Robot Navigation System with RFID and Ultrasonic Sensors

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Abstract— *This Paper proposed a new navigation method for indoor mobile robots. The robot system is composed of a Radio Frequency Identification (RFID) tag sensor and Ultrasonic sensors. The RFID tags are used as landmarks for global path planning and the topological relation map which shows the connection of scattered tags through the environment is used as course instructions to a goal. The robot automatically moves along hallways using the scanned range data until a tag is found and then refers to the topological map for the next movement. Our proposed technique would be useful for real-world robotic applications such as intelligent navigation for motorized wheelchairs, surveillance and security purposes and in Nuclear power plants where humans are prone to harmful radiations.*

Keywords— RFID Cards, Ultrasonic Sensor, Motor, Driver, Micro Controller.

I. INTRODUCTION

Navigation services which usually depend on GNSS are limited to use 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. In our approach Radio Frequency Identification (RFID) is used to determine the location indoors. In RFID positioning there are two common approaches to estimate the location. One method is based on signal strength. We take 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 location fingerprinting, cell-based positioning and the way using ranges to the tags calculated with RSSI. Another particular method to estimate the location is based on the landmarks. In the landmark-based navigation, landmarks are required to be set in the building, usually on certain doors and corners. A topological map with nodes corresponding to the landmarks is used to do the navigation.[1]

II. HARDWARE REQUIRED

A basic RFID system consists of three components

a) An antenna or coil
b) A transceiver (with decoder)
c) A transponder (RF tag)

RFID uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source such as a battery and may operate at hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object.[2]

Chip less RFID tags are RFID tags that do not require a microchip in the transponder. The robot system is composed of a Radio Frequency Identification (RFID) tag sensor, The RFID tags are used as landmarks for global path planning and the topological relation map which shows the connection of scattered tags through the environment is used as course instructions to a goal. The robot automatically moves along hallways using the scanned range data until a tag is found and then refers to the topological map for the next movement. Our proposed technique would be useful for real-world robotic applications.[3]

FIG.1. RFID CARDS

III. HARDWARE IMPLEMENTATION

A microcontroller is a small computer (SoC) on a single integrated circuit containing a processor core, memory, and programmable input/output peripheral. Some microcontrollers may use four-bit words Other microcontrollers may serve performance critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

Motor driver is one of the important components to drive the motor. Here we are going to use L293D motor driver. The L293D motor driver is available for providing User with ease and user friendly interfacing for embedded application. L293D motor driver is mounted on a good quality, single sided non-PTH PCB. The pins of L293D motor driver IC are connected to connectors for easy access to the driver IC's pin functions. The L293D is a Dual Full Bridge driver that can drive up to 1Amp per bridge with supply voltage up to 24V.

There are two Enable pins on L293D. Pin 1 (left H-bridge) and pin 9 (right H-bridge). To drive the corresponding motor, pin 1 or 9 need to be set to HIGH. If either pin 1 or pin 9 goes low then the motor in the corresponding section will suspend working.

The four Input pins for the L293D are pin 2 and 7 on the left and pin 15 and 10 on the right. Left input pins will regulate the rotation of motor connected on the left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided at the input pins as LOGIC 1 or LOGIC 0[4]

