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Development of Collision Mitigation Braking System

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Abstract: *The main focus of the study is to address the problem of slow braking reaction of the driver tends to frontal collision and also to develop the active safety system that will have the potential to braking itself automatically. The system consists of an autonomous vehicle and active collision avoidance system fixed at the frontal section of the vehicle. The collision mitigation braking system consists of an ultrasonic sensor and Node MCU microcontroller which is programmed by Arduino based software. The system was tested on small model which brakes the vehicle when an obstacle detected within the range of 12cm.*

Keywords: Frontal Collisions, Active Safety, Collision Avoidance, etc.

I. INTRODUCTION

According to the global road safety partnership annual report 2014, as many as 1:24 million people died each year due to various road accidents occurring throughout the world. Apart from the above-mentioned death toll, about 50 million people become victim of critical life-altering injuries. This is a global human disaster and this is 8th leading cause of the death globally. The scenario is becoming further worsen in the developing country like India where number of fatalities due to road accidents is on higher side. So, road safety is treated as an important major issue in the developing countries like India. Accidents causes a big loss to the national economy since these is leading to the damage of health and properties, but also bring the social sufferings and general degradation of the environment. One of the remedies to reduce the road casualties is to slow down the speed of the vehicles to a safe limit which will reduce the number of accidents caused by the over speed.

However, slowing down is not a best choice in today's fast-moving life. Focus to minimize the number of accidents, significant amount of research efforts had been contributed over the past few decades. Of these, the performances of real-time vision system for robotic travel aid, vision-based driver assistance system adopting stereo vision and motion analysis to determine deadly traffic situations and so on, are greatly affected by the bad weather conditions like heavy rain, fog or snow fall etc. On the other hand, different types of sensors as well as internet-of-things (IoT) nodes also play a very vital role in designing accident avoidance or warning system for on-road vehicles due to the significant advancement in micro electromechanical systems. Unfortunately, most of these existing systems not provide solution to the problem of predicting the collision in real-time. Thus, this paper focuses on the creation of a real-time collision avoidance system for on-road vehicles. The novelty of our proposed lies in its ability to warn the driver and also to provide him/her sufficient information and even breaks itself at the crucial moment in order to avoid any sort of collision. For instance, if the vehicle reaches within very close limit to either a static object or another moving vehicle, then our proposed system will brake automatically reducing the risk of collision to avoid the accident. Such system helps a driver to improve his/her driving skill too. Our proposed system applies an algorithm that processes information collected from its different nodes to estimate the probability of collision. Moreover, the proposed system can be easily placed on any existing road vehicle and does not require of any extra infrastructure on the road side. Furthermore, our proposed system is also cost-effective as it consists of various low-cost devices such as ultrasonic sensor, W-Fi module, microcontroller etc.

II. LITERATURE REVIEW

This part momentarily depicts different auto collision anticipating frameworks and notice frameworks proposed in writing throughout the course of recent many years. The greater part of the mishap expectation frameworks incorporates some sensor hubs and a microcontroller for handling the information gathered from those sensors.

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Then again, the correspondence among the close by vehicles to share data through vehicular impromptu organization, i.e., VANET [4] assumes a critical part. The distance cautioning framework [5], presented by Mitsubishi Engines for trucks and transports, can predict the possibilities of a backside impact and afterward cautions the driver in like manner. Albeit this proposed framework can send a caution to the driver on the off chance that some other vehicle is moving toward the host vehicle, yet the alert sign in this framework is created by the distance between the main and framework prepared vehicles as it were. Besides, such framework can't give target pursuing and danger appraisal [5]. The analysts in [3] have applied sound system vision and movement examination to distinguish the risky traffic circumstances and dissect the mishap likelihood. A neuro-fluffy vehicle crash forecast framework (NEFCOP) that applies laser running to gather the information about the encompassing street climate and afterward both the brain networks as well as fluffy rationale to deal with the gathered data to examine the likelihood of an impact, has been proposed in [6].

