Solar Powered Obstacle Avoiding Robot

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Abstract – This paper presents a real time motion planning and obstacle avoidance for an autonomous mobile robot. With the help of robots our daily life has become much easier. The mobile robot powered by solar power uses ultrasonic sensors to avoid collision with the upcoming obstacles and changes its direction to a safer side. The vehicle is controlled based on the information from these sensors. This technique is very simple but efficient. Several simulation and experiments demonstrate good performance even though using low-resolution sensors.

Index Terms – Mobile Robot, Obstacle Avoidance, Ultrasonic sensors, Solar Power.

1. INTRODUCTION

With the rapid development and popularization of computer and robotics, more and more people like to be dependent on machinery, and a large number of enterprises are replacing man power with Robots. More and more ideas are required to easy the daily life and developers are needed under this situation to make what the society desires. We have done this by taking an example of making a robot for SRM University, Ramapuram, Chennai. It will be made such that it avoids obstacles in its path rather than colliding with them. This will be done using hardware ball caster wheel, ultrasonic range sensor, motor driver IC, bread board, chassis, jumper wires, servo motor, arduino and software embedded C and Bluetooth RC controller. The robot can also be modified and made to be controlled with an android phone using Bluetooth connection.

2. EXISTING SYSTEM

The obstacle avoiding robots are introduced by using IR sensor with limited speed and powered with only motor batteries.

3. DRAWBACKS OF EXISTING SYSTEM

1) Infrared sensors can't work in dark environments while Ultrasonic Sensors can.

2) Brighter surfaces are easier to detect for Infrared than dark surfaces, as the sensor doesn't detect darker surfaces. Infrared sensor values normally fluctuate in variant light conditions.

3) There are a lot of limitations in infrared sensors, like the inability to use them in sunlight due to interference. It can make outdoor applications or dark indoor applications very difficult.

4) Use of renewable energy like solar power is not promoted when using motor batteries to power the robot.

4. LITERATURE SURVEY

Literature survey is the survey of existing work done by different groups or teams which can be taken as a base for the proposed model or system.

[1] The robot is equipped with low-resolution optical sensors and electronic compass and is driven by stepper motor. Thus, there are three guidance modes: target tracking using optical sensors, directional guidance using compass, and dead reckoning. There are another optical sensors equipped on board to detect obstacles. The vehicle is controlled based on the information from these sensors. In the proposed technique, the control algorithm is switched to wall following mode when facing an obstacle. This technique is very simple but efficient. Several simulation and experiments demonstrate good performance even though using low-resolution sensors.

[2] A navigation technique for a sonar- equipped mobile robot with real-time local map-building in unknown environments. A navigation algorithm is constructed with the proposed local map-building and reactive obstacle avoidance behaviours. The obtained local map could be used to build and/or update a global map of the environment. It is used to plan a desirable path for the next run. In navigation experiments using a commercial mobile robot named Pioneer-I, the built local map was effective for navigation in several environments compared to a reactive navigation technique without map-building, especially in complicated environments.

[3] Autonomous airborne systems have generated a lot of interest in civilian and military applications. The operation of such systems involves routing and navigation toward targets and obstacle avoidance. In this paper, these problems were tackled and solutions were applied to land-based robots as well as a quad-rotor aerial system. The quad-rotor flight path navigation and routing was programmed based on GPS and on-board measurement data.

Obstacle avoidance was implemented based on an algorithm that relies on the idea of Virtual Potential field. Kalman filters were implemented to improve the accuracy of the measured data. While 3D visualization was used to visually identify obstacles. In the case of in-building reconnaissance, where GPS signals are very weak and largely useless, we rely on laser sensors and data aggregation from proximity feeds to identify obstacles and the shape of the surrounding environment.

[4] Robot can be made capable of operating in the real world environment without any form of external control for an extended period of time. A robot with cognitive capabilities include perception processing, attention allocation, anticipation, planning, complex motor coordination, reasoning about other agents and perhaps even about their own mental states.

Robotic cognition embodies the behaviour of intelligent system in the physical world. Ultimately the robot must be able to act in the real world. In our project, a robot was built to sense any obstacle in its path avoids it and resumes its running involving the pre-computation of an obstacle free path. The robot utilizes ultrasonic sensor to identify its target by taking advantage of the robot's hard wire morphology.

