# Study of CAN Protocol in Avoiding Rear-End Collision of Vehicles

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**Abstract -** One of the important assets of automotive systems is safety, and it has been enhanced by Advanced Driver Assistance Systems (ADAS) in modern automotive systems. The safety of both driver and passengers is very significant. As the population of the country is increasing, more and more vehicles are seen on the road and there is increase of traffic on road. This has led to the increase in the number of accidents which term for a better driver assistance system to handle these situations and avoid accidents. Modern vehicles have lot of speed and cutting edge motors; because of these reasons there is a need to develop an embedded system which can constantly monitor the driver's actions and alert in case of any emergency. A work has been proposed to build a smart embedded system that guide the driver to avoid rear-end collision of vehicles. It would also help to safely overtake/pass the leading vehicle. This system monitors the breaking intensity of vehicles and alerts the vehicles that are following immediately. An accelerometer is interfaced to ARM Microcontroller to calculate the rate of breaking and gives a visual representation by the LED array mounted on the rear end to the driver of following vehicle. The same information is also transmitted to the following car using IR communication. Based on the breaking intensity detected a CAN message is generated to take appropriate controlling action. This message is placed on the CAN bus with proper format so that other CAN controllers present in the network can read it. The accident avoidance system decodes this message and actuates the appropriate electronic device as a controlling action. The proposed embedded system is very better in comparison with other existing systems because of its quick response and is independent from the external infrastructure. This system is cost effective and is reliable in real time. This system warns only the immediately following vehicle because of IR communication. We see that rear-end accidents are mainly due to immediately following vehicles so warning these is very important to avoid accidents. This makes the choice of IR more suitable in comparison to other technologies. Thus this system is very effective in reducing the rear-end accidents.

**Keywords -** Rear-end collision, Accelerometer, IR Communication, Embedded system.

## I. INTRODUCTION

The National Institute of Disaster Management analysis shows that, road accidents are occurring in India every 80 seconds and most of them are due to human errors and human faults. The accident due to human error accounts to 93% of all. Police reported that most of the accidents are due to backside or rear-end collisions because of sudden break application. STRADA (Swedish Traffic Accident Data Acquisition) conducted an examination which showed that 91% of all rear-end collisions and surpass crash include trucks [1].In addition, it is predicted that hospital bills, damaged properties and additional accident-related costs will add up to approximately one to three percent of the world's gross domestic product. Avoiding such accidents by building an intelligent embedded system would be a very important development in automotive industries. This intelligent embedded system calculates the breaking intensity of the leading car and sends this information to the immediately following car by establishing vehicle to vehicle communication and make vehicles smart to take corrective actions accordingly.

Systems are modelled using Kamm's circle prediction algorithms on laser scanner to predict collisions [2].Vehicle Adhoc Network for vehicle to infrastructure communication have also been implemented for traffic management and collision avoidance [3]. Various other systems based on WIFI, Zigbee and fizzy based have also been installed to fulfill the above purpose. But there are various cost matrices related to the above mentioned systems and technologies like algorithm complexity, communication delay, components cost, etc. This paper proposes an ARM controller based embedded system using CAN protocol to notify the collision and effectively overcome it.

Controller Area Network or CAN protocol is a means using which different electronic devices like engine management systems, ABS ,active suspension, , gear control, air conditioning, airbags, central locking etc embedded in an automobile communicate with each other. This was a thought of Robert Bosch in 1983. This initiation made automobiles more reliable, fuel efficient and safe. The advances in semiconductor industries and electronics replaced the mechanical systems in automobiles by more robust electronic systems which have improved performance. The improvement in the technologies led to the invention of new products with improved functionality and this shaped a new era for automobile industries. Earlier these electronic devices used complex interrelated signals for communication. This made the life of automobile engineers very difficult to design systems that need intercommunication among electronic devices for their operation. Robert Bosch realized this communication problem and came up with a new protocol named

CAN. CAN provide a mechanism in which various electronic devices can communicate among them using a common cable and can be incorporated in hardware and software.

