OBSTACLE AVOIDING ROBOTIC VEHICLE

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ABSTRACT

Obstacle detection is a challenging problem that has attracted much attention recently, especially in the context of research in self-driving car technologies, because of their high level of performance and reliability and which is a great help for human beings. To avoid collision with unexpected obstacles, the vehicle should be capable of finding and mapping the obstacles.

In the existing system, **steering algorithm** is used for robotic actions in which driver or a human being is controlling the robot using remote. Here driver is present, who can see the obstacle and navigate robot accordingly.

The project purposes an obstacle avoiding robotic vehicle that has an intelligence built in it such that it guides itself whenever an obstacle comes ahead of it. This **autonomous robotic vehicle** is built using an Arduino Uno and Ultrasonic sensor. **The robot gets the information from surrounding area through mounted sensors on the robot. Ultrasonic sensor is most suitable sensing device for obstacle detection and it is of low cost and has high ranging capability.**

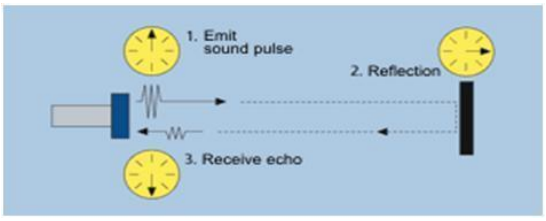
The Ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the Arduino. Depending on the input signal received, the Arduino redirects the vehicle to move in an alternate direction by actuating the motors which are interfaced to it through a Motor Driver.

Keywords-
Steering Algorithm, Robotic Vehicle, Autonomous, Arduino Uno, Ultrasonic Sensor, Motor Driver.

1. INTRODUCTION

The obstacle avoidance is a primary requirement of any autonomous vehicle. Autonomous Intelligent Robotic Vehicle are robots that are capable of moving on its own in an unknown and unstructured environment and can perform desired tasks without continuous human guidance.

The Ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the Arduino. Depending on the input signal received, the Arduino redirects the vehicle to move in an alternate direction by actuating the motors which are interfaced to it through a Motor Driver. The ultrasonic sensor is attached in front of the robot. It transmits the ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object.



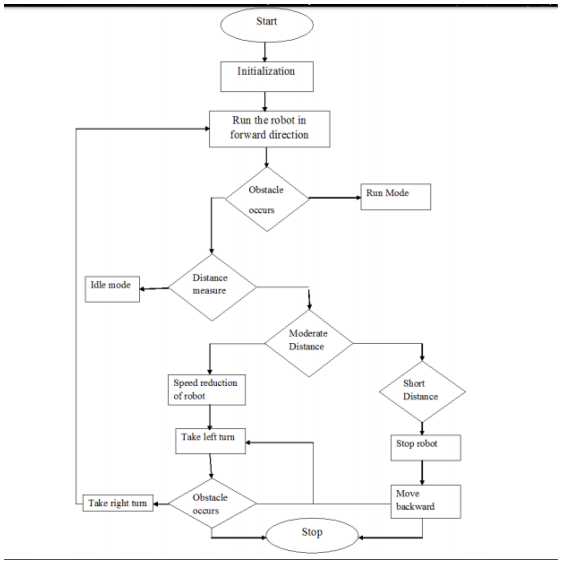
There are many applications using ultrasonic sensors like instruction alarm systems, automatic door openers etc. The ultrasonic sensor is very compact and has a very high performance.

Whenever the robot is going on the desired path the ultrasonic sensor transmits the ultrasonic waves continuously from its sensor head. Whenever an obstacle comes ahead of it the ultrasonic waves are reflected back from an object and that information is passed to the Arduino. The motor driver controls the motors left, right, back, front, based on ultrasonic signals. In

order to control the speed of each motor, Pulse Width Modulation is used (PWM).