[5] Utilizing advanced sensors such laser, sonar, and camera integrated with intelligent software system will make the mobile robot more intelligent and increase the degree of freedom to perform very sophisticated robotics tasks. In this paper, using the Mat lab platform to build a mobile robot in a virtual reality equipped with laser sensor as the only source of perception to navigate in a dynamic environment was developed.

The Mobile robot software system integrated with a prediction algorithm based on potential field algorithms were used to improve the robot's navigation. The developed software system was tested, and the result was compared with and without the prediction software system. The final results showed improvement of the navigation compared to the different sensors such a sonar sensor.

[6] Ultrasonic sensors are adopted to implement a real-time obstacle avoidance system for wheeled robots, so that the robot can continually detect surroundings, avoid obstacles, and move toward the target area. Secondly, six ultrasound sensors installed on the wheeled robot were utilized to detect large obstacles and to obtain distance information between the robot and the obstacle.

The PD controller was used in the wall-following method to achieve the optimized path design. Experimental results verified that ultrasonic sensors of the obstacle avoidance system on the wheeled robot, with ATMega162 embedded microcontroller as the core of the system, can indeed help avoid obstacles and reach the established target area.

[7] Mobile robots have the capability to navigate in the environment. We need some approaches for their collision-free and stable navigation. Authors have given their own algorithm and have implemented in C- language to move a robot from initial to final position. They have also shown the comparison in path length required by robot with the model proposed by Sir Parhi et al. in 2009.

5. SYSTEM ARCHITECTURE

5.1 Component Description

5.1.1 Arduino Uno

Arduino Uno is an AT mega 328p Microcontroller based prototyping board. It is an open source electronic prototyping platform that can be used with various sensors and actuators.

Arduino Uno has 14 digital I/O pins out of which 6 pins are used in this project.

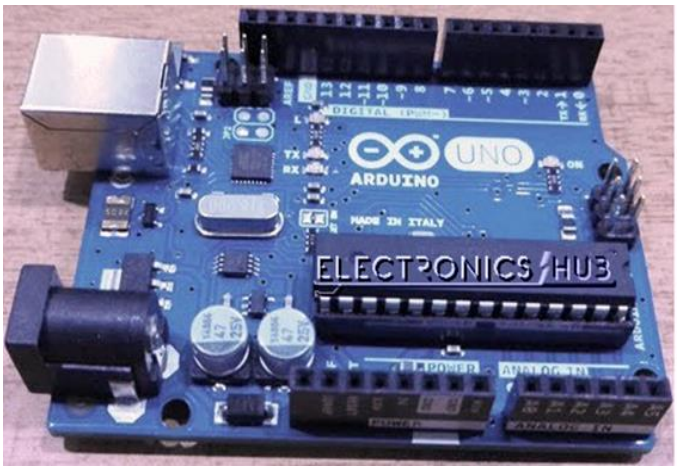

Figure 5.1 Arduino Due

5.1.2 HC – SR04

It is an Ultrasonic Range Finder Sensor. It is a non-contact based distance measurement system and can measure distance of 2cm to 4m

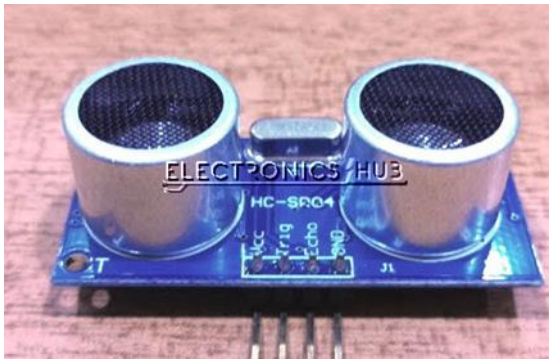

Figure 5.2 Ultrasonic sensors

5.1.3 L293D

It is a motor driver which can provide bi-directional drive current for two motors.

5.1.4 Servo Motor

The Tower Pro SG90 is a simple Servo Motor which can rotate 90 degrees in each direction (approximately 180 degrees in total).

