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Research Article

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A CAN Protocol Based Intelligent Transportation Systems Implemented on VANET

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Abstract-

In Global world increase of traffic on roads, there are increased cases of accidents and mishaps which call for a robust driver and passenger assisting systems that can overcome and handle these situations effectively. In a new technology for vehicle, the safety of drivers and passengers are most significance. The work proposes an intelligent embedded system that assists the driver in avoiding all [right, left, front, rear] end collision with it's on board diagnostics. It is a mechanism that monitors the side of the Vehicle ends and also braking intensity of vehicle and depending upon its intensity alerts with camera ranges [red, yellow, green] mark the other vehicles that are immediately following. The device on the following vehicle immediately is activated to take decisions to avoid the impending collision.
An camera , accelerometer interfaced to ARM Cortex M7 microcontroller is a part of the transmitter devices that calculates the rate of deceleration and notifies the device on following vehicle by displaying it on the rear LED arrays with camera position side will be display so Vehicle position can understand and transmitting messages through IR communication. The receiver device is responsible to decode the message and follow a control Advance CWS algorithm based on many other parameters to either decelerate or stop the vehicle notifying the driver immediately. The system also hosts an on board Diagnostic system over CAN protocol that assists the driver and the repair technician during servicing, thus reducing the debugging effort and facilitating easy. And additionally apart of them Vehicle understands the position based on that Monitor display the car position and also we can park. Based on the steering position the camera recoding video will be displayed.

Keywords: Accelerometer, Advance Collision Warning and Avoidance System, Embedded System, IR Communication, Braking Time of Following and Leading vehicle.

I. INTRODUCTION

Indian roads, nearly 20 to 30 types of vehicles of different shapes, sizes and speeds drive on available space and are in a rush to reach their destination. Road crashes, deaths and Injuries have become an important and leading cause of deaths, hospitalizations, disabilities and socio- economic losses in the country. According to the Road accidents report 2014 in India shows that driver fault is the single most important factor and accounted for 81 percent of total accidents. The impact of crash severity is influenced by presence or absence of certain protective mechanisms such as use of airbags, use of safety devices like helmets in the case of motorcycles, seat belts in case of four-wheelers and use of child-restraints for infants. Some experts say that 95 percent of accidents are caused by driver errors. Reducing such accidents with intelligent embedded system is one of the recent developments in automotive electronics.

A mechanism that not only evaluates the braking intensity of the car but also actively notifies the following cars i.e establishing vehicle to vehicle. An active intelligent diagnostic system on the car that alerts warns and assists the driver in efficient driving and the technician with diagnosis among other available data is the need of the hour. There are systems modeled for using Kamm's circle prediction algorithms on laser scanner to predict a collision. Vehicle to infrastructure communication namely Vehicle Adhoc Network have also been implemented to manage traffic and avoid collisions.

The Global positioning systems that uses satellite communication to locate other vehicles has been used to evaluate the relative velocity to avoid an impending collision. There is various cost metrics associated to the above mentioned methods and technologies such as complexities of algorithm, time delay in communication, cost of components, etc. The paper proposes an ARM Cortex-M7 controller based implementation to warn about a collision and overcome it effectively. It employs an accelerometer to measure the deceleration of leading car and send messages encoded in infrared signals to communicate with the trailing vehicle. And also vehicle camera will be providing the positions. It warns the driver and passengers on following vehicle with proper alert mechanism and avoids the collision with proper speed control according to the control program.

II. PROPOSED SYSTEM

The system is made of two sub-systems based on ARM M7 micro-controllers, one a Advance Collision Warning System and other Advance Collision Avoidance System as shown in Figure 1.

The Collision warning system fixed on leading vehicle is responsible for notifying the alert Collision Avoidance System mounted on the following vehicle to warn its driver and effectively handle a crash due to an approaching rear-end collision. The desired mode of communication required is straight range of communication to notify only the vehicles following the leading vehicle. The warning system inputs data from an accelerometer and the avoidance system outputs signal to control the braking mechanism appropriately. The two individual modules also boast a diagnostic mechanism that notifies the vehicle user about its current state and error states that shall be logged on event occurrence basis along with the time stamp for efficient fault diagnosis.

