups), locations (of perpetrators, facilitators, victims), methods/modes of action, tools, targets, affiliations and motivations (Table II). They made an analysis on the attributes of traditional terrorism and integrated computer into the matrix. They concluded that the scope of terrorism changes within each other due to the addition of the computer. However, attributes such as perpetrator and place require further investigation as what important is not the perpetrator or the place, but the action [43]. Perhaps further analysis based on case studies is required.

Table II. Matrix of Terrorism with Inclusion of the Computer (adapted from Gordon and Ford [42])

Attributes	Description	
Perpetrator	Group/ Individual	In the cyber context, virtual interactions can lead to anonymity and desensitization.
Place	Worldwide	The event does not have to occur in a particular location. The Internet has introduced globalization of the environment.
Action	Threats/ Violence/ Recruitment/ Education/ Strategies	Terrorist scenarios typically are violent or involve threats of violence. Violence in the virtual environment includes psychological effects, possible behavior modification and physical trauma.
Tool	Kidnapping/ Harassment/ Propaganda/ Education	Terrorists use the computer as a tool. Facilitating identity theft, computer viruses, hacking are examples that fall under this category.
Target	Government Officials/Corporations	Potential targets are corporations and government computer systems.
Affiliation	Actual/ Claimed	Affiliation refers to recruitment in carrying out given instructions. Affiliation can result in the strengthening of individual organizations as they can immediately acquire access to the information resources of their allies.
Motivation	Social/Political Change	Political, social and economic are the motivations present in real-world terrorism.

III. Analysis of Findings

Should website defacement be considered cyber terrorism? Would the use of the Internet by the terrorists such as fund raising, recruitment and propaganda be considered cyber terrorism? If somebody commits a certain act that meets the criteria of cyber terrorism, under what law will he/she be charged? Such examples highlight the need for a precise definition of cyber terrorism in order to avoid possible ambiguity and misinterpretation. This also will serve as a guide for distinguishing various terms of cyber incidents.

Interestingly, most governments in the world do not agree on one single definition of cyber terrorism [11] [44]. The term cyber terrorism generates different meaning in the minds of different people. However, understanding a common understanding as to what phenomenon contributes to this term is important in order for us to get a better understanding on the root causes of cyber terrorism. Unfortunately, we are in situation where there is still no consensus agreement on a definition on the concept of the phenomenon.

There is no common definition of cyber terrorism that is widely accepted, hence there is a lack of common ground on which policy makers and researchers can agree on what they are fighting against. In general, previous studies have defined cyber terrorism from various points of view. However, the connectivity between each component highlighted in defining this terminology is still unclear. Therefore, there is a strong need to have a specific concept of cyber terrorism, especially for a legal definition. The concept would provide a foundation to the legal fraternity such as prosecutors and judges.

In this study, the analysis is divided into four processes: Plan, data collection, data analysis, and reporting, which are similar with other traditional stages of research [45]. While most of the research methodologies are described in Section III, the reporting is presented in Section IV.

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A. Plan

The planning stage started with the identification and investigation of research problems surrounding the identified phenomena. There are many terms of cyber terrorism, and some of them only address a subset of cyber terrorism and not the whole context. Due to the complexity of various interacting attributes or elements in cyber terrorism, to formulate a framework as to describe its influential considerations would be beneficial. Therefore, there is a need for a more structured approach in understanding the various attributes of cyber terrorism. This is crucial to the researchers and policy makers in understanding the context of cyber terrorism.

B. Data Collection

The analysis was conducted by reviewing existing literature on terrorism and cyber terrorism. Our goal was to examine whether particular researchers had developed useful insight into this subject and to learn whether consensus agreement had already been reached on this subject. Based on our observations, we have found that there is limited literature focusing on the cyber terrorism framework. However, most of the literature reviewed is valuable in terms of framing the context rather than directly providing a solution to the issues of this study. The materials reviewed include overseas government reports, articles found in websites, published conference materials and referred publications.

One example of the qualitative research approach is grounded theory. Grounded theory was first presented by Glaser and Strauss in their 1967 book "The Discovery of Grounded Theory", which Goulding [46] describes the book was premised on a strong intellectual justification for using qualitative research to develop theoretical analysis. The phrase grounded theory refers to theory or general concepts that are developed from a corpus of data [47], [48] and the theory emerges through a close and careful analysis of the data [49]. As mentioned by Borgatti [47], the basic idea of the grounded theory approach is to read (and re-read) a textual database (such as a corpus of field note) and discover or label variables (called categories, concept and properties) and their interrelationship.

In grounded theory development, the literature review provides theoretical construct, categories and their properties that can be used to organize the data and discover new connections between theory and real-world phenomena [50]. Developing grounded theory should formulate them into a logical, systematic and explanatory scheme [51], [49]. The theory should be based exclusively on data collected whereby the researchers bring a considerable background in professional and disciplinary knowledge to an inquiry. Researchers approach the question with background and some knowledge with the literature in the domain [49]. Levy [51] explains that these positions recognize that a prior understanding of the literature can be therefore be used effectively in developing theory in a number of ways. Based on the review of pertinent literature, prior knowledge and experience of the researcher is useful to formulate of a preliminary conceptual model.

> " .. experience and knowledge are what sensitize the researcher to significant problems and issues in the data and allows him or her to see alternative explanations and to recognize properties and dimensions of emerging concepts" [52].

Haig argues that the grounded theory research begins by focusing on an area of study and gathers data from a variety of sources, including literatures [53]. It is important to note comment made by Levy [51], where the author explains that these positions recognize that a prior understanding of the literature can therefore be used effectively in developing theory in a number of ways. Based on the review of pertinent literature, the prior knowledge and experience of the researcher are useful to formulate a preliminary conceptual model.

Heath and Cowley reveal that a pre-understanding by early reference to the literature can contribute to the researcher's understanding of social processes observed [54]. They argue that prior reading may be required if the researcher wishes to clarify concepts and build an emergent theory. Heath and Cowley [54] cite the work by Jezewski [55] who carried out a literature-based concept before attempting to further develop the concept via grounded theory. Heath and Cowley [54] further cite the comment by Glaser and Strauss [56] that "the researcher will not enter the field from ideas, but differ considerably in the role they see for the literature". Thus, specific understanding from experience and literature may be used to stimulate theoretical sensitivity and generate the hypotheses. This notion is supported by Onion [57] who concludes that the application of the grounded theory method to review literature and derive a meta-theory is novel, whereby literature may be used as the primary data by the grounded theory method. This is ascertained by Esteves et al. [58] whereby they conclude that an analysis of issues related with the use of the grounded theory method is very useful for people starting a research project.

C. Data Analysis

The data analysis was conducted in two steps. In the first step, data analysis proceeded through axial coding (examining conditions, strategies and consequences). This method has been well described by Egan [45] and Borgatti [47]. In the second step, the data was mapped into a matrix format [58], where attributes as well as similarities or patterns between them emerged.

As described by Borgatti [47], axial coding is the process of relating codes (categories and properties) to each other, via a combination of inductive and deductive thinking. Borgatti [47] explains that grounded theorists emphasize causal relationships, and fit things into a basic frame of generic relationships. The author simplifies the process of axial coding framework as per Table III. This framework consists of systematized cause-and-effect schema which the researchers used to explicate relationships between categories (or attributes) and sub-categories.

Egan [45] explains that a general understanding of the phenomenon under investigation is considered sufficient for the initiation of this type of research. Egan [45] further explains, "Having established a problem or topic in general terms and chosen a site where the research questions could be examined more closely, evidence is allowed to accumulate by the

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researcher, resulting in an emerging theory". To develop this theory, "early activities by the researcher involve the identification of categories capturing uniformities in the data and then identifying compelling properties and dimensions of the data". This argument is further stressed by Glaser and Strauss [56] where they say, "A discovered, grounded theory, then, will tend to combine mostly concepts and hypothesis that have emerged from the data with some existing ones that are clearly useful".

Levy [51] explains that sampling should be directed by the logic and the types of coding procedures used in analyzing and interpreting data. The result is the revelation of meaningful differences and similarities among and between categories. The possibility for a hypothesis about the relationships between categories is always present. By using the framework provided by Borgatti [47], the relationships of categories are analyzed and observed.

Table III. Axial Coding Framework (adapted from Borgatti [47])

Elements	Description
Phenomenon	This is what in schema theory might be called the name of the schema or frame. It is the concept that holds the bits together. In grounded theory it is sometimes the outcome of interest, or it can be the subject.
Causal conditions	These are the events or variables that lead to the occurrence or development of the phenomenon. It is a set of causes and their properties.
Action strategies	The purposeful, goal-oriented activities that agents perform in response to the phenomenon and intervening conditions.
Consequences	These are the consequences of the action strategies, intended and unintended.

IV. The Proposed Framework

A conceptual framework links various concepts and serves as a motion for the formulation of theory [59]. A complete analysis of the data has revealed six emergent perspectives of cyber terrorism, which became the major findings of the study. In our view, the nature of cyber terrorism framework should have these six perspectives: Target, motivation, method of attack, domain, action by perpetrator, and impact.

With the growing interconnectedness of critical infrastructures on ICT, the selection of a target that allows the maximum level of disruption would significantly influence the terrorists. Motivation is about influencing human beings and the decisions they make. Motivation forces behind cyber terrorism are social, political and belief. Cyber terrorists can exploit vulnerabilities over a targeted system through a vast array of intrusive tools and techniques. The method of attack could be through network warfare and psychological warfare. Cyberspace is the domain in which a terrorist-type attack is conducted. Cyber terrorists employ unlawful use of force or unlawful attacks to conduct the premeditated attack. The impact or consequence is high as the cyber attacks are done to intimidate or coerce a government or people that lead to violence against persons or properties. The framework describing the components of cyber terrorism is proposed in Figure 2.

The framework provides a baseline when establishing and defining cyber terrorism. The aim is to show a more dynamic way in defining cyber terrorism as well as describing its influential considerations. Thus, it can be seen that formulating the framework from various strategic considerations would be beneficial in understanding cyber terrorism in its full context. Summarily, these factors will determine whether someone is involved in cyber terrorism or not.

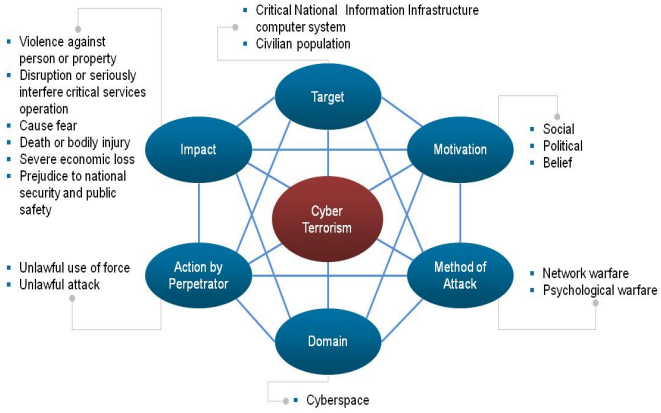

Figure 2. A Dynamic Cyber Terrorism Framework

The framework is dynamic in many aspects since the influential factors on the decision are based on all attributes (or components) within the framework. In other words, the framework suggests that all attributes (or components) contribute in the decision-making process in order to determine whether someone gets involved in cyber terrorism or not. The authors suggest that the framework presented here is an improvement over existing frameworks as it captures the important factors when considering that the perpetrator may combine these factors for conducting cyber terrorism. The components of cyber terrorism in this framework are bind together to form the concept of cyber terrorism. We need to combine the components with conjunction "AND", which means that each of those components is necessary to constitute cyber terrorism. Otherwise, if one or more components are not provided, it would not constitute cyber terrorism.

A. Target

The act of cyber terrorism is unique as it combines a specific target with a wider audience [60], which is illustrated in Figure 3. With this argument, the CNII computer system and civilian population contribute to the uniqueness of cyber terrorism [61]. The possibility of disabling the entire CNII communication networks and attacking civilian community at large would seem to provide a variety of attractive targets. At

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the same time, targets that are high-profile would probably be among the most influential factors in a terrorist group's decision as the damage and destruction would be extraordinarily significant and costly to society and the country attacked.

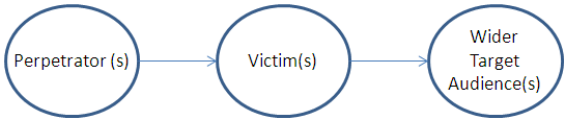

Figure 3. Target Model (adapted from Ackerman et al. [60])

The assumption that attacks against computer systems are less dangerous, such as leading to economic losses rather than human lives is not true. Due to the advancement of technology, many essential computing services are using the Supervisory Control and Data Acquisition (SCADA) systems, and nowadays, they are connected to the Internet and can be controlled remotely. An attack to the SCADA system that controls and manages critical infrastructures may have been unthinkable in the past, but with current technological developments, it is now possible for the SCADA system to become a target for terrorist attacks. Brunst [62] discusses that there are three scenarios that could be taken into consideration; attacks on hydroelectric dams, tampering with railways and air traffic control systems, and taking over control of power plants. Brunst in his literature review provides excellent examples of terrorist attacks in these control systems, which would generate fear within a population. Successful cyber attacks on these control systems certainly have long-term effects, create fear and pose immediate danger to human lives.

Apart from focusing on the ICT infrastructure, cyber terrorism also targets civilian population [5] [25] [60]. Attacks against critical infrastructure that spread fear and harm to innocent people within a community would be classified as cyber terrorism [20]. From an effect perspective, consequences on civilian population are bigger, thus it would get more media attention and be more widely publicized. The selection of a target that allows the maximum level of disruption would significantly influence the terrorists.