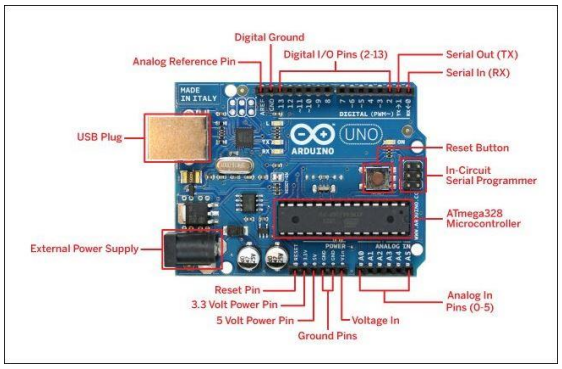
2. SYSTEM DESIGN

A. BLOCK DIAGRAM



B. HARDWARE AND SENSOR

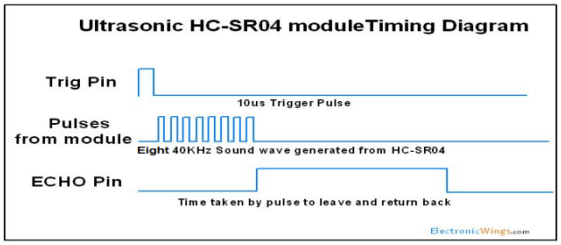
1) Arduino Uno :- The Arduino Uno board is a microcontroller based on the **ATmega328**. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontroller.



In our project, we are using the most official version Arduino UNO R3. It has an operating voltage of 5 volts, Flash memory of 32 KB of which 0.5 KB used by boot loader and SRAM memory of 2 KB.

2) Ultrasonic Sensor module :- The ultrasonic sensor works on the principle of **SONAR and RADAR system** which is used to determine the distance to an object comprising of an ultrasonic transmitter, receiver and control circuit. In our project, we are using a **HC-SR04 Open Type Ultrasonic Sensor Module which consists of 4 pins : VCC, Trigger, Echo and GND.**

We have to give trigger pulse, so that it will generate ultrasonic waves of frequency 40 kHz. After generating ultrasound—i.e. 8 pulses of frequency 40 kHz, it makes echo pin high. Echo pin remains high until it does not get the echo sound back. So the width of echo pin will be the time for sound to travel to the object and return back. Once we get the time we can calculate distance, as we know the speed of sound.



To calculate Distance-

We know that,

$$\text{Distance} = \text{Speed} \times \text{Time}$$

The speed of sound waves is 343 m/s.

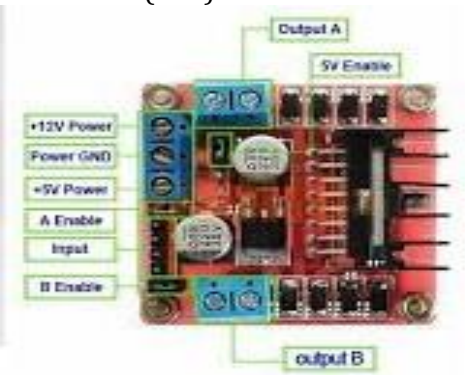
So,

$$\text{Total Distance} = \frac{343 \times \text{Time of High(Echo) Pulse}}{2}$$

(in metres)

Total distance is divided by 2 because signal travels from HC-SR04 to object and returns to the module HC-SR-04. **HC-SR04 can measure up to range from 2 cm - 400 cm.**

3) Motor Driver :- In our project, we are using Motor Driver L298N. It is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A. This depends on the voltage used at the motors (VCC).



4) Servo Motor :- Servo motor works on the **PWM (Pulse Width Modulation) principle**, which means its angle of rotation is controlled by the duration of pulse applied to its control PIN. Basically servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears.

In our project, we are using a Continuous Rotation MG995 Metal Gear Servo Motor which can go in any direction indefinitely. The control signal, rather than setting the static position of the servo, is understood as speed and direction of rotation. The range of potential commands sources the servo to rotate clockwise or anticlockwise as preferred, at changing on the command signal.

5) Gear Motor :- In our project, we are using four DC Gear Motors of 500 rpm each. "Gear motor" refers to a combination of a motor plus a reduction gear train. These are often conveniently packaged together in one unit. The gear reduction (gear train) reduces the speed of the motor, with a corresponding increase in torque. They are used in applications that require lower shaft speed and higher torque output. The wheels of the vehicle are driven by the gear motors.

6) Battery :- In our project, we are using a 12 volt battery to give power to the components of the vehicle.