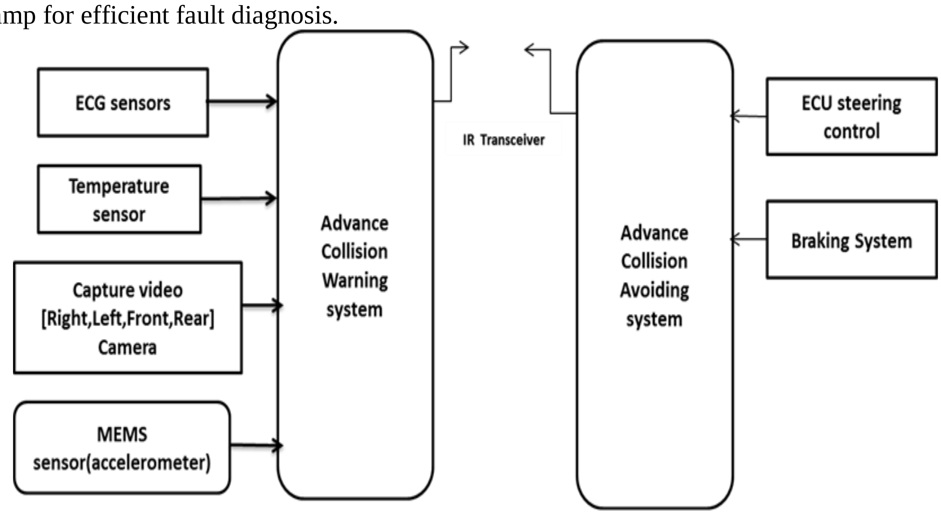

Figure 1. Block Diagram of Proposed System.

III. ADVANCE COLLISION WARNING SYSTEM

The warning system Figure 2 measures the rate of deceleration caused due to braking using an accelerometer and evaluates the threshold levels of deceleration. The warning system is CortexM7 controller with inbuilt 16 bit ADC that is used in digitizing the analog input signal at a very high rate. The input signal acceleration values are logged and dynamically slope of the signal is calculated at fixed interval of time. The control algorithm shown in Figure 3 is implemented in the ARM Cortex M7 Controller for prompt response. A decision drawn from the slopes is used to pulse width modulate a thirty kilohertz signal to be transmitted over Infrared to communicate with the Collision Avoidance system mounted on the vehicle following it. The algorithm calculates the slope of the response of Accelerometer dynamically. The array of LED of distinct colors is blinked according to the level of deceleration as shown in Figure 4(a), (b), (c). The levels of deceleration corresponding to a braking is transmitted to the Collision Avoidance System to act upon a control algorithm and take a control action as can be seen in the functional block diagram in Figure 2.

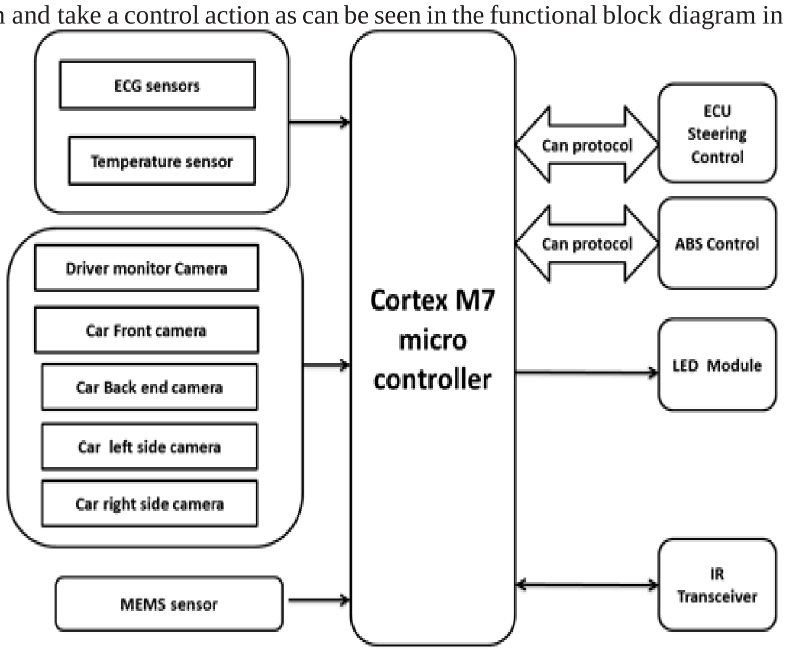

Figure 2. Block Diagram of the Advance Collision Warning System.

