Automatic Braking System

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Abstract: - Braking System in Automobile is one sector which is the most important in terms of safety division. However, in recent years braking system is one which is constantly evolving and each and every company are constantly working for research and development in braking system of vehicle. The desirable braking system of a land vehicle is that it can stop the vehicle or reduce the vehicle speed as quickly as possible, maintain the vehicle direction stable and recover kinetic energy of the vehicle as much as possible. In this research, an electronically controlled Automatic braking system for EV and HEV has been proposed, which integrates regenerative braking, automatic control of the braking forces of front and rear wheels and wheels antilock function together. This system works together with sensors and ECU of braking under any emergency situation when driver is unable to apply brake under any unforeseen condition.

Key Words: — ***Braking System, Automobile, EV, HEV.***

I. INTRODUCTION

An advanced emergency braking system (AEBS) is a system which handles the vehicle automatically in case of emergency. The road vehicle safety system comprises sensors which monitor the proximity of vehicles which are in front of it and detects the conditions where the relative speed and distance between the vehicle and the obstacle suggests that a collision is likely to happen, as shown in figure 1. In these situations, emergency braking can be automatically applied to avoid or reduce the chances of collision. AEB system has the capability to reduce the impact of speed or mitigate the effects of head on crashes, rear end crashes, right turn crashes and pedestrian crashes. Automatic Emergency Braking (AEB) is an emerging form of Advanced Driver Assisted Systems (ADAS) which works on the principle of electronically controlled Ultrasonic Sensors which analyze and sense the speed of the Vehicle coming, and thus helps to apply AEB system into working [1].

Manuscript revised May 01, 2022; accepted May 02, 2022.
Date of publication May 04, 2022.

This paper available online at www.ijprse.com

ISSN (Online): 2582-7898; SJIF: 5.59

The major factors responsible for the accident includes poor visibility of other vehicles or obstacles, ignoring traffic signals and not maintaining a specific and safe distance from another vehicle. AEB is based on vehicle-to-vehicle communications (V2V) which helps to mitigate the effect of high-speed collision to a low-speed impact collision.

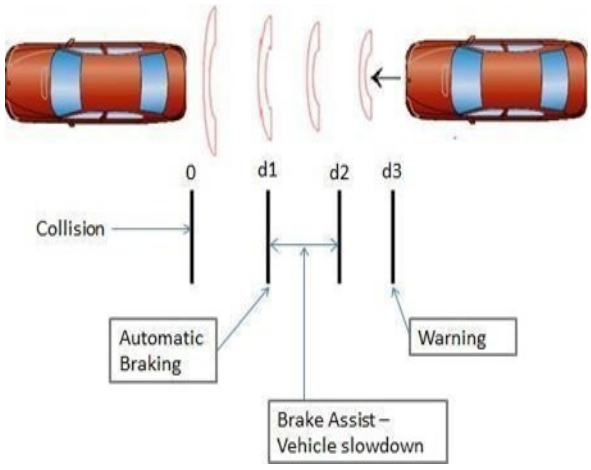

Fig.1. Working Principle of AEB System

These systems initially alert the driver to take feasible action to avoid the collision. The alert may be an audio signal to the driver, Alert on the Display screen or tightening of the seat belts. If the driver's steering and braking intervention is not adequate to avoid a collision, the automatic emergency braking system will be helpful in automatically applying the brake [2].

II. TECHNOLOGY USED

2.1 Ultrasonic Sensors with The Use of Stereo Cameras

The normal audible frequency range for humans is 20 to 20,000 Hz. Ultrasonic waves are those waves which are above this frequency level of hearing, so these waves have frequency above 20,000 Hz. Ultrasonic Sensors make use of high frequency waves to detect the presence of an object and determine its range. These sensors emit ultrasonic waves and estimate the echo which is obtained by the sensor which helps in calculating the time interval and thus calculating the distance between vehicle and the obstacle. The Echo reflections of moving objects will exhibit a Doppler Shift, which determines the speed of the other object. The ultrasonic sensors consist of two basic components: Transmitter and Receiver. An ultrasonic wave generator generates an ultrasonic wave and after the wave is produced, the ultrasonic transmitter transmits the ultrasonic waves to detect an obstacle. Then, when the ultrasonic wave detects the obstacle, it will produce a reflected wave as shown in figure 2. An ultrasonic receiver receives the ultrasonic waves reflected from the road surface to generate a received signal [3]. As ultrasonic sensors are not vision-based they can be used very effectively under the conditions of poor lighting and objects which are transparent in nature. Also, we have used Stereo Cameras along with the ultrasonic sensors which can detect up to 500m range. Low-cost components are only installed in this sensor. This sensor is adaptable for any conditions [4].