B. *Motivation*

Motivation is about influencing human beings and the decisions they make [1]. The motivating forces behind cyber terrorism are social, political and belief [63]. Through these forces, terrorists are psychologically motivated to drive terrorism. From the motivation perspective, cyber terrorism exists if the person or group of people operates with a specific political or ideological agenda to support their activities [20]. For example, the Irish Republican Army engages in terrorist activity for a predetermined political purpose with the objective to maintain and strengthen political control [6].

Cyber terrorism is defined as unlawful attacks and threats of attack against computers, networks and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives [11]. Digital technologies thus offer contemporary terrorists and terrorist organizations a wide range of opportunities to support their campaigns of violence and if they are proficient, significantly support their political objectives [25]. Terrorists wish to undermine confidence in the political structure and create difficulty within the body of politics. Cyber terrorists cause harm or damage to people or groups of people with a political agenda [32].

C. *Method of Attack*

Heickero [5] concludes that cyber terrorism comprises different types of methods such as computer network operations and psychological operations. The capability to conduct a cyber attack can be divided into three groups: Simple (unstructured), advanced (structured) and complex (coordinated) [64]. Heickero's [5] description of a computer network operation and O'Hara's [64] model of technical capabilities of a cyber attack fit well with the definition of network warfare. Veerasamy [65] defines network warfare as a modern form of conflict in which computers and networks are used as the weapons with information serving as the leverage control. Modern forms of network warfare include all the computer and network security means through which computers are attacked and exploited (worms, denial-of-service, bots) as well as all the protective mechanism being implemented (intrusion detection tools, anti-virus software and firewalls).

Taliharm [31] suggests that the term cyber terrorism should also involve several other activities carried out by the terrorist via the Internet, including propaganda via terrorist websites. Spreading of propaganda via Web 2.0 media is part of psychological operation [43]. Web 2.0 media enables terrorists or terrorist groups to establish their presence in cyberspace and to spread propaganda, especially for the press and public attention [62]. Coverage of mainstream media is important as news coverage in the media is always repeated, thus increasing the propaganda message's reach.

From a psychological perspective, a disgruntled employee within an organization also poses threats to the organization. One incident took place in Australia where a man had access to the sewerage control systems, which harmed the environment and killed wildlife [66]. It was reported that he had worked for the company and had knowledge of the tools that operated the sewerage control system. The driving forces for his action were revenge and the feeling of unfair treatment from the management. On the other hand, this category of individuals can be bought; and information can be sold to terrorist groups. An insider could also act as a cyber terrorist [5]. The extra advantage is that they have the inside knowledge. An insider can be planted within the organization or through a sympathizer who is working in that organization. The objective is perhaps to provide sensitive information or to perform certain tasks such as putting malware into critical control systems for future attacks. In the US, it was reported that 20 employees were arrested for possession of false identification used to obtain security access to facilities containing restricted and sensitive military technology [43].

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D. Domain

Cyber terrorism is the convergence of cyberspace and terrorism. Cyberspace, whether accessed by computer systems or other devices, is the domain (medium) through which a cyber attack would be delivered. The National Security Presidential Directive 54/Homeland Security Presidential Directive 23 of the US Government defines cyberspace as the interdependent network of information technology infrastructures, and includes the Internet, telecommunications networks, computer systems, and embedded processors and controllers [67]. The UK Government defines cyberspace as an "interactive domain that is made up of digital networks that is used to store, modify and communicate information. It includes the Internet, but also the other information systems that support our businesses, infrastructure and services" [68].

Cyber terrorism thus can be seen as a relevant threat due to its strong relation to ICT and cyberspace. Apart from land, sea, air and space, cyberspace is another dimension of warfare. Weimann [21] writes that cyberspace is in many ways an ideal arena for activity of extremist of terrorist organizations. Among others, it offers easy and fast flow of information. By its very nature, cyberspace is also capable of reaching out to a wide audience throughout the world and disseminates information in a multimedia environment via the combined use of text, graphics, audio and video.

E. Action by Perpetrator

Flemming and Stohl [6] argue that, terrorism is a process that involves acts or threats, emotional reactions and the social effects of the acts or threats and the resultant action. Terrorism in the cyber environment involves all of the above components. The advancement of ICT and rapid changes in the technological environment influence terrorist resources and opportunities. The convergence of physical terrorism and new advancements of ICT have spawned a new term called cyber terrorism.

Rollins and William [43] argue that, there are two views in defining cyber terrorism, which are based on impact (effect-based) and intention (intent-based). They clarify that, effect-based cyber terrorism exists when computer attacks result in effects that are disruptive enough to generate fear comparable to a traditional act of terrorism, even if done by criminals. This implies that, cyber terrorism should focus on the act rather than the perpetrator. While, intent-based cyber terrorism exists when "unlawful or politically-motivated computer attacks are done to intimidate or coerce a government or people to further a political objective, or to cause grave harm or severe economic damage".

The cyber terrorist can have the same motives as the traditional terrorist, but they use computer and network media to attack [69]. Cyber terrorists conduct unlawful use of force or unlawful attack to conduct the premeditated attack to intimidate or coerce a government or people to further political, social or belief objectives, or to cause severe economic damage. The impact or consequence is high as the attacks are done to intimidate or coerce a government or people that lead to violence against persons or properties.

F. Impact

The act of cyber terrorism is unique as it combines a specific target with a wider audience [6]. In this argument, the components of a purposeful violence against persons or properties, disruption or serious interference of critical services operation, causing fear, death or bodily injury, severe economic loss, and prejudice to national security and public safety contribute to the uniqueness of cyber terrorism.

Cyber terrorism exists when there is an attack on a computer system that leads to violence against a person or property; and the disruption is enough to generate fear, death or bodily injury [11] [12]. Cyber terrorism is done to cause grave harm or severe economic damage or extreme financial harm [6] [22]. As reported by Rollins and Wilson [43], if terrorists were to launch a widespread cyber attack, the economy would be the intended target for disruption, while death and destruction might be considered collateral damage. Terrorist-type cyber attacks may target chemical, biological, radiological or nuclear (CBRN) computer network installations [18] [43]. A successful attack to these installations would cause enough severe economic disruption and harm to civilian population (death and bodily injury).

With the growing interconnectedness and interdependencies of critical infrastructure sectors, the target selection of cyber terrorism is likely to be significantly influenced by those targets that allow for a maximum level of disruption [6] [20]. Terrorists' cyber attacks probably aim at critical infrastructure as their target. Successful cyber attacks in one sector will have cascading effects on other sectors. Due to this nature, a large-scale terrorist-type cyber attack could bring unpredictable and perhaps catastrophic impact to other sectors, and possibly long-lasting impact to the country's economy.

V. CONCLUSION

The term cyber terrorism generates different meanings in the minds of different people. Cyber terrorism is about threat perception that makes the concept differ from one to another. The concept of this term is an essentially-contested concept where it is interpreted differently at different levels such as researcher, professional and policy maker. Understanding similarities and differences in perception of what constitutes cyber terrorism can provide insight on the concept of cyber terrorism.

In this work, the data collected from the extensive literatures was analyzed using the grounded theory approach, in which the framework was drawn. The analysis was conducted to determine how the components of the concept of cyber terrorism come together to form the concept. From the finding, the authors have concluded that the concept of cyber terrorism can be described from six perspectives: Target, motivation, method of attack, domain, action by perpetrator, and impact.

This work provides a baseline when establishing and defining the concept of cyber terrorism. The perspectives are useful in determining whether someone is involved in cyber terrorism or not. In addition, the proposed framework shows an overall framework of cyber terrorism in a simplistic and dynamic manner. For future works, this framework can be

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validated and assessed by encompassing both qualitative and quantitative techniques. Continued research in this area can be further conducted, which may lead to the development of strategic and technological framework to counter cyber terrorism.

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Cooperative Cognitive Ecology in Self-organizing Networks: A Review Article

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***Abstract*—This survey is based on the introduction, motivation, and proposed system for ecological treatment of self-organizing cooperative cognitive wireless communication. We introduced the application of related literature in the proposed wireless communication scenario. The cooperative cognitive system resembles with the symbiotic ecological model of sharing mutual resources. This philosophy is nature inspired and system evolves with autonomous mutual interaction without any centralized controller. In other words, we can say it as evolutionary game, because of the biological game being played among the analogous biological species. Therefore, an overview of related stuff for ecological modeling for CCWC is introduced as may be implementable in other engineering disciplines.**

***Index Terms*—Cooperative Cognitive Ecology, Self-organizing Networks.**

I. Introduction

As the communication devices and services are increasing, the bandwidth demand is also increasing exponentially. The success of wireless communication is characterized by the allocated communication bandwidth and the Quality of Service (QoS) of the transmission medium. Bandwidth is the main resource for communication. By looking at the bandwidth allocation statistics issued by National Telecommunication & Information Administration (NTIA), it is clear that there is very small bandwidth capacity left for new communication technologies, and most of the bandwidth is dedicated to obsolete technologies, and services. This bandwidth resource scarcity is a major issue for research, both in industry and academia. By critically analyzing the bandwidth efficiency, it becomes evident that most of the bandwidth resource is seldom use.

A. Related work

The report by Spectrum Policy Task Force (SPTF) under the Federal Communications Commission (FCC) describe this as a major issue in Nov. 2002 for United States [1]. The cognitive radio (CR) communication technique emerged as a possible solution to this bandwidth scarcity and under-utilization problem. The idea of CR was first introduced by [2], to efficiently utilize the unused spectrum bands allocated to licensed users. In CR, the under-utilized bandwidth resource could be utilized by other communication devices and services, on opportunistic and need basis. With the maturity and implementation of this CR technology, the bandwidth efficiency issue could be solved at a large scale. In CR communication pattern, the licensed (primary) bandwidth could be used by unlicensed (secondary) communication users [3].

In wireless communications, the direct source to destination path could be degraded with fading and attenuation. This direct line of sight problem is solved by cooperating relays, and is known as cooperative communications (CC) [4]. These relay nodes help the source node in forwarding the data packet to the destination node [5]. Cognitive radio technique, which is used for effective utilization of under-utilized spectrum could also experience fading and attenuation problem. The combined method for both above motioned techniques emerged as cooperative cognitive wireless communications (CCWC), and could enhance the wireless bandwidth efficiency and solve communication problem. In CCWC, both primary and secondary users are willing to exchange under-utilized bandwidth with each other for robust communication. Hence, the CCWC is the mutual type of cooperation for two different types of secondary and primary bandwidth resources [6].

In recent years the wireless communication demand has greatly increase because of the increased number of communication devices and services. The main resource in communication is the bandwidth, like the natural resources which are scarce and limited. Most of the modern and traditional research is focusing on the efficient utilization of the bandwidth. Whatever the increase of communication devices, the overall bandwidth spectrum can't be increased. With cooperative cognitive communication the stated problem can be addressed to a large extent[3].

The application of cognitive radio (CR) technology is mainly dependent on the sensing and signal processing capabilities of the cognitive users. There is no problem in terms of the availability of the technological infrastructure. The need and application lie with the frequency allocation strategy policies implemented by frequency allocation authorities. Currently the FCC and European Telecommunication Standards Institute (ETSI) allocates bandwidth to specific users or applications. This divide and setting aside strategy by the spectrum regulatory authorities have to be modified to cater the need and implementation of cognitive radio technology.

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The examples of licensed frequency spectrum bands include air traffic control, radio, television, cellular, and satellite communications. Some application are security sensitive while the others are quality sensitive. The advantages of these fixed bandwidth allocation strategy are the least interference, and the enhanced quality of service (QoS) among communicating partners. The spectrum regulatory authorities have to take care all these issue while achieving the bandwidth efficiently using the CR technology [3].

In addition to the licensed bandwidth, there are also unlicensed band which facilitate the development and experimentation of newly emerging technologies. For example, 2.4 GHz unlicensed band is available for cordless phones, WiFi and Blue-tooth technology. Either its' a matter of licensed or unlicensed spectrum band, the application of the cognitive radio technology can greatly enhance the bandwidth application and usage if operated with minimal interference concepts. What ever the defining and explanatory features of cognitive radio are, the main philosophy of implementation lies with the network environment awareness [7].

Cognitive communication can be classified into three categories and described as follow [7]:

1) In *Underlay technique*, the cognitive (secondary) transmitter have the knowledge about the channel strength. The cognitive users can transmit simultaneously with non-cognitive user as long as interference to primary users caused by the secondary users are below some acceptable limit, and the cognitive users' transmit power is limited by the interference constraint.

2) In *Overlay Cognitive technique*, the cognitive nodes knows about the channel gain, codebooks and the message of the non-cognitive users. Cognitive user can transmit simultaneously with non-cognitive users; the interference to the non-cognitive user can be offset by using part of the cognitive user's power to relay the non-cognitive users message. Cognitive user can transmit at any power, and the interference to non-cognitive users can be offset by relaying the non-cognitive user's message. This technique can also be named as cooperative cognitive wireless communication (CCWC).

3) In *Interweave technique*, the cognitive user knows the spectral holes in space, time and frequency, when the non-cognitive user is not using these bandwidth holes. The cognitive user can transmit simultaneously with a non-cognitive user only in the event of a false spectral hole detection. Cognitive user's transmit power is limited by the range of its spectral holes sensing.