MEMS Input

MEMS is based on the accessories mode it will allow the driver to monitor the Cameras and also the electrical the access in the Vehicle and also the get the Input of the Feedback by Advance Collision Warning System and other Advance Collision Avoidance System as shown in Figure 4 .And then allow the software to monitor the values of the next level of the Input of ECG & Temperature.

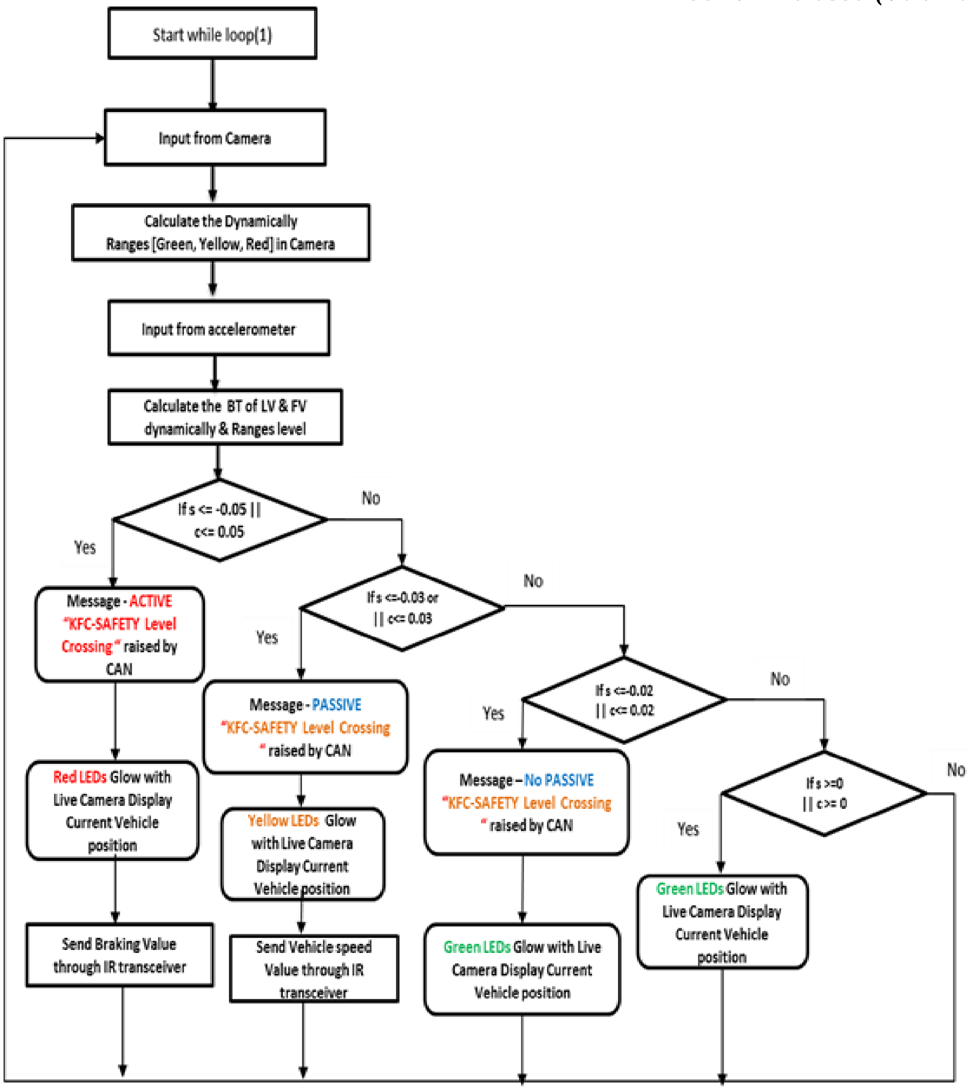

Figure 3. Flow Chart of the Advance Collision Warning System.

Temperature Input

Temperature sensor will be monitor and also provide the Input to the ARM controller and it is display Values and waveforms and also continuously it will be monitor the drivers and provide the safety of driver. Incase driver happened any issues related physical health related monitor and reported to the drivers and also stop the vehicle automatically based on the sensor Input and analysis the activated the Advance Collision Warning System and other Advance Collision Avoidance System as shown in Figure 3.1.

ECG Input

ECG sensor will be monitor and also provide the Input to the ARM controller and it is display Values and waveforms and also continuously it will be monitor the drivers and provide the safety of driver. Incase driver happened any issues related physical health related monitor and reported to the drivers and also stop the vehicle automatically based on the sensor Input and analysis the activated the Advance Collision Warning System and other Advance Collision Avoidance System as shown in Figure 3.1.

