NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

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Mini-Project on

"Obstacle Detection and Collision Avoidance of Autonomous Vehicle using Sensor Fusion"

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INTRODUCTION

In today's world, AUTOMATION is fast growing and an interesting field. In automotive industry, the concept of Autonomous (Self-Driving) Car is taking over the world. Designers need to analyze various situations while designing autonomous cars. One such situation is when an obstacle is detected along the path of an autonomous car. This project deals with how an autonomous car handles itself from crashing into an obstacle which is present along its path.

The main components in an autonomous car are the sensors. Sensors constantly keep monitoring outside environment (surroundings) and also the system. In this project the concept of Sensor Fusion is used.

Sensor: This is a device that detects any event and converts the obtained input to an electrical signal or any readable format. Depending on the kind of inputs they sense, the sensors can be analog, digital, active or passive.

Almost all the sensors have a linear transfer function (which is measured with respect to the sensitivity to the measured property), that is, the sensor output varies in equal magnitudes for a variation in the input.

If there exists a deviation in the sensor measurement, the faults (errors) of the sensor can be accounted to using various parameters like the sensitivity, range, accuracy amongst others.

INTRODUCTION TO SENSOR FUSION

Sensor Fusion refers to the collection of data from multiple sensors, intelligently, which aids in improving both, the application and system performance. Collecting information from multiple sensors also helps in overcoming the deficiencies of individual sensor, thereby, increasing its reliability.

There are two types of sensor fusion techniques:

Direct: Takes data from a set of like or unlike sensor for improving the reliability.

Indirect: Uses sources which have a-priori knowledge about several conditions.

Block Diagram of Sensor Fusion:

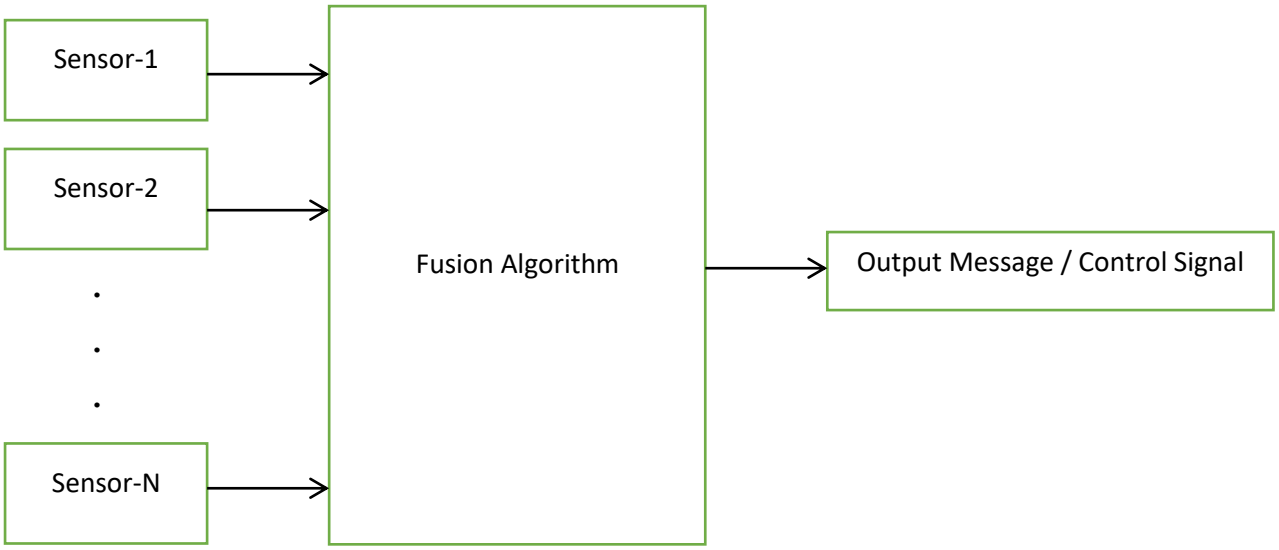

Fig 1: Block Diagram of Sensor Fusion

This project deals with the fusion between an infrared sensor and an ultrasonic sensor which can be used to detect the presence of an object and its distance from the source and minimizing the chances of collision. This is an example of Direct Sensor Fusion Technique.