In CCWC, the primary transmitter nodes lend their bandwidth capacity to the relay (secondary) nodes, and secondary nodes are behaving as cooperative (cognitive) partner for the primary nodes. In the work by [6], a solution for spectrum leasing based on the idea that secondary nodes can earn spectrum access in exchange for cooperation with the primary link is proposed and investigated. By casting the problem in the framework of Stackelberg games, the analytical and numerical results are provided, which confirmed the considered model as a promising paradigm for cognitive radio networks.

Another example of cooperative cognitive wireless communication (CCWC) can also be found in [8], which resembles to our proposed species communication model. Each type of primary and secondary users correspond to a species, geographically separated, and cooperate with each other based on exchange of bandwidth resource. Primary users offer spectrum opportunities along with price to the secondary users using centralized controller or dedicated control channel, while secondary users are sub-grouped on the basis of environmental parameters, mutual interference and primary spectrum availability.

The main cognitive task can be summarized as follow:

- Radio scene analysis which include the interference temperature estimation for the radio environment. This also include the detection of under-utilized spectrum bands called *spectrum holes*.

- Identification of the channel for channel state information (CSI) estimation and to predict the capacity of the channel to be used by the transmitter.

- The other major task for being cognitive is the control of transmitter power and the dynamic spectrum management.

Figure 1 describe the scenario for the existence of secondary users (SU). The geographical locality, where primary transmitter's (PT) under-utilized bandwidth can be consumed by SUs, with least interference concept, is given by the central solid circular area. The cognitive bandwidth can be utilized in anyone of already described three scenarios: Underlay, Overlay, and Interweave.

These cellular localities which constitute the combination of different wireless connection technologies, buildup a heterogeneous network as given in Figure 2. These localities are characterized by the type of communication technologies and types of users present in a particular cell. For the proposed and analyzed system scope in the research study, heterogeneous network is taken as an ecosystem. The mobile users types represent the organism and communicating with each other through biological protocols.

Evolutionary mechanism design can also be used to analyze a hybrid approach consisting of agent based, game theoretic, and evolutionary mechanism. There have be a lot work on analyzing the Nash or evolutionary equilibrium for agents with fixed set of strategies to be played. Much of the related work is analyzed with double auction scenario. There are scenarios, where in real practical systems, the

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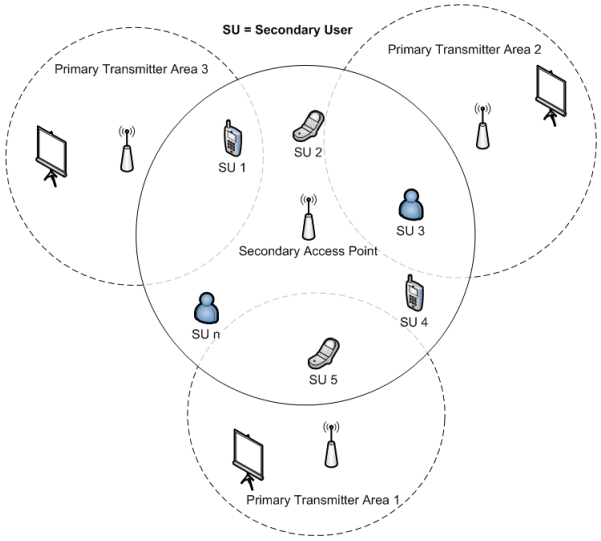

Fig. 1: Example: Model Scenario of Cooperative Cognitive Wireless Communication.

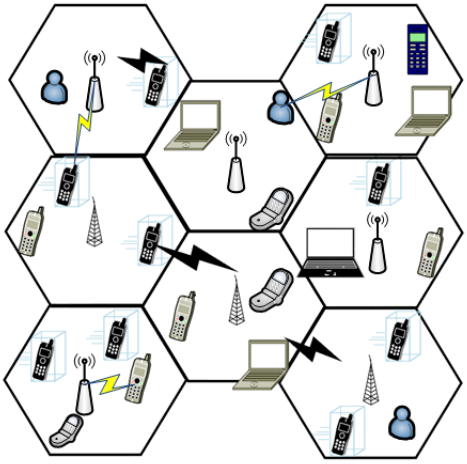

Fig. 2: Heterogeneous Ecological Network.

agents are not willing to play from available given strategies. This situation might arise when none of the combination of the given set of strategies constitute Nash Equilibrium (NE).

For a game with small number of agents or players, the payoff matrix is not large and is easy to calculate. But, for the scenario, where the agent space is large, the convergence takes a lot of time and payoff calculation is cumbersome to calculate. Hence, for the compact representation of payoff matrix in normal-form having k-strategies, the entries can be defined in the following way:

$$D = (d_1, ..., d_k) \tag{1}$$

where d_i is the total number of players, adopting i^th strategy. Every entry $d_i \in D$ is further mapped to another vector of the following form,

$$E = (e_1, ..., e_k) \tag{2}$$

where e_i is the expected payoff of the i^{th} player. So, for the n number of players, the definition of the total number of entries in the payoff matrix as follows:

$$p = \frac{(n + k - 1)!}{n!(k - 1)!} \tag{3}$$

B. Contributions

The contributions of this paper can be summarized as follows:

- The transformation of the cooperative cognitive wireless system into ecological model is given as one of the major objective.
- The cooperative cognitive ecological game is defined to be used in research.
- The selection and population dynamics are given for the cooperative cognitive wireless scenario case.

The rest of the paper is organized as follows: Section II describes the natural selection procedure with explanation of ecological G-function. Section III explains the centralized and decentralized species model in the macrocell environment. Section IV describes the ecological game and the rationale behind using this approach in this work. Section V describes many selection dynamics available in the ecological modeling for cooperative and cognitive scenario. Section VI and Section VII gives the description and foundation for two species population dynamism. Different game parameters for cooperative cognitive ecological game are given in Section VIII. The relationship type for competition is given in Section IX, with the summary of the paper in Section X.

II. Natural Selection

The biological systems are engineered by the process of natural selection, which result into significant and interesting aspects of evolution. The basic idea of evolution can be explored through [9] and stated as follow:

1) Likes tend to generate likes and the heritable variations in the traits can be observed in each different types of organism
2) Organisms struggle for existence between themselves.
3) Struggle for existence are influenced by the heritable traits.

The modern approach to natural selection is explained with genetic interaction. The genetic interaction between the organisms results into the heritable characteristics of the new born. The survival of the individual having a particular phenotype is influenced by either population size or/and frequencies of genes.

A. Ecological G-function

The evolution of strategies through the mechanism of natural selection is a major field in biological games. The tools developed by the ecologist for understanding the evolutionary concept plays an important role for understanding major natural algorithmic mysteries. The fitness generating function (G-function) is the tool to analyze the natural selection process based on the Darwin's theory of evolution. This is the natural selection process which result into the

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stable strategies called evolutionary stable strategies (ESS).

As compared to the established evolutionary game theoretic concept for wireless communication, G-function can introduce a virtual strategy. With the help of virtual strategy, any mobile user can adapt the parameters (e.g., bandwidth resource block allocation, transceiver power, coding, and modulation etc.) based on the available strategies (strategy set), adopted strategy of the other mobile nodes (organism), total mobile users in the cell (ecosystem), and the total availability of resource (bandwidth). With this G-function, the dynamism of heritable strategies and the evolution of natural selection can be developed.

Let X be a set of number of species with population densities, and U be a set of available strategies to each member of species set X, then $H(X,U)$ is the fitness matrix. The fitness generating function $G(v,U,X)$ can be defined if,

$$G(v,U,X)|_{v=u_i} = H_i(U,X) \tag{4}$$

for $i = 1, ..., n_s$, where n_s is the number of strategies [10].

III. Wireless Communication Species Model

The same type of mobile users (organism) constitute a species. For practical implementation, the species model could be centrally controlled through a base station controller or like self-organizing autonomous agents. For the first approach, the Figure 3 shows s species model with a centralized controller at base station. The species formulation is made like microcells within a macrocesll (ecosystem). The evolutionary game is being played among the member of the species, and inter-species game coordination is made through the central controller.

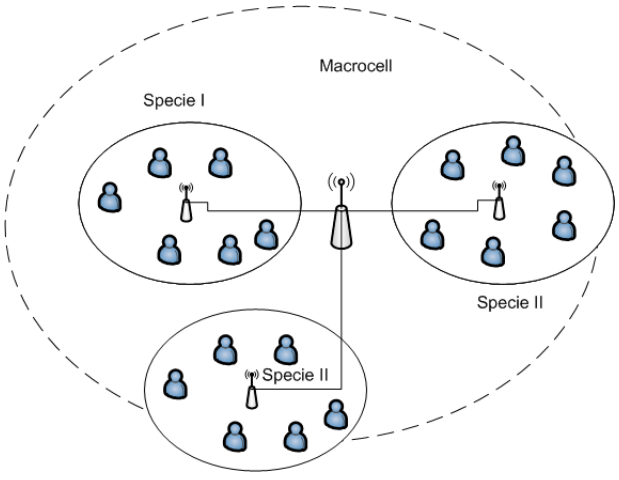

Fig. 3: Example of Cooperative Cognitive Network: III Species with Centralized Controller.

For the latter approach like autonomous interacting agents, shown in Figure 4, the organisms in each specie interact with each other randomly. Similarly the primary users (PU) who want to establish cooperative association with any mobile node has to interact with the neighboring mobile node, play game and evolve with natural selection procedure.

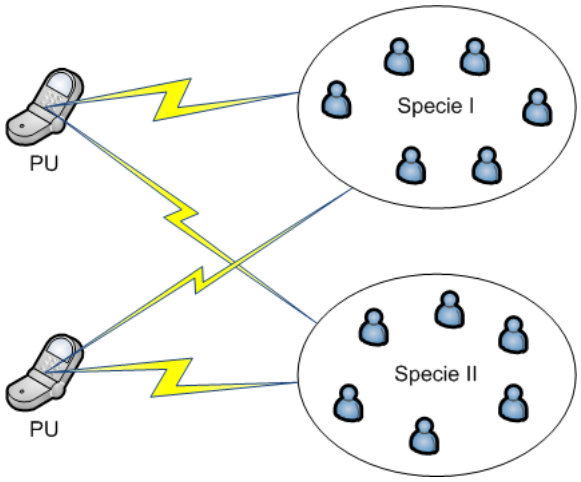

Fig. 4: Example of a Cooperative Cognitive Evolutionary System Model.

IV. Evolutionary Ecological Game

The total number of players in the system plays an important role in the species interaction. This field relates to the population dynamics of mutually competitive species. The frequency of strategies, play an important role for competition modeling among the individuals of the ecosystem. The population dynamics is determined with the inter- and intra-species interaction. These kind of interactions are important for evolutionary equilibrium determination. Different competition model among the members of the species can be formulated for resource distribution and optimal consumption of resources.

A. Evolutionary Ecological Game Rationale

Game theory (GT) have been successfully used to describe the strategic interaction between the interacting nodes in a communication network. The equilibrium state can be determined and analyzed from the Nash equilibrium (NE). In evolutionary game theory (EGT), which is a specialized branch of GT, the equilibrium behavior of the system is described by the evolutionary stable strategies (ESS). For evolutionary ecological game, the system is considered as of species model in the ecosystem. The following few point describe the encouraging reasons for applying ecological concept for CCWC.

- **Pareto-Optimality Solution:** In conventional game theoretic approach, the equilibrium observation to any strategic interaction between players is analyzed using Nash equilibrium. At Nash equilibrium point no players is willing to deviate from its current strategic position. This equilibrium point could be sub-optimal. The other global optimal position in the system can't be achieved, because no other player is moving away from its current strategy. This global optimal position can be achieved through evolutionary game theoretic approach

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by calculating the ESS point.

- **Adoption of New Strategies:** In classical non-cooperative game theoretic approach, players play their strategies at one, thus achieving the Nash Equilibrium point. In ESS, the players slowly adopt the new strategies, leading toward the system equilibrium point.

- **Learning Process:** The evolutionary game theoretic approach have a significant advantage over the conventional approach because of the learning phenomenon. The players can observe the strategies of other players and update their strategies.

V. Selection Dynamics based on Ecosystem

The basic work on evolutionary game theory (EGT) can be cited back to the work by Smith and Price given in [11]. The decision made by the rational mobile users (players in our system) in EGT is determined by channel state information (CSI), the embedded decision making algorithm (e.g. evolutionary Q-learning), and the limiting availability of computational time. The EGT approach start with the random allocation of power and resource block allocation along with the association with the macro or femtocell. The target for applying EGT is to attain evolutionary stable strategy (ESS) equilibrium, which resist any environmental strategy parameter (mutant strategy) for changing the optimal and robust equilibrium position.

For the analysis purpose in the formulation of EGT, population or selection dynamics equations are used [12]. The three important parameter for the selection of any dynamical approach are time, utility function, and the mobile user population. The decision has to be made regarding the selection among the discrete or continuous parameters for time and utility, and finite or infinite mobile user population size in the area of observance. Another parameter for dynamic approach selection are based on stochastic or deterministic process. In other words, with selection of populations the study on how the users will adapt to new strategies with changing population and time is formulated. The concept of mixed strategy can be defined with the strategy distribution profile [13].

A. Deterministic Dynamics

The deterministic dynamic selection are applicable to the scenario with normal time period duration of application. Some of the dynamics applicable to our system are give below.

