Hardware Implementation of Autonomous Obstacle Avoidance Robot

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***Abstract*— A robot is intelligent and it is a manmade device that can move by itself, whose motion can be modeled, planned, sensed and controlled. Obstacle avoidance robot is designed to allow the robot to navigate in unknown environment by avoiding collisions. It senses the obstacles in its path, avoids it and resumes its running. The proposed method uses a microcontroller of Arduino family. An ultrasonic sensor is used to detect any obstacles in its path and sends a command to the microcontroller. Depending on the input signal received, it redirects the robot to move in an alternate direction by actuating the motors which are interfaced with the motor driver. Arduino IDE (Integrated Development Environment) software is used to upload the program into the hardware.**

***Keywords*—Robot; Arduino; ultrasonic sensor; motor driver; Arduino IDE.**

I. INTRODUCTION

Today, commercial and industrial robots are in widespread use, performing jobs more cheaply or with greater accuracy and reliability than humans. They are also assigned for jobs that are too dirty, dangerous or boring to be suitable for humans. Robots are machines that will do what human beings would normally be expected to do. These machines imitate the operation of the human being or at least certain parts of it.

All mobile robots feature some kind of collision avoidance, ranging from primitive algorithms that detect an obstacle and stop the robot in order to avoid a collision. There are some very famous algorithms like wall-following, edge detection, line following and S-shape. These algorithms waste time to cover the entire room for avoiding obstacle [1].

In this paper, random walk algorithm is proposed which ensures that the robot does not have to stop in front of obstacles during its navigation [2]. Here section II describes the block diagram and its explanation; section III describes design algorithm and flow diagram. Section IV shows the implementation and section V concludes with the future work.

II. SYSTEM OVERVIEW

A. Block diagram:

The overall block diagram consists of controller board arduino UNO, ultrasonic sensors, DC motor, motor driver module, battery and voltage regulator as shown in Figure 1.

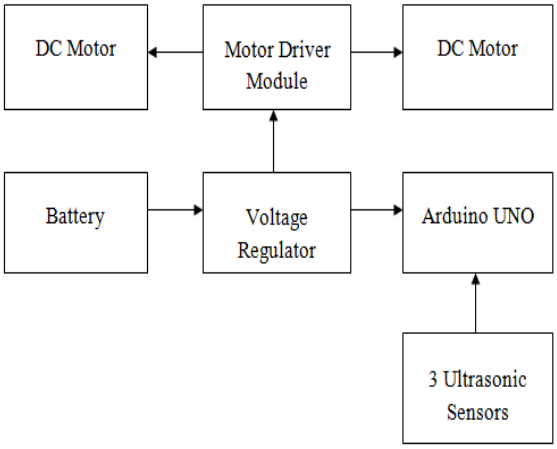

Figure 1.Overall block diagram

The autonomous robot is operated by means of 12V battery. There are three Ultrasonic sensors fitted to the chassis on front and both sides. Here the Ultrasonic sensors are used to find the distance between the obstacle and the robot. These ultrasonic sensors are used to avoid obstacles i.e) both static and dynamic which are present in the robot's moving path. The output from the ultrasonic sensors is given to the controller board Arduino UNO. The voltage regulator is used to convert 12V from the battery to 5V to power up Arduino UNO and Ultrasonic sensors. The controller board automatically generates control signals based on the sensors output. These control signals are given to the motor driver module for the wheel rotation. The motor driver module requires 12V which is received from the input terminal of voltage regulator.

B. Description:

1. ARDUINO UNO

Arduino UNO is the brain of the project. It is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It also has a memory size of 2 KB SRAM and 1 KB of EEPROM. The board can operate on an external supply from 6 to 20 volts The Uno board is the first in a series of USB Arduino boards.

2. ULTRASONIC SENSOR

Ultrasonic sensor is a device used to measure the distance of an object by using sound waves. The ranging module of HC - SR04 provides 2cm - 400cm non-contact measurement function. It can measure the distance by sending the sound waves at a specific frequency and listen the sound waves to bounce back. By recording the passing time between the sound wave generated and sound wave bounce back, it is able to calculate the distance between the sensor and the object. The sound waves can be able to travel 2 times the distance to the object before it was detected by the sensor. This is referred as round trip. The working of ultrasonic sensor is shown in Figure 2.

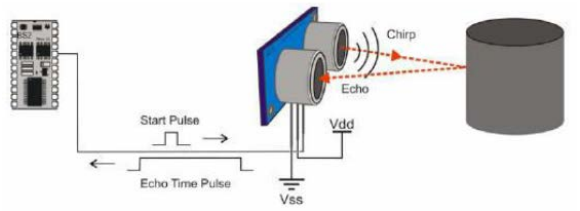

Figure 2.Working of ultrasonic sensor

The speed of the sound in air is 340m/s. The distance of the object is calculated as follows

Distance = (speed of the sound× time taken) /2

3. MOTOR DRIVER (L293D)

L293D is a dual H-bridge motor driver Integrated circuit (IC). Motor drivers act as current amplifiers because they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. It consists of input and enable pin. Input logic values 00 or 11 will stop the corresponding motor. Logic values 01 and 10 will rotate it in clockwise and anticlockwise directions respectively. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, driver is disabled and outputs are off and present in the high-impedance state.

