RFID Based Automatic Robot Navigation System With Distance Measurement

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Abstract — **Embedded systems are becoming an inevitable part of any product or equipment in all fields including household appliances, telecommunications, medical equipment, industrial control, consumer products etc. The field in which embedded systems place on important role is the Robotics. The evolution of robotics is from line following robot which follow the line and reach the target. An advancement is added to the above is obstacle detection. Manual operation was introduced to navigate the robot for pick & place an object. From the inspiration of above technologies, a new navigation method for indoor robot system is proposed.**

The proposed system composed of a Radio Frequency Identification (RFID) tag sensor, a LCD Module, a Buzzer and Ultrasonic sensors. RFID tags are used to track the items like cows, railroad cars and airline luggage, that were shipped over long distances. If the obstacle is in front of the vehicle it automatically changes the direction and it also estimates the distance and direction, which is important for the robot after detecting a target.

Keywords— **RFID Reader; RFID Tags; Ultrasonic Sensors; DC Motor; LCD Module; Buzzer;**

I. INTRODUCTION

Navigation services which usually depend on GNSS are limited to be used in open areas with satellite signals. If the users or robots are about to move in buildings, another approach must be used to navigate accurately[1-2]. In this approach Radio Frequency Identification (RFID) is used to determine the position of indoors. In RFID positioning there are two common approaches to estimate the position [3-4]. One method is based on the signal strength. It takes received signal strength indication (RSSI) which presents the power of received signal as the measurement. Then the position is computed with certain methods based on the measurements. Several methods have been studied, such as RFID position fingerprinting, cell-based positioning, the way using ranges to the tags calculated with RSSI.

Ultrasound sensors are very versatile in distance measurement. They are also providing the cheapest solutions. Ultrasound waves are useful for both the air and underwater [17]. Ultrasonic sensors are also quite fast for most of the common applications. In simpler system a low cost version of 8- bit microcontroller can also be used in the system to lower the cost. Ultrasound can be thought of as analogous to ultraviolet light in that it characterizes that region of acoustical phenomena which is not accessible to human perception [7]. The ultrasonic sensors can be treated as one of the major components in the robot. This is used for sensing the obstacle, measuring the distance and giving input to the controller. So that the controller can act accordingly and make other components integrated to it function accordingly [18,19]. The frequency and amplitude of sound waves can be measured by measuring the fluctuations and the pressure difference in air particles propagating sound waves through air.

RFID (radio frequency identification) technology has already proved its use in various areas such as security, library, airline, military, animal forms, sports and other areas. RFID can be used in various applications like many industries. For example, equipment tracking, access controls including personal and vehicle, logistic, baggage, items security in departmental store [10].

II. LITERATURE SURVEY

RFID is one of the type of automatic identification technology that enables the user to "tag" the objects with a small [9] device that can be later detected by automatic means. That detection range can simply noting from the presence of the device, to obtaining a fixed identification number from the device, and to initiating a two- way communication with the device. The essential functionality of radio frequency (RF) signal is emanated by a reader the tag can responds by sending back a reflected RF signal with the information in response. H Bridge is an electronic circuit where voltage can be applied in both the directions. We use IC L293D for moving front and back. L293D is firstly connected to LPC2148 and to the connect DC motor to it. The purpose of using H bridge motor driver is the motor requires more current amplifies it and generates more current and give it to the motor. This process is done by the motor driver which is a current amplifier [15,16]. Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target, and can detect certain clear or shiny targets otherwise obscured to some vision-based sensors. On the other hand, their measurements are very sensitive to temperature and

to the angle of the target. If the object is small compared to the wavelength there will be no noticeable shadow behind it at all since the sound is strongly deflected by the object [7].

III. EXISTED AND PROPOSED SYSTEMS

In existing system we discuss about the problems in previous systems to the evolution of robotics is from line following robot which follows the line and reach the target. After that an advancement of the line following robot is obstacle detection robot. The ultrasonic sensor transmitter continuously transmitting an ultrasonic signal, when the obstacle comes in the path the ultrasonic signal reflected back from the object and is received by the ultrasonic sensor. In such a way the robot uses ultrasonic sensors to detect the obstacles in between the path and then avoid them completely.

The Proposed system mainly to estimates the position of the robot by matching the unique ID of RFID tags. The global position of the robot as obtained from the RFID system is always estimated without reference to any obstacles [11,12]. This system contains a ARM7 LPC2148 automatic robot navigation system. It can monitors the parameters such as RFID Reader, RFID tags, Ultrasonic sensor, LCD Module and Buzzer. It also estimates the distance and provide the direction of vehicle, which is important for the robot after detecting the target. The distance will be shown in LCD Module and also provide the direction via RFID Tags automatically.

IV. OVERVIEW OF SYTEM DESIGNED

This section presents main features and the design requirements of the system.