1) Replicator Dynamics (RD): Replicator dynamics (RD) are the most commonly used dynamics for EGT analysis. In RD, the frequency strategy profile change with the consideration of changing payoff parameter vector [14]. During RD analysis, the utility gain of any mobile user is determined through the strategy action of all other players in the current geographical context.

The earlier work related to replicator dynamics can be found by P. Taylor in [15]. As an example of system model for macrocel underlaid by femtocells, the population can be divided either belonging to MBS (0) or FBS i, $\forall i \in \{1, ..., N_f\}$ thus forming $\mathbf{x} = \{0, 1, 2, .., N_f\}$ with corresponding mobile user population frequencies given by the set $Y = \{y_0, y_1, y_2, .., y_{N_f}\}$ and $(\sum_i y_i = 1)$. By considering replicator dynamics, it is assumed that each user can associate randomly between maceocell and femtocells or from one femtocell to another femtocell. The payoff matrix (U) is defined in such a way, that when a user of type $i \in \mathbf{y}$ interact with a user of type $j \in \mathbf{y}$, it gets the reward given by $u_{ij} \in U$. From above notations, the replicator dynamics equation for mobile user switching frequency can be given as [12].

$$\dot{y}_i = y_i((Uy)_i - y^T U y) \tag{5}$$

where $(Uy)_i$ is the expected payoff of a mobile user suffering interference and have tendency to switch between the cells, and $y^T U y$ is the expected utility gain. The strategy profile, which increases the payoff returns in the system have tendency to increase. As the mobile user have more options to switch between cells, the utility function take the complex form [16]. The generic RD form can be given as:

$$\dot{y}_i = y_i(f_i(y) - \bar{f}(y)) \tag{6}$$

where $f_i(y)$ is a fitness utility function and $\bar{f}(y) = \sum_i y_i f_i(y)$ is the average fitness.

2) Best response dynamics (BRD): The best response dynamics (BRD) is used to model the near or short-sighted behavior of rational mobile nodes. The underlying concept of BRD is that in a population of large number of mobile users, a small number of mobile users can change their strategy according to the mean strategy of the population. So, the rate of strategy change can be given as:

$$\dot{y} = \beta(y) - y \tag{7}$$

here $\beta(y)$ is the best reply e to the strategy set y such a way that $a^T A y \leq e^T A y$ for any a, e, z $\in S^n$. One of the big issue with BRD is that, the solution may not be unique. So, in short, the BRD enables the players to predict the strategy, which otherwise is difficult to achieve, without considering the mean population trend.

3) Smoothed best replies (SBR): One of the drawback of BRD is the possibility of multiple strategy profile equilibrium. SBR dynamics is the solution to BRD to quantify it into having unique solution. Another parameter $\epsilon > 0$ is introduced in such a way that BRD becomes a special case of SBR, and can be given as:

$$\dot{y}_i = \frac{e^{a_i}/\epsilon}{\sum_j e^{a_j(y)/\epsilon}} \min y_i \tag{8}$$

for taking $\epsilon \to 0$ as a special case, BRD is obtained.

VI. Two species Evolutionary Game based on Population Dynamics

For two species evolutionary population dynamics [9] formulated the separate strategy frequency dynamics for species I and J, and is given as follow:

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$$\dot{q}_i^I = q_i^I(F_i^I - \bar{F}^I), \dot{q}_j^J = q_j^J(F_j^J - \bar{F}^J) \quad (9)$$

where, q is the population size, $\dot{q}$ is the rate of change in population, $i = 1, ..., k$ is the strategy type index, F and $\bar{F}$ are the growth and mean growth rates.

The growth rates can be defined as:

$$F_i^I = r^I + [\pi^{II} e_i U^{II} q^I] + \pi^{IJ} e_i U^{IJ} q^J]/N^I$$

$$F_j^J = r^J + [\pi^{JI} e_j U^{JI} q^I] + \pi^{JJ} e_j U^{JJ} q^J]/N^J \quad (10)$$

where, π is the encounter rate between the species, and N is the total number of each user type.

The work by [17] signifies the usage of the species frequency or density and shows the results along with the explanation of already established models and specialized cases for a general two-species model which can be seen in Eq. 9 and Eq. 10. Moreover, the general model leads to natural questions of evolutionary game theory. They have shown that classical Gause or Lotka-Volterra species interactions emerge when strategy selection pressures are solely inter- or intra-species respectively. These systems that combine population dynamics with strategy evolution are more stable than one would expect looking at either effect separately.

VII. Population Dynamism

In population dynamism, different types of species may have complex interaction among the members of the species. The members of each type of species are involved in inter- as well as intra-species competition, as mentioned above, and given in Figure 5.

The population dynamism in CCWC can be classified among the following three classes.

- Positive Competition
- Negative Competition
- Mutualism or Symbiosis

		Effect on Recipient	
		+ve	- ve
Effect on Actor	+ve	Mutualism	Selfish
	-ve	Altruistic	Spite

Fig. 5: Interaction effect of inter-species collaboration.

Positive competition resembles with the coalition, when relaying capacity is available for primary users (PUs) and cognitive bandwidth is consumed by the secondary users (SUs). During the competition, either type of users can get benefit from the interaction, and no user harms the other user. During the negative competition which resembles with the inherent cheating behavior present in the cognitive users behaving selfishly. The result of such kind of competition can harm one type of users (specie I) while benefiting the other type of users (specie II). The Mutualistic or Symbiotic approach is the required scenario for cooperation where both primary and secondary users' capacities are enhanced. The competition set type for population dynamism (PD) is given in Figure 6.

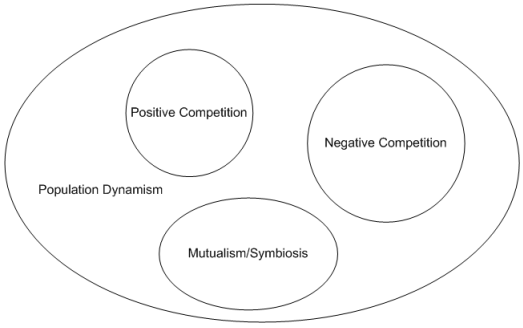

Fig. 6: Population Dynamism for Interacting Mobile Users.

VIII. Cooperative Cognitive Ecological Game Parameters

The cooperative cognitive wireless communication (CCWC) relationship for ecological model can best be exemplified by mutual coalition of algae and fungi, which is called lichen, or the relationship of sea anemones and hermit crabs. These kind of natural coalition is import for the existence of both type of species. Some of the important parameters for cooperative cognitive ecological game are given in Table I and explained as follows:

Dependency: The resource demand of one type of species from the other type of species can be classified as follows:

- Obligate Mutualism (OM) - High Mutualistic Dependency
- Facultative Mutualism (FM) - Low Mutualistic Dependency
- Asymmetric Mutualism (AM) - No Dependency

In the obligate mutualism (OM) scenario, primary and secondary users survival depend on the degree of cooperation. The more the cooperation, the more both type of users get benefited. The lack of one type of species from cooperation will block the cooperation for communication. In the facultative mutualism (FM) case, the cooperation could not be required by one type of species, but for the optimal social welfare function enhancement, both cooperate. While for the AM scenario, the cooperating species are indifferent for cooperation.

N interactions: The mutualistic interaction could depend on the number of interactions among the cooperative species. This degree of interaction depends on the behavior of

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mutualistic reward, and can vary from 1 to N.

Offer produced: The interaction among the members of the species can start randomly or based on offers. The random interaction may take some time for evolutionary convergence. The other type of interaction, where the offers are being made by participating species. The more beneficial offer leads to more cooperation possibility in the future. These offers are available even before the cooperation start. After each cooperative interaction, the newly modified offers are considered by each species member for prolonged cooperation. Cheating is a major cause of deviation from the evolutionary stability and leads to breaking the mutualistic contract.

Moves: The decisions made by the mobile users are called moves. In a strategic competitive interaction, the decision made by the users are simultaneous or alternating. These moves are further considered as being repetitive or sequential. In the repetitive move, there are many rounds of interaction depending on the willingness of the users according to the received benefit. The specialized type of game is the one-shot game, where decision comes in a single interaction.

Mobility: Mobility is one of the major characteristic of the wireless systems. Migration of users from one cellular community (ecosystem) to another is very tricky to implement in the analytical models. Most of the scenarios consider the sessile situations for the mobile systems. The differential equations based models are a useful way for consideration of the mobility. Other specialized situation for femtocell networks (FN) are the close-access and open-access scenario. For the close-access scenario, the sessile population model is taken for analysis. For open-access scenario, the mobile users can move from one ecosystem to another.

Active choice: Active choice is concerned with the partner selection mechanism. For mutualistic scenario in CCWC, the active choice is important for selection of pairs, having more affinity toward each other. The more the mutual benefit, they get from each other, the more the tendency for mutualistic cooperation. For open-access FN, active choice is also considered for selection of base station from different available femtocells or macrocell.

Partner recognition: Partner recognition plays it's role for mutualistic cooperation, when the pairing of cooperative mobile users are made through some centralized controller. The centralized controller implement some algorithm for robust and reliable CCWC system.

Behavioral options: In cooperative scenario, the interacting mobile nodes have the option to cheat or cooperate. Cheating can halt the mutualistic behaviors. Mechanism theory is the technique to design the cooperative games in such a way, that cheating is excluded from the rationality of players decision choice.

TABLE I: Critical Parameters for Cooperative Cognitive Game.

Parameter	Possible Combinations (Primary, Secondary)
Active Choice	Yes, No
Behavioral Options	Cooperate, Defect
Control over Interaction	Full, Limited
Dependency	High, Low
Investment	Yes-No, Variable
Mobility	Mobile, Sessile
Moves	Sequential, Simultaneous, Alternating
N Interaction	One-off, Repeated
Offer Produced	Prior, During, After
Partner Recognition	Yes, No
Payoff Symmetry	Symmetrical, asymmetrical

TABLE II: Analogy: CCWC vs. Ecosystem.

Communication Network	Ecology
Communication	Ecology
Communication System	Ecosystem
Mobile Devices	Organism
Communication Network	Species
Heterogeneous Network	Ecosystem
Coexisting Networks (CN)	Biodiversity
Each subnetwork in HN	Biome
World Wide Web	Biosphere
Wireless environment favoring communication	Niche
Environmental existence of any network	Habitat
Communication system engineering	Niche construction (Eco-sys engineering)
Handover	Migration
Communication Network	Food Web
Secondary Users	Consumers
Primary Users	Producers
Relays	Producers
Centralized Controllers	Keystone species
Resources	Biomass
Cooperative Cognitive Wireless Communication	Mutualism/Symbiosis
Interference	Parasitism
Spatial Distribution	Biogeography
Mobile density	Population density
Mobile user growth	Population growth
BAN energy generation from body	Metabolism

Investment: By investment, it means that the game players contribute toward social welfare function by playing altruistic strategy. Investment is concerned with the future rewards, which may be envisioned after the cooperation process is over.

Payoff symmetry: This parameter is required to incorporate the cheating behavior of rational mobile users.

Control over interaction: The game players (mobile users) have full control over the interaction process, and can finish it at anytime without harming the partner.

IX. Competition and Relationship Types

The competition among the mobile users could be any of the following form.

- Resource-resource competition
- Resource-service competition
- Service-service competition

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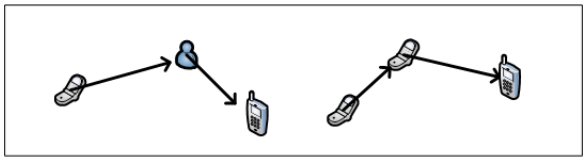
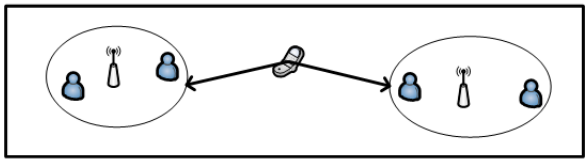
Cognitive wireless networks possess flexible architectures based on dynamically reconfigurable cognitive radios, where the concept of cognition is used to reach various end-to-end objectives, including frequency agility and adaptivity. Most of the current focus in cognitive networking systems is to optimize local network coordination and control. This is concentrated at the device level, and there is no specific direction to characterize the scale at which cognitive network interactions can co-evolve, grow and flourish, to understand their role and impact on a global scale towards future communication technologies.

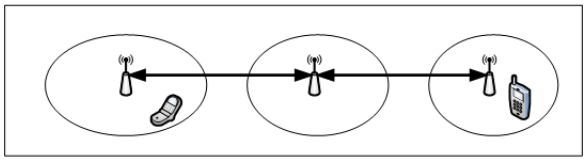
Biological Communication Diversity (BioCommDiv) measure the existence of heterogeneous types of network within a particular geographical area or locality. This is the system, where interoperability of devices and services matters a lot, for seamless communication among different types of devices with different type of protocols and operating system (OS). The more BioCommDiv factor shows the health of communication system (CS). The Figure 7 shows different scenarios for cooperative communication, cognitive radio, inter-cell coordination, and evolution toward ecological interacting cooperative cognitive network.



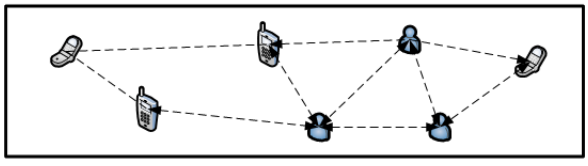
(a) Cooperative Communication



(b) Cognitive Communicaiton



(c) Inter-cell Networks



(d) Ecological Coop-Cog Network

Fig. 7: Interacting Mobile Networks.

