Revolutionizing Transportation:
Unleashing the Power of IoT in Automated Vehicles with Intelligent Obstacle Avoidance

Project submitted to the

SRM University – AP, Andhra Pradesh

for the partial fulfillment of the requirements to award the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

School of Engineering and Sciences

Submitted by

P. Prudhvi Krishna	AP20110020021
Nikhila Kumari Voleti	AP20110020090

Under the Guidance of

Dr. Satish Kumar Tiwari

SRM University–AP

Neerukonda, Mangalagiri, Guntur

Andhra Pradesh – 522 240

[May 2023]

Certificate

Date: 5/31/2023

This is to certify that the work present in this Project entitled "**Revolutionizing Transportation: Unleashing the Power of IoT in Automated Vehicles with Intelligent Obstacle Avoidance**" has been carried out by **P. Prudhvi Krishna** and **V. Nikhila Kumari** under my supervision. The work isgenuine, original, and suitable for submission to the SRM University–AP for the award of Bachelor of Technology in **School of Engineering and Sciences**.

Supervisor

(signature)

Dr. Satish Kumar Tiwari

Assistant Professor, ECE

SRM University–AP

Acknowledgements

I would like to express my special thanks and gratitude to my Supervisor, Dr. Satish Kumar Tiwari, who has given me the opportunity to work on the project "Revolutionizing Transportation: Unleashing the Power of IoT in Automated Vehicles with Intelligent Obstacle Avoidance", and also helped me in completing my report. I came to know about so many new things, I am thankful to him. His vast knowledge, expertise and insightful feedback have been instrumental in shaping the outcome of this work.

I am also thankful to Dr. Ramesh Vaddi, (Head of the Department ECE) for his encouragement and support towards me.

I am grateful to SRM University-AP for providing the necessary resources and facilities for the successful completion of this work.

Table of Contents

Abstract

The field of detecting obstacles is a broad one, also obstacle detection systems are rapidly increasing from the past few years. Road accidents are also being increased day by day and number of death cases are increasing. The working methodology deals with the avoiding of an obstacle and reach the destination safely.

Detecting an obstacle concept primarily focuses to identify any of obstruction that may block the way of the vehicle.

The proposed system automatically turns the vehicle left or right on detecting obstacles using ultrasonic sensors and commands to turn right or left using Bluetooth sensor which is connected to the IoT. The goal is to make the vehicle more secure and to ensure the safety of the passengers.

Statement of Contributions

The first contribution of this project is to avoid the road accidents by capturing a distant obstacle in front of the vehicle. One of the contribution is to attach a Bluetooth sensor to the vehicle which stops the vehicle with driver commands.

IoT-based vehicles can be equipped with a variety of sensors, where we are using an ultrasonic sensor, which can detect obstacles in real-time. Sensor Integration and Data Analytics plays an important role for building of any project.

Accordingly, our research is to have a groundbreaking “logic” that is robust enough regarding precise car stopping with utmost reliability.

Abbreviations

- ADXL : Analog Devices Accelerometer
- AV : Autonomous Vehicle
- HC–SRO4 : High-Conductance Ultrasonic Sensor
- IoT : Internet of Things
- PWM : Pulse Width Modulation

List of Components

1. Arduino UNO Board
2. Ultrasonic Sensor
3. Bluetooth Sensor
4. Accelerometer Sensor
5. Motor Drive
6. Servo Motor
7. Gear Motor
8. 18650 Li-ion Battery
9. Chassis, Including wheels, body part of car, etc.

