Implementation & Evolution of Obstacle Avoidance Vehicle Robot

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Abstract. Robots are widely used in manufacturing industries around the world for repetitive jobs that are boring, stressful, dangerous or labor-intensive for humans. However, due to high cost of robots, most of the industries in our country are reluctant to introduce this technology for their production chains. In this project, a low cost prototype industrial robot is introduced that travels between the pre-determined source and the destination in an industrial area with many obstacles. A vision-based novel obstacle avoidance algorithm is developed for mobile robot navigation. The state-of-the-art ultrasonic sensor is applied to detect obstacles during its travels. The proto-type robot is light weight and consumes only 4.5 watt. Moreover, the total implementation cost is only $25-30. With these evaluations, the proto-type discussed forecast a promising future of the application of robotics in our industrial environments.

Keywords: Obstacle avoiding robot, destination finding robot, microcontroller, ultrasonic sensor

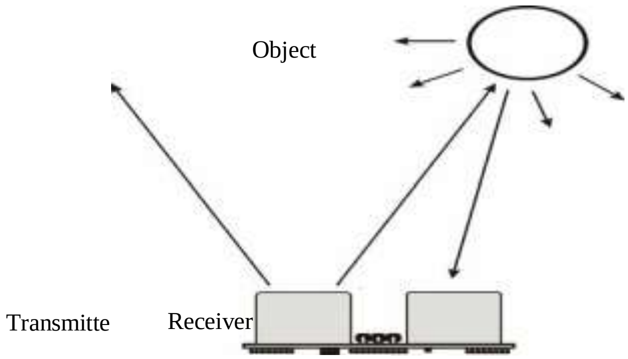
1 INTRODUCTION

The robot is a reprogrammable, functional, manipulator design to move material, parts, tools or specialized device through various programmed motions for the performance of various tasks. An industrial robot is an automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes. Robotics is a continuously emerging field. Various robots are built to perform basic function such as, line following, obstacle avoidance and then programmed to perform tasks such as collecting several elements or moving over stated pathways. The issue of obstacle avoidance in robotics demands a reliable solution since mobile platforms often have to maneuver in arbitrary environment with high level of risk .The most significant advantages of the presented work is the use of only one sensor, which significantly diminishes the computational cost.

2 DESCRIPTION OF THE CIRCUIT

2.1 Working principle

The working principle of the robot is demonstrated over two different techniques. The first technique involves avoiding obstacles and another is technique for destination selection. For avoiding obstacles the robot must have a sensor to sense it firstly. The sensor can be infrared, ultrasonic or other sensing device types. The prototype robot contains ultrasonic sensor for sensing obstacle. Whenever the sensor senses any obstacle within its limit, the sensor provides a feedback to the robot. Then the robot takes necessary action to overcome the obstacle. Figure 1 shows the concept of obstacle avoidance.



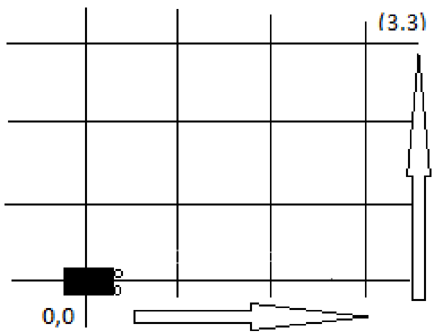


Fig. 1 Ultrasonic transmitter and receiver

Fig. 2 Destination analysis

For finding the destination, the robot follows coordinate analysis technique. The robot follows shortest possible path to reach its destination but if any obstacle is in the way, the robot moves in another coordinate. Figure 2 demonstrates the destination analysis operation. The main component of this project work includes: microcontroller (AT mega 8), ultrasonic sensor (#28015), motor driving IC (L293D) and dc motor.

2.2 Circuit Arrangement

When the robot is switched on, it scans its surroundings by the Ultrasonic sensor. Then the distance of the nearest obstacle in each direction will be measured and the data is fed to the main controller (AT mega 8). The main controller implements the Potential Field Algorithm and decides the direction to which the robots should move. According to that, the main controller sends the control signal sequence to each dc motor to turn the robot to the specified direction using differential steering. The direction of the robot is actually determined by an IC (L293D) which gives the valued voltage level to motor to turn left or right. Power source, capacitor, resistor, IC, processor completes the circuit arrangement as shown in figure 3.

