" Real-Time Obstacle Avoidance Manipulators and Mobile Robot "

CSE3006 –EMBEDDED SYSTEM DESIGN

A Final Project Report

Submitted By

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CERTIFICATE

This is to certify that the project work entitled "Real-Time Obstacle Avoidance for Manipulators and Mobile Robot" that is being submitted by Paritosh Pal Singh(16BCE0849), Munjal Patel(16BCE0276), Naishal Shah(16BCe0322), Srijan Gupta(15BCE0471) for EMBEDDED SYSTEM DESIGN(CSE3006) under my supervision. The contents of this Project work, in full or in parts, have not been taken from any other source.

Signature of Faculty

Prof. Lijo V P

ABSTRACT

Accidents have become a common sight these days. Accidents take place due to rashness of people which often involve fatal injuries or deaths. Statistically, the number of accidents are increasing exponentially day by day. Driving models are needed by many researchers to improve traffic safety and to advance autonomous vehicle design. So we have come up with a prototype of "Obstacle Avoidance and Detection Autonomous Car" based on sensor applications.

The purpose of the project is to implement an ultrasonic sensor, Arduino chip and motor driver to develop a motion sensing obstacle detector car. It is programmed by Arduino chip in such a way that it moves by taking command from the laptop.

It sends an ultrasonic wave and delay time is fixed in the code to avoid obstacles. It is based on the principle of echo. The motion sensor helps us in understanding digital input/output to make further progress. The turning radius is improved by stopping the left DC motor when the car is turning towards the right and vice versa.

ACKNOWLEDGEMENT

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1. INTRODUCTION

Many intelligent vehicle designers need to make driver aids that work in dynamic traffic situations. Traffic engineers need them to improve the safety of highways. Robot vehicle builders need them to drive vehicles autonomously in traffic. So, based on these criteria we developed an Autonomous car which detect and avoid the obstacle. The main task is that whenever a car finds the obstacle in its path, it senses the obstacle using ultrasonic sensor and avoid the obstacle to move in its path.

The concept of Mobile Robot is fast evolving and the number of mobile robots and their complexities are increasing with different applications. There are many types of mobile robot navigation techniques like path planning, self – localization and map interpreting. An Obstacle Avoiding Robot is a type of autonomous mobile robot that avoids collision with unexpected obstacles. In this project, an Obstacle Avoiding Robot is designed. It is an Arduino based robot that uses Ultrasonic range finder sensors to avoid collisions.

