Design of Auto-Braking System for Accident Prevention and Accident Detection System Using IoT

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Design of Auto-Braking System for Accident Prevention and Accident Detection System Using IoT

Gitanjali Mehta, Manoj Singh, Shubham Dubey, Uzair, and Yogesh Mishra

Abstract In recent times, frequencies of accidents have increased considerably. This is because of an increase in the number of vehicles, carelessness of drivers, and over speeding. Over speeding is the main reason for increase in the number of accidents. In this work, the primary concern is to decrease the impact of collision, and after that communicating with the nearby hospital for providing necessary support to the victims. According to data provided by the Ministry of National Highway, most of the deaths occurred because of not getting help in crucial times or not getting an ambulance service in time. Our main aim is to communicate with the nearest hospital through GPS and help the victims. Our work is divided into two main parts. One is sensing and communication part. Other is the braking part which has three steps. When the distance of the vehicle from the obstacle is more than 30 m then the system is disabled. If the distance becomes less than 30 m then a warning is generated by the system for the driver to apply brakes. If the distance is further reduced and becomes less than 4 m understanding that the driver has lost control over the vehicle, control is fully transferred to the braking system and plugging braking is used to stop the vehicle instantly to reduce the impact of a possible collision.

Keywords Accident prevention · Auto-braking system · Accident detection · Internet of Things

1 Introduction

1.1 Overall Description

India is one of the most populated countries, hence the population explosion has made a direct impact in the market of automobiles. The cause of the accidents is mainly due to the quality of roads and the unavailability of new technologies in vehicles. Transportation is the basic need for daily life and to reduce the severity of

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accidental impact these technologies should be updated. Many people face various problems in their day-to-day life because of a lack of available traveling resources. The government is not taking the required decision and lacking the appropriate laws of traffic so that common men and children are not able to travel in secure vehicles [1–3]. So, for the betterment of the society, we came up with the research work "Design of Auto-Braking System for Accident Prevention and Accident Detection System using IoT".

There are many applications in the market to provide safety in vehicles but they are not up to the mark. In our work, we have developed such a technology which can prevent accidents and in case of failure which is evitable there is an alarming system built in the setup which will alarm the nearby hospital, police stations, and the relatives of the victim by sending messages to registered contact number [3, 4].

1.2 Survey

We use transportation to do many of our daily life works but it can create the worst scenarios and even kill people through accidents. In 2008, India ranked fourth in fatal injuries caused by road accidents and the age group which is more involved in these injuries is 15–29. In the absence of required actions, traffic crashes will reach the toll of death of around 1.9 million people annually by 2020.

1.3 Accident Detection

When an accident occurs, we are going to communicate with the nearby hospital to provide the necessary support to the victim. According to statistics from the Ministry of National Highway, accidents are classified into three types. In the first type, the accident is so severe and the victim dies on the spot. In the second type, the victim is seriously injured and can be safe if proper health facility is provided to him on time. In the third type, causality is not severe and takes time to recover but can be recovered. So our prime concern is on the second type and we are focused to provide them help on time thus providing a signal to the nearby hospital using IOTs [5, 6].

1.4 Motivation

We get the motivation for this work from fall detection technology in Apple watch. Similar technology is used by Apple watch, which detects when there is a hard fall or there is a severe impact. An emergency message is popped up in which we can

ask for emergency help if we are seriously injured, or can click on "I M OK", to disable the system. If any option is not chosen then the watch will wait for a few seconds and automatically send the signal to relatives or nearby hospitals. Recently an incident occurred in San Francisco in which a person falls from the terrace and is not able to move, then watch sends signal automatically and the person is rescued.

1.5 Braking Mechanism

In this part, we are concerned about reducing the impact of collision, as by reducing the impact we can decrease the severity of accidents. According to statistics from the Ministry of Highway, Government of India, most of the accidents occurred due to over speeding, so by reducing the speed of vehicles at the last moment we can definitely reduce the casualties. According to statistics, many accidents occurred due to panic of the driver when an accident is going to occur, and he is unable to apply brakes or lose control over vehicles [7, 8]. So we also need to sense the distance between vehicle and obstacle and give warning to the driver to apply brakes (Fig. 1). When the distance is further reduced motor driver circuit comes into picture and decelerates the motor. When the distance is less than 4 m brakes are applied automatically.