Advantages of Sensor Fusion:

1. Provides tools for fault improvement.
2. The analytical redundancy introduced can be used to detect and isolate faulty sensors.
3. This redundancy also allows for the reconfiguration of the system in case of a sensor breakdown.

HARDWARE AND SOFTWARE

1. Arduino Uno

The Arduino Uno is a microcontroller based on the ATmega328. It has 20 input-output pins out of which 14 are digital pins and 6 are analog. Apart from the input-output pins, it also has 16 MHz resonator (clock speed), reset pin, an USB connection, a power jack and an ICSP header.

The Arduino works efficiently anywhere in the range of 7-12 volts of input power. It has 5 power pins- Vin to supply power to the board, 5V pin to get a regulated 5V output, likewise the 3.3V pin gives a regulated 3.3V as an output to the board, the GND pin is used for grounding and the IOREF pin gives the reference voltage with which the board operates.

The ATmega328 has 32KB memory with 2KB SRAM and 1KB EEPROM. The Arduino board is as shown below in figure 2.

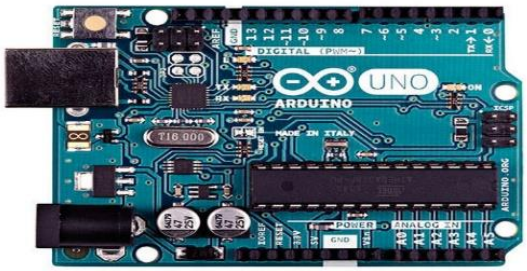

Fig 2: An Arduino board

2. Arduino IDE

The Arduino IDE is used to program the Arduino board. The term sketches in Arduino is synonymous to a program in the IDE. The sketches are written in the text editor window of the IDE shown in figure 3.

The message area at the bottom gives the feedback and errors of the particular program while it is being uploaded. The text console gives complete detail of the message area. The serial port and the type of board being configured is given at the bottom right corner. And, the toolbar gives various options like uploading, saving, opening and creating a sketch among others. Additionally, the IDE gives 5 different menus- File, Edit, Sketch, Tools and Help.

Fig 3: An Arduino IDE

3. Infrared Sensor

'Infrared' refers to the portion of the electromagnetic spectrum which lies between the visible and the microwave region. These waves are not visible to the human eye. The infrared waves can be categorized into three: Near Infrared (0.75-3 micrometers); mid-infrared (3-6 micrometers) and the far infrared (higher than 6 micrometers).

An Infrared sensor is an electronic device that senses an object either by emitting or by detecting the infrared radiation. They are capable of measuring the heat and the motion of an object.

Fig 4: Infrared sensor

4. Ultrasonic Sensor

A sensor that measures the distance by radiating a sound-wave at a particular frequency and listening to it bounce back. It estimates the time taken between the generation of a sound-wave till the reception of the bounced back wave.

For estimating the total round trip distance, the calculated time is multiplied by 344 meters as the sound travels with that speed (344m/s). This is twice the desired distance as the sound wave is propagating from the sensor to the object and back. To find the desired distance, the round trip distance is halved. The formula is given below.

Distance = [speed (sound) x time taken]/2

Fig 5: Ultrasonic Sensor

5. Motor Driver

The motor driver used in this project is L293D 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.

It contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

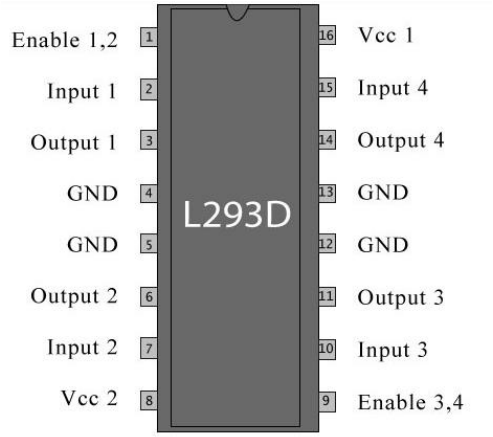

Fig 6: Pin Diagram of L293D

METHODOLOGY

This project mainly functions with the help of two sensors namely, infrared(IR) and ultrasonic sensor as mentioned before and hence we are demonstrating the concept of sensor fusion. A vehicle prototype was developed, shown in the figure 8 to demonstrate this technology. A solid object was used as an obstacle.