2. PROBLEM DEFINITION

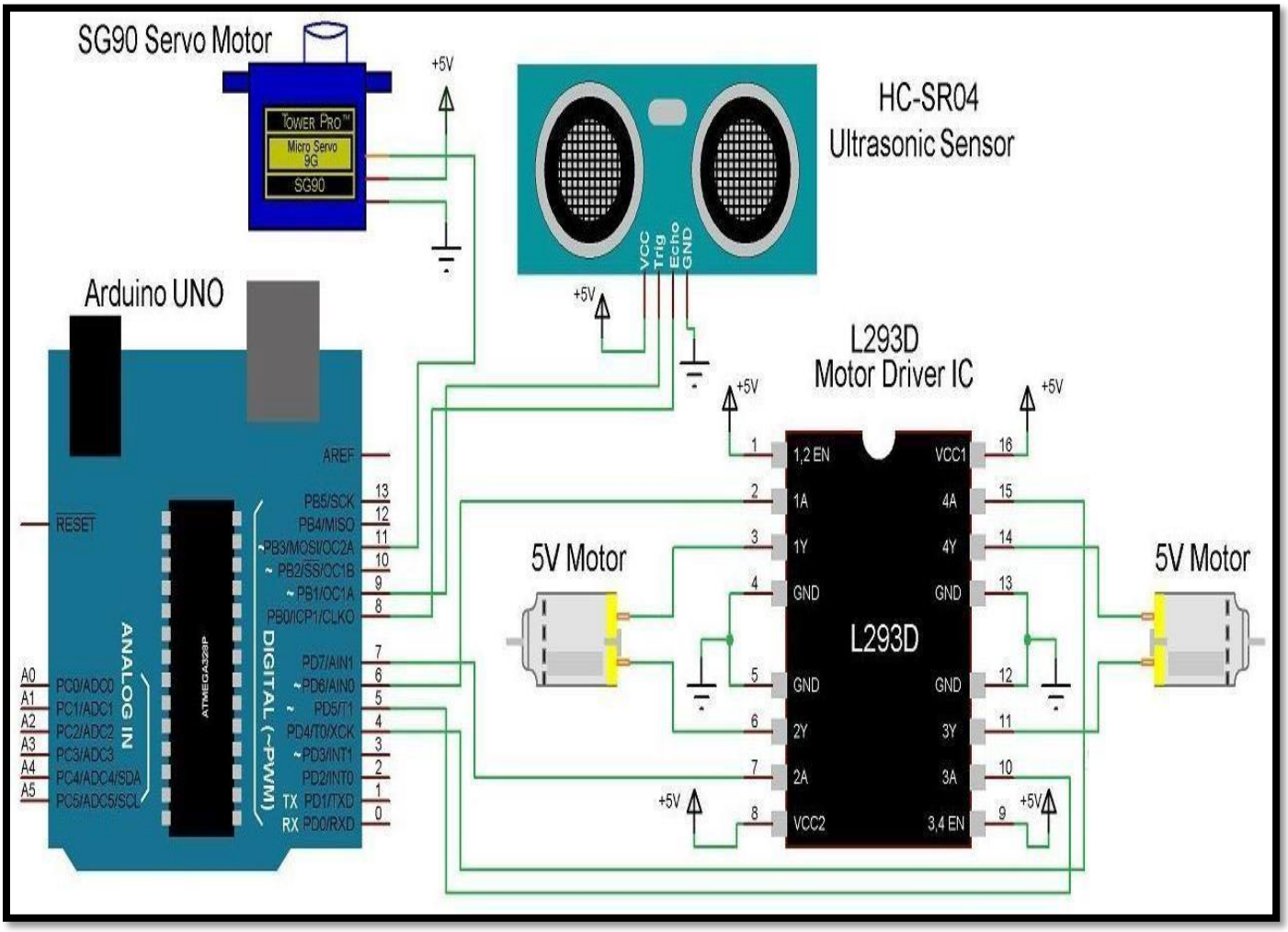
As discussed before, accidents are increasing day by day. The damage caused by these accidents is irreparable. So, a method that helps in preventing these life taking accidents is a huge thing. The autonomous obstacle avoider car can help to reduce the number of accidents, as a result save many precious lives. As described above it can detect the obstacles in front of it and avoid collision, hence it can be a very useful tool to avoid collisions on the road which take place due to lack of concentration during driving.

3. LITERATURE SURVEY

In the related application field, obstacle avoidance has been extensively integrated into the wheeled robots. Sezer and Gokasan designed an obstacle avoidance algorithm named ‘‘follow the gap method’’, which was easy to tune and taken into consideration the field of view and the non-holonomic constrains of the wheeled robots. Hoeller et al. proposed a local navigation planning approach for collision avoidance, which used motion prediction and probabilistic roadmaps to plan collision-free paths to a given target location relative to the robot. Rashid et al. introduced a multi-robot collision free navigation method based on reciprocal orientation, which generated both smooth and collision-free robot trajectories and can be applied in dynamic environments. Hongjiu Yang et al. generated a prudential function to solve the problems of obstacle avoidance for a wheeled mobile robot and a nonlinear controller is designed. Martin Wermelinger et al. proposed a cascaded planning structure makes use of different levels of simplification to allow for fast search in simple environments, while retaining the ability to find complex solutions, such as paths through narrow passages. Thi Thoa Mac et al. developed a simple algorithm for robot obstacle avoidance using bumper event. Kai-Tai Song et al. proposed a shared-control scheme combines active obstacle avoidance and passive-compliant motion commands.

Recently, Tai Lei and Liu Ming have proposed a deep network solution towards the obstacle avoidance of the mobile robot. They built a complex hierarchical deep-network, which comprises a CNN front-end network for perception and a fully connected network for decision making. The input of the network is the raw depth sensor data, and the output is the robot control commands. The contribution of their work is that the similar deep network method can be used to solve related model-less robotic problems. The deep-network method needs to build complex hierarchical network model, and use a lot of experimental data to train the model. The training process is complicated, and maybe need some cumbersome operations under the human beings’ supervisions. In this paper, we mainly focus on proposing a direct, simple and effective method to solve the obstacle avoidance problem of a complex legged robot system.