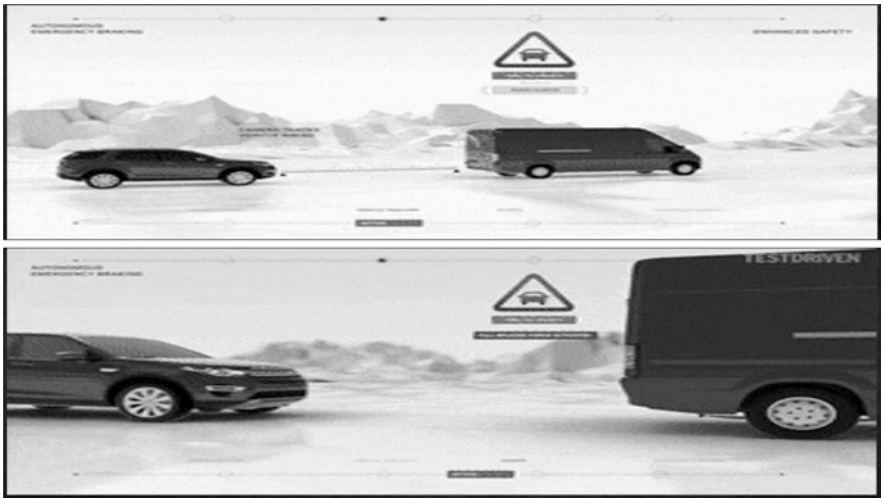


Fig. 1 Braking mechanism to prevent collision of two vehicles

2 Methodology

2.1 Block Diagram

Figure 2 shows the block diagram of the proposed system. The Arduino Uno is a microcontroller board based on the Microchip ATmega328P microcontroller. Arduino has made a huge impact in the electrical and electronics world. In this work, it is used to detect the input from the piezoelectric sensor and send the signal through GPS. A separate 9 V portable power supply powers the Arduino board or we can use the supply of the vehicle [8].

GPS is a global positioning system used to detect the location of anything on the earth. It uses longitude and latitudinal coordinates to find the position of the device. There is a transmitter and a receiver in the GPS module in which the transmitter transmits the signal to satellite and the receiver receives the coordinates. In this project, GPS is used to communicate with nearby hospitals.

A piezoelectric sensor is a type of transducer which takes pressure as input and converts it into electrical signal. In this system when there is a collision between two vehicles a piezoelectric sensor is used in the front part which detects the collision and sends a signal to Arduino.

Internet of Things is abbreviated as IoT. In the present time every device can be connected with each other with the help of IoT, data is stored in the cloud so that our time can be saved. IoT is almost used everywhere in today's world and after Industry 4.0 even large machines can be controlled from anywhere around the world [5, 6].

2.2 Flowchart

Figure 3 shows the flowchart of the process involved in the designed system.