7) There are various supportive components used in the circuit :-

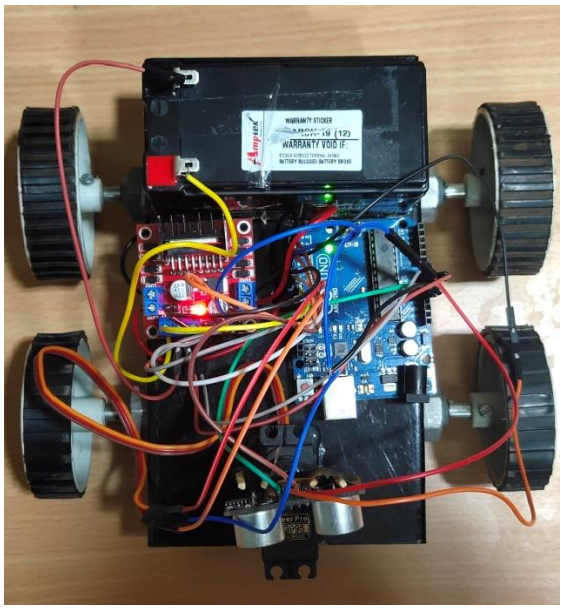
- **Chassis board** :- It is used to withhold all the components together in a single piece.
- **Wheels** :- To run the vehicle in a desired direction.
- **Jumper wires** :- To make connections between the components or to connect all the required ports of the components together.

3. EXPERIMENTAL PROTOTYPE

Working Principle

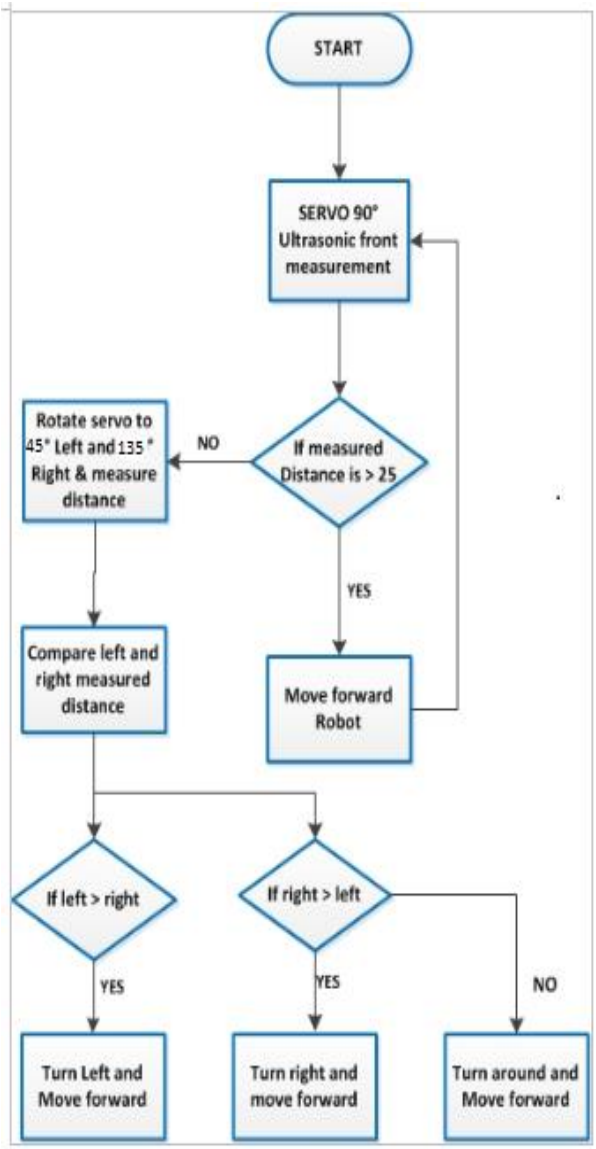
The vehicle works on the principle of obstacle detection and mapping system using ultrasonic sensor.

The ultrasonic sensor emits the short and high frequency signal. If they detect any object, then they reflect back echo signal which taken as input to the sensor through Echo pin.



Firstly we initialize Trigger and Echo pin as low and push the robot in forward direction. When obstacle is detected Echo pin will give input as high to microcontroller. **readPing() function** is used for calculating the time of distance from the obstacle. Everytime the function waits for pin to go high and starts timing, then timing will be stopped when pin go to low. It returns the pulse length in microseconds or when complete pulse was not received within the timeout it returns 0.