4. CIRCUIT DIAGRAM



5. REQUIREMENTS

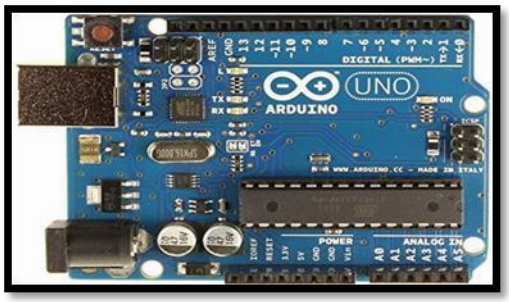
Software Requirements: Arduino Ide

Hardware Requirements:

- ✓ Arduino Board
- ✓ Bread Board
- ✓ Batteries
- ✓ Motor
- ✓ Wheels
- ✓ Motor Driver

6. COMPONENTS DESCRIPTION

- **Arduino Uno**
  Arduino Uno is an ATmega 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.



- **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.

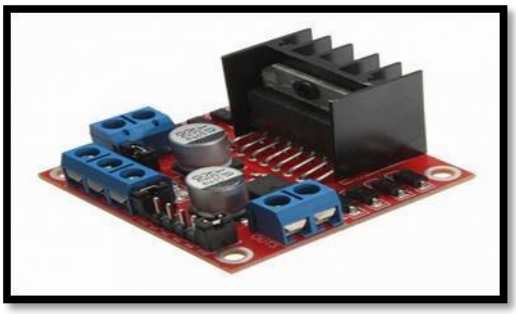
- **Batteries**
  A container consisting of one or more cells, in which chemical energy is converted into electricity and used as a source of power.

- **Motor**

  A machine, especially one powered by electricity or internal combustion that supplies motive power for a vehicle or for another device with moving parts.

- **Motor Driver**

  A motor driver is a little current amplifier; the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor.

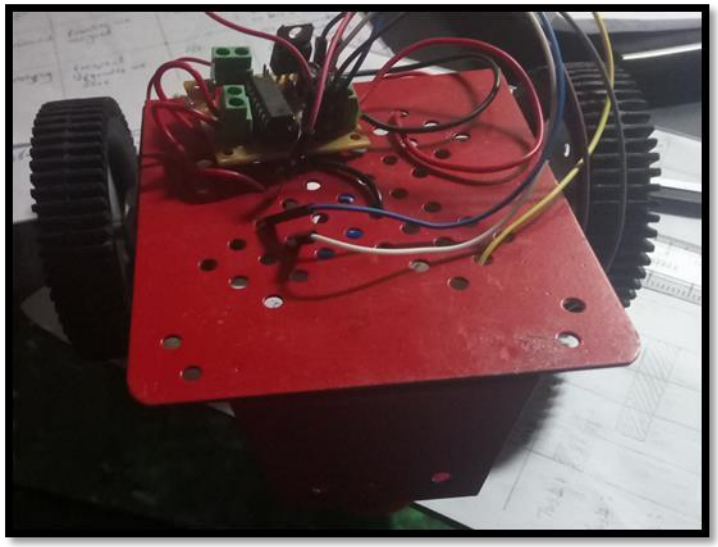


- **Wheels**

  A circular object that revolves on an axle and is fixed below a vehicle or other object to enable it to move over the ground.

- **Chassis**

The base on which our bot will be based. A chassis consists of an internal vehicle frame that supports an artificial object in its construction and use, can also provide protection for some internal parts.



7. DESIGN

- Arduino is the main processing unit of the robot. Out of the 14 available digital I/O pins, 6 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 supply pins of the Arduino. Trig is connected to the 11th pin and Echo is connected to 10th pin of the Arduino.
- L293D is a 16 pin IC. Pins 1 and 9 are enable pins. They are connected to Vcc. Pins 2 and 7 are control inputs from microcontroller for first motor. They are connected to pins 9 and 8 of Arduino respectively.
- Similarly, pins 10 and 15 are control inputs from microcontroller for second motor. They are connected to pins 4 and 3 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 Vcc. The 8th pins is 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 9V supply.
- Motor Driver boards are available with on – board 5V voltage regulator.