The intelligent embedded system proposed is an ARM controller based system which uses an accelerometer to evaluate the breaking intensity of leading vehicle and sends this information to the following vehicle in an encoded for by pulse widths modulating the IR signal. Based on this information an appropriate controlling action is taken.

Organization of paper is section II describes the proposed system and section III deals with conclusion.

## II. Proposed System

The proposed system consists of two parts. First, an accident warning system and another is accident avoidance system as shown in Figure 1. One used to alert the driver and other used to take some corrective action.

The accident warning system takes input from the accelerometer about the breaking intensity of leading car and sends this information to the immediately following car to inform the driver and warn about the accident. This helps in effectively handling the crash due to rear-end collision of approaching vehicle. Straight optical range of communication is needed to send information only to the immediately following vehicle.

The accident avoidance system sends an output signal to the breaking control system based on the status of information received to avoid collision


Fig. 1 Proposed System's block diagram

### A. The Accident Warning System

The accident warning system is shown in Figure 2. This measure the deceleration rate of leading vehicle using the accelerometer shown in figure 5 and sends this measured information to accident avoidance system in an encoded form. ARM controller is acting as warning system here. This ARM controller has inbuilt 10-bit Analog to Digital Converter (ADC) which converts the analog information from accelerometer to digital which is very easy to process. The slope of the input signal from the accelerometer is calculated dynamically at fixed time intervals. The control algorithm shown below in Figure 3 is implemented in ARM controller to give proper response. Based on the decision taken by the control algorithm a 30 KHz signal is pulse width modulated and it is transmitted to the accident avoidance system present in the following vehicle to inform about the breaking intensity.

An array of LEDs of different color are mounted on the rear end of the vehicle to give visual representation of breaking intensity of leading vehicle to the following vehicle's driver as shown in Figure 4(a), (b), (c). Based on the decision taken by the control algorithm the appropriate color LEDs glows which is very helpful during the night times.