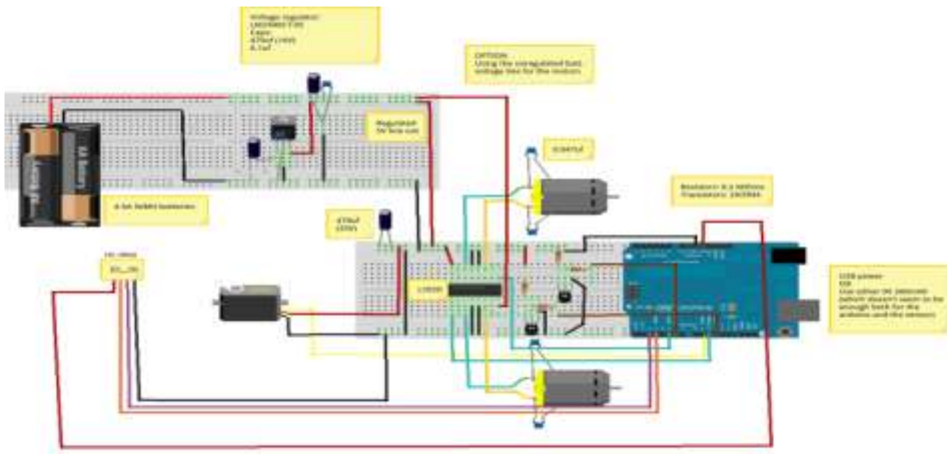


Fig. 3 Circuit Arrangement

3 CIRCUIT SIMULATIONS

The project simulation is done in PROTUES software. When the ultrasonic gets any feedback, sensing PIN of microcontroller becomes high. As a result, the robot moves in specific direction. The robot turns right direction when left motor is rotate in clock wise and right motor is remaining still and vice-versa to turns left. The figure 4 shows the circuit simulation.