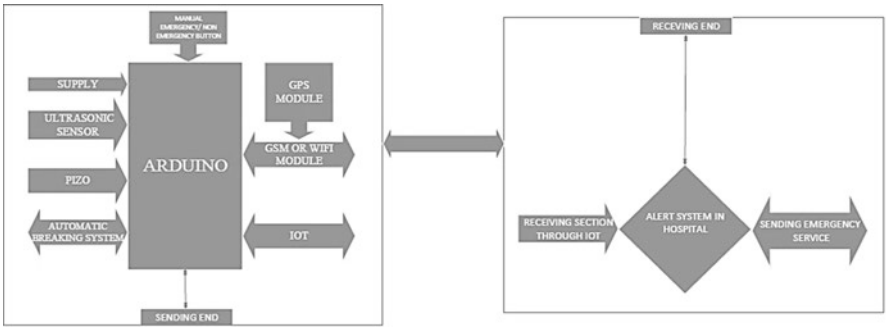


Fig. 2 Block diagram of the system

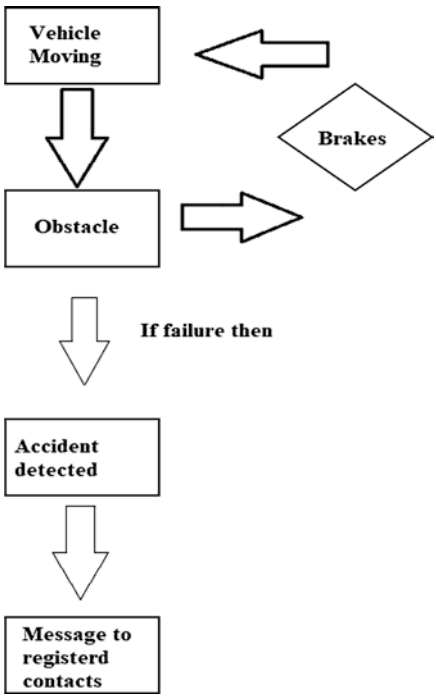


Fig. 3 Flowchart of the process involved in system design

2.3 Software Tools

MATLAB: Matrix Laboratory is a computing environment and mathematical programming language invented by MATHWORKS. It allows manipulation of data and functions. It is used to implement algorithms, create a user-friendly interface.

Multisim: It is developed on the BERKELEY SPICE software simulation. It is an electronic schematic maker and simulation program. It is used to make circuits and to do the simulation.

Proteus: It is a software tool suite developed for the designing of circuits. It generates digital blueprints of the required circuit.

3 Component Description

3.1 Arduino

Arduino is an open-source device, it has various types. In this we are using Arduino Uno. It uses its own Arduino language to compile the Arduino and works on that language to compile the Arduino. But it can be programmed in various other languages also like C, C++, Python, and Java. It consists of 28 pins, in the pin

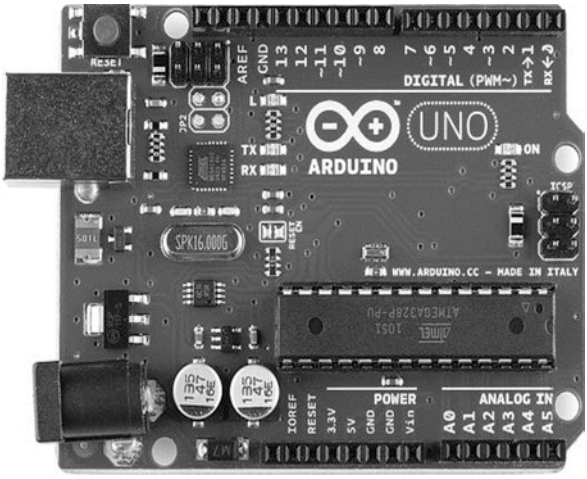


Fig. 4 Arduino Uno Board

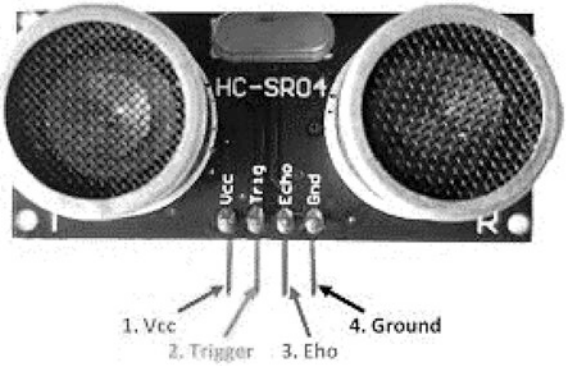


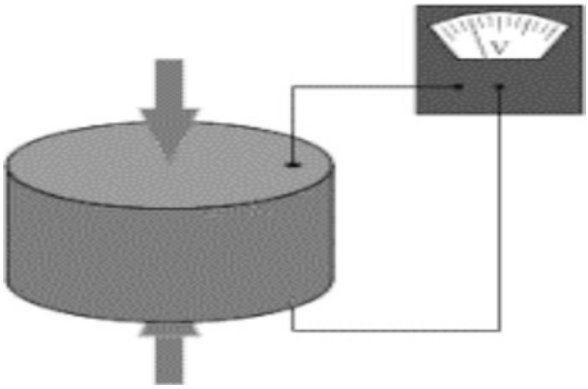
Fig. 5 Ultrasonic sensors

configuration it has 13 digital input-output pins which can be used for either input or output. It has six analog pins that can be also used for input and output port, and it works on 5 V supply, it consists of three GND terminals (Fig. 4) [8].