FIG.2.ULTRASONIC SENSOR

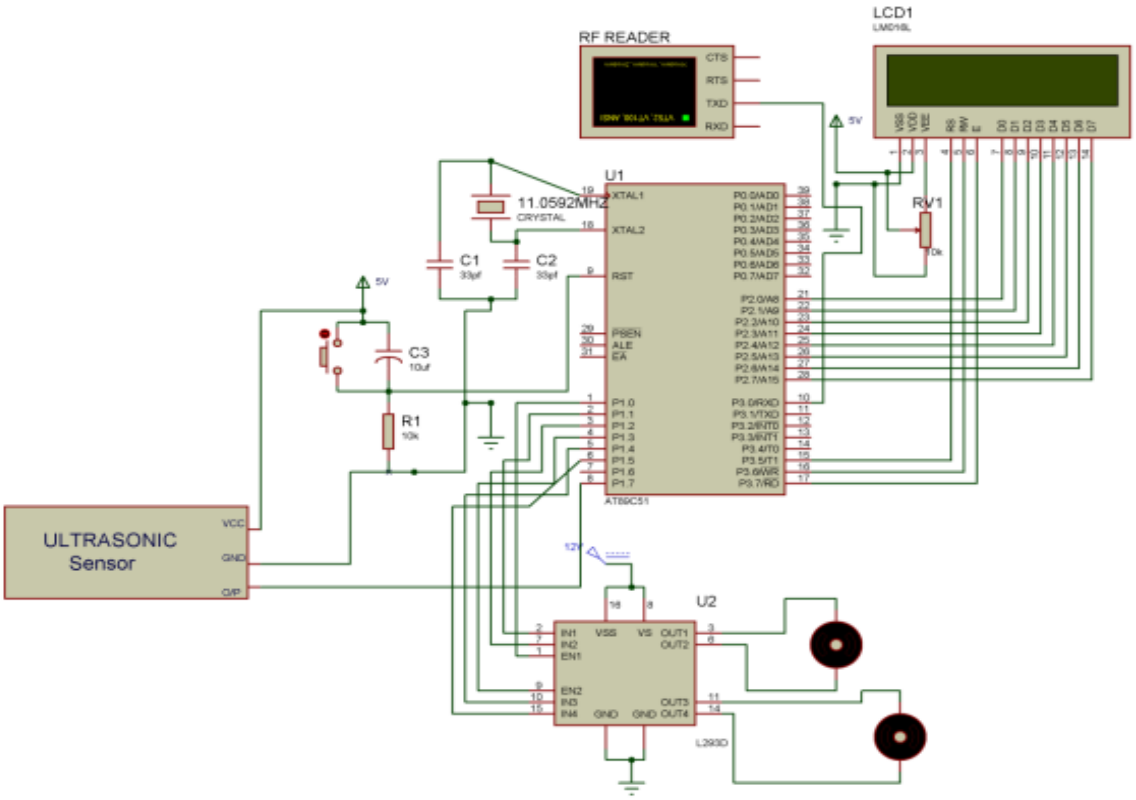

FIG.3 HARDWARE IMPLEMENTATION SCHEMATIC DIAGRAM

Ultrasonic sensors are devices that use electrical–mechanical energy transformation, the mechanical energy being in the form of ultrasonic waves, to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a succession of compressions and rarefactions along the direction of wave propagation through the medium. Any sound wave above the human auditory range of 20,000 Hz is called ultrasound.

When ultrasonic waves are incident on an object, diffused reflection of the energy takes place over a wide solid angle which might be as high as 180 degrees. Thus some fraction of the incident energy is reflected back to the transducer in the form of echoes and is detected. The distance to the object (L) can then be calculated through the speed of ultrasonic waves (v) in the medium by the relation where‘t’ is the time taken by the wave to reach back to the sensor. If the object is in motion, instruments based on Doppler shift are used.[5]

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage. According to the layout features of a building, the whole space is divided into a number of rooms and hallways The doors and intersection of hallways are important places for a robot, at which the robot must do the choice to go straight, turn left, turn right or stop if it is the destination.

To mark the special places it uses RFID tags pasted in the centre of the route at the mentioned place. When it detected the tag and get its unique ID, computer inside the robot will figure out where the robot is. With the topological map the robot is going to find out the next node to go on the route. Since the robot may access every place in every direction, “turn left or right” orders do not seem to work well enough. Therefore, it uses directions as North (N), South (S), East (E), West (W) for robot movement control. We should first assign directions when making a map. With the topological map and the directions, the total route of robot is easy to set up.

IV. PROPOSED SYSTEM

The robot is consisting of the mechanical part, a computer, a RFID reader and an antenna, and ultrasonic sensors. The mechanical part is a platform with wheels and motors which is controlled by the microcontroller. The RFID interrogator is connected to the computer via RS-232 serial port. The ultrasonic sensors are attached to the sides of the robot and used to measure the distance to walls. Since the area where tags can be detected at intersections is quite large, the robot has to use ultrasonic sensors to determine when to turn without collision to the wall. And the sensors will keep robot out of collision when the hallway is not straight.[5]The computer is in charge of processing the data from the RFID interrogator and ultrasonic sensors via serial ports and sending orders to the microcontroller to impact on the movement of the robot.[6]