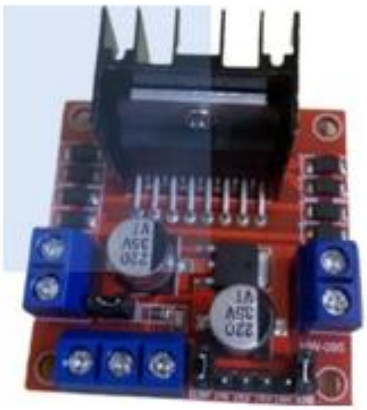
List of Figures

Arduino UNO Board

Ultrasonic Sensor

Bluetooth Sensor

Motor Drive

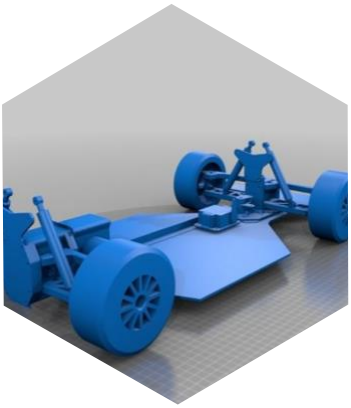


Servo Motor

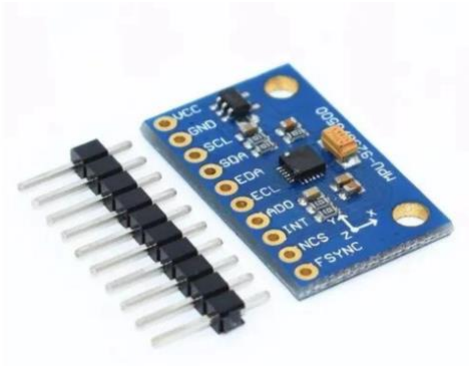
Gear Motor

TZONE 12V 1.3AH LEAD ACID BATTERY

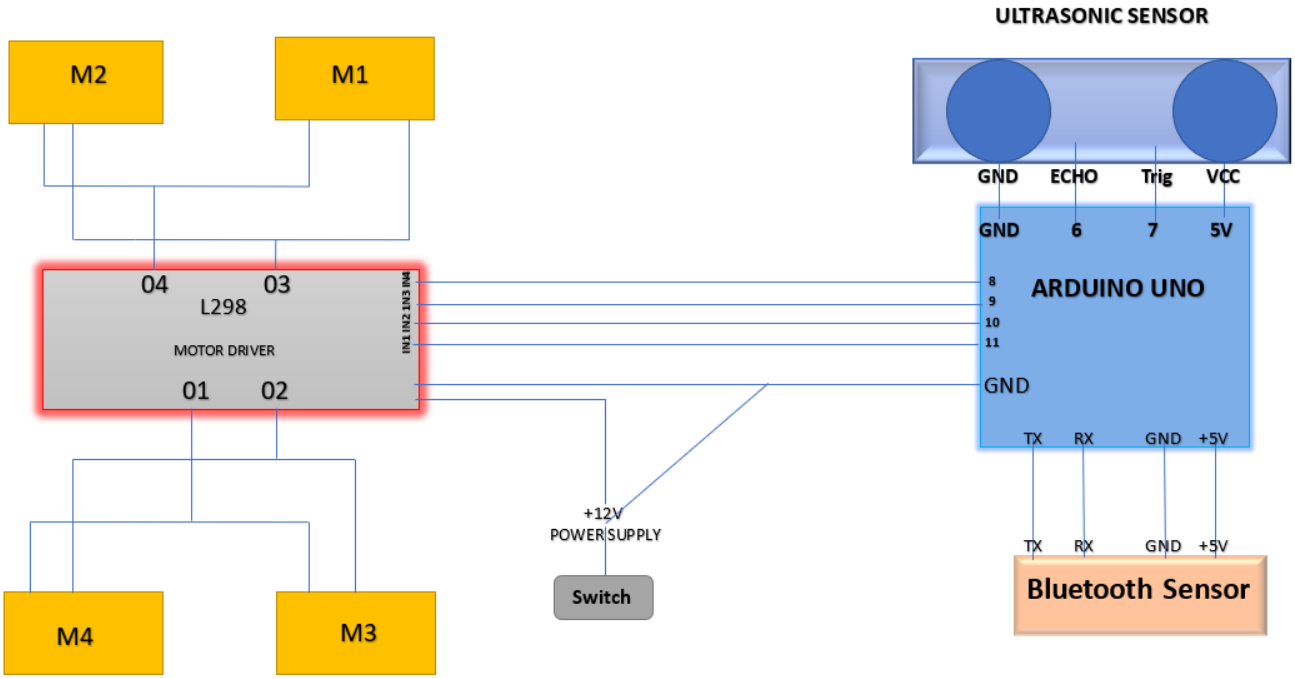
Chassis: Body parts, etc.



Accelerometer Sensor



Block Diagram for the Developed Prototype



List of Equations

Ultrasonic Sensor

- Distance will be calculated by measuring the travel time of ultrasonic sound and its speed as

$$\textbf{Distance} = \textbf{Time} \times \frac{\textbf{Speed of sound}}{\textbf{2}}. \quad \textbf{(1)}$$

- Speed of the sound can be calculated as

$$\textbf{v = c * sqrt(T),} \quad \textbf{(2)}$$

where **V** is the speed of sound in meters per second (m/s), **C** is a constant approximately equal to 20,042 meters per second (m/s), and **T** is the temperature in degrees Celsius (°C).

1. Introduction

The transportation industry is undergoing a remarkable transformation with the advent of revolutionary technologies. Among these new innovations, the Internet of Things (IoT) has emerged as a powerful catalyst, reshaping the way we envision transportation systems with the integration of IoT in automated vehicles and the incorporation of intelligent obstacle avoidance capabilities.

In real time, avoiding the obstacle is one of the good solutions for succeeding in various kinds of applications. The algorithms are complex, as they involve not only the detecting an obstacle, but also measuring the obstacle's dimensions. With the determined parameters in hand, the obstacle avoidance algorithm guides the vehicle around obstacles, seamlessly returning it to its intended path.