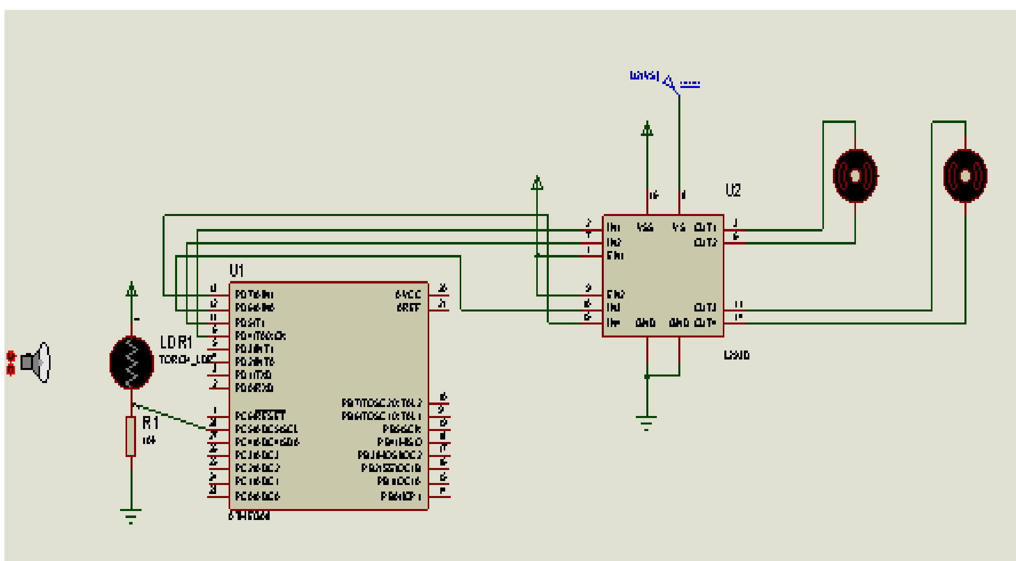
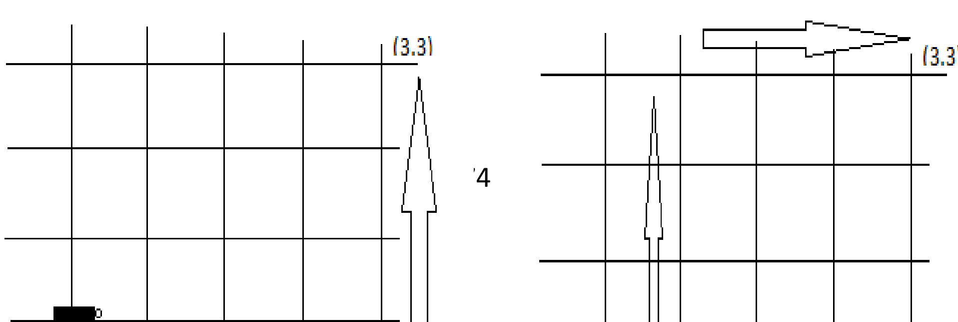
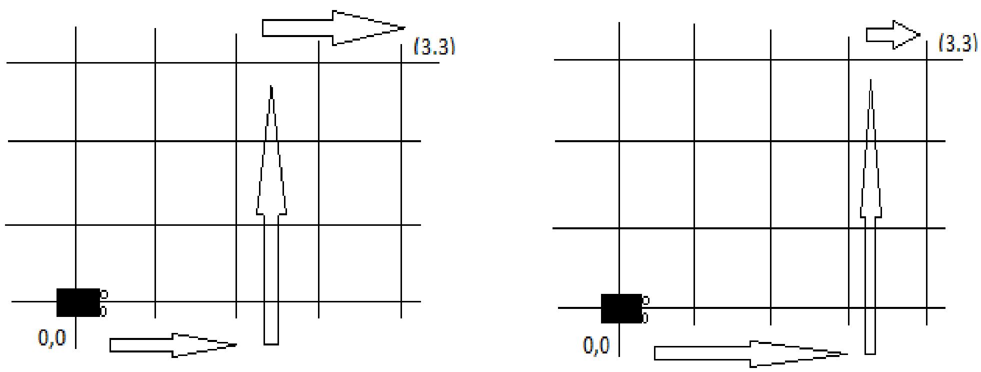


Fig. 4 Circuit simulation

Finding the destination, the robot does some simulations in coordinate analysis. Firstly, the robot verifies the x-axis whether there is any obstacle or not. If there is no obstacle, the robot follows x-axis direction and if any obstacle is found, it changes its path in y-axis direction. By using this algorithm the robot reaches its destination. For finding the destination different algorithms are developed, some of these processes are in figure 5a-d.





(c) (d)

Fig. 5(a-d) Destination finding

4 PRACTICAL HARDWARE

The project contains ultrasonic sensor, microcontroller, motor driving IC, voltage regulator and few other electrical components. The brief characteristic of these component are described in the preceding sections.

4.1 Ultrasonic sensor

The sensor detects objects by emitting a short ultrasonic burst and then "listening" for the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air at about 1130 feet per second, hits an object and then bounces back to the sensor. The sensor provides an output pulse to the host that will terminate when the echo is detected; hence the width of this pulse corresponds to the distance to the target. Here, in figure 6, Host is Transmitted signal and Ping is Received signal.