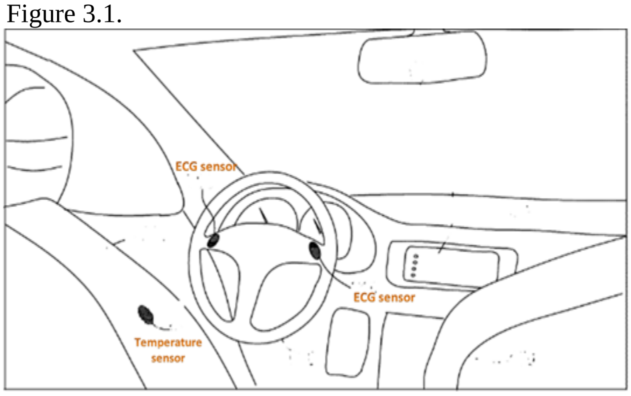

Figure 3.1. Block Diagram of the ECG & Temperature sensor

Monitor Cameras Input

Cameras is focus in the all the sides and displayed in the system by ARM M7 micro-controllers in the following Vehicles and analysis the Input in it by Advance Collision Warning System and other Advance Collision Avoidance System as shown in Figure 4.Front Camera, Left Camera, Right Camera & Rear Camera is capture the outside environment.

Based on the outside input given to the Advance Collision Warning System based on the Advance Collision Avoidance System.

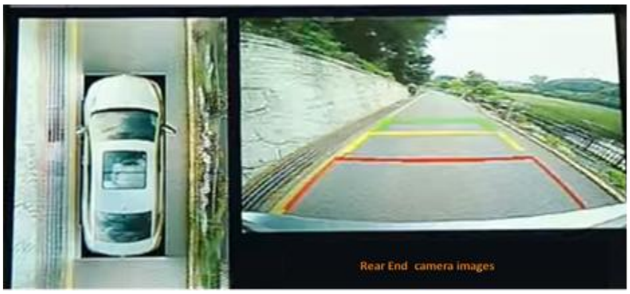

Figure 3.2. Diagram for Rear end screenshot images

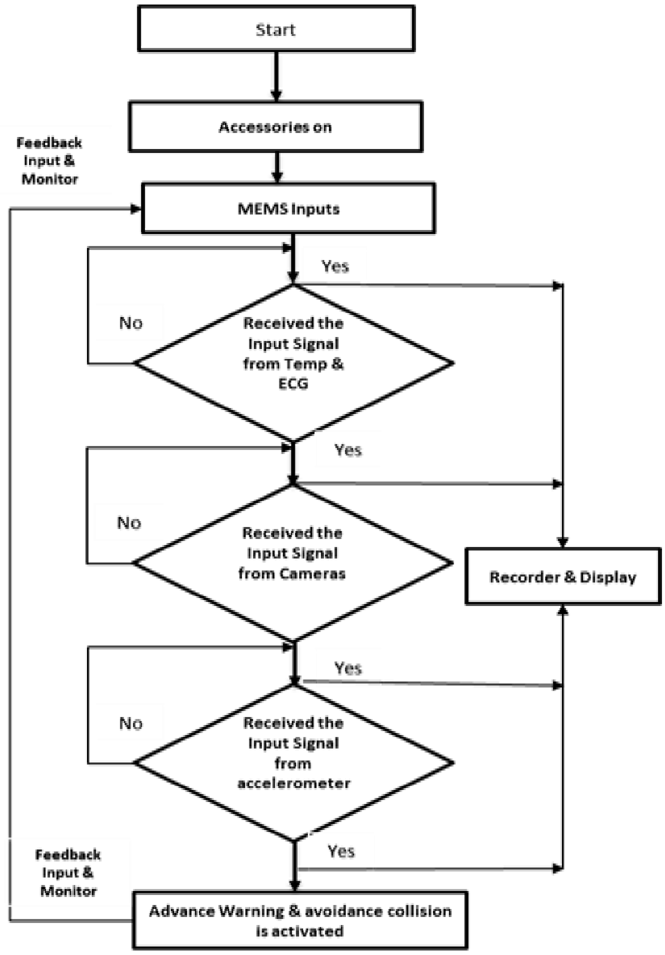

Figure 4 Flow Chart of the Advance Warning & avoidance Collision System.