The ultrasonic sensor of vehicle senses the distance between itself and the obstacle. By trial and testing, a particular threshold distance was fixed. If the distance between vehicle and obstacle decreases such that it goes below this threshold value, then a warning message is given to the vehicle asking it to go slow or asking the driver to take over the control.

If the distance between the vehicle and obstacle keeps decreasing further such that it reaches a particular level, then the IR sensor goes high. The IR sensor at this point detects the obstacle and the motor driver stops the vehicle one from moving further. Arduino Uno is used as the controller. It can clearly seen that the IR and ultrasonic sensor is working in synchronization for detecting an obstacle and to stop the vehicle from collision. The flow diagram of the project is given below.

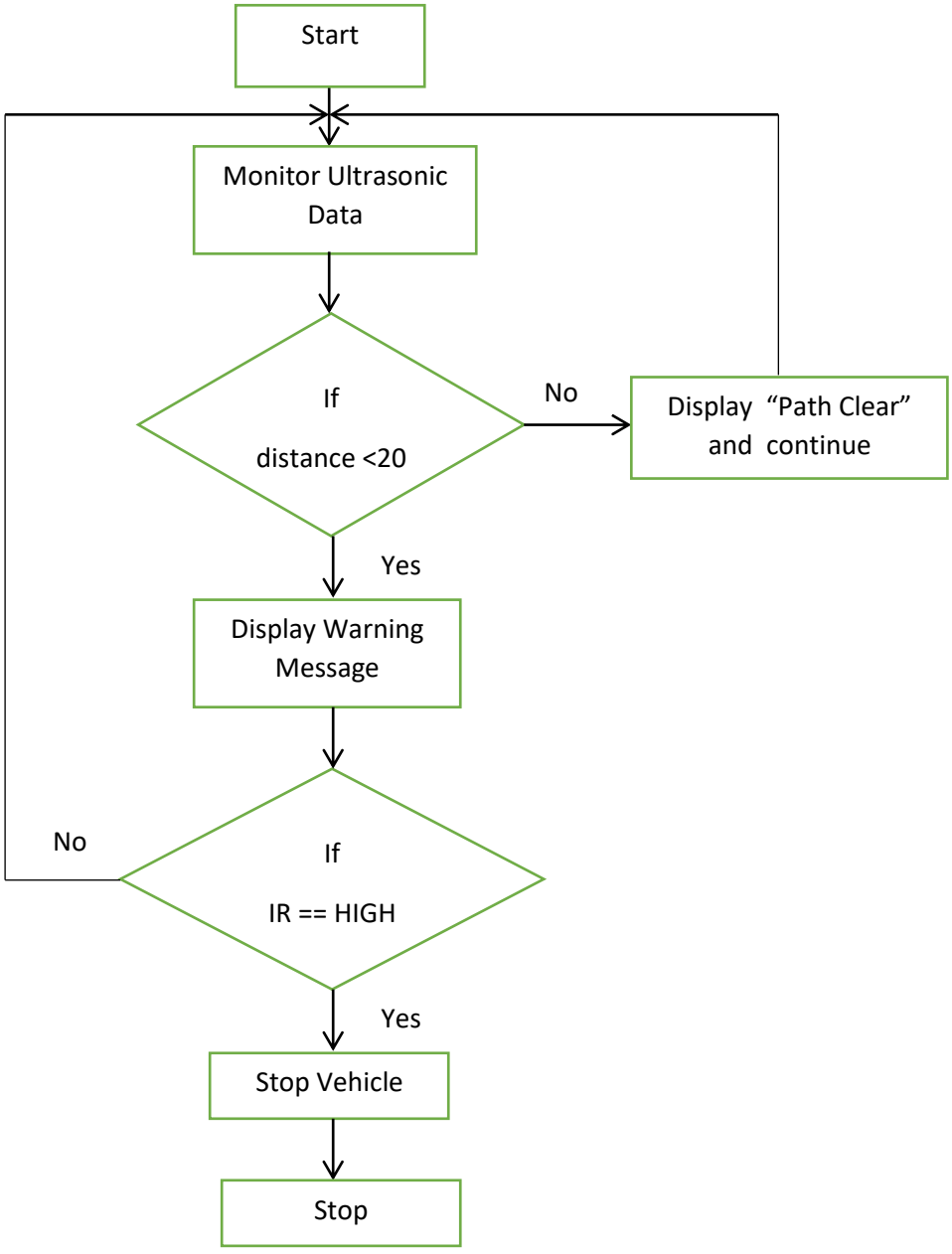

Fig 7: Fusion Algorithm

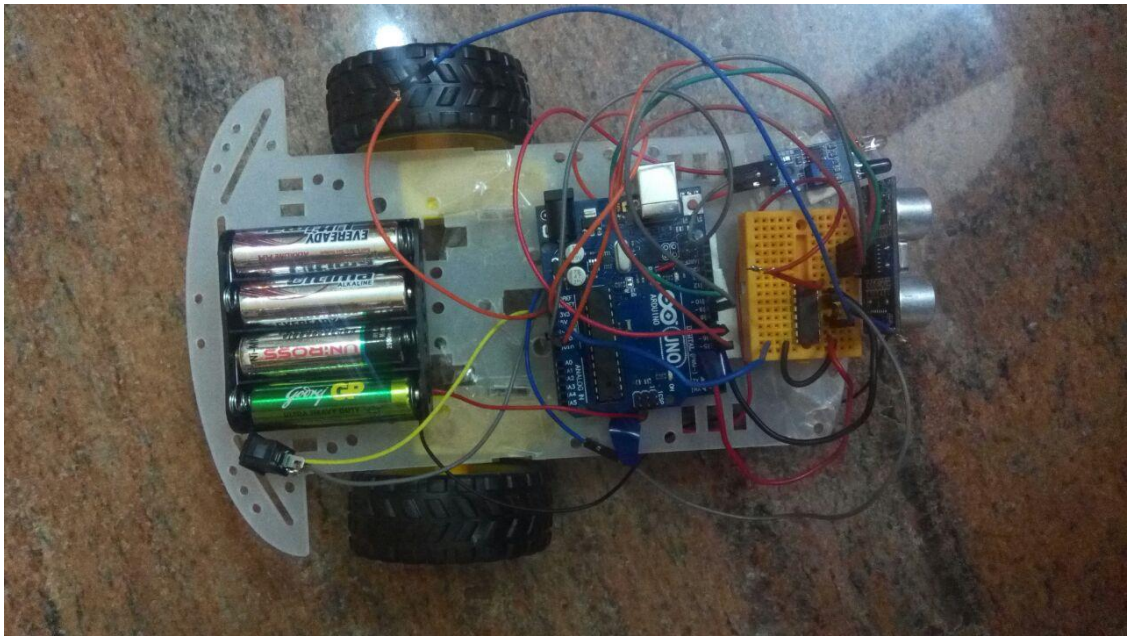

Fig 8: Vehicle prototype

RESULT

The following figures show the output values of ultrasonic and IR sensor as displayed on the serial monitor of Arduino Uno.

