DESIGN AND DEVELOPMENT OF A RFID BASED MOBILE ROBOT

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Abstract

The present manuscript proposes a novel mobile robot navigation technique using a customized RFID reader with two receiving antennas mounted on the robot and a number of standard RFID tags attached in the robot’s environment to define its path. The paper deals to design for skilled navigation in mobile robotics usually requires solving two problems pertaining to the knowledge of the position of the robot, and to a motion control strategy. When no prior knowledge of the environment is available, the problem becomes even more challenging since the robot has to build a map of its surroundings as it moves. These three tasks ought to be solved in conjunction due to their interdependency. In here, we show that using the RF signal from the RFID tags as an analog feedback signals can be a promising strategy to navigate a mobile robot within an unknown or uncertain indoor environment. The ARM Microcontroller of Microchip LPC 2148 is used to control the autonomous mobile robot to communicate with RFID reader. By storing the moving control commands such as turn right, turn left, speed up and speed down etc. into the RFID tags beforehand and sticking the tags on the tracks, the autonomous mobile robot can then read the moving control commands from the tags and accomplish the proper actions. This method is computationally simpler and more cost effective than many of its counterparts in the state of the art. It is also modular and easy to implement since it is independent of the robot’s architecture and its workspace.


1. INTRODUCTION

Concept proposed in 1949 Developed for the Defense Industry 20+ years back for Missile Tracking and Telemetry Smaller size and lower cost allowed use in 1980’s for Animal and Industry uses Large Scale in Europe for Animal Tagging Large Scale use in the US for Parking/Toll Roads Many companies in India use RFID for Supply Chain Management (SCM). An ADC (Automated Data Collection) technology that uses radio-frequency waves to transfer data between a reader and a movable item to identify, categorize, track. Is fast and does not require physical sight or contact between reader/scanner and the tagged item and performs the operation using low cost components. Attempts to provide unique identification and backend integration that allows for wide range of applications. Radio Frequency Identification (RFID) technology has been attracting considerable attention with the expectation of improved supply chain visibility for both suppliers and retailers. It will also improve the consumer shopping experience by making it more likely that the products they want to purchase are available.

Recent announcements from some key retailers have brought the interest in RFID to the forefront. This guide is an attempt to familiarize the reader with RFID technology so that they can be asking the right questions when considering the technology. RFID is a generic term for technologies that use radio waves to automatically identify people or objects. Unlike bar codes, no clear line of sight is required to obtain an accurate read. The basic RFID system comprises a transponder, a reader and an antenna. Data is stored in a transponder device called a tag. Current tags, depending on application, can hold up to 2 Kbits of data. Tags can be read-only or read/write. The transponder memory may comprise read-only (ROM), random access (RAM) and non-volatile programmable memory for data storage depending upon the type and sophistication of the device. The ROM-based memory is used to accommodate security data and the transponder operating system instructions which, in conjunction with the processor or processing logic deals with
the internal “house-keeping” functions such as response delay timing, data flow control and power supply switching.

2. EXISTING TECHNOLOGY AND PROBLEM

Unlike bar codes, no clear line of sight is required to obtain an accurate read. The basic RFID system comprises a transponder, a reader and an antenna. Data is stored in a transponder device called a tag. Current tags, depending on application, can hold up to 2 Kbits of data. Tags can be read-only or read/write. The transponder memory may comprise read-only (ROM), random access (RAM) and non-volatile programmable memory for data storage depending upon the type and sophistication of the device. The existing microcontroller used is the PIC 18F4550 microcontroller is used to control the autonomous mobile car and to communicate with RFID reader[1]. By storing the moving control command such as turn right, turn left the autonomous mobile car can accomplish the proper action. The ROM-based memory is used to accommodate security data and the transponder operating system instructions which, in conjunction with the processor or processing logic deals with the internal “house-keeping” functions such as response delay timing, data flow control and power supply switching.

3. PROPOSED WORK

Undoubtedly, industrial automation application is one of the key issues in developing RFID. The utilization of RFID technology is novel and might enhance the existed automation system. A RFID-based autonomous mobile robot is designed and implemented in this paper for more extensively application of RFID systems. The ARM Microcontroller of Microchip LPC 2148 is used to control the proposed autonomous mobile robot and to communicate with RFID reader [1]. Due to the uniqueness of RFID tag, the moving control commands such as turn right, turn left, speed up and speed down etc. The autonomous mobile robot can read the moving control commands from the tags and accomplish the proper actions. The novel localization system for a mobile robot is proposed to improve the efficiency of the system.

The RAM-based memory is used to facilitate temporary data storage during transponder interrogation and response.

1. The Antenna is a coil of wound copper wire designed specifically to emit RFID signals.

2. The Reader Unit powers the coil of wire known as the antenna, filters and powers them for transmission over distance.

3. The Transponder (Tag) a memory device, usually EEPROM, programmed with a series of bits.

4. The Interface unit interfaces the reader to an intelligent device (Ex: Microcontrollers, ARM Processors)

4. ARCHITECTURE AND DESCRIPTION FOR DESIGNED SYSTEM

The basic RFID system comprises a transponder, a reader and an antenna. Data is stored in a transponder device called a tag. Current tags, depending on application, can hold up to 2 Kbits of data. Tags can be read-only or read/write.

Figure 1: Approach for Designed System

4.1 RFID Tags (transponder)

Consists of a microchip and an antenna. Attached to an object to be tracked (vary in size) Stores information about the object Read/Write or Read Only. Contact less, line of sight not required. Read Range: few inches if passive to hundreds of feet if active.

Figure 2: RFID tag
4.2 RFID Reader (interrogator)

It is used to power up the tag. It established Bidirectional data link. It can communicate with network server. Inventory tags and filter results. It can read 100 to 300 tags per tag. These readers can be fixed or mobile type.