3.2 Ultrasonic Sensors

Ultrasonic sensor (Fig. 5) plays a major role in measuring the distance between two vehicles or any obstacles. Ultrasonic sensor uses high-frequency signals or waves which cannot be heard by normal human ears. Sound wave is emitted by ultrasonic sensors which strike with obstacles and revert, which calculates the distance between the vehicles and obstruction. Ultrasonic sensors are used in submarines, aircrafts, and radars. It consists of two parts, i.e., transmitter and receiver. The transmitter transmits the signal whereas the receiver collects the reflected signal to calculate the

Fig. 6 Piezoelectric sensor



distance. The formula for calculating the distance is: Distance $d = 1/2 \times t \times v$ where d is the distance travelled, t is the time taken between the emission and reception, and v is the speed of sound.

3.3 Piezoelectric Sensor

A piezoelectric sensor (Fig. 6) is a type of transducer which takes pressure as input and converts it into electrical signal. In this system when there is a collision between two vehicles a piezoelectric sensor in front or back part of the vehicle detects the collision impact and sends signals to Arduino.

3.4 Motor Driver IC L293D

L293D Motor Driver IC shown in Fig. 7 is one of the important components used in braking. Motor driver circuit is used for controlling the speed of the motor. When the distance between vehicle and obstacle is less than 30 m then motor driver comes into picture and motor slightly decelerates and a warning is generated by Arduino. When the distance is further reduced final warning is generated and motor further decelerates. In the final step when the distance is less than 4 m then the driver circuit fully takes control and applies plugging brakes to stop the vehicle.

L293D Motor Driver IC consists of 16 pins: 4 output pins, 2 enable pins, 4 input pins, 2 Vss, and 4 GND. Input pins are connected with Arduino to take the signal from it. Output pins are used for controlling the speed of the motor. It works on 12 V and other terminal is used for providing voltage to motor (Fig. 8).

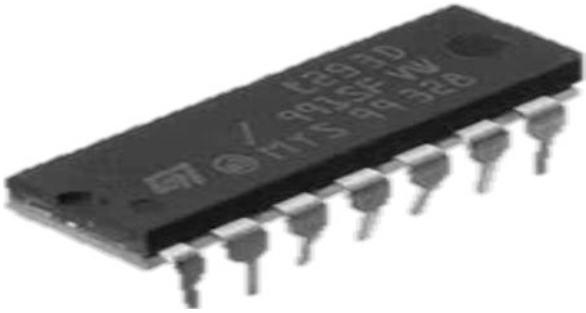


Fig. 7 L293D Motor Driver IC

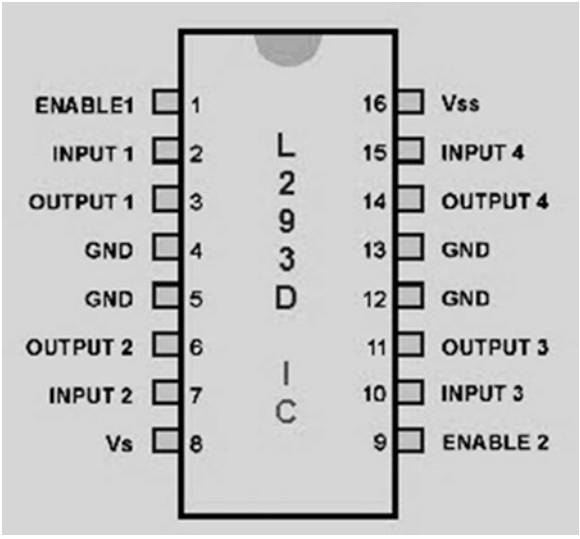


Fig. 8 Pin configuration of L293D Motor Driver IC

4 Design Process

4.1 Design Steps

While driving, the sensors monitor the distance between the vehicles. Figure 9 shows vehicle with sensors and auto-braking system. Working of the braking system can be divided into four parts:

1. When the distance between vehicles is more than 30 m, system is not activated or it is disabled.
2. When the distance is less than 30 m braking process will start. Motor starts decelerating or a little brake is applied by the system, and warning is given to the driver.
3. When the distance is less than 10 m further deceleration of motor takes place and extra warning is given by the system to the driver.