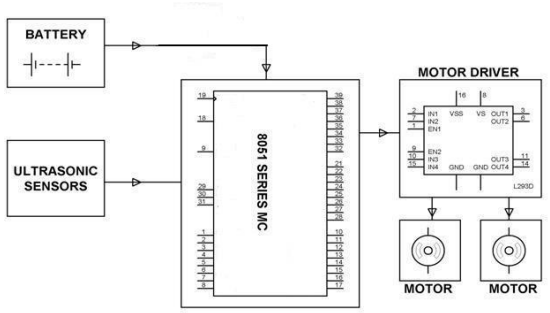
The timing has been determined means it gives length of the pulse and will show errors in shorter pulses. Pulses from 10 microseconds to 3 minutes in length are taken into consideration. After determining the time, it converts into a distance. If the distance of object is moderate then speed of robot get reduced and will take left turn, If obstacle is present in left side then it will take right turn. If the distance of object is short then speed of robot get reduced and will turn in backward direction and then can go in left or right direction.



The flowchart in figure outlines the flow of events as the microcontroller sends trigger messages to the ultrasonic sensor during the process of obstacle detection. An obstacle is detected if it falls within a range.

Implementation

The implementation of obstacle avoidance strategy for a robotic vehicle involves the writing and compilation of program using Arduino software. It consists of a simple hardware platform on which Arduino is placed as well as a free code editor which has a “one click compile or upload” feature. Arduino offers an open-source electronic prototyping platform that is easy to use and flexible for peoples who are beginners in robotics field with both the software and hardware perspective.



Sensors are connected with the Arduino board using jumper wires. Microcontroller (Arduino) is able to sense the environment through receiving input from sensors. It is also able to control its surrounding through controlling motors and other actuators. The Arduino programming language that is based on the processing are used to program the microcontroller found on the chassis. Due to its open source environment, we can able to easily write and upload codes to the I/O board. Arduino environment is written in Java hence it can be run on Linux, Mac OS and Windows platforms. The output of the comparator is given to the microcontroller, which then moves actuators in left or right direction by giving power through DC motor.

Result

Autonomous robots are independent of any controller and can act on their own. They are programmed to respond in a particular way to an outside stimulus. Ultrasound is one of the commonly used technologies in obstacle detection. This is due to its low cost compared to other technologies. The technology however comes with a number of shortcomings that limit its applications in certain areas. This study sought to apply ultrasonic technology in obstacle detection in a real road scenario.

Ultrasonic technology has also been applied in Unmanned Aerial Vehicles (UAVs). UAVs are particularly useful in applications where the operating site cannot be reached by ground operating vehicles or applications that require an aerial view of the whole scene.

A disadvantage with obstacle avoidance based on edge detecting is the need of the robot to stop in front of an obstacle in order to provide a more accurate measurement.

Obstacles under motion can only be accurately detected within 2-meter ranges with some fewer detection failures.

The driver's environment is composed of obstacles with different detectable surface areas and heights and can be in different positions and angles with respect to the sensor's position. Thus, the higher the sensor's position, the lower the probability of detecting obstacles with smaller heights.

Specification

In this model, the ultrasonic sensor generates the high-frequency sound (ultrasound) waves. When this ultrasound hits the object, it reflects as echo which is sensed by the receiver. By measuring the time required for the echo to reach to the receiver, we can calculate the distance. It offers excellent non-contact range detection from about 2 cm to 400 cm or 1'' to 13 feet. Its operation is not affected by sunlight or black material. **It even allows for detection of even small and hard to sense obstacles such as tree branches or cables at high frame rates, as well as see-through obstacles such as windows.**

4. CONCLUSION

We build a robotic vehicle which moves in different directions like **Forward, Backward, Left, and Right when an obstacle appears in its path**. The goal of our project is to create an autonomous robotic vehicle which intelligently detects the obstacle in its path and navigate according to the actions that we have set for it.

The main motto of designing such type of Robotic Vehicle is that this technology can be used in today's very fast transportation to avoid accidents that generally happen in

congested areas by applying emergency brake. If we use this technology in the car or any vehicle, it will automatically sense the obstacles then it will take a side to the available free space. An obstacle may be a living thing or any other object. Thus, by using this technology in vehicles, we make the drive safe.

However, ultrasonic sensors have a challenge in detecting sound absorbing or soft surfaces like clothes. They are thus not reliable in the detection of objects like human beings.

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"We'll never be able to give you back what you gave us".

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