A typical reader generally has following parts
1. Digital Signal Processor.
3. Following Radio modules
   - 915MHz
   - 13.56MHz
   - 125KHz

The PCB mounted diagram of typical RFID reader consists of two processors these are DSP and N/W processors. DSP deals with the radio frequency signals. The other circuitry is also shown in the diagram. There is a coil antenna which is quit big in size with other components. This antenna is used for radio wave transmission.

There are also four pin outs as follows:
1. VCC: This is for providing required voltage to circuit.
2. GND: For grounding purpose.
4. En: This is kept at ground level.

RFID systems operate according to one of two basic procedures: full duplex (FDX)/ half duplex (HDX) systems, & sequential systems (SEQ). Full Duplex and Half Duplex Transponder sends during energy transmission. Techniques needed to detect weak signals from tags Sequential tag sends its data when the reader is turned off Battery supply is required to send the data.


![Figure 3: Command control for RFID reader & tag](image)

There are many different versions of RFID that operate at different radio frequencies. Three primary frequency bands have been allocated for RFID:

1. Low Frequency (125/134 KHz) – Most commonly used for access control and asset tracking.
2. Mid-Frequency (13.56 MHz) – Used where medium data rate and read ranges are required.
3. Ultra High-Frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) – offer the longest read range.

![Figure 4: Concepts of RFID-based Autonomous Mobile Car](image)

For example, while the robot moves to tag 1 and receives the commands of turn left and speed up, then the MCU will make some control actions to let the robot conform the commands. While the robot moves to tag 2, the commands of go straight and slow down were received, the MCU will once again make some control actions to let the robot conform the commands. Therefore, the robot will then move in moving path 1 automatically. Of course, the robot can also move in the other paths according to the commands received from tags. Fig. 5 shows the physical hardware of the proposed RFID-based autonomous mobile robots.
5. OBJECTIVES FOR THE DESIGNED SYSTEM

5.1 LCD Module

This module is used to show the desired output of the user. This is of two types listed as below:

1. Alpha numeric used to display the characters or digits.
2. Graphical display such as LCD TV’S, MONITOR’S etc.

The LCD module we use is “Alpha numeric”. The format followed in this module is “ASCII”.

5.2 LCD Module Commands

<table>
<thead>
<tr>
<th>Hex</th>
<th>Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clear display screen</td>
</tr>
<tr>
<td>2</td>
<td>Return home</td>
</tr>
<tr>
<td>4</td>
<td>Decrement cursor (shift cursor to left)</td>
</tr>
<tr>
<td>6</td>
<td>Increment cursor (shift cursor to right)</td>
</tr>
<tr>
<td>5</td>
<td>Shift display right</td>
</tr>
<tr>
<td>7</td>
<td>Shift display left</td>
</tr>
<tr>
<td>8</td>
<td>Display off, cursor off</td>
</tr>
<tr>
<td>A</td>
<td>Display off, cursor on</td>
</tr>
<tr>
<td>C</td>
<td>Display on, cursor off</td>
</tr>
<tr>
<td>E</td>
<td>Display on, cursor blinking</td>
</tr>
<tr>
<td>F</td>
<td>Display on, cursor blinking</td>
</tr>
<tr>
<td>10</td>
<td>Shift cursor position to left</td>
</tr>
<tr>
<td>14</td>
<td>Shift cursor position to right</td>
</tr>
<tr>
<td>18</td>
<td>Shift the entire display to the left</td>
</tr>
<tr>
<td>1C</td>
<td>Shift the entire display to the right</td>
</tr>
<tr>
<td>80</td>
<td>Force cursor to beginning of first line</td>
</tr>
<tr>
<td>C0</td>
<td>Force cursor to beginning of second line</td>
</tr>
</tbody>
</table>

5.3 LED Module

The basic LED module consists of 8 led which is equal to 8bits. This is connected to the 8bit ports for observing the desired output of the codes. Generally used in interrupts programs/codes to get alerts during the execution of the program. Mostly we use 8bit or 4bit so that our circuit board complexity is reduced.

LED module consists of anode and cathode, one notch, one chip, die, or pellet and bond wire or whisker and at last it is
having a reflector cup. It is generally used for alerting in the program.

### 5.4 UART Module

It is a protocol which is used to transfer the data from PC to our programmer kit & vice-versa. There are two types of serial Transmissions of data:

1. Synchronous (having same pulse)
2. Asynchronous (change or different)

Baud rate is used to set the speed of transfer of bit between the transmitter & receiver. This is given as,

**Baud rate= No of bits per second**

There is a register for transmitting & receiving the data. Transmitting register is used to store the data which is going too transmitted whereas receiving register is used to store the data which is received.

![UART receive block diagram](image)

**Figure 8: UART receive block diagram**

### 5.5 DC motors

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion. Let’s start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a “North” polarization, while green represents a magnet or winding with a “South” polarization)

### 6. CONCLUSIONS & FUTURE WORK

A novel RFID-based robot navigation system is proposed in this paper. The proposed algorithm is very modular as it can be easily implemented virtually any type of robotic systems and working environments. This prototype can be used effectively in the real world like in the industries for transportation of goods from the working place to the gate downs. The feedback circuit used in this such as the logic used in path following robot so that if the robot makes any wrong in detecting the RFID tags this helps in directing the robot. The selection of the wheels must be apt according to the environment where the robot moves. These wheels can be replaced by the legs using the advanced technologies. Thus, the project on the navigation mobile robot is successfully implemented in the predefined environment. The future scope of this project on the navigational mobile robot using RFID can be extended using the GSM, ZIGBEE technologies. The drawback of knowing the unknown environment can be cross over using the above proposed technologies.

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### REFERENCES


