Implementation of Sensor System for Automotive Crash Prediction

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Abstract—This paper focuses on the use of magneto resistive and sonar sensors for imminent collision detection in cars. The magneto resistive sensors are used to measure the magnetic field from another vehicle in close proximity, to estimate relative position, velocity, and orientation of the vehicle from the measurements. Here the sonar sensor is mainly used to measure the distance only for medium inter vehicle distances whereas for small intervhelelve distances magneto resistive sensors are used. A magneto resistive sensor detects the vehicle based on the magnetic field. An operating system is also used to carry on the necessary steps after the distance is measured which predicts the crash of two vehicles.

Key words: Crash detection, crash sensors, magnetic sensors, Sonar sensors

I. INTRODUCTION

Total no of vehicles on road has experienced a remarkable growth during the last decades leading to increased traffic density and increasing the drivers attention requirements. Immediate effect of this situation is an exponential increase in number of accidents. Nowadays vehicles are integral part of human life; we cannot imagine a day without automotives. But there is a drastic increase in the number of traffic accidents in India leading to deaths, fatal injuries, disabilities which impose severe socio-economic costs across the world.

So there is urgent need to develop an inexpensive system to road accidents. The main aim of this paper is to predict the collision of a vehicle with the other one before the collision occurs. The crash prediction should be accurate and a little early in order to provide safety measures to the passengers in the vehicle like pretightening of seat belts and gentler inflation of air bags. It should be noted that active occupant protection measures involve considerable cost, discomfort, and even a small risk to the occupants. Therefore, these measures can be initiated only if the collision prediction system is highly reliable. A false prediction of collision has highly unacceptable costs.

II. OVERVIEW OF EXISTING CRASH PREDICTION SYSTEMS

Traditionally, radar and laser systems have been used on cars for adaptive cruise control and collision avoidance [1]–[6]. These sensors typically work at intervhelelve spacing greater than 1 m. They do not work at very small intervhelelve spacing and further have a very narrow field of view at small distances [3]. Collision prediction based on sensing at large distances is unreliable. For example, even if the relative longitudinal velocity between two vehicles in the same lane is very high, one of the two vehicles could make a lane change resulting in no collision. An imminent collision can be reliably predicted enough to inflate air bags only when the distance between vehicles is very small and when it is clear that the collision cannot be avoided under any circumstances. Radar and laser sensors are not useful for such small distance measurements. Radar or a laser sensor can cost well over $1000. Hence, it is also inconceivable that a number of radar and laser sensors be distributed all around the car in order to predict all the possible types of collisions that can occur. It should be noted that camera-based image processing systems suffer from some of the same narrow field of view problems for small distances between vehicles.

A vehicle Frontal Collision Warning System (FCWS) based on improved target tracking and threat assessment for accident prediction utilizing radar and Lidar sensors are described in the paper [7]. Radar and Lidar sensors are used to capture the longitudinal and lateral information of the objects from the vehicle. In this model, when a target is detected by both sensors, the fused longitudinal position is a weighed sum of both radar and Lidar, and the lateral position is from the Lidar The combination of Radar and Lidar helps in getting better target positions and to provide robustness under severe weather. Based on the information obtained from the sensors, if the potential collision is detected, warning signal will be passed to the driver for his immediate attention. Another important development in the accident detection model which can detect the presence of animal on road during night travel. This model [8] uses the features of thermal imaging technology for the object detection. The prototype consists of an infrared thermal temperature image grabbing and processing system, which includes an infrared thermal camera, a frame grabber, an image processing system and a motion tracking system, which includes two motors with their motion control system. By analysing the infrared thermal images which are independent of visible light, the presence of an animal can be determined in either night or day time through pattern recognition and matching. All the system based on radar or laser sensors have the drawback that the system won’t work properly with the bad weather condition such as rain, snow or fog[9]. Laser radar(Lidar) have good angular resolution and range. Paper [10] provided influence of different weather conditions on the performance of these sensors. Radar and laser sensors are expensive well over $1000. Hence, it is also unaffordable that a number of radar and laser sensors be distributed all around the vehicle in order to predict all the possible types of collisions that can occur.