4. VOLTAGE REGULATOR

The 7805 voltage regulator IC is used to maintain the output voltage at a constant value. It consists of three pins namely input, ground and output. This 7805 is a 78xx series of fixed linear voltage regulator IC used to maintain the fluctuation. The input voltage range from 7 V to 35 V and current rating is 1 A. Here 12V battery is used as an input and regulate the output to 5V which is the required voltage for arduino and ultrasonic sensor.

III. ALGORITHM

Random walk algorithm

The random walk algorithm avoids obstacles in random movement. It is used because it doesn't waste time in reaching the target like S shaped and wall follow algorithm which is used to cover the entire room for avoiding obstacle. The random walk algorithm consists of the following steps for the movement of mobile robot.

- Step 1: Start
- Step 2: Move forward until obstacle is detected.
- Step 3: If obstacle is detected, move backward.
- Step 4: Check for distance1>distance 2 using sensors.
- Step 5: If Step 4 satisfies, turn left and move forward.
- Step 6: If Step 4 doesn't satisfy, turn right and move forward.

The flow chart shown in Figure 3 explains the random walk algorithm for random movement to avoid obstacle using sensors.

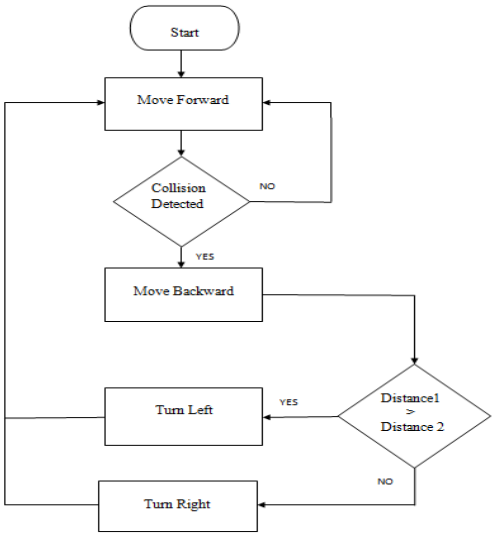

Figure 3.Random walk flow

IV. IMPLEMENTATION

The implementation of obstacle avoidance strategy for robot involves writing and compilation of program using Arduino software. It consists of a simple hardware platform on which microcontroller is placed and it is compiled using arduino IDE.

The obstacle avoidance was performed by interfacing arduino and ultrasonic sensors. The ultrasonic sensor was placed on either side of the chassis and on the front to measure the distance between the robot and obstacle. Based on the ultrasonic sensor value, the robot can make a decision to turn either right or left side.

The driver module L293D can be able to drive the motor based on the conditions mentioned in chapter 4. The driver module was interfaced with 12V rechargeable battery. Whenever the echo pin of ultrasonic sensor is high, the distance between the obstacle and robot can be calculated. Based on the distance value (30cm), the robot will avoid the obstacle. The code was implemented using arduino IDE software. At this stage, the robot was able to avoid static obstacle and take the random path using random walk algorithm.

The experimental working model of obstacle avoidance robot is shown in Figure 4.

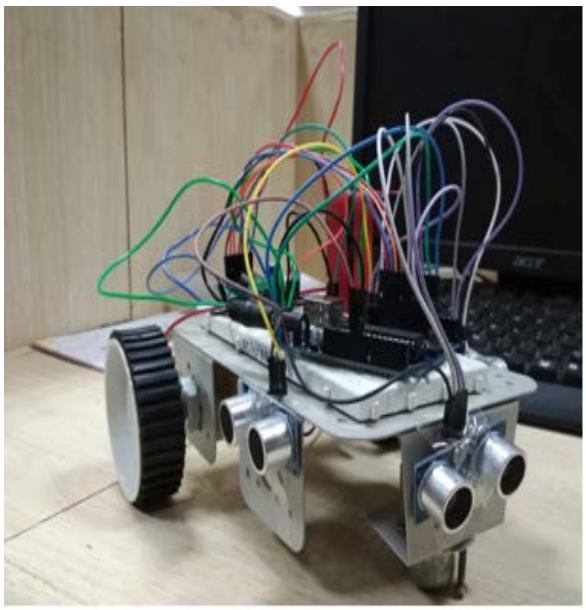

Figure 4.Front view of robot

The output of obstacle avoidance which shows the movement of robot in forward, backward, left and right direction in Arduino IDE is shown in Figure 5.

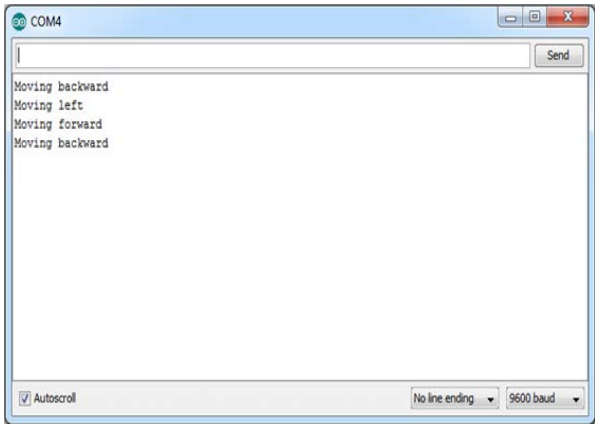

Figure 5.Output of obstacle avoidance

V. CONCLUSION AND FUTURE WORK

The robotic vehicle which moves in different directions like forward, backward, left, and right when input is given was tested using arduino. Future work includes complex environment and develop path planning algorithm to reach the target by avoiding static and dynamic obstacles in a shortest path.

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