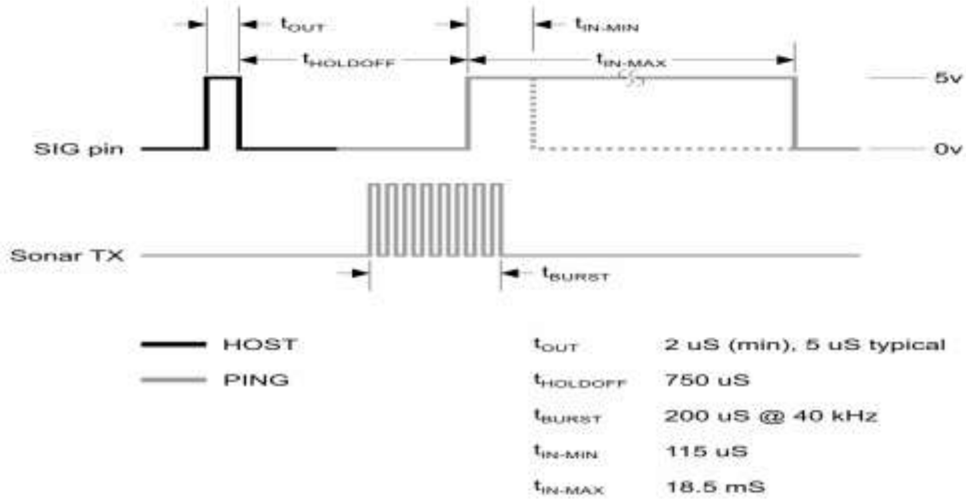


Fig. 6 Operation of ultrasonic sensor

4.2 Microcontroller

This is the main controller of the mobile robot. When the robot is turned on, the main controller is ready to receive an obstacle scanned by the ultrasonic sensor. Once the data is received, it will be placed into the conventional potential field algorithm as described earlier. This algorithm will decide the direction to which the mobile robot should turn. Then the appropriate signal will be sent to the dc motor to get the desired direction. A microcontroller is an amazingly useful device. At mega is a very specialized CPU, a microcontroller is small, consumes very little power, and can be programmed to quickly and reliably perform a wide variety of tasks.

Microcontrollers can be found commonly in appliances such as microwave oven, remote controls, and vending machine. Programming a microcontroller, however, can often be complicated and tedious. A developer has no way to look inside of the chip to see what is going on while his code is running, making debugging very difficult without the aid of expensive equipment (in the range of thousands of dollars). Furthermore, microcontrollers must traditionally be programmed, or “burned,” with the code they are to run. This requires a special piece of equipment to do and requires that the chip be taken out of the circuit it is being used in, placed into the programmer, have data “burned” to it (which can take several minutes), then be replaced back in the circuit. This process is time consuming and risky, as the pins on a microcontroller are easily bent out of their proper position. A special piece of code, called a boot loader, can alleviate the problem of having to use an external programmer to program and test code. One basic application of PIC microcontrollers is their use to control motion based on input from a sensor. This is applicable to many different fields, from manufacturing to aeronautics to robotics.

4.3 Motor driving IC

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

H-Bridge

H-Bridge is an electronic circuit which enables a voltage to be applied on either side of the load and the H-bridge DC motors allow the car to run backwards or forwards. H-Bridge is a configuration of 4 switches, which switch in a specific manner to control the direction of the current through the motor. Figure 7 shows the simplified H-bridge as switches. The states of these four switches can be changed in order to change the voltage across the motor, of the current flow and the rotation of motor.

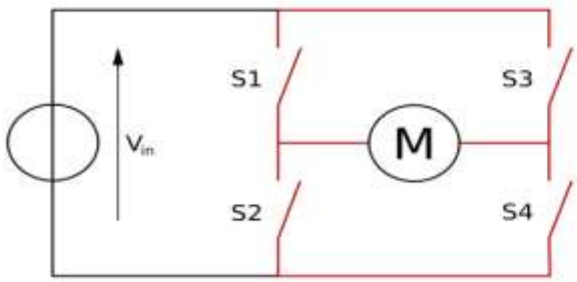


Fig.7 Basic Structure of a H-Bridge

In Figure 7, all switches are open and the motor terminals are disconnected from the circuit. This state allows the motor to spin freely. If we open switches S1 & S4 and close S2 & S3 as in first part of Figure 4.10 there will be current flow across the circuit and motor will run. But if S1, S4 are close and S2, S3 are open, the voltage across the motor will switch around and that will cause the motor to rotate in the opposite direction. Table 1 summarizes the basic operation of the H-bridge depending upon the voltage applied across the switches.

Table 1. H-Bridge Operation Summary

S1	S2	S3	S4	RESULT
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor free runs
0	1	0	1	Motor breaks
1	0	1	0	Motor breaks

4.4 Implemented circuit arrangement

The group of functions and programs prepared as part of this project were particularly effective for implementing control algorithms from within real time. The development of the light seeking/obstacle avoidance algorithms served to verify this claim and to help define the functional requirements as it was being constructed.