5.2 Design of Obstacle Avoiding Robot using Arduino

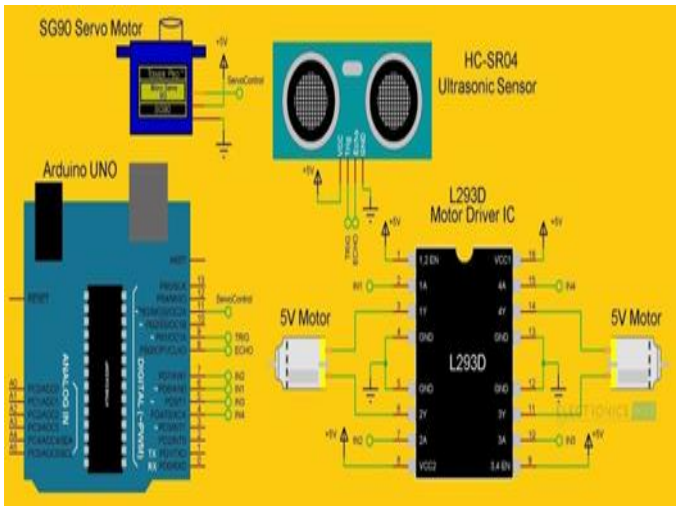

Figure 5.3 Circuit of the model

Arduino is the main processing unit of the robot. Out of the 14 available digital I/O pins, 7 pins are used in this project design.

The ultrasonic sensor has 4 pins: Vcc, Trig, Echo and Gnd. Vcc and Gnd are connected to the +5v and GND pins of the Arduino. Trig (Trigger) is connected to the 9th pin and Echo is connected to 8th pin of the Arduino UNO respectively.

A Servo Motor is used to rotate the Ultrasonic Sensor to scan for obstacles. It has three pins namely Control, VCC and GND. The Servo Control Pin is connected to pin 11 of Arduino while the VCC and GND are connected to +5V and GND.

L293D is a 16 pin IC. Pins 1 and 9 are the enable pins. These pins are connected to +5V. Pins 2 and 7 are control inputs from microcontroller for first motor. They are connected to pins 6 and 7 of Arduino respectively.

Similarly, pins 10 and 15 are control inputs from microcontroller for second motor. They are connected to pins 5 and 4 of Arduino. Pins 4, 5, 12 and 13 of L293D are ground pins and are connected to Gnd.

First motor (consider this as the motor for left wheel) is connected across the pins 3 and 6 of L293D. The second motor, which acts as the right wheel motor, is connected to 11 and 14 pins of L293D.

The 16th pin of L293D is Vcc1. This is connected to +5V. The 8th pins are Vcc2. This is the motor supply voltage. This can be connected anywhere between 4.7V and 36V. In this project, pin 8 if L293D is connected to +5V supply.

NOTE: The power supply to the Motor Driver i.e. Pins 1 (enable 1), 8 (VCC2), 9 (enable 2) and 16 (VCC1) should be given a separate power supply.

Motor Driver boards are available with on – board 5V voltage regulator. A similar one is used in the project.

5.3 Working of the robot:

Ultrasonic principle: Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected back as echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo.

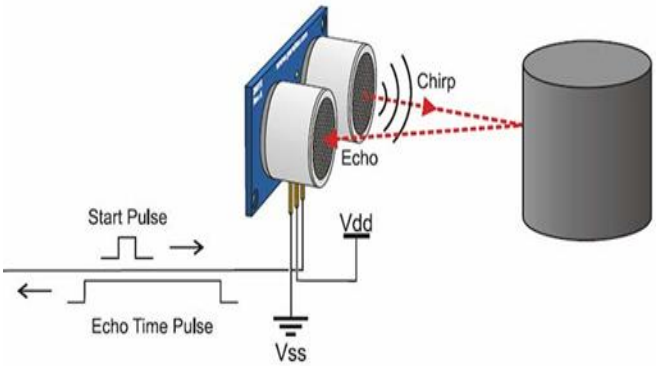

Figure 5.4 Working of sensor

Using an external trigger signal, the Trig pin on ultrasonic sensor is made logic high for at least 10µs. A sonic burst from the transmitter module is sent. This consists of 8 pulses of 40KHz.

The signals return back after hitting a surface and the receiver detects this signal. The Echo pin is high from the time of sending the signal and receiving it. This time can be converted to distance using appropriate calculations.

The aim of this project is to implement an obstacle avoiding robot using ultrasonic sensor and Arduino. All the connections are made as per the circuit diagram. The working of the project is explained below.

When the robot is powered on, both the motors of the robot will run normally and the robot moves forward. During this time, the ultrasonic sensor continuously calculates the distance between the robot and the reflective surface.