8. ARDUINO IDE CODE

```
int ma[]={2,4}; intmb[]={7,8}; intvcc = A0; int trig = A1; int echo = A2;
intgnd = A3; int duration; void setup()
{
Serial.begin(9600);
for(int i=0;i<2;i++)
{ pinMode(ma[i],OUTPUT); pinMode(mb[i],OUTPUT);
}
pinMode (vcc,OUTPUT); pinMode (gnd,OUTPUT);
digitalWrite(vcc,HIGH); digitalWrite(gnd,LOW);
pinMode(echo,INPUT); pinMode(trig, OUTPUT);
}
void loop()
{
digitalWrite(trig, LOW); delayMicroseconds(2); digitalWrite(trig,
HIGH); delayMicroseconds(5); digitalWrite(trig, LOW);
duration = pulseIn(echo, HIGH);
if (duration< 1000)
{ Serial.println("Moving left"); left();
left();
delay(500);
}
else
{ Serial.println("Moving Forward");
fwd();
}
}
```

```
voidfwd()
{
digitalWrite(ma[1],HIGH);
digitalWrite(ma[2],LOW);
digitalWrite(mb[1],HIGH);
digitalWrite(mb[2],LOW);
}
voidbck()
{
digitalWrite(ma[1],LOW);
digitalWrite(ma[2],HIGH);
digitalWrite(mb[1],LOW);
digitalWrite(mb[2],HIGH);
}
void left()
{
digitalWrite(ma[1],HIGH);
digitalWrite(ma[2],LOW);
digitalWrite(mb[1],HIGH);
digitalWrite(mb[2],HIGH);
}
void right()
{
digitalWrite(ma[1],LOW);
digitalWrite(ma[2],HIGH);
digitalWrite(mb[1],HIGH);
digitalWrite(mb[2],HIGH);
}
voidnomove()
{
digitalWrite(ma[1],LOW);
digitalWrite(ma[2],LOW);
digitalWrite(mb[1],LOW);
digitalWrite(mb[2],LOW);
}
Laptop control int ma1=2;
int ma2=4; int mb1=7; int mb2=8; void setup() {
```

```
// put your setup code here, to run once: Serial.begin(9600); pinMode(ma1,OUTPUT); pinMode(ma2,OUTPUT); pinMode(mb1,OUTPUT); pinMode(mb2,OUTPUT);
}
void loop() {
// put your main code here, to run repeatedly: if(Serial.available()>0)
{
int x=Serial.read(); if(x=='F' || x=='f')
{
digitalWrite(ma1,LOW);
digitalWrite(ma2,HIGH);
digitalWrite(mb1,LOW);
digitalWrite(mb2,HIGH);
}
if(x=='S'|| x=='s')
{
digitalWrite(ma1,LOW);
digitalWrite(ma2,LOW);
digitalWrite(mb1,LOW);
digitalWrite(mb2,LOW);
}
if(x=='L' || x=='l')
{
digitalWrite(ma1,HIGH);
digitalWrite(ma2,HIGH);
digitalWrite(mb1,LOW);
digitalWrite(mb2,HIGH);
}
if(x=='R' || x=='r')
{
digitalWrite(ma1,LOW);
digitalWrite(ma2,HIGH);
digitalWrite(mb1,HIGH);
digitalWrite(mb2,HIGH);
}
if(x=='B' || x=='b')
{
```

```
digitalWrite(ma1,HIGH);
digitalWrite(ma2,LOW);
digitalWrite(mb1,HIGH);
digitalWrite(mb2,LOW);
}
}
}
```

9. WORKING PRINCIPLE

Before going to working of the project, it is important to understand how the ultrasonic sensor works. The basic principle behind the working of ultrasonic sensor is as follows:

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 40 KHz.

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 calculate 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 left wheel motor is reversed in direction and the right wheel motor is operated normally. This will rotate the robot towards right. This rotation continues until the distance between the robot and any obstacle is greater than 15cm. The process continues forever and the robot keeps on moving without hitting any obstacle.

10. CONCLUSION

In conclusion we can say that our project is just a prototype of an obstacle detection car. We have used arduino coding to make the car to detect the obstacle. Further it has many other applications such as Gesture control car, Joystick controlled car, DTMF etc. If it is used in modern cars it will be helpful to avoid accidents.

APPLICATIONS :

•Obstacle avoiding robots can be used in almost all mobile robot navigation systems.
•They can be used for household work like automatic vacuum cleaning.
•They can also be used in dangerous environments, where human penetration could be fatal.

11. ADVANTAGES

• As the project is based on Arduino, the programming is very easy and can be easily modified.
• Doesn't require the Arduino Motor Shield.
• When using a 9V battery, at least 2 such batteries are needed to power the robot. It is better to use 3 9V batteries (one for Arduino and ultrasonic sensor, one for L293D and other for motors).
• The ultrasonic sensor should not be connected directly to power supply as it might affect the normal performance.
• Additionally, a servo motor can be fixed to the ultrasonic sensor and only ultrasonic sensor rotates according to the servo. Based on the distance, the entire robot rotates.
• Instead of ultrasonic sensor, an IR transmitter – receiver pair can aso be used.

12. REFERENCES

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