A Front facing Impact Cautioning Framework (FCWS) for the vehicles in view of ceaseless following of the vehicle and conveying messages in regards to the plausible crash, has been proposed in [7]. The proposed framework in [7] utilizes radar and Lidar sensors to decide the place of the articles closer to the ongoing vehicle and furthermore uses the vehicles speed and rakish speed for expectation of the mishap. In [8], the scientists have involved the distance between two vehicles as an overseeing element to foresee the mishap. They have utilized ultrasonic sensor hub to appraise the distance and their proposed framework can identify the vehicle inside specific distances on both side (front and back) of the host vehicle.

On the contrary hand, the plausibility and proficiency of the VANET that is framed among the vehicles out and about, in keeping away from impacts to ensure the street security, have been concentrated in [9]. Convergence cautioning framework (IWS) [10] and convergence crash cautioning framework (ICWS) [11] are one more two framework that endeavour to stay away from the impacts at the street crossing segments simply by sending some notice at whatever point a vehicle moves toward the host vehicle at the crossing point regions. A Robotized hostile to crash framework that can identify just hindrances by sharp distance sensor, sends cautions in the event that the vehicle is in close distance of impact and endeavours to stop the vehicle without the assistance of human mediation, has been proposed in [12].

The specialists in [13] means to plan a shrewd vehicle framework that can recognize any strange condition or mishap by detecting different boundaries from the safety belt sensor, vehicle black box and the eye squint sensor put inside the vehicle and can naturally illuminate it to the traffic police as well as the family members of the driver about the area of mishap through GSM/GPRS innovation on the off chance that mishap happens. One of the significant explanations for the street mishaps is drive's consideration towards the street while driving because of their exhaustion and sluggishness. The creators in [14] have evaluated different driver illuminating frameworks that helps us to forestall or keep away from the impacts on street by applying advancements like computerized picture handling, electrocardiogram, electroencephalogram and so on.

III. Components Needed

1. **Microcontroller** - It is the main processing unit of our proposed system. (ESP8266 controller).
2. **Power Supply Unit** - It delivers the required power to the system.
3. **Display Unit** - It is an output which displays the nearby traffic scenarios along with some special messages like warning messages.
4. **Wi-Fi Module** - It acts as a transceiver which is used to communicate with other vehicle or in some cases to other infrastructural unit (like Road side unit).
5. **Ultrasonic Sensor** - It aids to detect the front object. (HCSR04).
6. **L293D IC** – It is the Dc motor driver which drives the vehicle based upon our control.
7. **Cloud Based Software**- This software helps to control our bot by using mobile app (Blynk APP).
8. **DC motor-** These motors are used to drive the vehicle(bot).

IV. Methodology

1. Studying and identifying the present mechanisms.
2. Identifying the potential problem through abstraction.
3. Collecting useful data.

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4. Interpreting data as the problem definition.
5. Developing conceptual design and selecting based on the digital logic approach procedure of product design and development.
6. Finally preparing the embodiment design of the product

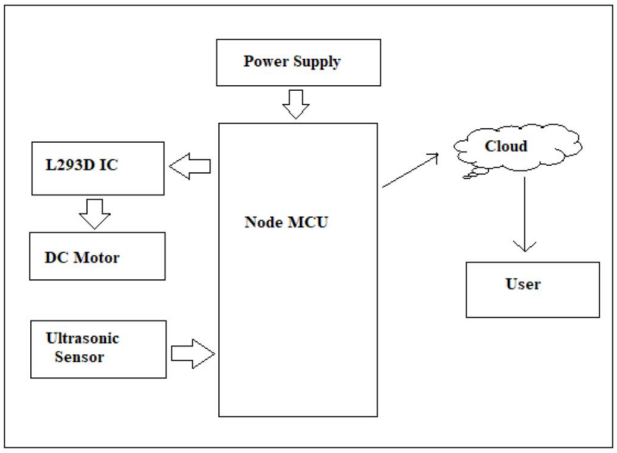

Figure 1: Block Diagram of the Anti-Collision Avoidance System Bot

V. CALCULATION

5.1 Time of Collision

Most forward collision systems make use of the Time to the collision to evaluate the collision risk. The metric has proved to be effective over the years for measuring the severity of traffic conflicts.

$$TTCF = \frac{XL(t) - XF(t) - lL}{XF(t) - XL(t)}$$

Where X denotes the position, $\dot{X}$ denotes the derivative of X with respect to time or the speed and lL denotes the leading vehicle length; L and F as subscripts refer to leading and following vehicle in a car-following process.