The benefits of this revolution extend beyond safety and efficiency. IoT-based automated vehicles with intelligent obstacle avoidance capabilities promise increased accessibility for individuals with mobility challenges, reduced traffic congestion, and environmental advantages through optimized routes and reduced fuel consumption.

2. Methodology

We would connect the vehicle with different types of sensors and integrate them with proper connections. Sensors such as ultrasonic sensors, Bluetooth sensors are utilized to capture real-time data about the vehicle's surroundings. These sensors detect and measure distances, velocities, and other relevant parameters required for obstacle detection and avoidance.

The ultrasonic sensor will be connected in the front part of the vehicle and the 4-pins of ultrasonic sensor are connected to the Arduino board in the following manner

Pin 1 → V_{cc} to 5V

Pin 2, 3 → Trig and Echo pins to 5^{th} pin and 6^{th} pin of Arduino board

Pin 4 → GND to GND

With ultrasonic signals as its guide, the microcontroller adeptly steers the motors in varying directions—left, right, back and front ensuring that the vehicle circumvents obstacles effortlessly. Utilizing pulse width modulation (PWM), the microcontroller deftly adjusts the speed of individual motors, all while relying on ultrasonic feedback to circumvent obstacles, ensuring a seamless and controlled robotic movement.

To attain the desired functionality, a microcontroller is employed, serving as the central control unit for seamless operation. Interfacing with the microcontroller, the motors establish a connection via the motor driver IC, enabling efficient coordination and precise control.

The entire project is controlled by Arduino board and ultrasonic sensor. Where we dump the code in Arduino and perform the simulation. All the sensors and motors are connected to the Arduino as shown in the above circuit diagram.

3. Implementation

We have implemented the below codes for executing the Arduino board and to get desired output.

In this we have been implemented two types of codes which runs the vehicle.

1. Ultrasonic Sensor
2. Bluetooth connectivity

Code for Ultrasonics sensor to function:

```
String readString;
const int trigPin = 6;
const int echoPin = 7;
// defines variables
long duration;
int distance;
#define m11 8
#define m12 9
#define m21 10
#define m22 11

void forward()
{
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, HIGH);
  Serial.println("FORWARD");
}

void backward()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, HIGH);
  digitalWrite(m21, HIGH);
  digitalWrite(m22, LOW);
  Serial.println("BACKWARD");
}

void right()
{
```

```
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, HIGH);
  digitalWrite(m22, LOW);
  Serial.println("RIGHT");
}

void left()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, HIGH);
  digitalWrite(m21, LOW);
  digitalWrite(m22, HIGH);
  Serial.println("LEFT");
}

void Stop()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, LOW);
  Serial.println("STOP");
}

void setup()
{
 pinMode(m11, OUTPUT);
 pinMode(m12, OUTPUT);
 pinMode(m21, OUTPUT);
 pinMode(m22, OUTPUT);
 pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
 Serial.begin(9600);
}

void loop() {
 ultrasonic();
}

void ultrasonic()
{
 forward();
 digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
```

```
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);

if(distance<15)
{
 Stop();
 delay(1000);
 right();
 delay(1000);
}
}
```

Code for Bluetooth to function:

```
String readString;
const int trigPin = 6;
const int echoPin = 7;
// defines variables
long duration;
int distance;
#define m11 8
#define m12 9
#define m21 10
#define m22 11

void forward()
{
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, HIGH);
  Serial.println("FORWARD");
}

void backward()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, HIGH);
  digitalWrite(m21, HIGH);
```

```
  digitalWrite(m22, LOW);
  Serial.println("BACKWARD");
}

void right()
{
  digitalWrite(m11, HIGH);
  digitalWrite(m12, LOW);
  digitalWrite(m21, HIGH);
  digitalWrite(m22, LOW);
  Serial.println("RIGHT");
}

void left()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, HIGH);
  digitalWrite(m21, LOW);
  digitalWrite(m22, HIGH);
  Serial.println("LEFT");
}

void Stop()
{
  digitalWrite(m11, LOW);
  digitalWrite(m12, LOW);
  digitalWrite(m21, LOW);
  digitalWrite(m22, LOW);
  Serial.println("STOP");
}

void setup()
{
 pinMode(m11, OUTPUT);
 pinMode(m12, OUTPUT);
 pinMode(m21, OUTPUT);
 pinMode(m22, OUTPUT);
 pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
 Serial.begin(9600);
}

void loop() {
 bluetooth();
}
```

```
void bluetooth()
{

while(Serial.available()){
  delay(3);
  char c = Serial.read();
  readString+=c;
}

if(readString.length() >0)
{
  Serial.println(readString);
  if(readString == "U")
  {
  forward();
  }
 else if(readString == "D")
  {
  backward();
  }
  else if(readString == "L")
  {
  left();
  }
  else if(readString == "R")
  {
  right();
  }
  else if(readString == "S")
  {
  Stop();
  }
  readString = "";
}

}
```