X. Summary

This paper establishes the basic model for cooperative cognitive ecological system. This can be seen that there is almost complete analogy between the communication system and ecological system. The evolutionary algorithms and protocol are robust enough to reshape the communication techniques and strategies. This paper forms the fundamental base for ecological communication system. The future work based on cooperative cognitive ecological system is very promising in many research disciplines.

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Experimental Analysis of Performance of Wireless LAN

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Abstract:
Wireless local-area networks based on IEEE 802.11 a/b/g standards are growing rapidly. WLANs can provide the benefits of network connectivity without the restrictions of being tied to a location or restricted by wires. Despite the convenience of mobility, the performance of a WLAN must be addressed carefully before it can be adopted and deployed in any environment. In our research, we addressed the impact of various key parameters on the actual performance of IEEE 802.11g. We performed series of experiments to assess the performance of IEEE802.11g, in the presence of interferences, and finding the maximum through-put under realistic conditions. In addition the impact of co-channel, adjacent channel interferences and noises on the quality of WLAN speed was also exposed. Overall, we conducted independent set of experiments to measure the IEEE 802.11g's effective application-level throughput. The analysis results and measurement provided insights into the required provisioning for 802.11g WLAN to ensure that it will provide the needed coverage and capacity for the intended users.

I- Introduction:
Wireless technologies enable freedom of mobility for users by releasing the constraint of physical connections – network connections become cable-free. Wireless technologies use radio frequency (RF) as the medium of transmission, and allow organizations to eliminate cables for simpler network management at effective costs. The IEEE 802.11 standard establishes several requirements for the RF transmission characteristics of an 802.11 radio. Included in these are the channelization scheme as well as the spectrum radiation of the signal (that is, how the RF energy spreads across the channel frequencies). In IEEE 802.11g, channels 1, 6 and 11 are considered to be non-overlapping and hence the premise that these channels can be used such that multiple networks can operate in close proximity without interfering with each other [6]. Interference has always been considered as an unavoidable peril in wireless networks. Based on channel of origin, interference can be categorized into co-channel (from transmissions on the same channel as the receiver) and adjacent-channel (transmissions on adjacent and overlapping channels). The IEEE 802.11 b/g standards operate in the unlicensed ISM 2.4 Ghz spectrum which has 11 out of 14 channels available for use in the US [4, 5]. These overlapping channels degrade network performance. Few researches have been conducted in this area. In this paper we present a full scale performance study and analysis on IEEE 802.11g, to measure its effective application-level throughput under different scenarios. In order to improve its performance, a clear understanding of WLAN behavior is needed, therefore measuring and analyzing the performance of system under realistic conditions is of paramount importance. In my experiments, we studied the effect

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of interferences on TCP traffic.
The rest of paper is organized as follows. In section II, we discuss the related work. Experimental setup is described in Section III. Performance evaluation methodology is explained in section IV. The results obtained are described in section V; we present our conclusion and discuss future work in section VI.

II- Related Work:

Stine *et al.* (2003) [7] stated that Interference has always been considered as an unavoidable peril in wireless networks. To reverse the effect they constructed simple analytical and empirical models of such interference occurring in IEEE 802.11 networks, and illustrated two scenarios where such interference can be exploited. **Banerjee (2006)** [1] stated that in 802.11 and other wireless networks, adjacent channel interference is considered a peril. In order to avoid this peril, two simultaneously communicating nodes that are in close proximity are assigned to different non-overlapping channels, i.e., channels 1, 6, and 11 in 802.11b are non-overlapping. **Boulmalf *et al.* (2006)** [2] addressed the impact of various key parameters on the actual performance of IEEE 802.11g in the presence of interferences, and found the maximum through-put under realistic conditions. The analysis results and measurement campaign provided insights into the required provisioning for 802.11g WLAN to ensure that it provided the needed coverage and capacity for the intended users. **Liese *et al.* (2006)** [3] studied the relative performances of single and multiple channels in both single hop and multi hop wireless mesh networks. In one of their experiments, they studied the effect of antenna placement on the access point and determine the impact on performance. **Sharma *et al.* (2006)** [6] characterized the performance of multi-channel IEEE 802.11g wireless networks. They conducted the experiments on a sample topology consisting of just two flows on non-overlapping channels and found that the expected increase in throughput was seen only when the separation between the antennas of the radio devices was above a threshold value.

III- Experimental Setup:

One testing location in University of Agriculture Faisalabad was selected for research, Testing environment consisted of two 802.11g APs, four 802.11g wireless cards, IBM ThinkPad same configuration laptops running windows XP and two Dell Latitude dame configurations laptops as shown in Figure 1.1. Laptops were placed at a distance of 5 meters from APs. Experiments were conducted by keeping channel of one AP constant while changing the channels of the other AP in order to check the interference caused by channel overlapping. Iperf was used to generate TCP traffic and measure the throughput. SPSS was used to perform analysis of the results that we got from my experiments.

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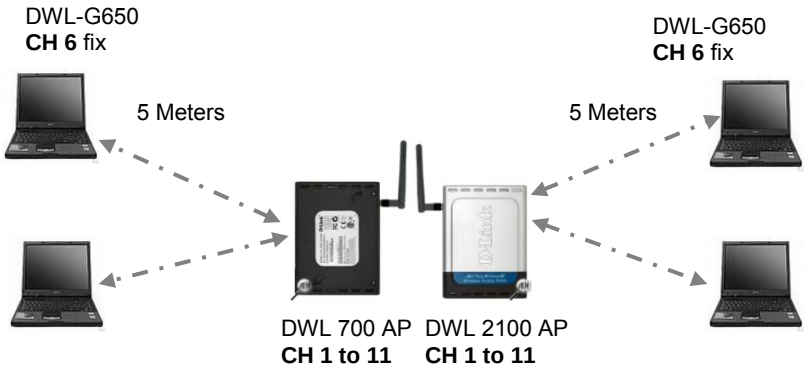

Figure 1.1 Experimental Setup

A. Hardware Requirements

Sr. No.	Brand Computer	Operating System	Processor	RAM
1	IBM T22 ThinkPad	Microsoft Windows XP	900 MHz	256 MB
2	IBM T22 ThinkPad	Microsoft Windows XP	900 MHz	256 MB
3	Dell Latitude D 600	Microsoft Windows XP		
4	Dell Latitude D 600	Microsoft Windows XP		

Sr. No.	Access Points	WLAN Standard
1	D Link DWL-700	IEEE 802.11 g
2	D Link DWL-900	IEEE 802.11 g

Sr. No.	Wireless Network Cards	WLAN Standard
1	D-Link DWL G650	IEEE 802.11 g

B. Software Requirements

Sr. No.	Tools
1	DU Meter
2	Iperf
3	SPSS

IV- Performance Evaluation Methodology:

In our experiments we characterized the results on the basis Throughput of TCP generated through Iperf. We measured the effect on throughput by changing the frequency channel schemes:

AP / Wireless Cards	Frequency Channel
D-Link DWL 700AP	1
D-Link DWL 2100AP	1
D-Link DWL G650	6
D-Link DWL G650	6
D-Link DWL G650	6
D-Link DWL G650	6

Table 1.1 Frequency Channel Schemes

The frequency channel scheme showed in table 1.1 was changed as: Keeping 700AP

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channel 1 and changing 900AP from 1 to 11, than changing 700AP channel to 2 and again changing 900AP from 1 to 11, utilizing 700AP all channels one time and 900AP channels 11 times thus making 121 possible combinations.

V- Experimental Results:

The experiments were done 10 times in university environment, and the mean results of 10 sheets were calculated. The detail results in the form of graphs are given below:

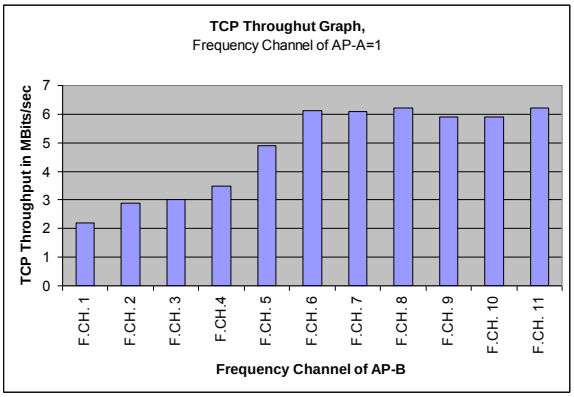

Figure 2.1: TCP Throughput Graph

Figure 2.1 shows that when the channel of both 2100AP and 700AP is 1 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping.

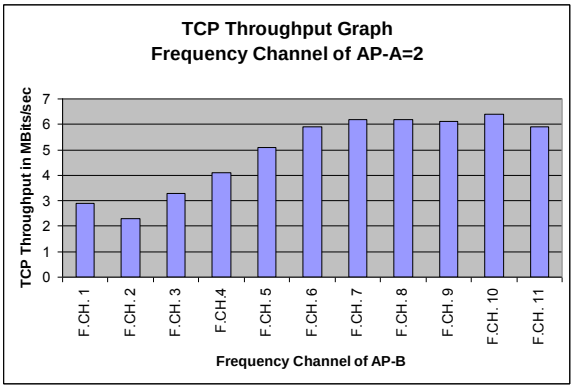

Figure 2.2: TCP Throughput Graph

Figure 2.2 shows when the channel of both 2100AP and 700AP is 2 TCP throughput decreases while with all other channels its value increased due to the fact that same channels overlap each other and cause interference. Highest possible throughput value is achieved when the channel of AP2 is in the range of 6-11.

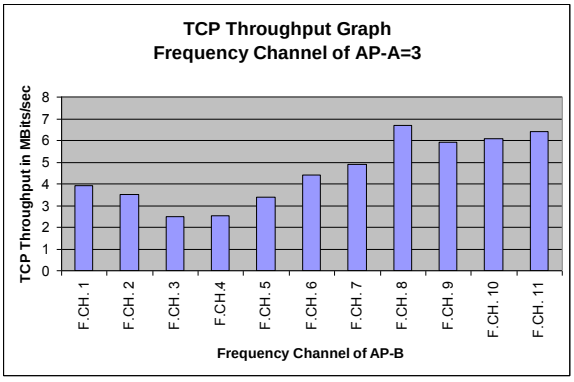

Figure 2.3: TCP Throughput Graph

Figure 2.3 shows when the channel of both 2100AP and 700AP is 3 TCP throughput decreases while with all other channels its value increased due to the fact that same channels overlap each other and cause interference. Highest possible throughput value is achieved when the channel of AP2 is in the range of 6-11

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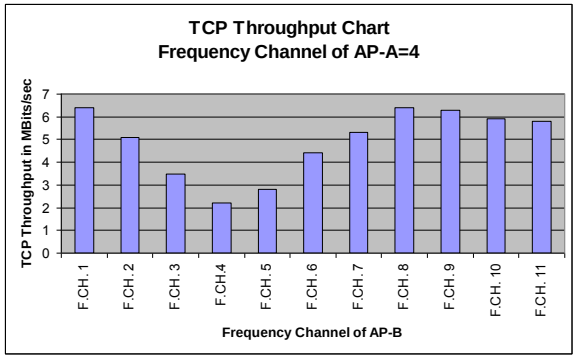

Figure 2.4: TCP Throughput Graph

Figure 2.4 shows that when the channel of both 2100AP and 700AP is 4 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping. The combination of 4-3 and 5-3 gives smaller throughput values as compared to other combinations.

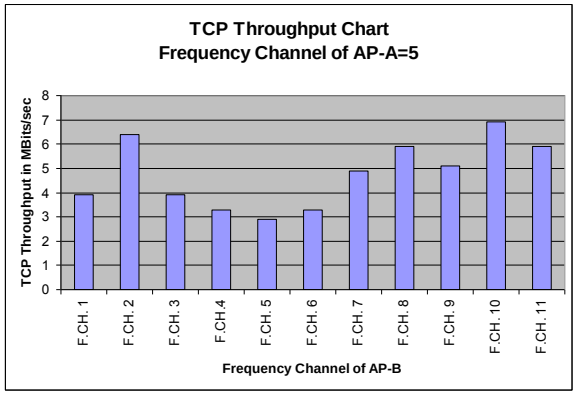

Figure 2.5: TCP Throughput Graph

Figure 2.5 shows when the channel of both 2100AP and 700AP is 2 TCP throughput decreases while with all other channels its value increased due to the fact that same channels overlap each other and cause interference. Highest possible throughput values are achieved with the combination of 2-5, 10-5.