The system consists of an embedded ARM7 LPC2148. This ARM7 acts as main processor. And various types of sensor modules such as HC-SR04 (Ultrasonic sensor), L293D motor driver, DC motor, EM-18 (RFID reader), Buzzer, RFID tags, LCD module is also used. The ARM hardware is built on single chip module. There are various slots to the ARM7 processor for connecting the various external devices such as RFID reader. A regulated power supply is provided to the overall system as shown in fig.1

All the sensors sense the respective data in the plant and send this data towards the controlling unit such as ARM7. Thus all the data is collected by the ARM7 and is maintained at this location.

Here, the data is stored in the RFID tags. At this stage signal conditioning is done and only required amount of data is sent forward. Thus a successful communication is achieved between a controller and reader by using this type of system. Thus information will continuously sends all the data to microcontroller.

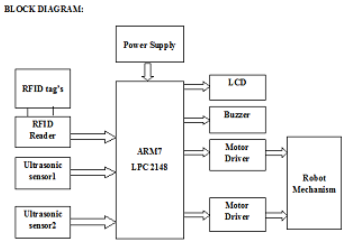


Fig1:Block diagram of implemented system

V. IMPEMENTATION OF THE SYSTEM

The design and implementation consists of two sections as

5.1. Hardware design

5.2. Software design

The hardware design consists of various sensors, ARM7 LPC2148 processor, Ultrasonic sensor, RFID reader, RFID tags, a far off LCD Module & buzzer. All these hardware‟ s are interfaced with each other. We're developed a coding in µVision4 in Keil program. Additionally we're making use of RTOS to manage the whole project and to provide a outcome in actual time.

Hardware Design:

To implement the overall system we used different hardware ”s.

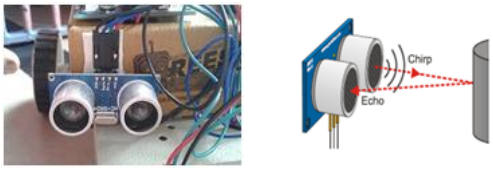
5.1.1. ARM7 LPC2148 Processor:

The LPC2148 is also known as Cortex- M3 which is ARM based Family. It is manufactured by NXP Semiconductors Company which is formerly known as Phillips. Cortex – M3 is a 32-bit Micro controller which is used an Harvard Architecture. Harvard Architecture is also known as Princeton architecture which has a Separate Memory and Bus line for both Program and Data. In Harvard architecture the data accessing will be fast and at a time we can access the both program memory and data memory.

The ARM7- based embedded system is heart of entire System. It is designed based on low power 32-bit ARM7 (LPC2148). It is RISC architecture and can use oscillators, thus it is ideal to be used as an embedded system. The LPC2148 is an 32k instructions program buffers, 512kb of RAM, three timers and 32 bit A/D converter microcontroller. It is highly performance and low cost solution for embedded applications. LPC2148 is a Low Power Consumption, it has two power modes which is used to reduce the usage of power when it is Ideal mode with an Operating Voltage of 3.3v. The crystal Operating frequency is varies from 1MHZ to 25MHZ as it consists of PLL (Phased Lock Loop). LPC2148 consists of Two ports and has a 64-pin Low Profile Quad Flack Package (LQFP).It has a lower in power Real Time Clock with individual battery supply [20].

5.1.2. HC-SR04 ultrasonic sensor:

Ultrasonic waves are similar to sound waves, where both travel through a medium. Ultrasonic waves consist of high- frequency sound waves that are inaudible to human beings. The frequency of the ultrasound waves is normally above 20kHz. However, some creatures such as bats can hear as well as generate the high- frequency ultrasound waves [5,6]. It offers an excellent non-contact range detection with high accuracy and stable readings in an easy to use package. From 2 cm to 400 cm or 1" to 13 feet.



(a) (b)

Fig 2(a ,b): Ultrasonic Sensor

They typically operate by generating a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse is presented at fig 2(b).

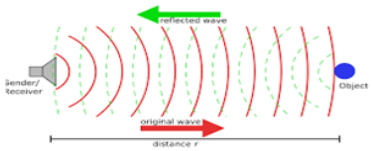


Fig 3: Illustration of ultrasonic sensor

Fig 3 represents the ultrasonic transducers transmit ultrasonic waves and then receive those ultrasonic waves reflected from an object. The time delay between transmission and reception of the ultrasonic waves is used to detect the position of the object and to estimates the distance of an object from ultrasonic sensor. When a wave is travelling through one material and effect on a boundary between it and a second medium, part of the energy travels forward as one wave through the second medium while a part is reflected back into the first medium, usually with a phase change. Ultrasonic signals that would normally be received at a certain point may be diverted by diffraction and received at some other position [8].

5.1.3. RFID :

A reader contains an RF module, which acts as both a transmitter and receiver of radio frequency signals. RFID tags were used to track large items like cows, railroad cars and airline luggage, that were shipped over long distances. RFID tags and readers have to be tuned to the same frequency in order to communicate.

Fig 4: RFID Reader Module

Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders.

Some RFID tags can be operate over a very short distance of a few centimeters or less only, while other tags may be operate at longer distances of several meters or more. At the higher- end of RF technology, the contactless RFID tags have been enhanced with the full capabilities of smart card chips containing general- purpose computer processors and larger non-volatile memory spaces.