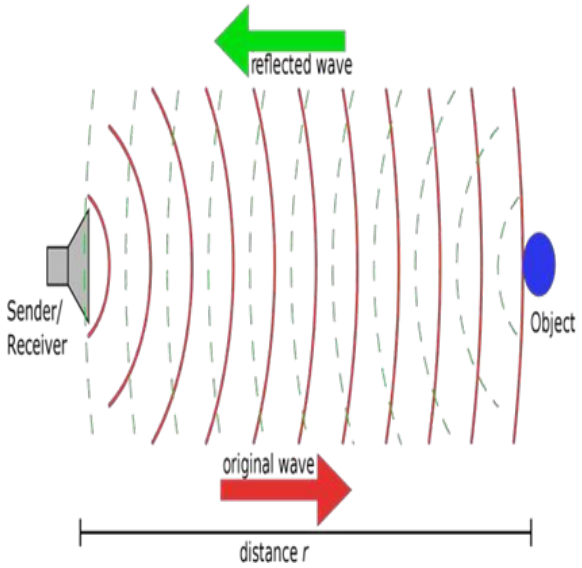

Fig.2. Working of Ultrasonic Sensor

III. CONVENTIONAL SYSTEM

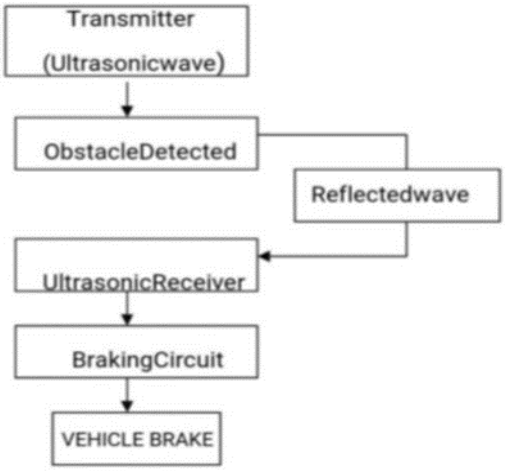

Fig.3. Conventional Braking System

Figure.3. shows the conventional arrangement comprising of antilock braking system (ABS) which is used to apply the brakes with the help of discrete locking of disc and was known to be a very efficient method of applying brakes by pushing brake pedal downwards. This method helped to mitigate the skidding effect in the vehicle and was very helpful for the stability of the vehicle while at higher speeds. It reduced the danger of accidents to some extent.

IV. PROPOSED SYSTEM

The basic aim of this work is to develop a safer braking system so as to have less human attention to the driving. Previously cars with sensors have been made which just sense

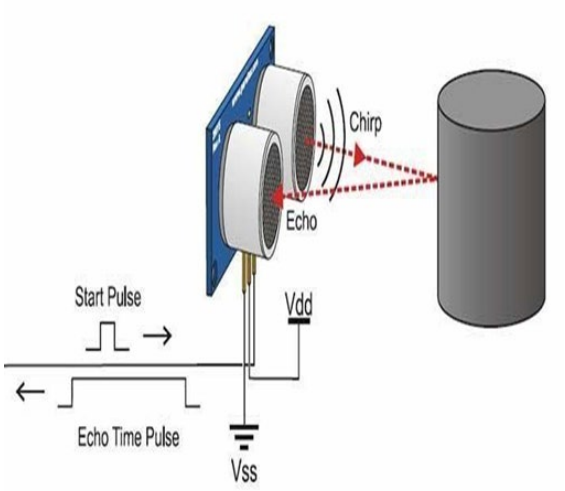

Fig.4. Ultrasonic Sensors

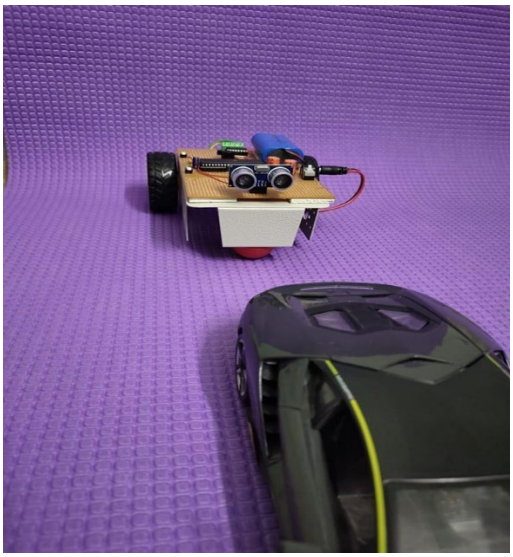

Fig.5. Automatic Braking Against the Vehicle

the obstacles and gives an alert to the driver. In this system we are exploring the recent work in an innovative way. This system has an ultrasonic sensor with the combination of Stereo cameras which has a spatial intelligence of 50 meters and is having an environmental recognition of 500 meters. The basic epitome of this system is to apply the brakes automatically if no action is taken by the driver in case of an emergency. National Highway Traffic Safety Administration claims that the use of Automatic Emergency Braking System would reduce the accidents up to 27% [5].