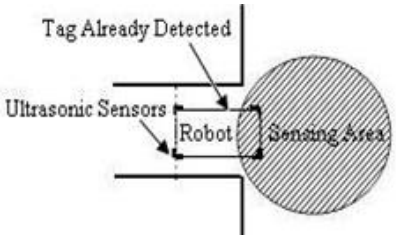

FIG.4. ROBOT CANNOT TURN

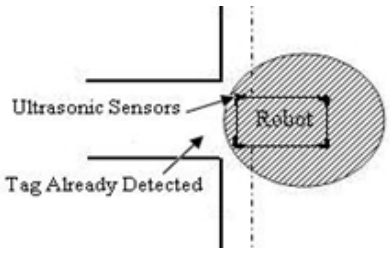

FIG.5. ROBOT CAN TURN WITHOUT COLLISION

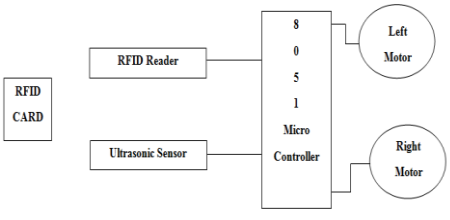

FIG.6. BLOCK DIAGRAM OF ROBOT NAVIGATION

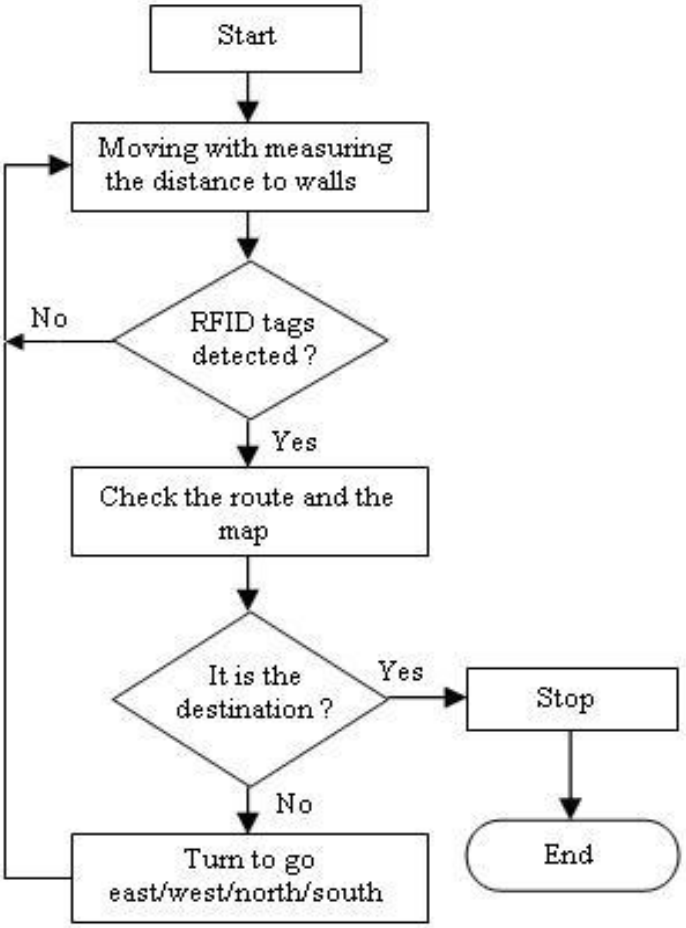

FIG.7. FLOW CHART SHOWING FUNCTIONING OF KIT

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.[7] 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. Here, in this implementation it is showed 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 [8,9].

