An Intelligent Mobile Robot Navigation Technique Using RFID Technology

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Abstract

Now a day’s mobile robots are vastly used in many industries for performing different activities. Controlling a robot is generally done using a remote control, which can control the robot to a fixed distance, but here by designing control system for a robot such that the mobile robot is controlled using mobile and wireless RF communication. In this method controlling is done depending on the feedback provided by the sensor. This contains different modules such as

- Wireless unit module
- Sensing and controlling module

In the sensing module when the PIC micro controller is powered-up the high-speed dc motors. The sensor is mounted on the robot. The encoder mounted on the robot transmitting the data continuously. Here the robot consists of Transmitter and receiver. Here the frequency used is 433 kHz.

Keywords— Mobile robots, navigation, position control, Radio Frequency (RFID), robot sensing systems.

1. Introduction

In this method the mobile robot navigation is using Radio Frequency technology. Navigation based on processing some analog features of an RF signal is a promising alternative to different types of navigation methods in the state of the art. The main idea is to exploit the ability of a mobile robot to navigate a priori unknown environments without a vision system and without building an approximate map of the robot workspace, as is the case in most other navigation algorithms. The suggested algorithm is capable of reaching a target point in its a priori unknown workspace, as well as tracking a desired trajectory with a high precision. The proposed solution offers a modular, computationally efficient, and cost-effective alternative to other navigation techniques for a large number of mobile robot applications, particularly for service robots, such as, for instance, in large offices and assembly lines. The effectiveness of the proposed approach is illustrated through a number of computer simulations considering test beds of various Complexities.

Mobile robot navigation has stood as an open and challenging problem over the last few decades. Despite the significant advances in this field, researchers have yet to reach a comfortable level of satisfaction. The proposed algorithm takes advantage of the emerging Radio Frequency (RFID) technology.

1.2 System Analysis

1.2.1 Existing System

Numerous robot navigation methods have been suggested over the past few years. These systems generally fall under one of the following categories: dead-reckoning-based, landmark based, vision-based, and behavior-based techniques. The fundamental idea behind dead-reckoning navigation systems is the integration of incremental motion over time. This navigation method is based on continuous encoder readings that provide the position, orientation, and linear and angular velocities of the robot. This type of navigation is widely used due to its simplicity and ease of maintenance. However, small precision errors and
sensor drifts inevitably lead to increasing cumulative errors in the robot’s position and orientation, unless an independent reference is periodically used to correct the error. Given these shortcomings, researchers shifted their interest to vision-based navigation to improve the robot position estimation by tracing the visual features in the environment and using them as landmarks. This measurement usually returns bearing to the visual features only, with no a priori knowledge of the landmark positions. Nevertheless, such a technique also has its own disadvantages, which include the lack of information depth, complex image processing algorithms with high computational burden, and its dependence on the working environment. Adopting behavior-based navigation systems can alleviate this problem, as they can incorporate a relatively large number of sensors, making them suitable for navigation in unstructured environments. However, relying on numerous sensors makes the system vulnerable to their drifts and cumulative errors.

1.2.2 Proposed System

An innovative mobile robot navigation technique using radio frequency technology. Navigation based on processing some analog features of a RF signal is a promising alternative to different types of navigation methods in the state of the art. The main idea is to exploit the ability of a mobile robot to navigate a priori unknown environments without a vision system and without building an approximate map of the robot workspace, as is the case in most other navigation algorithms. The suggested algorithm is capable of reaching a target point in its a priori unknown workspace, as well as tracking a desired trajectory with a high precision. The proposed solution offers a modular, computationally efficient and cost-effective alternative to other navigation techniques for a large number of mobile robot applications, particularly for service robots, such as, for instance, in large offices and assembly lines. The effectiveness of the proposed approach is illustrated through a number of computer simulations considering test beds of various complexities.

2. RFID Systems and Microcontrollers

2.1 RFID Systems

RFID is an automatic identification method that relies on storing and remotely retrieving data. The basic communication between the robot and the system based on radio frequency (RFID) technology. A communication antenna is usually built within the wireless control unit and sensor and flying unit. The RF encoder in the wireless control unit sends the information to the flying robot. RF Decoder in the sensing and control unit receives the information and controls the motor and the information from the sensing and control unit transmitted to the wireless control unit. Encoder HT 12E and decoder HT12D is used for mobile robot navigation technique. The 212 encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information, which consists of N address bits and 12_N data bits. Each address/ data input can be set to one of the two logic states. The Programme addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 212 series of encoders. The HT12A additionally provides a 38 kHz carrier for infrared systems.
### 2.2 Driving Relays:

Using the outputs of the HT-12D or HT-648L decoder ICs to drive relays is quite simple. Here are schematics showing how to drive relays directly from the data-output pins of the decoder.