Fig 5: RFID Tag

Fig 5 represents the tag is a device used to transmit information such as a serial number to the reader in a contact less manner. The technology requires some extent of cooperation of an RFID reader and an RFID tag. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. This is a low frequency (125Khz) RFID reader with serial output with at range of 8-12cm. It is a compact units with built in antenna and can be directly connected to the LCD.

5.1.4. LCD Module:

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. And a 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

Fig 6: LCD Module

5.1.5. DC Motor:

In this project the DC motor is used for the movement of the robot. The rear wheels were driven by a motor. Depending upon the input of ultrasonic sensor and ARM7 LPC2148, the speed of the motor varies. When the obstacle is at certain distance from the robot, it slows down at first and when it approaches the obstacle it shows down more, and after getting close to the obstacle, it stops [13,14]. The robot used here is two-axis Robot. The wheels of the robot is designed such that it can make the robot to move in forward, backward, turn left or turn right. The robot has a flat metal body mounted with 12V DC motors. The rotation of the DC motor will make the wheel to rotate.

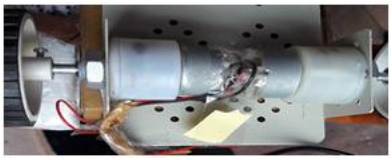


Fig 7: DC Motor

5.1.6. L293D Motor Driver:

The L293D motor driver is available for providing User with ease and user friendly interfacing for embedded application. The L293D is a Dual Full Bridge driver that can drive up to 1Amp per bridge with supply voltage up to 24V. Two H bridges of L293D can be connected in parallel to increase its current capacity to 2 Amp as shown in fig 8.

Fig 8: L293D Motor Driver

Truth Table				
High Left	High Right	Low Left	Low Right	Description
On	Off	Off	On	Motor runs clockwise
Off	On	On	Off	Motor runs anti-clockwise
On	On	Off	Off	Motor stops or decelerates
Off	Off	On	On	Motor stops or decelerates

Fig 9: H- bridge Driver

5.2. Software Tools:

A. Keil µvision 4:

The Keil's µVision IDE software toolsets provide a powerful, easy to use and easy to learn environment for developing embedded applications. The manual development tools of Keil software designed for Cortex-Mx, ARM7, ARM9, C166, XE166, XC2000, and 8051 microcontrollers. It introduces the µVision Integrated Development Environment, Simulator, and Debugger and presents a step-by-step guided tour of the numerous features and capabilities the Keil embedded development tools offer. They include the components you need to create, debug, and assemble your C/C++ source files, and incorporate simulation for microcontrollers and related peripherals. The RTX RTOS Kernel helps you to implement complex and time-critical software.

B. Flash Magic:

Flash Magic provides a clear and simple user interface to these features and more as described in the following sections. Under Windows, only one application may have access the COM Port at any one time, preventing other applications from using the COM Port. Flash Magic only obtains access to the selected COM Port when ISP operations are being performed. This means that other applications that need to use the COM Port, such as debugging tools, may be used while Flash Magic is loaded. The manual third party Compilers are listed alphabetically. No preferences are indicated or implied.

VI. RESULTS & DISCUSSIONS

The block is implemented in hardware where ARM7 LPC2148 is used as the main processor. When compared to other processors this type of processor uses low power. In this proto type Sensor modules will check the obstacle distance and direction i.e, ultrasonic sensor, RFID reader these data is given to controller for further processing. controller will check condition and give the signals to LCD module. And controller will have only one UART used to interface LCD, Buzzer. TX for ultrasonic sensor and RFID reader, RX for LCD.

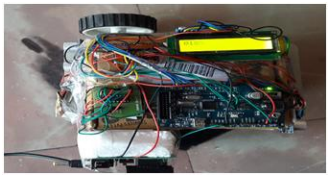


Fig10: Total system response of the proposed system

Fig 11 represents when the obstacle comes in front of the vehicle at that time the robot will moves right direction, and automatically it will moves front direction. And the distance will be shown in LCD module as shown in fig 12. Here the distance will be measured in inches.

Fig11: Obstacle comes in front of the ultrasonic sensor

Fig12: LCD Module with obstacle distance values

Fig 13 represents when the RFID tag will nearer the RFID reader at that time tag sequence number will sense the reader and will the information i.e, it will give the directions of the robot by using an interfacing of the reader and controller.

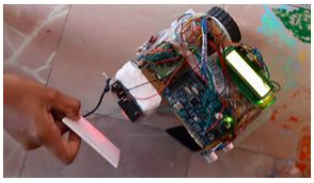


Fig 13: RFID reader will senses the RFID tag

VII. CONCLUSION

The design and development of microcontroller based on safety and security system for goods by using ARM7 LPC2148 controller, if any particulars face the problems in goodwons. Here the ultrasonic sensor will senses those objects and the signal will send back to the microcontroller. And sensor will provide the right direction to Robot, sensor will estimates the obstacle distance. Now, whenever the tags will nearer to the reader, the reader will sense the tag information, that information will store in microcontroller. After that the reader will provides the direction of the goods.

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