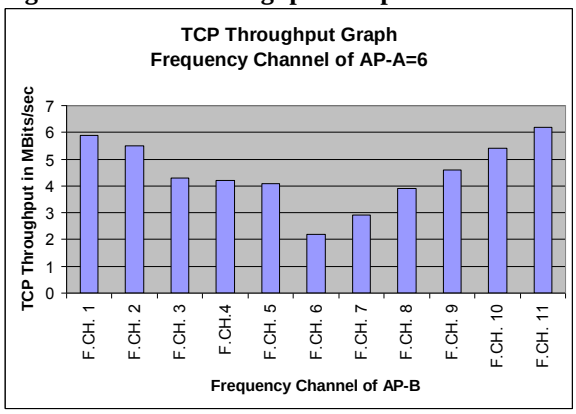

Figure 2.6: TCP Throughput Graph

Figure 2.6 shows that when the channel of both 2100AP and 700AP is 6 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping

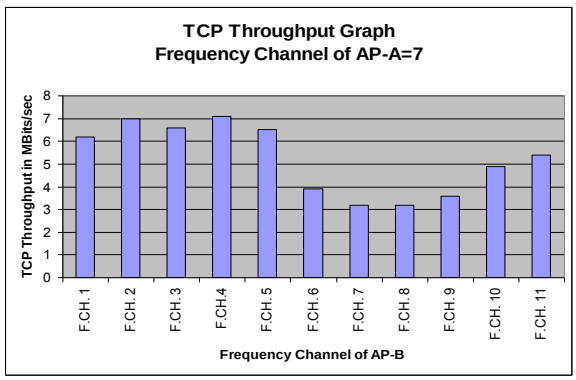

Figure 2.7: TCP Throughput Graph

Figure 2.7 shows when the channel of both 2100AP and 700AP is 7 TCP throughput decreases while with all other channels its value increased due to the fact that same channels overlap each other and cause interference. Lowest possible throughput value is achieved when the channel of AP2 is

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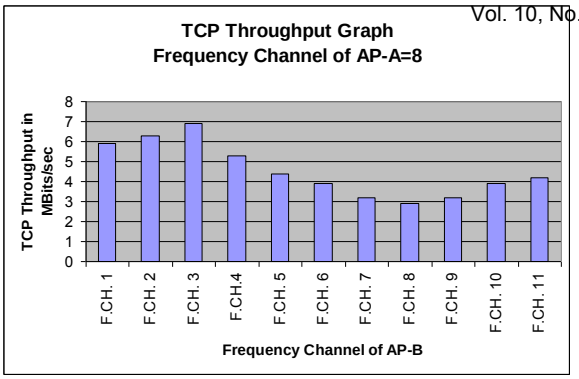

Figure 2.8: TCP Throughput Graph

Figure 2.8 shows when the channel of both 2100AP and 700AP is 8 TCP throughput decreases while with all other channels its value increased due to the fact that same channels overlap each other and cause interference. Lowest possible throughput value is achieved when the channel of AP2 is in the range of 5-11.

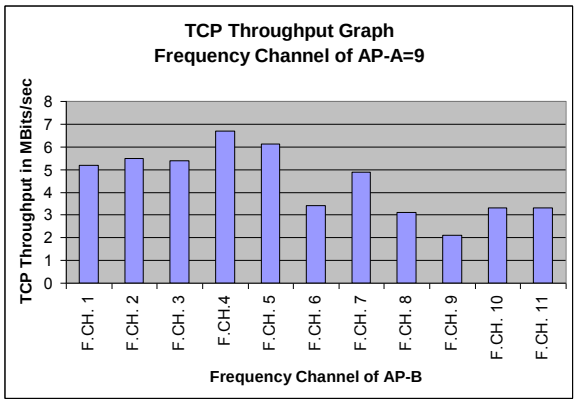

Figure 2.9: TCP Throughput Graph

Figure 2.9 shows that when the channel of both 2100AP and 700AP is 9 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping. Highest throughput values are obtained from 1-5

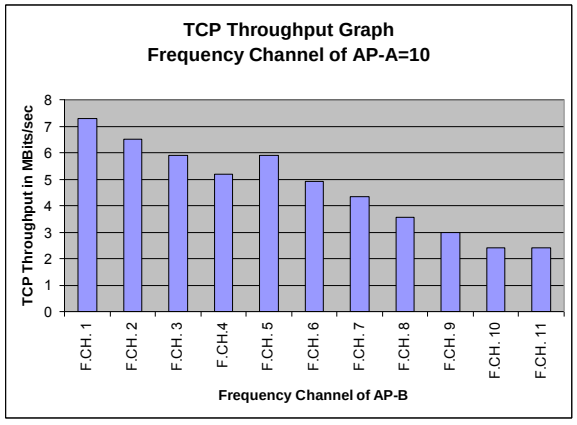

Figure 2.10: TCP Throughput Graph

Figure 2.10 shows that when the channel of both 2100AP and 700AP is 10 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping. Throughput is decreased as the level of frequency channels moves from 1 to 11 accept at 10 which gives lowest value due to interference.

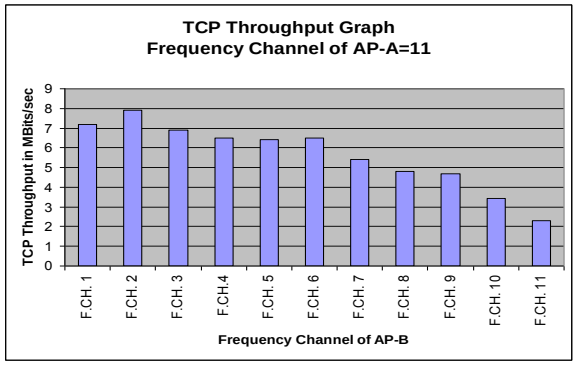

Figure 2.11: TCP Throughput Graph

Figure 2.11 shows that when the channel of both 2100AP and 700AP is 11 TCP throughput decreases while with all other channels its value increase because same frequency causes interference and decrease the throughput due to overlapping. Throughput is decreased as the level of frequency channels moves from 1 to 11.

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VI. Conclusion and Future Work

Overall results show that overlapping channels cause performance degradation. When AP1 has channels from 1 to 5 adjusting the channels of AP2 from 1 to 5 cause low throughput value and high throughput value was achieved from channel number 6 to 11. While adjusting AP1 between 6 to 11 and changing AP2 channels from 1 to 5 cause higher throughput than that from 6 to 11 which cause lower throughput in this case.
In future researchers can conduct experiments by using 802.11a standard. They can make comparison among 802.11a, 802.11b and 802.11g standards. They can use more combinations of frequency channels as 802.11a have more non-overlapping frequency channels as compared to 802.11b and 802.11g.

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Cooperative Cognitive Ecological System for Wireless Communications

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***Abstract*—This paper analyzes the cooperative cognitive wireless communication (CCWC) model based on biological mutualism (BM). In BM, different types of species help each other for mutual existence in the ecosystem. We tried to formulate our CCWC problem similarly like BM scenario, and examined how the bandwidth resource would be shared with each other for mutual existence, and the number of primary and secondary users which can coexist based on the available bandwidth resource.**

***Index Terms*—Cooperative Cognitive Wireless Communications; Ecological Systems.**

I. Introduction

Cooperative cognitive wireless communication (CCWC) consist of two types of resources: licensed bandwidth owned by primary users and relay bandwidth owned by secondary users. Primary Users can be modeled as one type of species and the secondary types of users can be modeled as another type of species. In CCWC both types of user species are willing to lend bandwidth to each other in exchange of their own bandwidth resource. Talking in ecological concepts, both primary and secondary type of users are in the state of mutualism: where cooperation is in mutual benefit for each other [1].

A. Related work

For the systems which are behaving strategically and competing for the allocation of resources, game theory can best describe the allocation of resources and equilibrium position [2]. Within game theory, evolutionary game theory can best describe the dynamism of any system [3]. The wireless system is characterized by the moving and changing position of the mobile terminals. Therefore, for the type of system like wireless, evolutionary game theory can best answer many questions.

For the proposed model, the dynamical branch of game theory for the analysis of cooperative cognitive systems is being used. Dynamical framework can best be described by Lotka Volterra equations which work almost same as replicator equations and is the foundation of ecological modeling. For cooperative cognitive systems, primary and secondary users get benefit from the presence of each other. The more the number of resources for sharing, the more they get benefits. Figure 1 draws the mutualistic model for primary and secondary users.

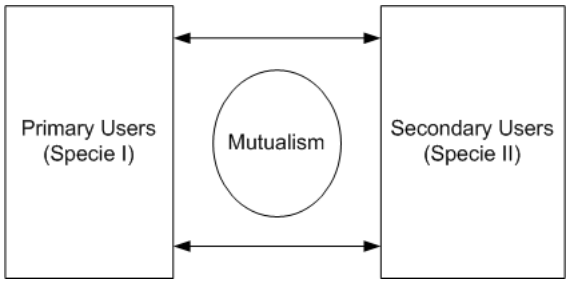

Fig. 1: Mutualistic Model for Cooperative Cognitive Radio.

B. Contributions

The contributions of this paper can be summarized as follows:

- The basic structure of cooperative cognitive ecological system is described.
- The effects of population dynamism with varying number of primary and secondary users are discussed.
- The ecological game with analysis from Lotka-Volterra equations are given with cooperative cognitive mobile user population.

The rest of the paper is organized as follows: Section II explains the system model. Section III analyzes the growth in density dependent mobile users. Section IV explains the evolutionary game scenario for cooperative cognitive users with formulation of the game. Section V explains the Lotka-Volterra competition with explained results. The matrix game and local stability is discussed in Section VI, with the summary of the paper given in Section **??**.

II. System Model

The proposed system model is given in Figure 2. The two cooperative types of users are primary and secondary, each labeled as species I and species II. The primary nodes (species I) can lease their under-utilized bandwidth to the secondary users and secondary users can behave as cooperating relays for primary users, thus forming a mutualistic system in ecology.

One major estimation for the cooperative cognitive communication system is the population dynamisms for each type of species, after transferring our system in mathematical ecological form. The mutualistic behavior in natural ecosystem

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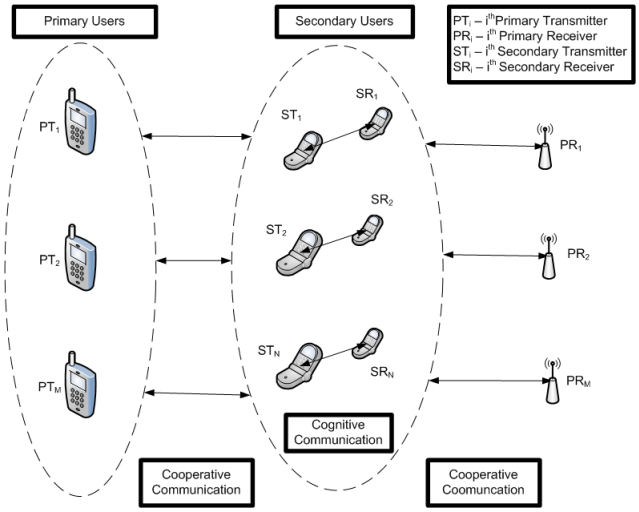

Fig. 2: The System Model.

is very complex because of the many types of species influencing on each others resource directly and indirectly. The system is made simple, but still it is very complex because of the spatial position of the cell, terrain condition, cellular population distribution, hardware complexity, and many types of interferences and noise. One possible type of the ecosystem is where species exploit the common resources, and situation like *tragedy of the commons* occur. Here, species are rivals and tries to exploit each others resources. The proposed system is based on mutualistic model, where cooperation mean the survival of interacting species. The benefit or payoff is directly proportional to the existence and population of any type of species.

III. Density Dependent Communication Growth

For the simulation of density dependent communication growth rate, linear negative feedback from mobile users is assumed. It is started with some specific user population $N(0)$, cellular carrying capacity K, and per capita bandwidth growth rate r.

By assuming the population dependency, it is meant to say that number of users effect the per capita bandwidth growth. So, if K is cellular user's environmental carrying bandwidth capacity in terms of individual user, then $N-K$ is the amount of unsed carrying bandwidth capacity, while $(N-K)/K$ shows the remaining fractional carrying bandwidth capacity. Therefore,

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right). \quad (1)$$

If user population is almost zero, then the carrying bandwidth capacity is almost under-utilized, and dN/Ndt is nearly equal to per capita bandwidth growth rate. If the total number of mobile users are equal to the carrying capacity, then the cellular environment is totally occupied or used, and the corresponding rate of change of number of users with respect to time variable is zero.

In Figure 3 it is tried to show how the continuous logistic mobile population growth rate change. The simulation is started with 5 mobile users, carrying capacity of 500 mobile users, and per capita intrinsic growth rate greater than zero and showed how the system will gradually accommodate new mobile users while reaching the carrying capacity of 500 mobile users.

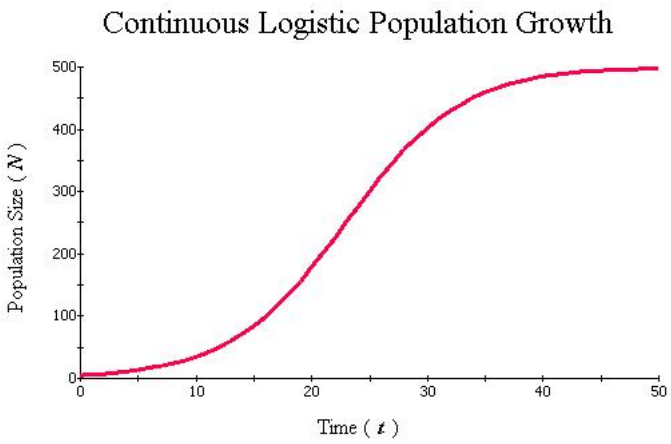

Fig. 3: The Continuous Logistic Mobile Population Growth.

A. Using Evolutionary Game Theory

In economical theory, the strategic behavior is characterized by the conscious behavior present between the players in which the competitors (players) are aware of mutually conflicting interest and interdependence of the decisions. The exact resemblance of this strategic behavior can be seen in cooperative cognitive communication in which the primary and secondary (relay) nodes are the strategic players, with conflicting interest of bandwidth allocation (resource) and decisions (allocated bandwidth to each other). The branch of economics dealing with such kind of strategic partner, is called game theory and have been very successful in term of answering the strategic interaction of cellular nodes in cooperative communication. The same kind of strategic interaction is present in cognitive radio between primary and secondary users, and the calculation is being made for the stability point in term of Nash equilibrium (no player is better off in changing the strategy).