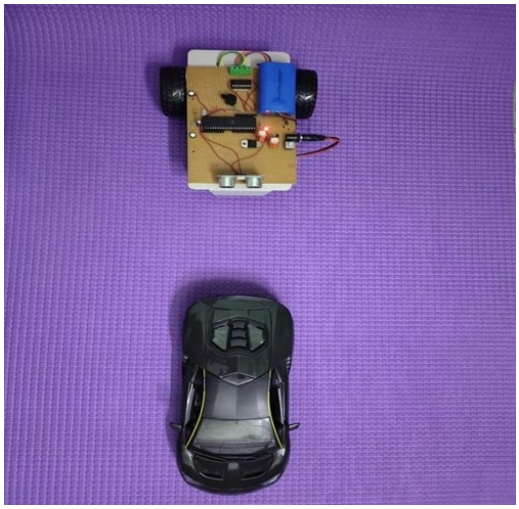

Fig.6. Proposed System

In this system Ultrasonic sensors and the Stereo Cameras are attached to the ECU which records all the information of the signal given by them. A proximity sensor is attached to the lower side of the Brake pedal to sense if the pushing action is provided on the brake pedal by the driver or not and is attached to the ECU for simultaneously working of all the sensors so that the system should work effectively. The idea was further moved to actuate the piston of master cylinder with the help of solenoidal coils which are wrapped around the master cylinder as shown in figure 4. The solenoidal wires will get actuated with the help of a signal provided by ECU, thus making the master cylinder work and application of brakes will take place automatically [2]. Different Manufacturers call the AEB system with their own proposed names. Audi calls it Adaptive Cruise Control with Pre-Sense Front, BMW call it Driving Assistant Plus, Honda names it as Collision Mitigation Braking System, Mercedes has Collision Prevention Assist 3.0 and Volvo names it as City Safety etc. [6].

V. WORKING OF THE PROPOSED SYSTEM

This system will engage the brakes automatically only when there is no assistance by the driver for an action to take place under the condition of an emergency. There will be two working regions of the system. In the first region, the ultrasonic transmitters will transmit the ultrasonic waves to find the distance of an obstacle towards the road surface. If the sensor detects any kind of physical obstacle, it will produce a reflected wave. The Ultrasonic receiver will then receive the reflected signals to measure the accurate distance of the obstacle. The use of Stereo Cameras is basically for the detection of vehicles, pedestrian and objects. This camera helps to identify the moving objects and it reduces the effect of false recognitions of objects from a far distance [7].

This system will then detect the relative distance of the obstacle and also the relative speed of that obstacle. If the system judges that an accident is likely to happen, it will first warn the driver with help of audio signals, alert messages on the display, tightening of the seat belt or even using red lights inside the vehicle. In the second region the use of piezoelectric sensors will come into play. After the alert signals, if the brake pedal is pushed to avoid the collision, then AEB system will get disengaged, if pedal is not pushed, the AEB system will be engaged. Piezoelectric Sensors will sense if the brake pedal was pushed or not and will send the information to the ECU. Consequently, ECU will send the signal to actuate the Master cylinder with the help of solenoidal wires and thus in the second region Automatic Emergency Braking system will apply brakes automatically to avoid any collision which was meant to happen without this system [2].