#### Figure 2.2 NPN Driver Relay

![NPN Driver Relay Diagram](image)

#### Figure 2.2.1 PNP Driver Relay

![PNP Driver Relay Diagram](image)

### 2.3 ENCODER HT12E

**FEATURES**

- Operating voltage 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1\_A (typ.) at VDD=5V
- HT12A with a 38kHz carrier for infrared transmission medium
- Minimum transmission word Four words for the HT12E
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components
- HT12A/E: 18-pin DIP SOP package

### 2.4 BLOCK DIAGRAM

![HT12E Block Diagram](image)

**Figure 2.4 Block Diagram Of HT 12E**

### 2.5 Flow Chart Of HT 12E

- HT12E
  - Power on
  - Standby mode
  - Transmission enabled?
    - Yes: 4 data words transmitted
    - No: Transmission still enabled
      - Yes: 4 data words transmitted continuously

![HT12E Flow Chart](image)

**Figure 2.5 Flow Chart Of HT 12E**

### 2.6 Timing Diagram Of HT 12E

![HT12E Timing Diagram](image)

**Figure 2.6 Timing Diagram Of HT 12E**
2.7 DECODER HT12D FEATURES

- Operating voltage 2.4V~12V
- Low power and high noise immunity CMOS Technology
- Low standby current
- Capable of decoding 12 bits of information
- Pair with Holtek's 2 Series of encoders
- Binary address setting
- Received codes are checked 3 times
- Address/Data number combination
- HT12D: 8 address bits and 4 data bits
- HT12F: 12 address bits only
- Built-in oscillator needs only 5% resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external components

2.8 Block Diagram Of HT 12D

2.9 Flow Chart Of HT 12D

```
Power on

Standby mode

Code in?

Yes

No

Address bits matched?

Yes

No

State data

Match previous stored data?

Yes

No

3 times of checking completed?

Yes

No

Latch data go output & activate VT

Address or data error?

Yes

No

Disable VT & ignore the rest of this word
```

VT -Valid Transmission.

Figure 2.9 Flow Chart of HT 12D

2.10 Timing Diagram Of HT 12D

```
Decoder timing

Encoder Timing

Transmitted bit

Decoder Timing

Encoder Timing

Transmitted bit

Decoder Timing

Address

Latch

Data Out
```

Figure 2.10 Timing Diagram Of HT 12D
2.11 RF TRANSMITTER
The RF Transmitter used is TLP434A. It has frequency range of 315 MHz to 433 MHz. It operates at a voltage range of 2-12 VDC.

Figure 2.11 RF Transmitter

2.12 RF RECEIVER
The RF Receiver used is RLP434A. It has frequency range of 315 MHz to 433 MHz. It operates at a voltage range of 3.3-6 VDC.

Figure 2.12 RF Receiver

2.13 ATMEL 89C2051 MICROCONTROLLER
The AT89C2051 is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programable and erasable read-only memory (PEROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set.

DESCRIPTION
The AT89C2051 is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programable and erasable read-only memory (PEROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.
The AT89C2051 provides the following standard features: 2K bytes of Flash, 128 bytes of RAM, 15 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, a precision analog comparator, on-chip oscillator and clock circuitry. In addition, the AT89C2051 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes.

The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

### 2.14 PIN CONFIGURATION

![Pin Diagram Of HT 12D](image)

**PIN DESCRIPTION**

**PORT 1**

The Port 1 is an 8-bit bi-directional I/O port. Port pins P1.2 to P1.7 provide internal pull-ups. P1.0 and P1.1 require external pull-ups. P1.0 and P1.1 also serve as the positive input (AIN0) and the negative input (AIN1), respectively, of the on-chip precision analog comparator. The Port 1 output buffers can sink 20 mA and can drive LED displays directly. When 1s are written to Port 1 pins, they can be used as inputs. When pins P1.2 to P1.7 are used as inputs and are externally pulled low, they will source current (IIL) because of the internal pull-ups. Port 1 also receives code data during Flash programming and verification.