The most of the work in game theory for cooperative cognitive communication have be dealing with the formulation and existence of Nash equilibrium. The statistical interpretation of the population of primary and secondary nodes have been neglected for most of the work. This behavior was first analyzed by [3] in which he studied the behavior of population for pre-programmed players meeting strategically and discussed the evolutionary stable strategy (ESS) criterion.

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IV. Cooperative Cognitive Evolutionary Game (CCEG)

In cooperative cognitive wireless communication (CCWC) game, the competition for the resource is between the primary and secondary user, in which each type of users have its own objective function, which need to be maximized. Each primary user from the pool of primary users want to maximize it's utility by using the appropriate number of relays from secondary users, thus forming cooperative communications model. For primary users the competition is among other primary users as well as in selection of relays form the secondary users. on the other hand, the secondary user want to maximize their utility function by getting more share opportunistically by getting dedicated bandwidth from secondary users.

Every game is characterized by the players, strategies and payoffs. Similarly the players, strategies and payoffs for CCEG can be described as follow:

- **Players:** In CCEG, the two types of distinct players are the primary users and secondary users, which may also called an individual species. The individual member in each species is a distinct player. So, in our proposed system, there are two (2) types of species: *M* number of players in specie-I (primary users), and *N* number of players in specie-II (secondary users). This formulation lead to a total number of $M\times$ N individual players interacting strategically with each other.

- **Strategy:** Each player in each type of species (primary, secondary) are willing to sell or lease its bandwidth to the members of other type of species. In our model, primary (licensed) bandwidth can be used by secondary nodes, and relay (unlicensed) bandwidth can be used by the primary nodes, using cooperative technique. In addition to the bandwidth being offered to other types of species members, nodes also have to offer price to charges in exchange of bandwidth. So, the set of strategic pairs for primary and secondary users would be $\{(w_{P_i}, p_{P_i})\}$ and $\{(w_{S_j}, p_{S_j})\}$, respectively.

- **Payoff:** In evolutionary game theory, payoff is also referred as the fitness. This fitness function is determined by each player's net utility.

Even for simplest model of species, the population dynamics have complex behavior, which may include bifurcation and chaos. When cooperative cognitive system is transformed into mathematical ecological form, the major task is the investigation of population densities dynamism for both primary and secondary users. For natural ecosystem, many types of species interact with each other, forming a complex dynamic system. Our proposed system consist of two species, still making it quite complex, involving many different types of noise introduction, hardware complexity, spatial position and distribution etc. It is also tried to analyze the dependence of density on dynamism.

V. Lotka-Volterra Competition

Density dependent growth models like the logistic equation simulate an intra-specific competitive process; resources become limiting as the population increases, and the per capita growth rate declines. In this scenario, an additional term is added to the logistic to represent inter-specific density-dependent effects, and a pair of the resulting expressions comprise the *Lotka-Volterra competition equations*, which provide a simple and historically important vehicle for thinking about competitive interactions. In the Lotka Volterra equations, densities of both species are subtracted from the carrying capacity to give a density dependent feedback term, and the number of inter-specific competitors is weighted by a term called the competition coefficient which varies with the species' similarity in resource requirements. The basic Lotka Volterra equations for CCWC system can be given as,

$$\dot{x} = x r_x \left(1 + \frac{x}{K_x} + \alpha \frac{y}{K_x}\right) \tag{2}$$

$$\dot{y} = y r_y \left(1 + \frac{y}{K_y} + \beta \frac{x}{K_y}\right) \tag{3}$$

Where, x and y represent the primary and secondary user population, K_x and K_y as the cellular carrying capacity for primary and secondary users, r_x and r_y as primary and secondary growth rate, and α is the competition coefficient, describing the competitive effect of secondary users on primary users, and similarly the β is the competitive coefficient for secondary users, describing the competitive effect of primary users on secondary users [4].

The Figure 4 - Figure 8 show some of the examples for Lotka Voltera Mutualism.

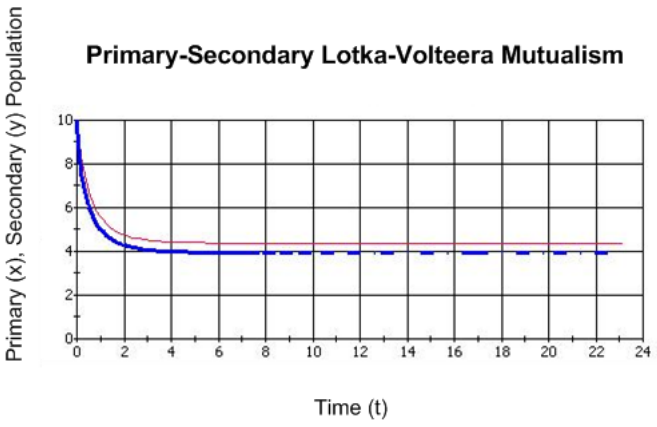

Fig. 4: The Primary-Secondary Lotka-Volterra Mutualism I.

The parameters used for Figure 4 - 8 are: $x(0) = 10$, $r_x = 0.9$, $K_x = 500$, $\alpha = 0.6$, $y(0) = 10$, $r_y = 0.9$, $K_y = 500$, $\beta = 0.6$.

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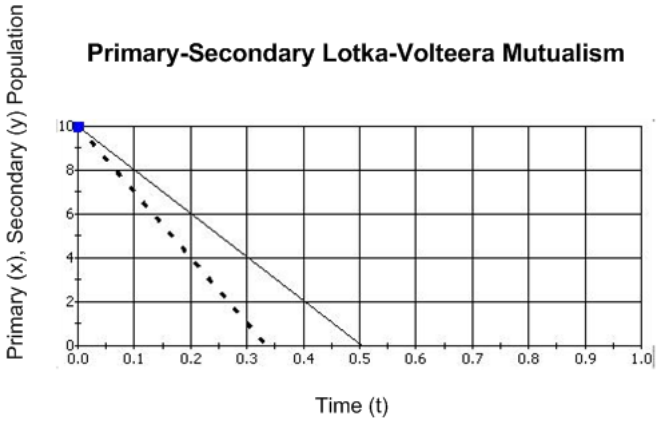

Fig. 5: The Primary-Secondary Lotka-Volterra Mutualism II.

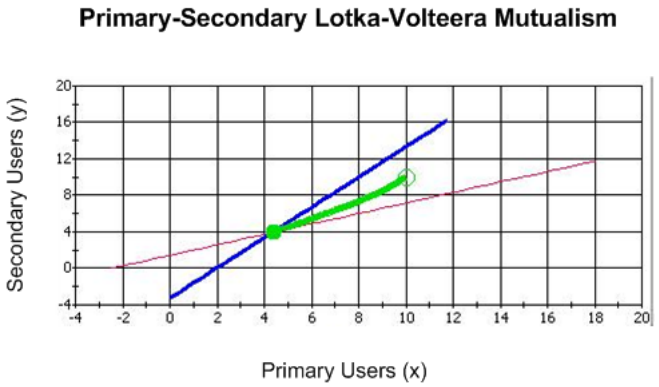

Fig. 6: The Primary-Secondary Lotka-Volterra Mutualism III.

Density-dependent communication growth is similar to intra-species competition behavior. With the increasing population, the decline in the resource availability and per-capita communication growth, can be observed. The already described density-dependent growth rate equations can be modified to cater the inter-species interaction. These type of equations are labeled as Lotka-Volterra equations [4].

The non-zero population at equilibrium can be given as follows:

$$x^* = \frac{\alpha K_y - K_x}{1 - \alpha\beta}, \tag{4}$$

$$y^* = \frac{\beta K_x - K_y}{1 - \alpha\beta}. \tag{5}$$

Where superscript * represent the equilibrium user population.

The parameters used for Figure 9 and Figure 10 are: $x(0) = 30$, $r_x = 1.5$, $K_x = 560$, $\alpha = 0.7$, $y(0) = 20$, $r_y = 3$, $K_y = 600$, $\beta = 0.8$.

Figure 9 shows the population dynamics for primary and secondary users. The line corresponding to primary user is the net zero isocline for primary users, while the straight line corresponding to the secondary user is the net zero isocline

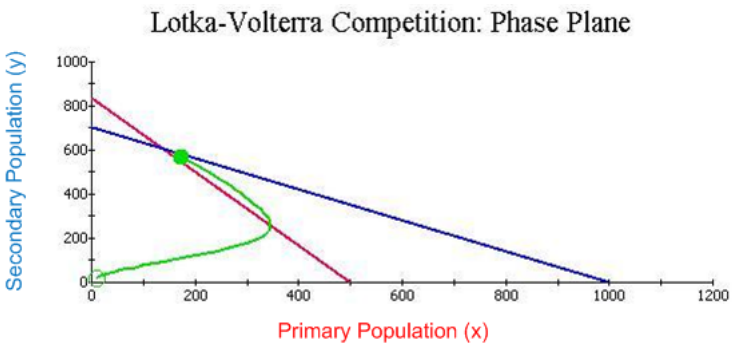

Fig. 7: The Primary-Secondary Lotka-Volterra Mutualism IV.

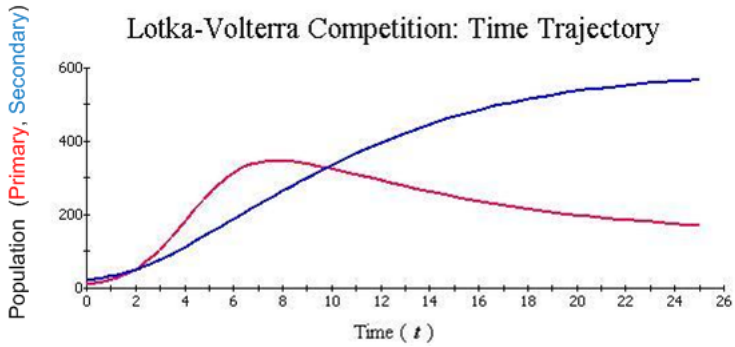

Fig. 8: The Primary-Secondary Lotka-Volterra Mutualism V.

for secondary users. These are the lines for equations where the rate of change of population is zero ($\frac{dx}{dt} = 0 = \frac{dy}{dt}$). The intersection point shows the equilibrium position. The curve shows how the equilibrium position is achieved after starting our simulation from initial population of primary and secondary users.

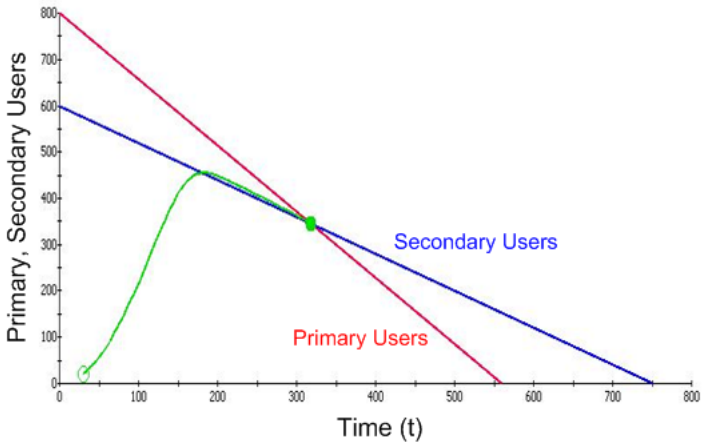

Fig. 9: The Primary-Secondary Lotka-Volterra Mutualism VI.

Similarly, Figure 10 shows the variation of both types of mobile users with the passage of time, with respect to the inter-dependence of mutual bandwidth resource. The simulation is started with almost the same number of each type of users. The population of secondary users, grow rapidly as compared

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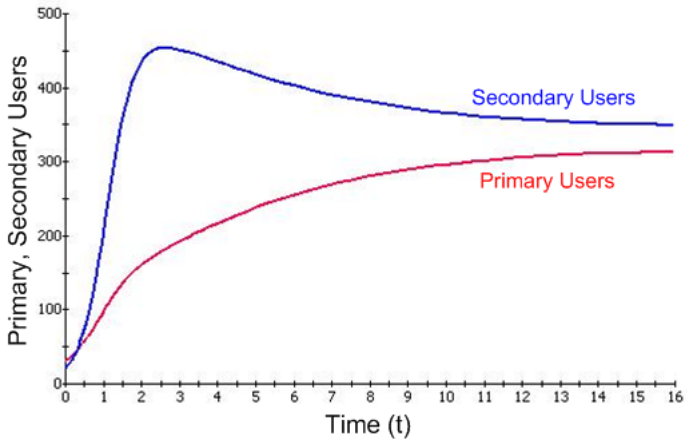

Fig. 10: The Primary-Secondary Lotka-Volterra Mutualism VII.

to primary users. As the time passes, the system converge to stable situation and primary and secondary users are stable at some fixed population.

VI. Matrix Game and Local Stability

For formulation of cooperative cognitive matrix game, the individual payoff of individuals of each type of specie is represented by a matrix. For our formulation of game with two species, the two matrices, each representing the payoffs of primary and secondary users are formulated. If the total number of primary users are represented by M and total number of secondary users are N, then the order of the two payoff matrices would be M*N. The matrix in CCMG is not symmetric, because each type of specie have different types of benefits and prices to pay for pairwise coalition.