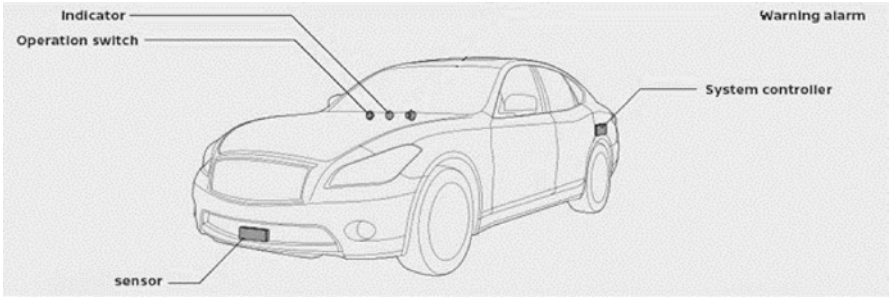


Fig. 9 Vehicle with sensors and auto-braking system

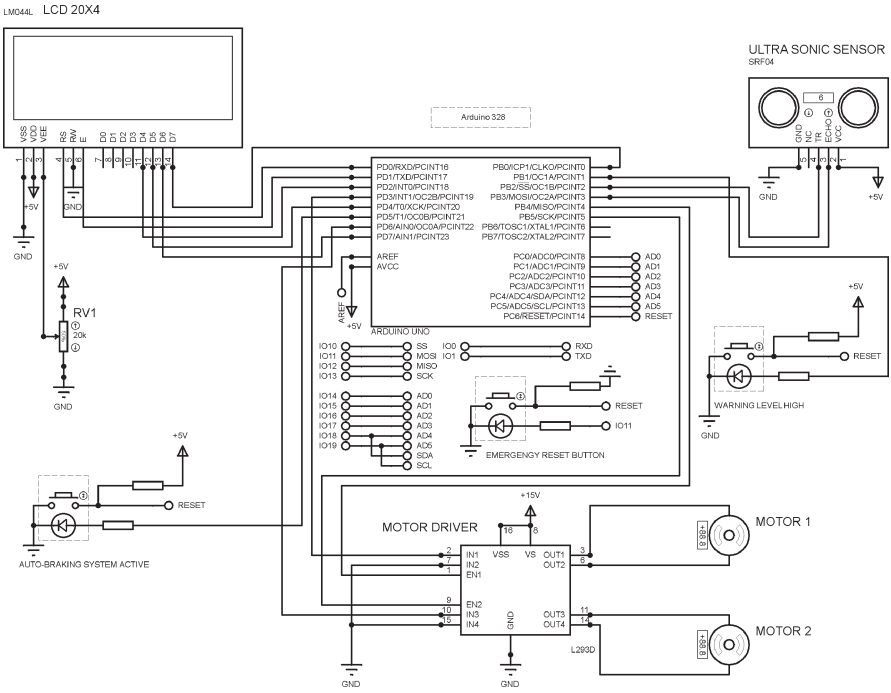


Fig. 10 System configuration

4. When the distance is less than 4 m whole system is fully automatic and there is no control of driver in vehicles. An emergency brake is applied by the system. This will reduce the damage caused by the collision of two vehicles.

4.2 System Configuration

Figure 10 shows the system configuration.

5 Results and Discussion

Figure 11 shows the Proteus simulation circuit.

When the distance between the obstacles is less than 4 m, the Auto-Braking System will be activated and automatic brakes will be applied as shown in Figs. 12 and 13.