(a)

(b)

(c)

Figure 5. (a) Green led representing low braking intensity.(b**)** Yellow pair of penultimate led representing gradual braking and **(c)** RED led at ends representing sudden high braking intensity.

Accelerometer ADXL335 & Deceleration Levels Evaluation

The accelerometer is an electromechanical device that is used to measure static and dynamic acceleration of a moving vehicle. It employs quantum physics to draw an appropriate response to the acceleration; hence it is very quick in response time and is more reliable in measuring acceleration of any moving object. It is also very small in size that can be mounted anywhere on the surface of the vehicle. An ADXL335 Figure 5 accelerometer is an analog device which has to be interfaced to the microcontroller’s Analog to digital convertor to get the values in digital form for processing. This module is a small and low power module that measures acceleration in three axes within the range of ±3g.5.To get the actual response of accelerometer for vehicle acceleration, it was experimented on a car with actual road trials. The value of the accelerometer was logged in a file using a serial terminal. Analysis was made on the data available which are described below in Figure 6.

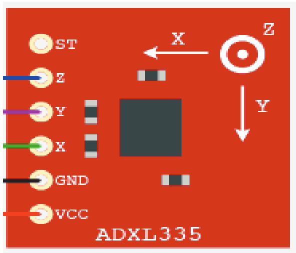

Figure 6. An ADXL335accelerometer.

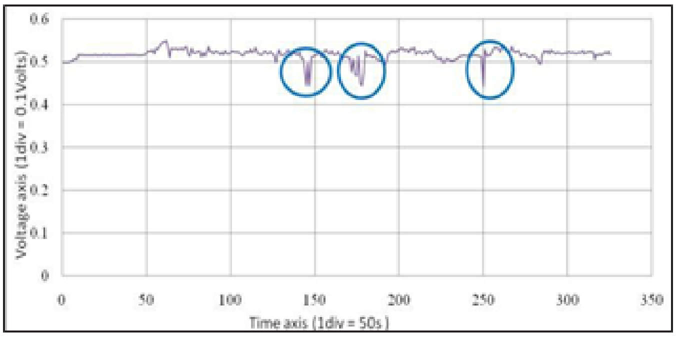

Figure 7. Accelerometer response graph for braking intensity of a vehicle.

The real-time response plotted gives information about the intensity of brakes. The sharp dips indicate decelerated and hence symbolize the braking action. The slopes of these dips that are to be calculated distinguish it for the different level of braking. Gradual slope indicate gradual braking as seen around time-sample 175 and steep slope indicate hard braking as observed around time-sample 250 (refer Figure 6). The slope of the response has to be calculated dynamically on real-time by programming the microcontroller unit. It can be inferred from the plot that for the given vehicle brake system, deceleration values above –0.03 represent safe braking represented inside green circle while deceleration values lower than it represent further levels of gradual and hard braking. This is evident around time-sample 175 and 250 represented by yellow and green circle respectively in Figure 7. It is red level that is to be taken care of by alerting and activating the warning and collision avoidance system.

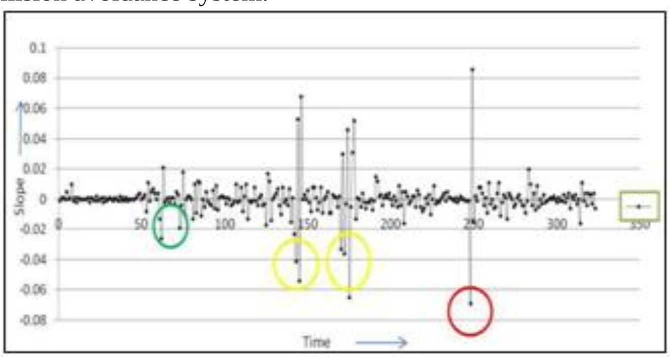

Figure 8. Plot of slope against time.

Braking Display LED Array

The various slope levels mapped on to level of braking from the above graph need to be conveyed to the driver and the vehicle following. There is an arrangement LED arrays that represents the tail light of leading vehicle. It blinks with particular color to indicate the level of blinking thus making the following car give a visual signal about the leading cars braking level. Based on the level of braking the leds glow green, yellow and red color .The window level for glowing green led that represent low intensity braking is more than –0.03. Similarly, while yellow led glow in window period from –0.03 to –0.05 representing gradual braking, red led glow in window period more than –0.05 representing sudden hard braking as shown in below Figures.