Many types of coalition games can be formulated as a matrix game [5]. And, most of the evolutionary game theoretic approach are formulated as matrix games [3]. So, similarly there is feasibility for formulating cooperative cognitive game as matrix game.

The equilibrium can be analyzed based on the availability of both types of resources and the number of each type of users. If there is a local stability point for the co-existence of both types of users, then the equilibrium is attained after some iterative duration. In the calculation, the analysis of the equilibrium conditions can be obtained. The possible variables used for work are the varying amount of bandwidth resource and the changing number of users of each type.

For the local stability of the equilibrium situation, the Jacobian matrix of primary and secondary types of users for primary and secondary type of bandwidth can be formulated. As an example, for the two types of changing variables (Mobile users, Bandwidth resource) for two types of users (primary, secondary) competing for two types of resources (primary, secondary) result into a Jacobian matrix of degree 4×4. The locally stability criteria ensures that the eigenvalues of the Jacobian matrix can have negative numerical real values.

VII. Summary

Cooperative cognitive mutualism is the interaction of primary and secondary users. More specifically, in this type of coalition primary users give benefits to the secondary users in-term of allowing the usage of fixed bandwidth, while secondary users behave as relays to the primary users, in return of advantages to each other. The similar type of definition of mutalism can be found in [6]. This type of exchange is beneficial to both primary and secondary users. The same type of mutualistic behavior can be observed in [7] where pollens or nectars are spread with the services of bees. This idea can also be supported by economic theory of comparative advantages, where abundant goods are exchanged among different type of species in trade [8]. This mutualistic behavior can be treated as positive-positive interaction. This interaction type has been described as Lotka-Volterra equations.

Mutualism is defined as the relationship between two organisms that benefits both. Cooperative cognitive mutualisms (CCM) carry costs and benefits to both primary and secondary nodes. CCM is favorable when the mutual benefits are greater than the individual costs, so it is the net benefits (or benefit cost ratio) that determine the outcome of these interactions. If the individual communication without the mutual cooperation of primary and secondary node is not feasible, CCM is called obligatory cooperative cognitive mutualism (OCCM). And, if the primary and secondary communication can survive in the absence of the each other, CCM is called facultative cooperative cognitive mutualism (FCCM). The CCM relationship may not be symmetric. For example either primary or secondary node may be obligated to the mutualism, while the other can live without its mutualistic partner. The CCM can be symbiotic, meaning that the existence of primary and secondary communication is always found together. Based on the Lotka-Volterra mutualistic system model, the future work can explains the bandwidth resource competition for fixed and variable amount of bandwidth from ecological point of view.

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Track A: Security

Access control, Anonymity, Audit and audit reduction & Authentication and authorization, Applied cryptography, Cryptanalysis, Digital Signatures, Biometric security, Boundary control devices, Certification and accreditation, Cross-layer design for security, Security & Network Management, Data and system integrity, Database security, Defensive information warfare, Denial of service protection, Intrusion Detection, Anti-malware, Distributed systems security, Electronic commerce, E-mail security, Spam, Phishing, E-mail fraud, Virus, worms, Trojan Protection, Grid security, Information hiding and watermarking & Information survivability, Insider threat protection, Integrity
Intellectual property protection, Internet/Intranet Security, Key management and key recovery, Language-based security, Mobile and wireless security, Mobile, Ad Hoc and Sensor Network Security, Monitoring and surveillance, Multimedia security ,Operating system security, Peer-to-peer security, Performance Evaluations of Protocols & Security Application, Privacy and data protection, Product evaluation criteria and compliance, Risk evaluation and security certification, Risk/vulnerability assessment, Security & Network Management, Security Models & protocols, Security threats & countermeasures (DDoS, MiM, Session Hijacking, Replay attack etc,), Trusted computing, Ubiquitous Computing Security, Virtualization security, VoIP security, Web 2.0 security, Submission Procedures, Active Defense Systems, Adaptive Defense Systems, Benchmark, Analysis and Evaluation of Security Systems, Distributed Access Control and Trust Management, Distributed Attack Systems and Mechanisms, Distributed Intrusion Detection/Prevention Systems, Denial-of-Service Attacks and Countermeasures, High Performance Security Systems, Identity Management and Authentication, Implementation, Deployment and Management of Security Systems, Intelligent Defense Systems, Internet and Network Forensics, Large-scale Attacks and Defense, RFID Security and Privacy, Security Architectures in Distributed Network Systems, Security for Critical Infrastructures, Security for P2P systems and Grid Systems, Security in E-Commerce, Security and Privacy in Wireless Networks, Secure Mobile Agents and Mobile Code, Security Protocols, Security Simulation and Tools, Security Theory and Tools, Standards and Assurance Methods, Trusted Computing, Viruses, Worms, and Other Malicious Code, World Wide Web Security, Novel and emerging secure architecture, Study of attack strategies, attack modeling, Case studies and analysis of actual attacks, Continuity of Operations during an attack, Key management, Trust management, Intrusion detection techniques, Intrusion response, alarm management, and correlation analysis, Study of tradeoffs between security and system performance, Intrusion tolerance systems, Secure protocols, Security in wireless networks (e.g. mesh networks, sensor networks, etc.), Cryptography and Secure Communications, Computer Forensics, Recovery and Healing, Security Visualization, Formal Methods in Security, Principles for Designing a Secure Computing System, Autonomic Security, Internet Security, Security in Health Care Systems, Security Solutions Using Reconfigurable Computing, Adaptive and Intelligent Defense Systems, Authentication and Access control, Denial of service attacks and countermeasures, Identity, Route and

Location Anonymity schemes, Intrusion detection and prevention techniques, Cryptography, encryption algorithms and Key management schemes, Secure routing schemes, Secure neighbor discovery and localization, Trust establishment and maintenance, Confidentiality and data integrity, Security architectures, deployments and solutions, Emerging threats to cloud-based services, Security model for new services, Cloud-aware web service security, Information hiding in Cloud Computing, Securing distributed data storage in cloud, Security, privacy and trust in mobile computing systems and applications, **Middleware security & Security features:** middleware software is an asset on
its own and has to be protected, interaction between security-specific and other middleware features, e.g., context-awareness, **Middleware-level security monitoring and measurement:** metrics and mechanisms for quantification and evaluation of security enforced by the middleware, **Security co-design:** trade-off and co-design between application-based and middleware-based security, **Policy-based management:** innovative support for policy-based definition and enforcement of security concerns, **Identification and authentication mechanisms:** Means to capture application specific constraints in defining and enforcing access control rules, **Middleware-oriented security patterns:** identification of patterns for sound, reusable security, **Security in aspect-based middleware:** mechanisms for isolating and enforcing security aspects, **Security in agent-based platforms:** protection for mobile code and platforms, Smart Devices: Biometrics, National ID cards, Embedded Systems Security and TPMs, RFID Systems Security, Smart Card Security, Pervasive Systems: Digital Rights Management (DRM) in pervasive environments, Intrusion Detection and Information Filtering, Localization Systems Security (Tracking of People and Goods), Mobile Commerce Security, Privacy Enhancing Technologies, Security Protocols (for Identification and Authentication, Confidentiality and Privacy, and Integrity), Ubiquitous Networks: Ad Hoc Networks Security, Delay-Tolerant Network Security, Domestic Network Security, Peer-to-Peer Networks Security, Security Issues in Mobile and Ubiquitous Networks, Security of GSM/GPRS/UMTS Systems, Sensor Networks Security, Vehicular Network Security, Wireless Communication Security: Bluetooth, NFC, WiFi, WiMAX, WiMedia, others

This Track will emphasize the design, implementation, management and applications of computer communications, networks and services. Topics of mostly theoretical nature are also welcome, provided there is clear practical potential in applying the results of such work.

Track B: Computer Science

Broadband wireless technologies: LTE, WiMAX, WiRAN, HSDPA, HSUPA, Resource allocation and interference management, Quality of service and scheduling methods, Capacity planning and dimensioning, Cross-layer design and Physical layer based issue, Interworking architecture and interoperability, Relay assisted and cooperative communications, Location and provisioning and mobility management, Call admission and flow/congestion control, Performance optimization, Channel capacity modeling and analysis, Middleware Issues: Event-based, publish/subscribe, and message-oriented middleware, Reconfigurable, adaptable, and reflective middleware approaches, Middleware solutions for reliability, fault tolerance, and quality-of-service, Scalability of middleware, Context-aware middleware, Autonomic and self-managing middleware, Evaluation techniques for middleware solutions, Formal methods and tools for designing, verifying, and evaluating, middleware, Software engineering techniques for middleware, Service oriented middleware, Agent-based middleware, Security middleware, Network Applications: Network-based automation, Cloud applications, Ubiquitous and pervasive applications, Collaborative applications, RFID and sensor network applications, Mobile applications, Smart home applications, Infrastructure monitoring and control applications, Remote health monitoring, GPS and location-based applications, Networked vehicles applications, Alert applications, Embeded Computer System, Advanced Control Systems, and Intelligent Control : Advanced control and measurement, computer and microprocessor-based control, signal processing, estimation and identification techniques, application specific IC's, nonlinear and adaptive control, optimal and robot control, intelligent control, evolutionary computing, and intelligent systems, instrumentation subject to critical conditions, automotive, marine and aero-space control and all other control applications, Intelligent Control System, Wiring/Wireless Sensor, Signal Control System. Sensors, Actuators and Systems Integration : Intelligent sensors and actuators, multisensor fusion, sensor array and multi-channel processing, micro/nano technology, microsensors and microactuators, instrumentation electronics, MEMS and system integration, wireless sensor, Network Sensor, Hybrid

Sensor, Distributed Sensor Networks. Signal and Image Processing : Digital signal processing theory, methods, DSP implementation, speech processing, image and multidimensional signal processing, Image analysis and processing, Image and Multimedia applications, Real-time multimedia signal processing, Computer vision, Emerging signal processing areas, Remote Sensing, Signal processing in education. Industrial Informatics: Industrial applications of neural networks, fuzzy algorithms, Neuro-Fuzzy application, bioInformatics, real-time computer control, real-time information systems, human-machine interfaces, CAD/CAM/CAT/CIM, virtual reality, industrial communications, flexible manufacturing systems, industrial automated process, Data Storage Management, Harddisk control, Supply Chain Management, Logistics applications, Power plant automation, Drives automation. Information Technology, Management of Information System : Management information systems, Information Management, Nursing information management, Information System, Information Technology and their application, Data retrieval, Data Base Management, Decision analysis methods, Information processing, Operations research, E-Business, E-Commerce, E-Government, Computer Business, Security and risk management, Medical imaging, Biotechnology, Bio-Medicine, Computer-based information systems in health care, Changing Access to Patient Information, Healthcare Management Information Technology. Communication/Computer Network, Transportation Application : On-board diagnostics, Active safety systems, Communication systems, Wireless technology, Communication application, Navigation and Guidance, Vision-based applications, Speech interface, Sensor fusion, Networking theory and technologies, Transportation information, Autonomous vehicle, Vehicle application of affective computing, Advance Computing technology and their application : Broadband and intelligent networks, Data Mining, Data fusion, Computational intelligence, Information and data security, Information indexing and retrieval, Information processing, Information systems and applications, Internet applications and performances, Knowledge based systems, Knowledge management, Software Engineering, Decision making, Mobile networks and services, Network management and services, Neural Network, Fuzzy logics, Neuro-Fuzzy, Expert approaches, Innovation Technology and Management : Innovation and product development, Emerging advances in business and its applications, Creativity in Internet management and retailing, B2B and B2C management, Electronic transceiver device for Retail Marketing Industries, Facilities planning and management, Innovative pervasive computing applications, Programming paradigms for pervasive systems, Software evolution and maintenance in pervasive systems, Middleware services and agent technologies, Adaptive, autonomic and context-aware computing, Mobile/Wireless computing systems and services in pervasive computing, Energy-efficient and green pervasive computing, Communication architectures for pervasive computing, Ad hoc networks for pervasive communications, Pervasive opportunistic communications and applications, Enabling technologies for pervasive systems (e.g., wireless BAN, PAN), Positioning and tracking technologies, Sensors and RFID in pervasive systems, Multimodal sensing and context for pervasive applications, Pervasive sensing, perception and semantic interpretation, Smart devices and intelligent environments, Trust, security and privacy issues in pervasive systems, User interfaces and interaction models, Virtual immersive communications, Wearable computers, Standards and interfaces for pervasive computing environments, Social and economic models for pervasive systems, Active and Programmable Networks, Ad Hoc & Sensor Network, Congestion and/or Flow Control, Content Distribution, Grid Networking, High-speed Network Architectures, Internet Services and Applications, Optical Networks, Mobile and Wireless Networks, Network Modeling and Simulation, Multicast, Multimedia Communications, Network Control and Management, Network Protocols, Network Performance, Network Measurement, Peer to Peer and Overlay Networks, Quality of Service and Quality of Experience, Ubiquitous Networks, Crosscutting Themes – Internet Technologies, Infrastructure, Services and Applications; Open Source Tools, Open Models and Architectures; Security, Privacy and Trust; Navigation Systems, Location Based Services; Social Networks and Online Communities; ICT Convergence, Digital Economy and Digital Divide, Neural Networks, Pattern Recognition, Computer Vision, Advanced Computing Architectures and New Programming Models, Visualization and Virtual Reality as Applied to Computational Science, Computer Architecture and Embedded Systems, Technology in Education, Theoretical Computer Science, Computing Ethics, Computing Practices & Applications

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