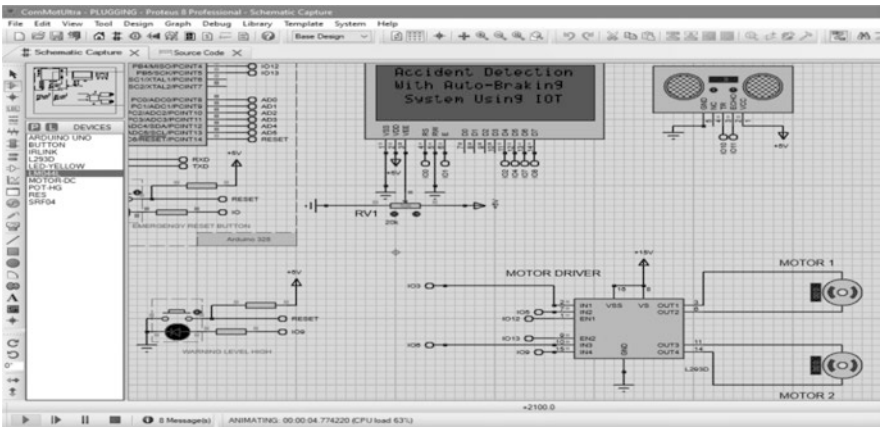


Fig. 11 Simulation circuit

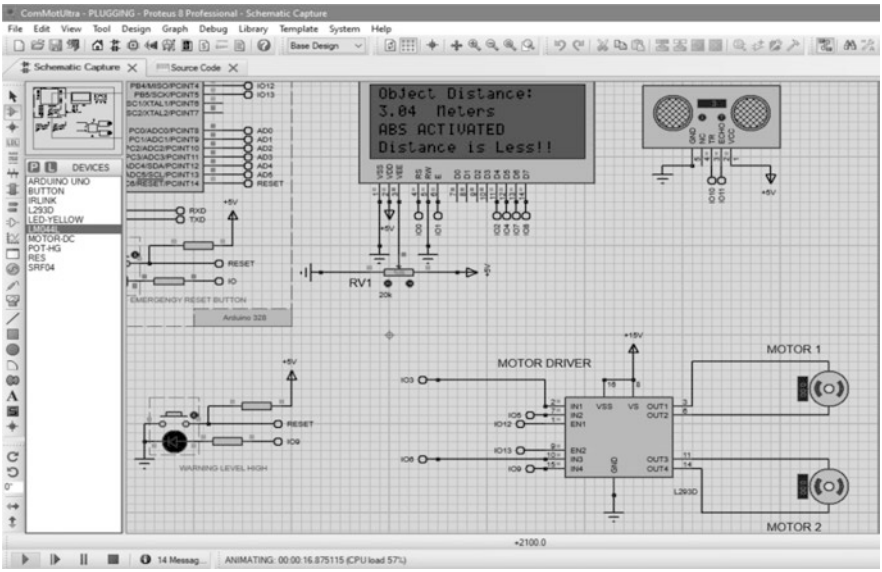


Fig. 12 Simulation result when obstacle is less than 4 m and automatic brakes applied

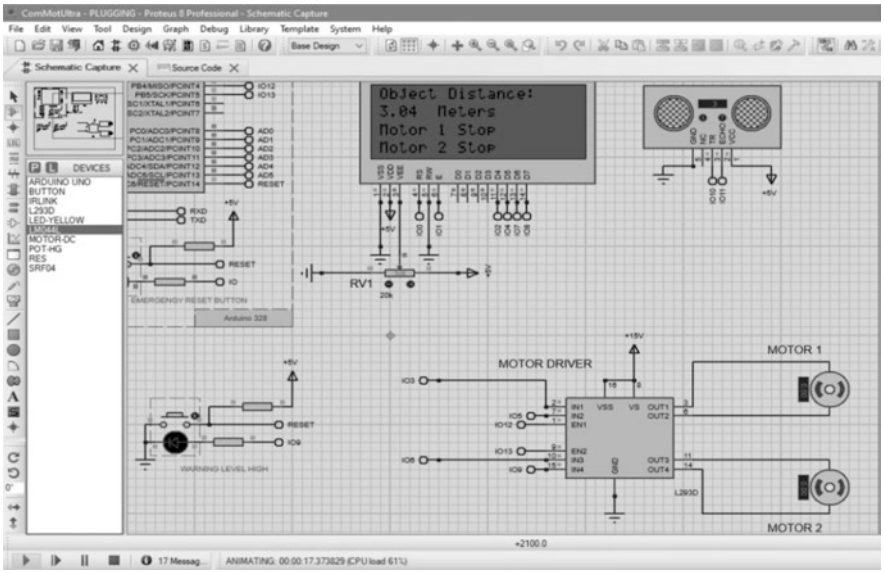


Fig. 13 Simulation result when automatic brakes applied to stop the car

When the distance between the obstacles is between greater than 4 m and less than 10 m, the Auto-Braking System will generate a signal to motor driver to limit the speed to the desired value and alert the driver of the car also as shown in Figs. 14 and 15.