The code is stimulated in the microcontroller but it was tested a few times before stimulation and while using the burner circuit care should be taken to fix the fuse bit. Win AVR was used to de bug the robot and AVR Studio was used to write the code for the project. This robot is made from the most basic things available in the market. It can have multiple uses. In industries like garments, shipping, chemical refineries etc. the robot can be used widely. It can research facilities and the cost will be much less. Heavy industries, docks can use the robot to carry loads from one place to another. Finally, the implemented hardware is displayed in figure 8.

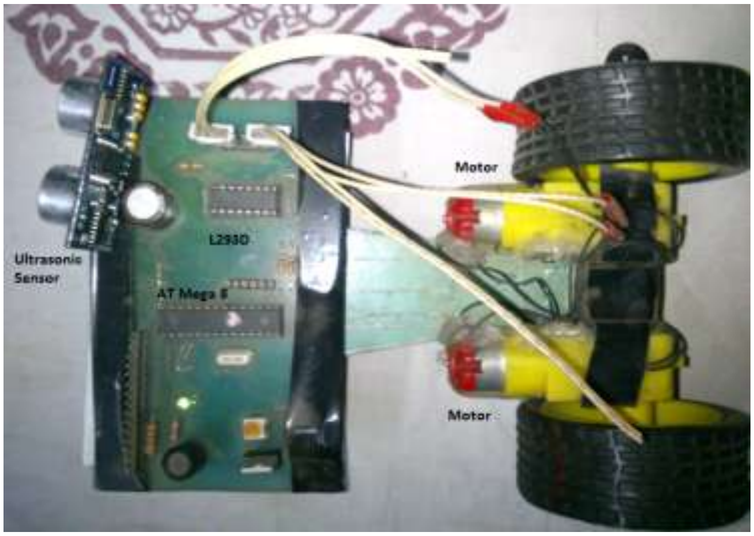


Fig. 8 Implemented circuit arrangement

5 LIMITATIONS

Some limitations of the developed robot have been listed below:

1. Destination is fixed.
2. The castle ball is not very high-quality wheel (because it is dependent wheel)
3. Only one sensor (to minimize the cost)
4. Angle rotation is not highly accurate.

5.1 Suggestions for future work

Controlled by AVR microcontroller, the obstacle avoidance robot was made of steel but can also be replaced by wood or any other metallic objects. The lighter the robot the faster it can move and avoid obstacle effectively.

Another area of improvement can be the ultrasound sensor. High frequency sensor can be used to make the operation more proficient and much more functional. The coupling motor can of much higher model to increase it speed and functionality. Light pair of tires should be used to make the movement faster and easier. The coding can be replaced by a much fruitful coding system for sending correct commands swift and easy.

6 CONCLUSIONS

The final goal of this project work was to evaluate the utility in the design and implementation of the light seeking and approaching control algorithm. The projects main priority was to make an obstacle avoiding robot which is both perfect in its operation and cost efficient to construct. Both the priorities have been fulfilled to its fullest in the project. Ultrasonic sensor was preferred over infrared sensor as it has high range and great performance. The installation of this sensor made it an 'almost perfect' obstacle avoiding robot. The robot is slightly slow in finding its destination. To improve its target finding capability, further work is under process.

Reference

Moore K., Torrie M. (Aug 1999). John Deere Final Report: *Obstacle Detection and Avoidance for an Automated Tractor*. Tech. Rep. Center for Self-Organizing and Intelligent Systems, Utah State University.

Serment L. N., Paredis C., and Khosla P. (1999). A beacon system for the localization of distributed robotic teams. Proceedings of the International Conference on Field and Service Robotics, (pp. 232-237)
.

Bailey T., Nebot E., Rosenblatt J., and Durrant-Whyte H.(1999). Robust distinctive place recognition for topological maps. Proceedings of the International Conference on Field and Service Robotics (pp. 347-352).

Bischoff R.(1999). Advances in the development of the humanoid service robot-HERMES. Proceedings of the International Conference on Field and Service Robotics (pp. 156-161).

Dheeman Paul received B.Sc. Engg. (EEE) degree from American International University-Bangladesh (AIUB) Dhaka, Bangladesh in January 2013. His research interest includes Robotics; Microcontroller based robotics, and embedded systems.

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