Infrared Communication

The braking levels one calculated must also be communicated. A pulse width modulated IR signal is used to represent the levels. The duty cycle of the pulse width modulated signal is proportionate to the deceleration levels. The Figure 12 shows us a rectangular pulse on the Cathode Ray Oscilloscope (CRO) and IR led glowing in dark sending the signal modulated by the controller according to the calculated deceleration level. PWM of a 50% duty cycle represent normal braking of above –0.03 deceleration and hence no action is expected from the avoidance controller. PWM of different duty cycle lesser than 50% represent the slope levels of –0.04 to –0.05 below.

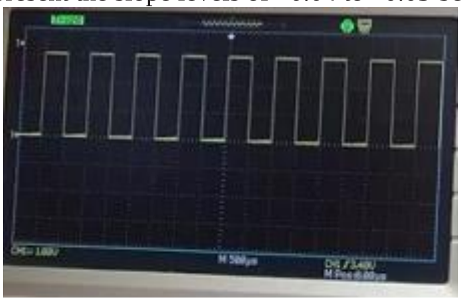

Figure 9. IR LEDs communicating in a CRO.

Advance alerts Collision Avoidance System

The IR signal transmitted by the Advance Collision Warning System (ACWS) is received by the Advance Collision Avoidance System (ACAS) to draw a proper control decision from the control program. The control program calculates the time to collision and thus decisions are made on its pre decided values. Figure 14 represents the control flow of the ACAS.

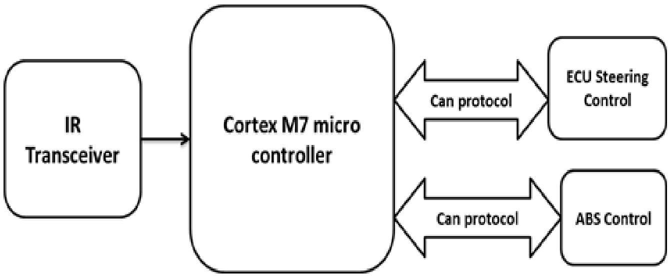

Figure 10. Block Diagram of the Advance Collision Avoidance System.

IR Receiver

An IR photo diode along with the signal conditioning circuitry is used as the PWM generator modulated proportional to the intensity of the brake levels. These IR rays incident on the following car are to be received and demodulated to decode the information of brake level applied in the leading car. This information is prime input to the control algorithm of the CAS to make decision on control action.

Advance Collision Time Gap Calculation

Keeping a safe following distance from the leading vehicle (LV) is critical for mitigating rear-end crashes in vehicle following situation since it allows the following vehicle (FV) sufficient time to stop, and to stop gradually. So Implemented the Advance minimum safe time gap (AMSTG) is introduced. The AMSTG is defined as the minimum time required by the following vehicle to decelerate and safely stop without hitting the leading vehicle when both leading and following vehicles apply the emergency brakes due to unforeseen circumstances. The value of AMSTG (as illustrated in Figure 12) is obtained by considering the braking time of the following vehicle (BTFV) and the leading car (BTLV) as well as Perception reaction time of the following vehicle driver. Different case of truck-Following-car, will affect the AMSTG value due to different in braking performance and capability.

Similarly, the following vehicle driver's physical and mental condition will affect the perception-reaction time hence affecting the AMSTG the Perception reaction time of the following vehicle driver. Different compositions of leader-follower pairs, say for example in the case of truck-Following-car, will affect the AMSTG value due to different in braking performance and capability. Similarly, the following vehicle driver's physical and mental condition will affect the perception-reaction time hence affecting the AMSTG.

In Figure 12 is explain about "Suppose there are two vehicles in a following situation travelling at a small relative speed. The front of FV being tg seconds behind the back of LV and Advance Collision time Gap ACTG is defined as time gap. Further suppose that the LV commences emergency braking, and then, after some perception reaction time, the FV also commences emergency braking. Then, the FV will or will not hit the LV depending upon whether ACTG is smaller or greater than AMSTG."

Equation for AMSTG incorporating braking time and perception-reaction time can be expressed as follows:

$AMSTG = BT_{FV} - BT_{LV} + RT$ --------------------------> (1)

$RT = G + Y$

$ACTG = \frac{AMSTG}{\text{Velocity of Following Vehicle}}$ -----> (2)

where, RT is driver's perception-reaction time ,Y is Yellow, G is Green, R is Red & BTFV and BTLV are braking time of following and leading vehicle, respectively.