When the distance between the obstacles is between greater than 10 m and less than 30 m, the Auto-Braking System will generate a signal to motor driver to limit the speed to desired value as shown in Fig. 16.

When the distance between the obstacles is greater than 30 m, the Auto-Braking System will be active but will not generate any signal to the motor driver (Fig. 17).

6 Review and Comparison

The objective of the proposed work is to prevent or reduce the severity of a collision. This safety feature will reduce those accidents which can be fatal or at least the impact can be reduced up to a maximum extent. The speed of the vehicle is automatically reduced so as to reduce the impact of collision. Even after automatic emergency brake if there is a collision, then the sensing and communication part takes place. Piezoelectric sensor senses the impact and Arduino detects the collision and sends the signal to the nearby hospital through GPS.

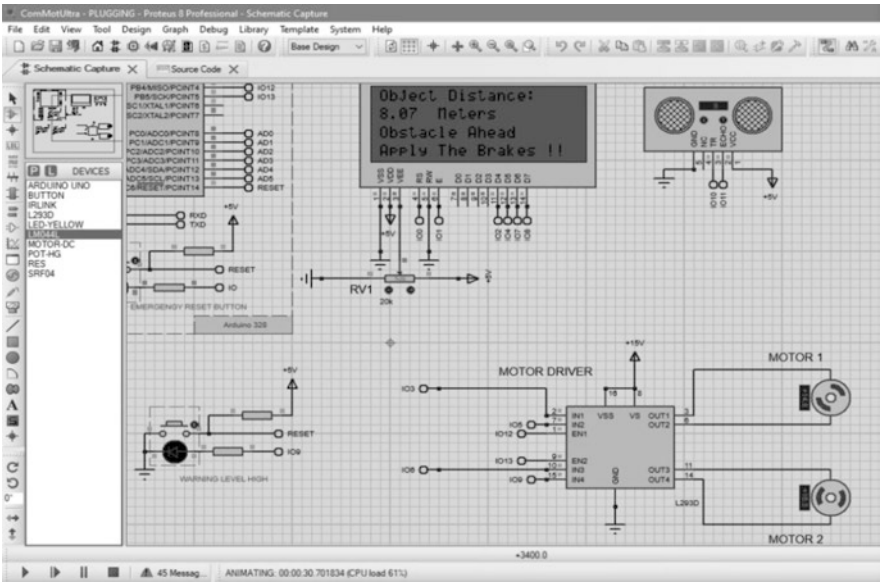


Fig. 14 Simulation showing alert signal when obstacle is between 4 and 10 m

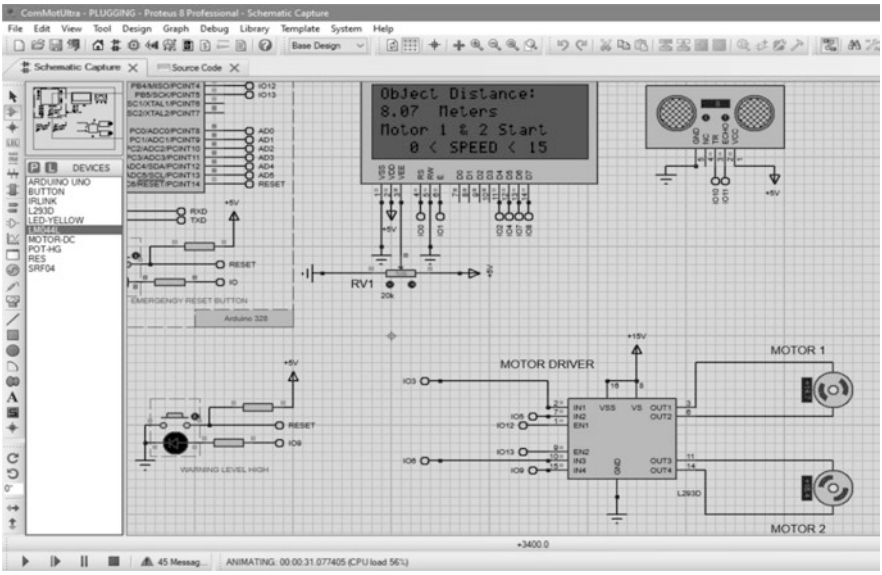


Fig. 15 Simulation signaling the driver to limit the speed to the desired value