4. Discussion

The integration of Internet of Things (IoT) technology in the transportation industry is revolutionizing the way we perceive and interact with transportation systems. With IoT, automated vehicles are becoming more intelligent, equipped with obstacle avoidance capabilities that enhance safety and efficiency. Real-time obstacle avoidance is a critical factor for the successful application of mobile robot systems. While basic collision avoidance algorithms can detect obstacles and halt the vehicle to prevent collisions, more sophisticated algorithms enable vehicles to navigate around obstacles, considering their dimensions and making quantitative measurements. These advanced algorithms allow for autonomous navigation, where obstacle avoidance and steering towards a target occur simultaneously.

The advantages brought about by this transformation go beyond safety and efficiency. This involves determining the desired level of automation, performance objectives, and safety considerations. During the system design phase, the selection of appropriate sensors, communication protocols, and decision-making algorithms is crucial to achieving the desired functionality. Various sensors, such as ultrasonic sensors and accelerometer sensors, play a key role in capturing real-time data about the vehicle's surroundings. These sensors provide information on distances, velocities, and other relevant parameters necessary for detecting obstacle and avoiding it.

Within the realm of obstacle avoidance, ultrasonic sensors are commonly employed. These sensors continuously transmit ultrasonic waves and detect their reflections from objects in front of the vehicle. This information is then relayed to a microcontroller, which controls the motors, which are connected through a motor driver. Based on ultrasonic signals received, the microcontroller commands the motors to adjust the vehicle's movement, enabling it to navigate around obstacles. PWM is used to control the speed of each motor.

Typically, such projects are implemented using Arduino boards and ultrasonic sensors. The code is uploaded to the Arduino board, and the simulation is performed. The Arduino board serves as the central control unit, connecting and managing the sensors and motors according to the circuit diagram.

5. Conclusion

In conclusion, the integration of Internet of Things (IoT) technologies and intelligent obstacle avoidance capabilities in the transportation industry is reshaping the way we envision and experience transportation systems. This remarkable transformation holds the potential to revolutionize road safety, accessibility, and efficiency.

By leveraging IoT in automated vehicles and incorporating intelligent obstacle avoidance capabilities, we can create a future where transportation is safer and more efficient than ever before. The real-time obstacle avoidance algorithms, ranging from basic collision prevention to advanced navigation and detouring, ensure that vehicles can navigate their surroundings with precision and adaptability.

6. Future Work

In the continuation of this work, we are introducing the same IoT concept for ENABLED STRUCTURAL HEALTH MONITORING ROADS. This Project talks about Pothole Identification Methods that have been created and proposes a practical answer for distinguishing the Potholes on streets and roads and gives the Information to the Road Management System (Government). It Provides the Information where the Potholes are present.

Further research can be carried out to analyze the mobile phone sensors data during road journey. An android application can be Implemented for safety of drivers, so that they can be careful to avoid mishaps.

References

[1] J. Borenstein, "Real-time obstacle avoidance for fast mobile robots", IEEE Trans. Syst. Man Cybern., vol. 19, pp. 1179-1187, Sept./Oct. 1989.

[2] A. Kosaka and A. Kak, "Fast vision-guided mobile robot navigation using model-Based reasoning and prediction of uncertainties", CVGIP Image Understanding, vol. 56, no. 3, pp.271-329, Nov. 1992.

[3] J. Neira, J. Horn, J. D. Tardo´s and G. Schmidt, "Multisensor mobile robot localization", Proc. IEEE Int. Conf. Robot. Automat., pp. 673-679, Apr. 1996.

[4] K. Sugihara, "Some location problems for robot navigation using a single camera", Comput. Vision Graph. Image Process., vol. 42, no. 1, pp. 112-129, Apr. 1988.

[5] Moazzam, I.; Kamal, K.; Mathavan, S.; Usman, S.; Rahman, M. Metrology and visualization of potholes using the microsoft kinect sensor. In Proceedings of the 2013 16th International IEEE Conference on Intelligent Transportation Systems-(ITSC), The Hague, The Netherlands, 6–9 October 2013; pp. 1284–1291.

[6] Fox, A.; Kumar, B.V.; Chen, J.; Bai, F. Crowdsourcing undersampled vehicular sensor data for pothole detection. In Proceedings of the 2015 12th Annual IEEE International Conference on Sensing, Communication, and Networking (SECON), Seattle, WA, USA, 22–25 June 2015; pp. 515–523.