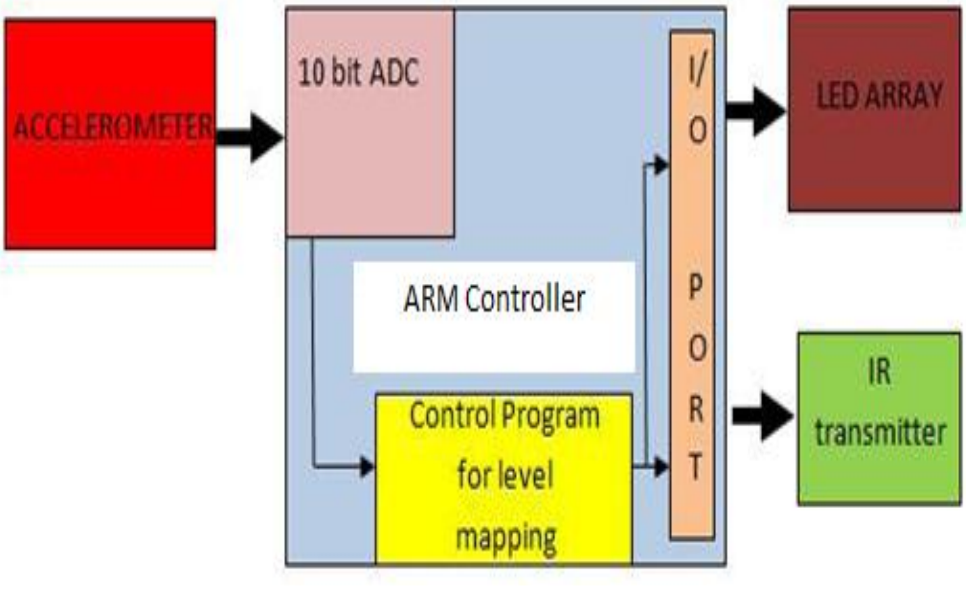



Fig. 2 Accident warning system

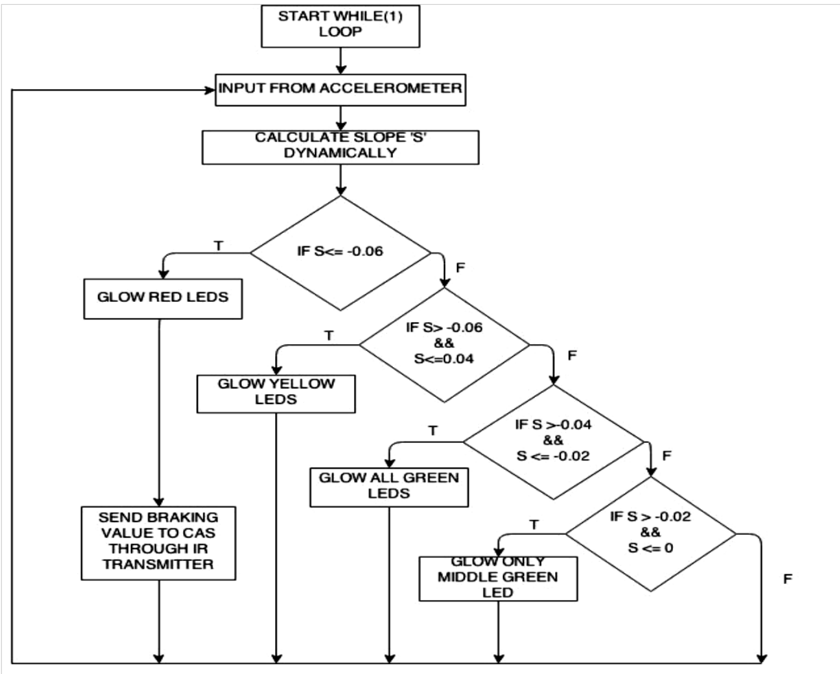
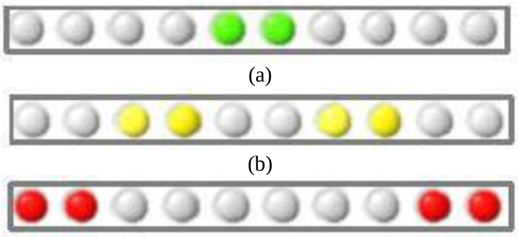



Fig. 3 Accident warning system's control algorithm



(a)

(b)

(c)

Fig. 4 (a) low breaking level shown by Green LEDs. (b) Medium breaking level shown by Yellow LEDs (c) Sudden breaking shown by Red LEDs.


Fig. 5 ADXL335 Accelerometer

B. Array of LEDs to show breaking intensity

The breaking levels information which is given by various slop levels should be conveyed to the driver of following vehicle. The LEDs are arranged as an array and are mounted at the rear end of the car representing the back light of Vehicle ahead. These LEDs blink with different colors to show the intensity of breaking levels of leading car, thus giving a visual signal to the following car. Three colors green, yellow and red are used to represent low, medium and high breaking levels. Green LEDs glow to indicate low breaking intensity. Yellow LEDs glow to represent medium or gradual breaking and red LEDs glow to represent high or sudden hard breaking as shown in Figure 5.

C. IR Communication

The breaking intensity calculated by the accident warning system must be transmitted to accident avoidance system. An IR signal is pulse width modulated to represent the breaking levels. The duty cycle of the modulated gives the deceleration information. The ARM controller modulates the IR signal based on the calculated deceleration level and it is sent to the immediately following vehicle. If the duty cycle of the modulated signal is 50% then it indicates normal breaking level and hence no action is taken by the accident avoidance system. If the duty cycle is less than 50% then it indicates sudden breaking and hence the accident avoidance system should take some controlling action.