III. CRASH PREDICTION SYSTEM USING AMR AND ULTRASONIC SENSORS

The main objective of this new proposed method is to develop an inexpensive and efficient sensor system for collision prediction. In order to achieve that purpose AMR and ultrasonic sensors are used. This sensing system uses the earth’s inherent magnetic field for vehicle detection. A vehicle is made of many metallic parts (for example, chassis, engine, body, etc.), which have a residual magnetic
field and/or get magnetized in the Earth’s magnetic field[11]. AMR sensor detects the change in earth’s magnetic field caused by the vehicles. AMR sensors are comparatively available for low cost and are very useful for small distances which is an advantage over conventional laser and radars. In the proposed system Honeywell triaxial HMC5883L is used. The Honeywell HMC5883L magneto resistive sensor circuit is a trio of sensors and application specific support circuits to measure magnetic fields. With power supply applied, the sensor converts any incident magnetic field in the sensitive axis directions to a differential voltage output. The magneto resistive sensors are made of a nickel-iron (Perm alloy) thin-film and patterned as a resistive strip element. In the presence of a magnetic field, a change in the bridge resistive elements causes a corresponding change in voltage across the bridge outputs. These resistive elements are aligned together to have a common sensitive axis (indicated by arrows in Fig:1) that will provide positive voltage change with magnetic fields increasing in the sensitive direction. Because the output is only proportional to the magnetic field component along its axis, additional sensor bridges are placed at orthogonal directions to permit accurate measurement of magnetic field in any orientation.

![Fig. 1: Magnetic Orientation of HMC5883L](image)

The Ultrasonic sensor is mainly used to determine the distance between two vehicles and it is based on Doppler Effect. It will directly measure the position with respect to itself independent of relative speed. It can measure larger distances compared with the magnetic sensors and it has a narrow field of view at short distances. HC SR-04 ultrasonic sensor is used in this proposed method which has a maximum range of 4meters. The principle of ultrasonic distance measurement used the already-known air spreading velocity, measuring the time from launch to reflection when it encountered obstacle, and then calculate the distance between the transmitter and the obstacle according to the time and the velocity.

**IV. WORKING OF THE PROPOSED SYSTEM**

In this sensor system initially ultrasonic sensor is active to update the position and distance, since the magnetic sensors are not yet affected by the approaching vehicle. The distance between the vehicle and approaching vehicle is calculated by ultrasonic sensor and it is updated to the microcontroller then the controller displays the distance on the display for the driver to react to the situation and to regulate the speed. As soon as the magnetic sensors respond to the vehicle presence i.e approaching vehicle distance is less than 1 meter and the x-axis, y-axis and z-axis readings are displayed. If the values vary beyond the threshold limit then the vehicle is automatically stopped through the controller.

![Fig. 2: Block Diagram of the Proposed System.](image)

These sensors are distributed all around the car and the collision from four sides i.e either front, back and left, right can be predicted and necessary action is carried to avoid crashing. In this system APR9600 is also used to alert the driver about his car movement. LPC2148 is used along with FreeRTOS to provide a decision making capability to the system. Whenever there is a collision prediction from any two sides i.e from front and left then by using preemptive scheduling algorithm the system executes the task with highest priority.

![Fig. 3: Crash Prediction System Hardware module.](image)

**V. CONCLUSION**

This paper, discusses about various technologies used for automotive accident prediction as well as notification system. For accident prediction system, the excellent features of AMR and sonar sensor lead to the development of a vigilant module. Radar and laser sensors need to be replaced because of their high cost and will not work at short distances. Magneto-resistive sensors are previously used for traffic intensity measurements, vehicle detection in parking applications they are used for the first time in combination with sonar sensors for automotive crash prediction and notification system. This system can also predict the intensity of accident using value of AMR sonar
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(IJSRD/Vol. 3/Issue 11/2016/006)

sensor fusion. The proposed model is an inexpensive, highly reliable model for accident prediction and alert system.

REFERENCES