**PORT 3**

Port 3 pins P3.0 to P3.5, P3.7 are seven bi-directional I/O pins with internal pull-ups. P3.6 is hard-wired as an input to the output of the on-chip comparator and is not accessible as a general-purpose I/O pin. The Port 3 output buffers can sink 20 mA. When 1s are written to Port 3 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89C2051 as listed below: Port 3 also receives some control signals for Flash programming and verification.
PORT 3 FUNCTIONS

<table>
<thead>
<tr>
<th>Port Pin</th>
<th>Alternate Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3.0</td>
<td>RXD (serial input port)</td>
</tr>
<tr>
<td>P3.1</td>
<td>TXD (serial output port)</td>
</tr>
<tr>
<td>P3.2</td>
<td>INT0 (external interrupt 0)</td>
</tr>
<tr>
<td>P3.3</td>
<td>INT1 (external interrupt 1)</td>
</tr>
<tr>
<td>P3.4</td>
<td>T0 (timer 0 external input)</td>
</tr>
<tr>
<td>P3.5</td>
<td>T1 (timer 1 external input)</td>
</tr>
</tbody>
</table>

Table: Port 3 Functions

RST
Reset input. All I/O pins are reset to 1s as soon as RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the device. Each machine cycle takes 12 oscillator or clock cycles.

XTAL1
Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2
Output from the inverting oscillator amplifier.

OSCILLATOR CHARACTERISTICS
The XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 5.1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 5.2. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed. Oscillator Connections Note: C1, C2 = 30 pF ± 10 pF for Crystals = 40 pF ± 10 pF for Ceramic Resonators

External Clock Drive Configuration

Port Pin Alternate Functions

P3.0 RXD (serial i/p port)

MODES OF OPERATION

IDLE MODE
In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset. The P1.0 and P1.1 should be set to –0” if no external pull-ups are used, or set to –1” if external pull-ups are used. It should be noted that when idle is terminated by a hardware reset, the device normally resumes program execution, from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when Idle is terminated by reset, the instruction following the one that invokes Idle should not be one that writes to a port pin or to external memory.

POWER-DOWN MODE
In the power-down mode the oscillator is stopped, and the instruction that invokes power-down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the power-down mode is terminated. The only exit from power-down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before VCC is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize. The P1.0 and P1.1 should be set to –0” if no external pull-ups are used, or set to –1” if external pull-ups are used.

3. PIC16F877 MICROCONTROLLER
The PIC16F887 is high-performance Risk processor up to 8Kx14 words of flash programmable memory, 368x8 bytes of data memory and 256x8 bytes
of EEPROM memory. The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set.

3.1 FEATURES

- Power saving SLEEP mode
- Selectable oscillator options
- Low-power, high-speed CMOS FLASH/EEPROM Technology
- Fully static design
- In-Circuit Serial Programming (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial and Industrial temperature ranges
- Low-power consumption: < 2 mA typical @ 5V, 4 MHz; 20 mA typical @ 3V, 32 kHz; < 1 mA typical standby current

3.2 SIMULATION RESULTS

1. PIC 16F877A

Figure 3 Block Diagram Of PIC 16F877 Micro Controller

3.2 Simulation Results For PIC 16F877A
4. AT89C 2051

4.1 Timer Outputs

4.2 Interrupt And Serial Output

5. Conclusion:

Embedded systems are integral part of our life and play a major role in improving the standard and quality of life. Consumer appliances to Bio-Medical equipment, communications, nuclear application and space research are some of the key areas where embedded systems play a vital role.

The use of micro controller has been enhanced to such an extent that we cannot expect the world without micro controller, the advantage over the much used micro processor is that it has got the internal memory to store the program which makes it more usable in the real time world. With the help of sensor feedback mechanism with RF communication the mobile robot can be controlled from a far distance, which is desirable fact when the robot is working in hazardous environment.

6. FUTURE WORK

A potential future research avenue to extend this paper is to append the algorithm with a real-time path-planning module to which the RFID tag locations in the 3-D space would be a priori known (but not to the navigation module, however). It would also be important to extend the capabilities of the proposed navigation system to be able to track curvilinear and circular paths.
7. References


About the Authors

R.Kousalya* received her B.E degree in Electrical and Electronics from Sri Sowdambika college of Engineering, Arupukottai in 2006. She received his M.E degree in Embedded Systems from S.A Engineering college, Chennai in 2009. She is having more than 5 years of experience in teaching. Presently she has been working as Assistant Professor in Vel tech multi tech Dr. Rangarajan Dr. Sakunthala Engineering college, Chennai, India since June 2010. His research interests include design, control, and analysis of power converters, Robotics, FACTS, HVDC, Power systems, Electrical machines, etc.

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