D. Accident Avoidance System

The block level representation of accident avoidance system is shown in below Figure 6. It has an IR receiver which receives the modulated IR signal from the accident warning system. This modulated signal should be demodulated to get the information of breaking intensity. This is the source of input to the control algorithm of accident avoidance system to take appropriate controlling action.

The control algorithm of the avoidance system is shown is Figure 7 which calculates the time gap and takes appropriate controlling decision.

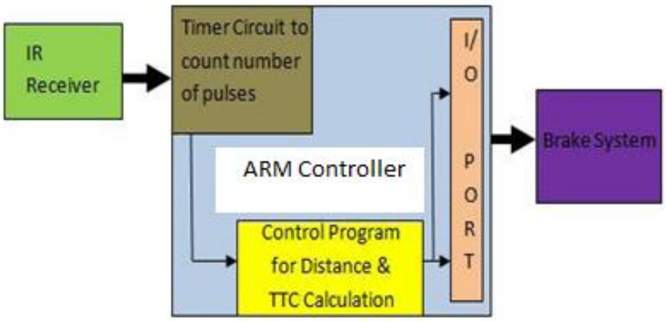



Fig. 6 Accident Avoidance System

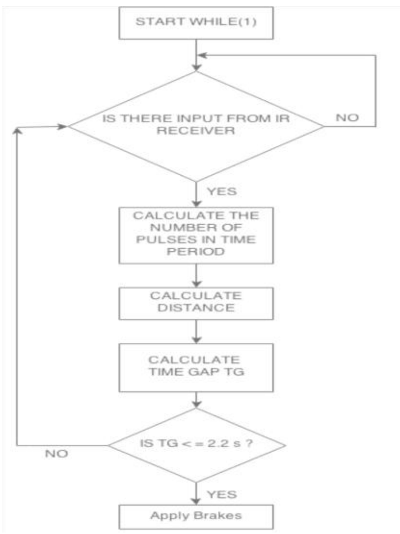



Fig. 7 Flow chart of accident avoidance system

E. Control System

The control system has a timer which is programmed in an interrupt mode to count the number of pulses received. This helps in calculating the distance between the two vehicles. Using this information the time gap between the collisions is calculated using the equation shown below.

$$TG = \frac{Distance}{Velocity\ of\ following\ Car} \qquad (1)$$

The reference time gap (TG) is taken from Honda. Honda says that if time gap is less than 2.2 seconds then applying breaks in the following vehicle to stop the vehicle would be very dangerous. So if time gap is less than 2.2 seconds any other controlling action has to be taken like seed reduction of following vehicle etc. But if time gap is more than 2.2 seconds then we can automatically apply breaks to stop the vehicle. This will be demonstrated in prototype using DC motor. In real time implementation if time gap is less than 2.2 seconds then some other controlling action like seat belt tightening, antilock breaking etc can be initiated to avoid major injuries if accident occurs.

F. CAN Communication

The accident avoidance system and the accident warning system placed in the vehicles must communicate with other electronic devices present in the vehicle. We use CAN protocol for this communication as we have seen its advantages. Communication of accident warning system and accident avoidance system with other electronic devices is very important to take controlling actions. Based on the breaking intensity detected a CAN message is generated to take appropriate controlling action. This message is placed on the CAN bus with proper format so that other CAN controllers present in the network can read it. The accident avoidance system decodes this message and actuates the appropriate electronic device as a controlling action.

## III. Conclusion

The intelligent embedded system proposed is an ARM controller based system. This system gives response very fast and it is very efficient. It is very better in comparison with other existing systems because of its quick response and is independent from the external infrastructure. This system warns only the immediately following vehicle because of IR communication. We see that rear-end accidents are mainly due to immediately following vehicles so warning these is very important to avoid accidents. This makes the choice of IR more suitable in comparison to other technologies.

The choice of CAN protocol also makes the proposed system better over other available systems. Some more future features that can be added are Steering moving (right or left) indication system, if fog is in front of vehicle, then red headlight beam will glow automatically and safely overtake/pass the leading vehicle.

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