5.2 Torque of the Motor

The motor selection is based on torque, speed and cost. But the most important criterion to choosing is the torque.
Thus, *Torque = 8 X Coefficient of friction X Total Weight X Diameter of wheels*
Coefficient of friction is between 0.001 and 0.3,
Torque = 8 x 0.3 x 106.05g x 8cm = ***2036.16g. cm***

Hence the justifiability of the choice of motor was the Gear box motor which has a torque of 2kg.cm and weighs 17.5g causing the total weight to increase to 123.55g. With this new weight, the torque increases to;
Torque = 8 x 0.3 x 123.55 X 8cm = ***2372.16 g.cm.***

5.3 HC-SR04 Ultrasonic sensor distance

An Ultrasonic sensor is a device that can measure the distance to an object with the help of sound waves.
For the project the formula below is used to calculate the distance
distance = duration / 58
Sound travels at 340m/s, which is 29 microseconds per centimetre. The ping has to travel twice the distance (to the object and its rebound back to the sensor). Hence, we have to use 2*29 which is 58 microseconds per centimetre.

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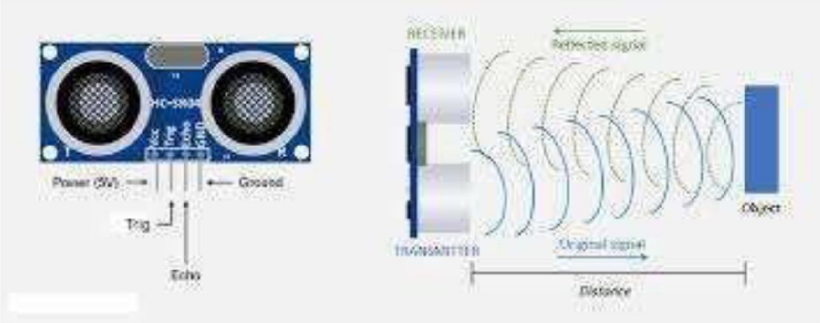

Figure 2: HC-SR04 Ultrasonic Sensor Working

VI. TEST RESULTS

The autonomous vehicle had created with the microcontroller, motor controller and ultrasonic sensor and the actual test has been conducted to verify and validate the aim of our project. This system works under integration and able to brake automatically if an obstacle is detected. The actual photographs of testing the autonomous vehicle detecting the obstacle within 12cm range.