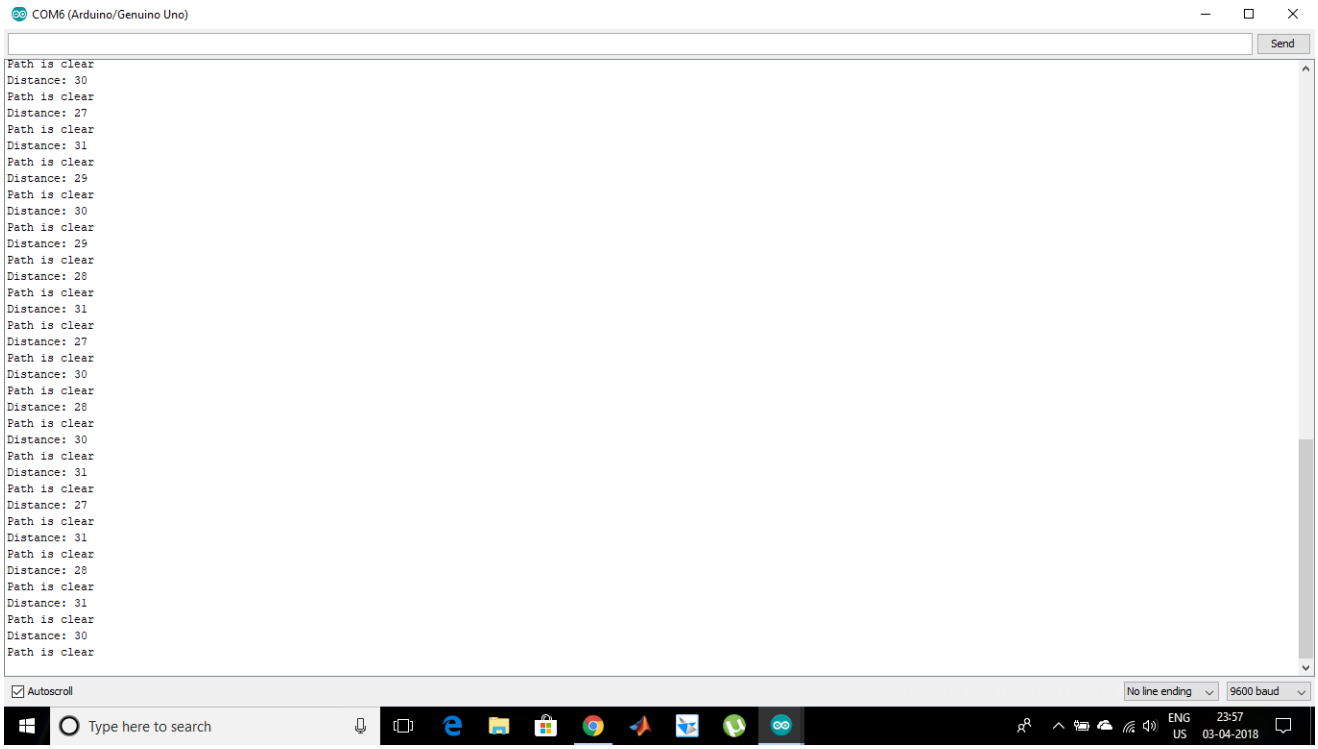

Fig 9: Messages and values when path is clear

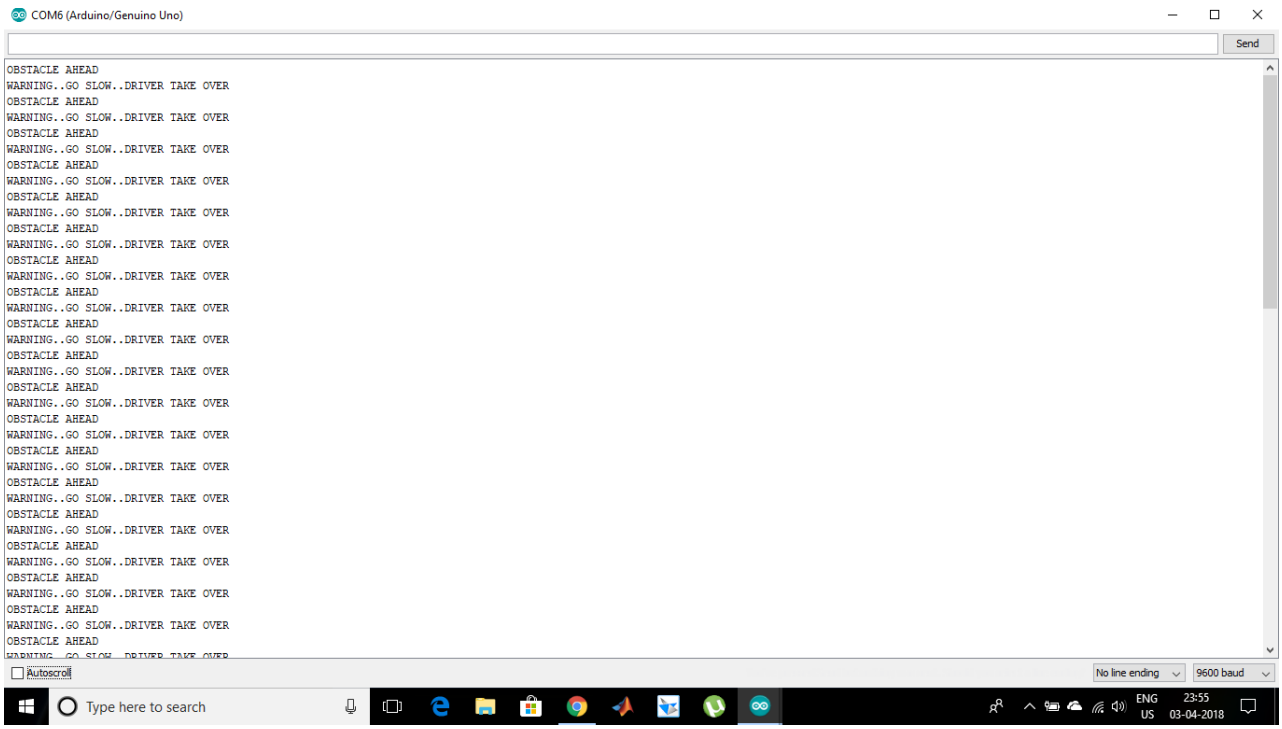

Fig 10: Messages when an obstacle is detected

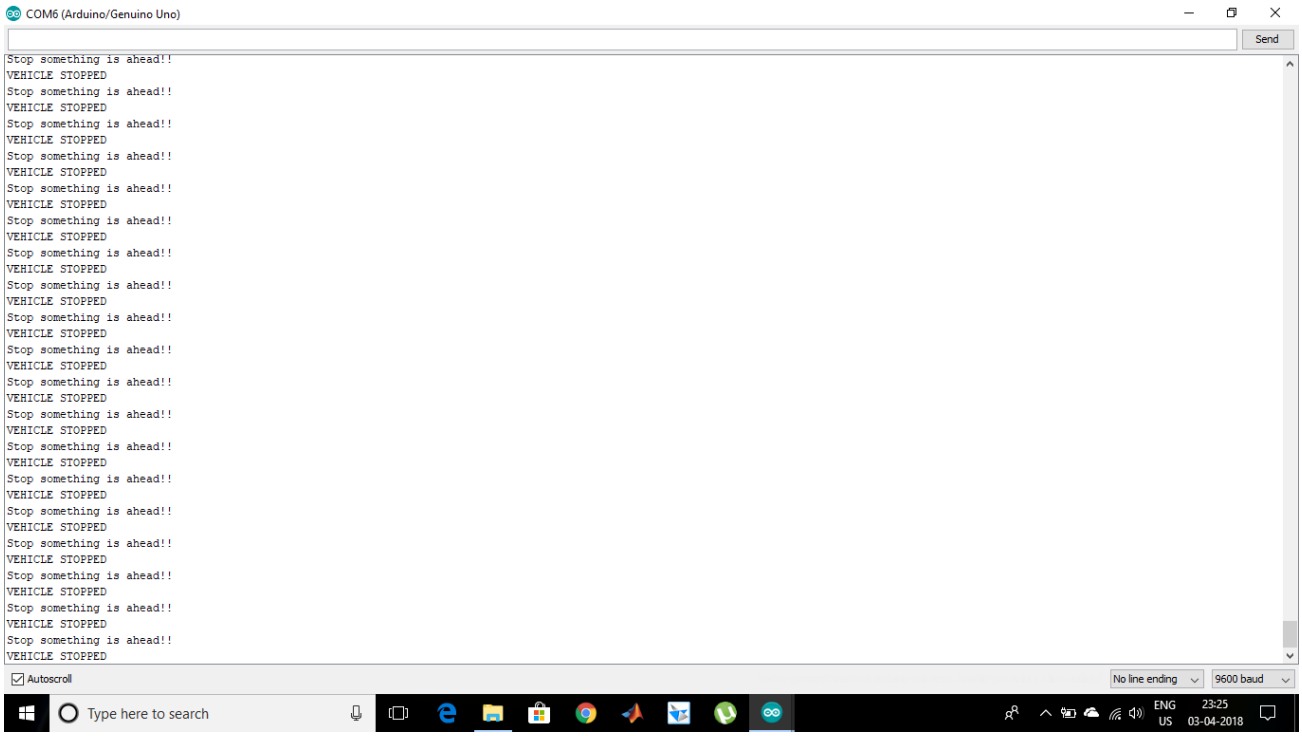

Fig 11: Messages when the vehicle has to stop

CONCLUSION

An autonomous vehicle prototype was successfully built for testing for obstacle detection and collision avoidance using sensor fusion technique. The testing was successfully carried out using Arduino UNO microcontroller and the results were verified.

REFERENCES

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3. TechTalk@KPIT, a quarterly journal of KPIT Technologies Limited, Vol.9 issue 1 January – March 2016