V. RESULTS

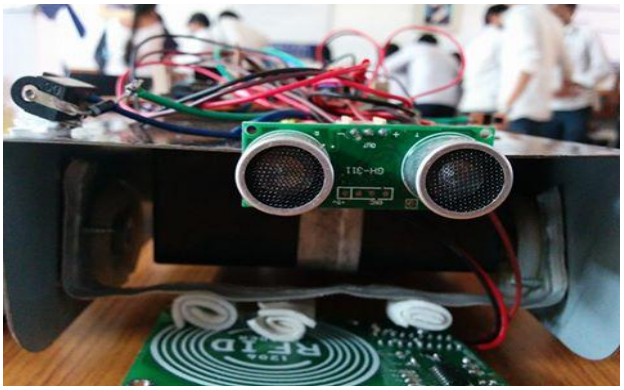

FIG.8.FRONT VIEW OF ULTRASONIC SENSORS

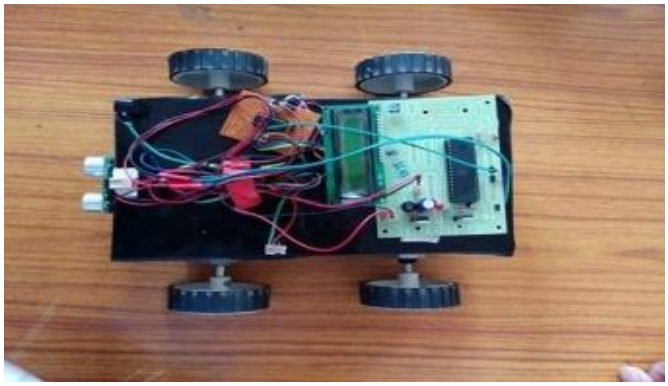

FIG.9. TOP VIEW OF OVERALL KIT

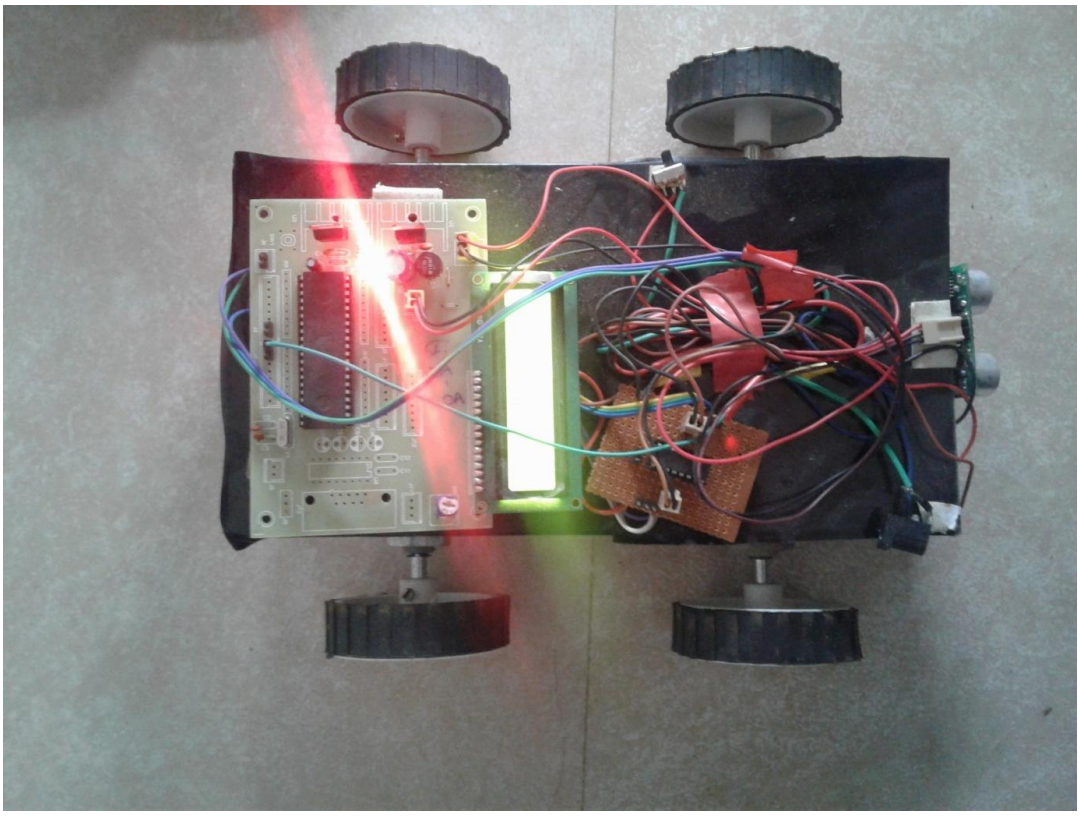

FIG.10. RUNNING SNAPSHOT

VI. CONCLUSION

A novel RFID based robot navigation system is proposed in this paper. This system makes the robot able to navigate around the building and records in indoor environment. The core part of the system is the RFID system and the ultrasonic sensors, which enable the robot to locate itself and move without mistakes. This also uses a topological map of the building plan, which makes the robot to move in proper route quickly. This paper brings a new product to the world of industry to increase speed and efficiency. This approach is a practical and feasible way to create a smart security robot with navigation function. For future extension of this paper the robot may use different materials to its designing process, based on different functional operations of it. More number of IR sensors can be used to avoid obstacles from different sides. And also the robot may increase RFID ranges.

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