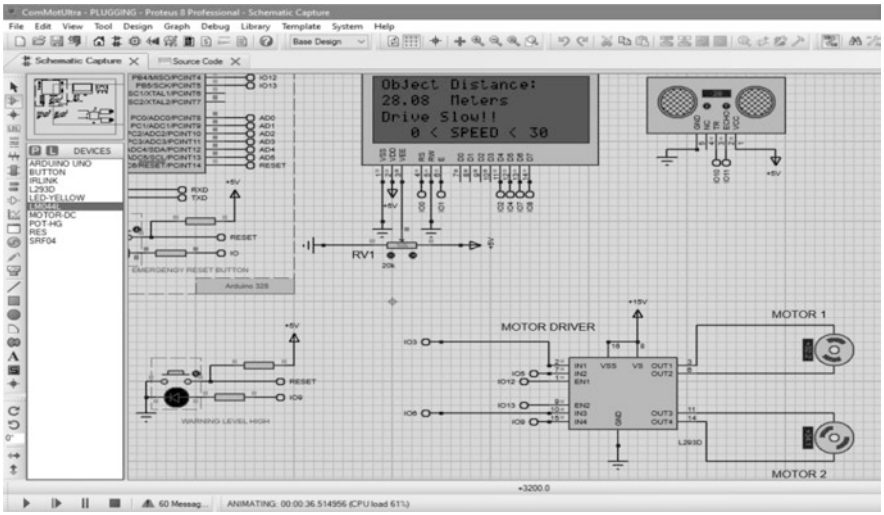


Fig. 16 When the distance between the obstacles is between 10 and 30 m

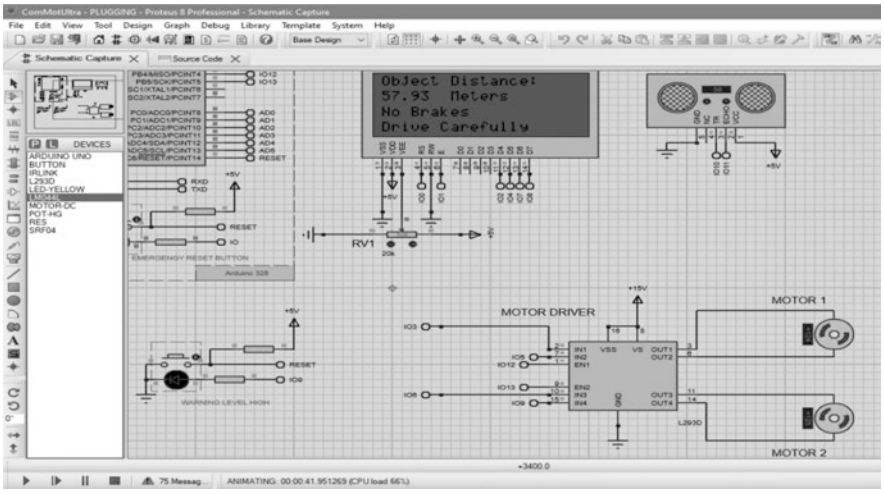


Fig. 17 When the distance between the obstacles is greater than 30 m

The advantages offered by the proposed system are:

- It is fully automatic.
- It has a simple electronic control unit.
- The components used are cost-effective.
- Automatic brakes are applied to prevent collision.
- The system is helpful for front as well as back collisions.

However, there are certain challenges involved:

- We cannot totally depend on the braking system, because sometimes there are various conditions in which distance is less but we do not require the emergency braking.
- Emergency braking may cause wear and tear in motor parts.
- Dust and dirt can reduce the efficiency of ultrasonic sensors.

The proposed system can be used in any type and size of the vehicle, AI-operated vehicles as effective assistance, and in concept cars for reducing the chances and impact of vehicle crash and providing immediate assistance in case of any casualty.

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