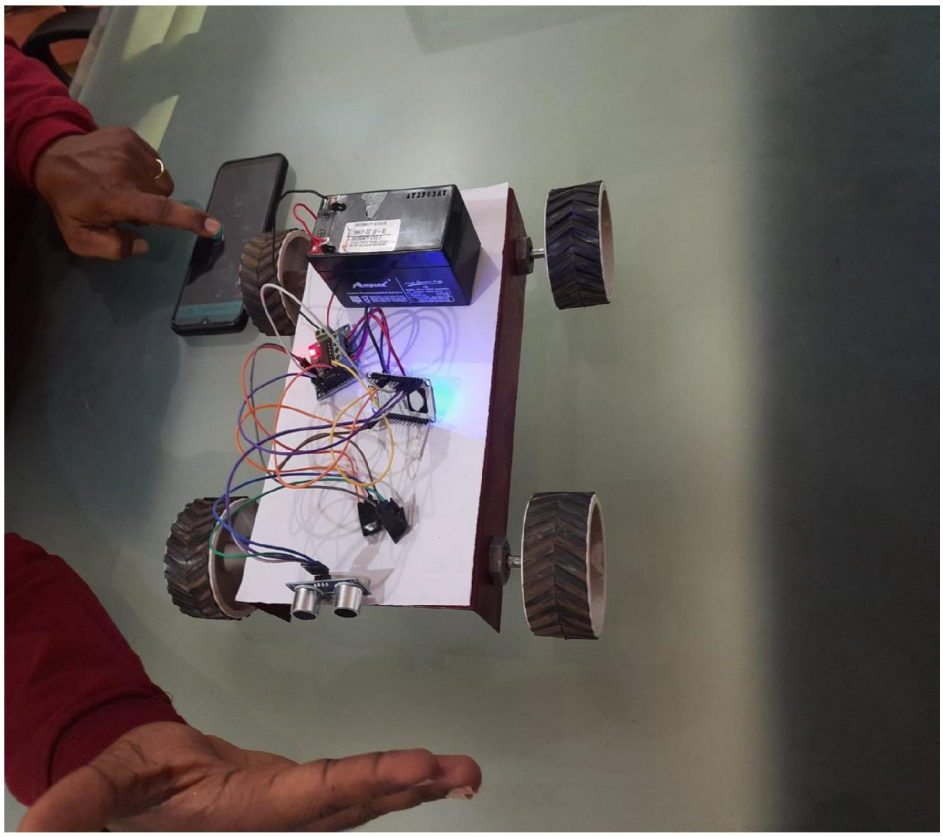

Figure 3: Bot Detecting the Object Within Range of 12cm

The Communication within the system in the form of block diagram is explained in below.

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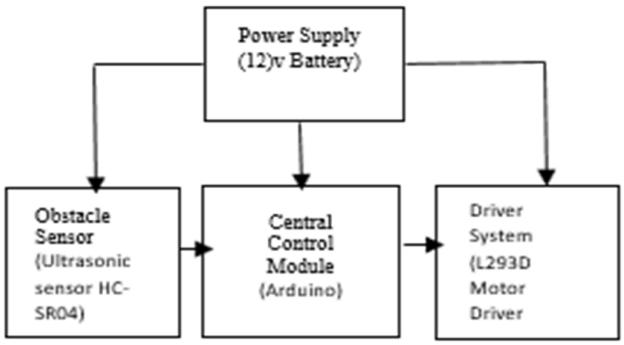

Figure 4: Block Diagram Communication Within System

VII. CONCLUSION

The result of this research is a successful implementation of collision avoidance system in autonomous car has been done, with a complete system consisting of an onboard controller and ultrasonic sensor, which gives the car the ability to detect an obstruction at a certain distance. The data from the ultrasonic sensor (HC-SR04) read by the microcontroller SR04) read by the microcontroller (Arduino uno) which is positioned inside the vehicle. The Arduino uno converts the distance read into centimetres as that is the design consideration for this project. The algorithm for obstacle detection is a conditional loop based on the ranging distance.

The combined elements in the designed car work together without an augment for human intervention. This autonyms car can detect obstacle and cause the vehicle to stop moving thus reducing the potential of road accidents. Overall, the system is successful but it still needs improvement to achieve a hundred percent accuracy because today we are in the world of autonomous cars (AC). The project is "Development of Collision Mitigation Braking System" is practically proved by using the Ultrasonic sensor for sensing the autonomous car, Motor Driver Controller for the driving the DC motors, DC motor is used for the movement of the autonomous car with the help of the Arduino Microcontroller. A lot of factors determined the accuracy of the autonomous car we designed. These factors were the environmental phenomenon within which the autonomous car was tested, the quality of obstacles present, making the test space crowded or relatively less crowded, the type and shape of the obstacle (the robot is meant for a homogenous shaped obstacle). These factors majorly affected the sensors. The accuracy of the autonomous car is relying on the sensors used. Thus, the character of the sensor and its accuracy defines the accuracy of the autonomous car.

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