This information is processed by the Arduino. If the distance between the robot and the obstacle is less than 15cm, the Robot stops and scans in left and right directions for new distance using Servo Motor and Ultrasonic Sensor. If the distance towards the left side is more than that of the right side, the robot will prepare for a left turn. But first, it backs up a little bit and then activates the Left Wheel Motor in reversed in direction.

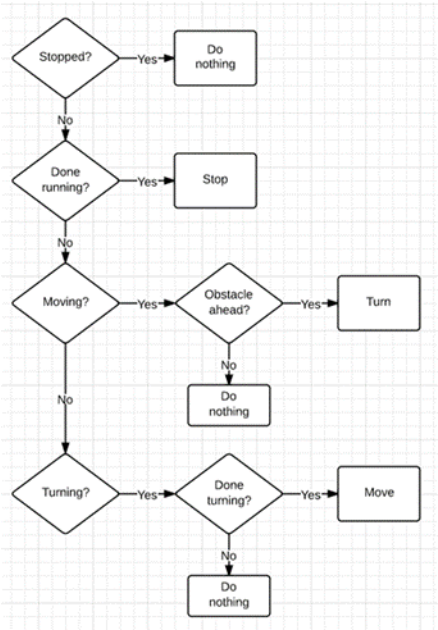

Figure 5.5 Flow diagram

Similarly, if the right distance is more than that of the left distance, the Robot prepares right rotation. This process continues forever and the robot keeps on moving without hitting any obstacle.

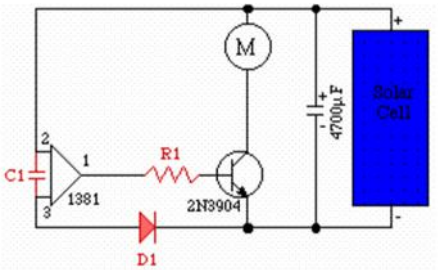

Figure 5.6 Solar powered circuit

The above image shows the circuit through which solar power will be used as an optional source of power.

6. REQUIREMENT ANALYSIS

6.1 Hardware Required

- Arduino Uno
- Ultrasonic Range Finder Sensor – HC – SR04
- Motor Driver IC – L293D
- Servo Motor (Tower Pro SG90)
- Geared Motors x 2
- Robot Chassis
- Power Supply
- Jumper wires

6.2 Software Required

- Embedded C
- Bluetooth RC controller

7. EXPECTED OUTCOME

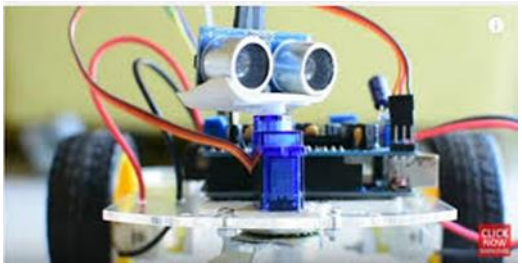

Figure 7.1 Expected model

The expected outcome will be similar to this. We are going to make the robot which will be powered by solar energy by charging it during sunlight using solar cells and an ultrasonic sensor will be placed at the head of the robot just like in the above image. Jumper wires will be used to connect all the elements of the robot like bread board, chassis and etc.

Moreover, the robot will detect obstacles in its path and avoid collision by changing its direction since the sensor will give it signals to do so.

Thus, robots like this will be used in the future to avoid accidents and injuries and a more advanced version can also be used in future vehicles.

8. CONCLUSION

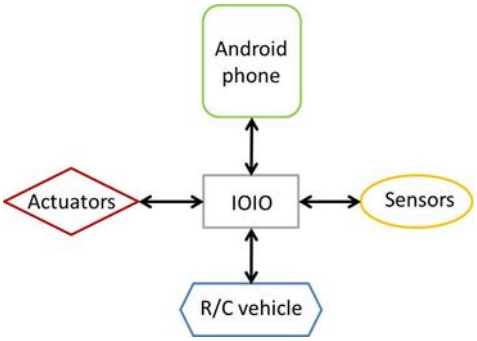

Figure 8.1 Flow diagram of model

A solar powered obstacle avoiding robot is created such that it can also be modified and made such that it can also be controlled by an android phone using sensors, actuators, arduino etc.

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