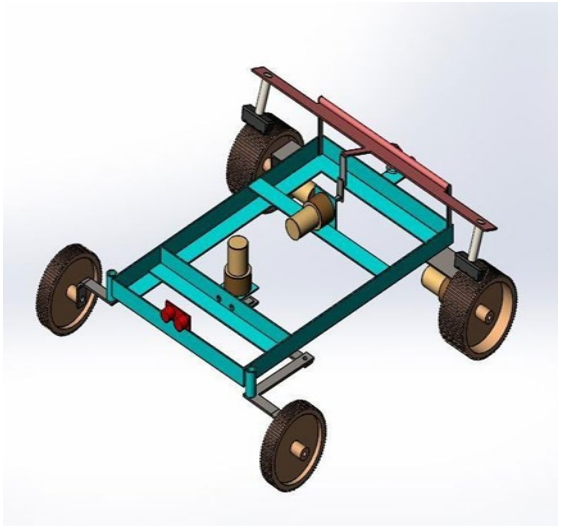

Fig.6. Isometric view of Project

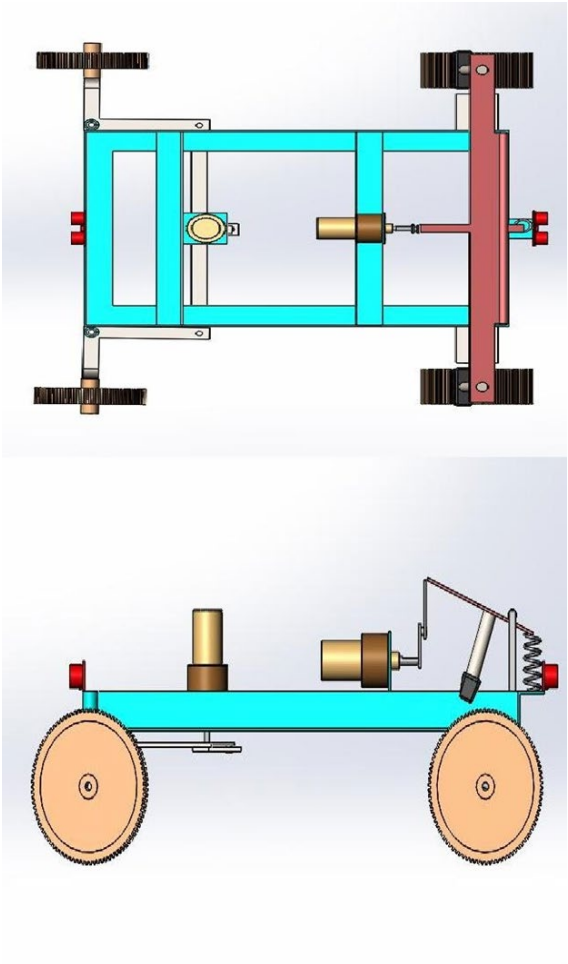

Fig.7(a) Top view Model, Fig.7 (b). Side view of Model

5.1 Calculations

Stopping distance $D = 0.5 (V)^2/a$ (1)

Where 'V' is initial velocity and 'a' is acceleration. Every car has its own braking efficiency which depends upon the force exerted by the tires on the surface given by

$$F= \mu N \qquad (2)$$

Where 'μ' is the frictional coefficient between the tire and surface and N is the weight of the car.
If we increase the value of μ the efficiency of car would decrease and if we increase the weight of the car, we will have to counteract higher momentum. Therefore, an efficient method of having greater downward force is achieved by using spoilers or by using sticky tires.

If we consider 1g decelerating force which tires exert on the surface then the relation between total stopping distance and the alert area in Automatic Emergency Braking System is depicted by the graph shown in the figure.5.

Braking Distance = V / 2μg (meter) Where
V= Velocity of the vehicle (m/s)
μ = Coefficient of friction of road = 0.8
g = Acceleration due to gravity = 9.81(m/s2) Now, for velocity 10 km/hr.
Braking Distance = (10*1000/3600)/ (2*0.8*9.81)
= 0.18 m
For velocity 20 km/hr.
Braking Distance = (20*1000/3600)/ (2*0.8*9.81)
= 0.35 m

5.2 Advantages

With the use of an automatic steering system, a driverless car can be conceived and materialized.

- In the proposed system, the uses of Ultrasonic sensors are reliable in rainy weather as well and this gives an advantage of using the sensors outside the body of an automobile. Stereo cameras are used for eliminating any noisy signals taken up by ultrasonic waves and once the distance of the object is sensed by US sensors it further provides depth of instructions about the shape and size of the obstacle. The combination of US

sensors and the stereo cameras make the system cost effective as they are cheap and reliable.

- A recent study in US revealed that an overall 38 percent reduction for vehicles having low speed AEB as compared to vehicles with no AEB and approximately 70,000 U.S. police reported rear-end crashes in 2013 and 30,000 injuries in such crashes could have been prevented if all vehicles were equipped with Forward Collision Warning with AEB [8].
- With AEB installed in the cars, the car insurance premiums are reduced. The manufacturer sees a reduced possibility of accidents thus they provide insurance at cheaper rates. A study by IIHS in the US presented that people owning Volvo vehicles having AEB technology were given insurance at 25 percent lesser proportions [9].

VI. CONCLUSION

Automatic Emergency Braking system eliminates or mitigates the severity of various types of crashes like head on collision, pedestrian crashes. In the present work, the use of ultrasonic sensors with the use of stereo cameras helps to determine the distance between the vehicle and the obstacle. These sensors are quite cheaper than other types of sensors available in the market.

An Ultrasonic sensor can detect any kind of obstacle thus it also prevents collision of vehicle with pedestrians or it can at least mitigate the effect of the crash. It is emerging as the safest technology presently for the prevention of accidents.

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