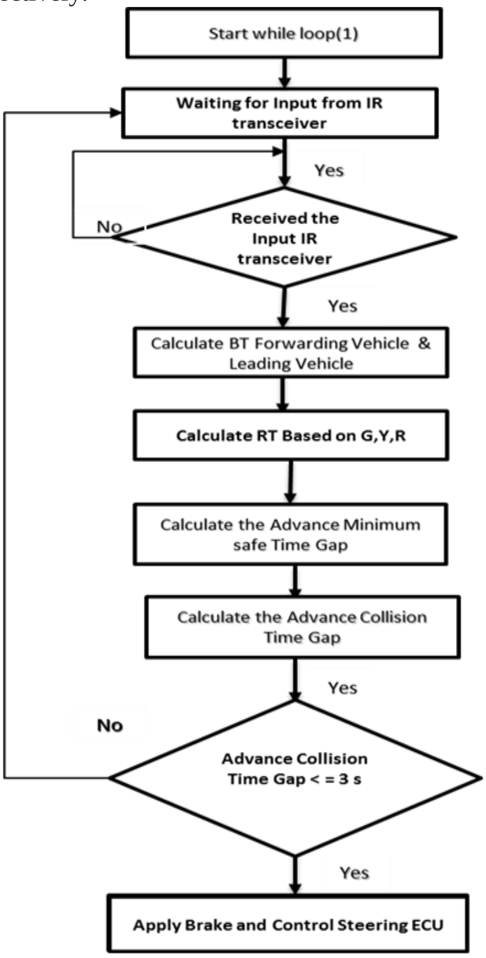

Figure 11. Flow Chart of the Advance Collision Avoidance system.

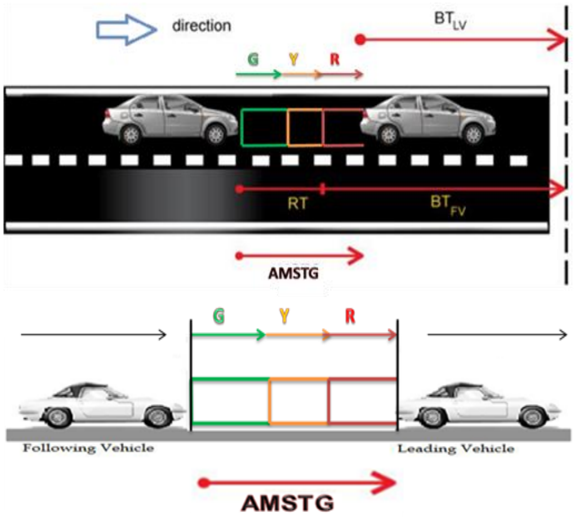

Figure 12. Concept of Advance Mean Safe Time Gap (AMSTG).

As per the Safety time gap various it will be vary for the country following Based on the Honda Algorithm is used as the reference algorithm which is dependent on the time to collision parameter and hence the time gap for collision avoidance in Honda Cars. According to it, it is very critical to apply brakes and stop the following vehicle if the Time Gap (TG) is detected to be less than 2.2 seconds.

Based on new Advance Collision Time Gap algorithm less than 3 seconds due to cover the Various Country Standard with Safety. Thus a control action of reducing the speed and stopping the vehicle can be emulated with a prototype shown in Figure 17. A DC motor resembling the wheel of the vehicle is used to demonstrate the control action. In reality, other active and passive safety mechanisms can be activated like the Antilock braking, Electronic stability program, Traction control, Seat belt tightened and the Air bag inflation according to their need at the situation.

Steering & Brake ECU CAN Communication

The ACWS and the ACAS devices mounted on the vehicles need to communicate of their states and actions with other Electronic control Units of the car over an internal communication network, normally a Controller Area Network (CAN) network. This communication is important for activation and deactivation of other mechanisms of the vehicle related to the safety of the driver and passenger. In the prototype we use the on board CAN controller following CAN3.0B protocol specification of Atmel Xplained development board to simulate an environment of communication between the Device and other Electronic control unit. This is demonstrated by the DC motor control by the ECU on trigger from the device as seen in Figure 13.

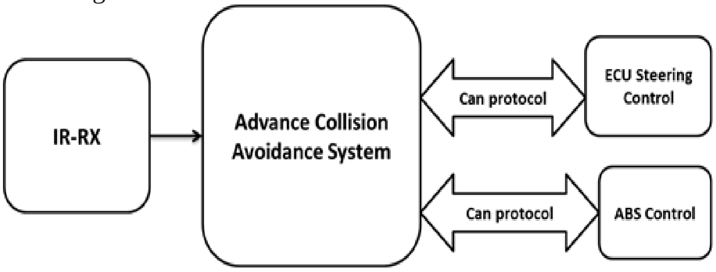

Figure 13. Communication flow of the ACAS.

An interrupt driven control program is used that generates CAN message as a part of the interrupt sub- routine to generate the appropriate control action on detection of the appropriate braking level and time gap. These messages are handled internally by storing them in Message Objects. This message object is then checked in accordance to Message Handler's acceptance filtering for their correctness according to the CAN protocol. Once the objects clear the filtering they are stored in the CAN controller's

Message RAM. The message handler finite state machine handles the data in transmit and receive registers of the controller, The Tran-receiver then places the data on the CAN bus with its appropriate frame format that can be read by other CAN controller of other electronic control unit which are a part of the CAN network. The CAN message is decoded to get the information and then control the DC motor according to it as the response of the Advance Collision Avoidance system.

IV. DIAGNOSTIC SYSTEM & RESULT IN SIMULATOR

Board diagnostics present for devices use the telemetric of vehicle to assist safe driving, monitor vehicle climate, measure speed of wheels, alignment, engine health, monitor tire pressure, fuel level, check emission efficiency and also connect over internet to log data related to the current health of the vehicle. They also help with the fault diagnostics during the servicing of the vehicle by logging data and managing them to draw quick conclusions. Based on the Various scenarios in simulator for calculate the ranges in red, green, yellow for scenario A, B & C in figure 14 shown Error mode state Message are:

- ACTIVE =>"KFC-SAFETY Level Crossing"
- PASSIVE=> "KFC-SAFETY Level Crossing"
- SEMI PASSIVE=>"KFC-SAFETY Level Crossing"
- OFF => "KFC-SAFETY Level Crossing"

- **Error Passive mode**

When the Transmit Error Counter and the Receive Error Counter exceed value **128**, the node goes into Error Passive state depicting high level disturbance in the CAN node receive **Message "KFC-SAFETY Level Crossing"** with passive code.

- **Error Semi Passive mode**

When the Transmit Error Counter and the Receive Error Counter exceed value **127**, the node goes into Error Passive state depicting high level disturbance in the CAN node receive **Message "KFC-SAFETY Level Crossing"** with semi passive code. .

- **Error Active mode**

When the Transmit Error Counter and the Receive Error Counter is within the value 127, the node is in Error

Passive state depicting low level disturbance in the CAN node receive **Message "KFC-SAFETY Level Crossing"** with active code.

- **Bus OFF mode**

When the Transmit Error Counter and the Receive Error Counter reaches the value 256, the node is pushed into Bus Off state. In this state the node cannot interact with the bus. These error and states need to be logged as per the activity of the Bus and the controller.

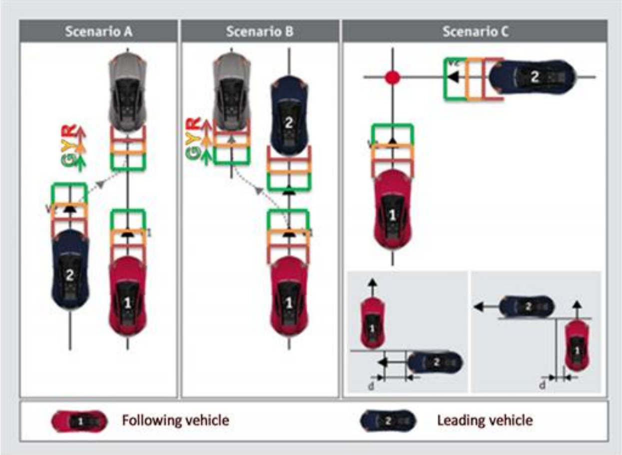

Figure 14. Various scenarios Vehicle in stimulator.

V. CONCLUSION & FUTURE SCOPE

Under the Advance collision Time gap is effectively for quick response time and efficient control response by ARM cortex M7 proposed system. The system has advantages over the other available system in terms of response time and independency on external infrastructure by using the camera and also effective fast response. It is also cheap in terms of cost and reliable when tested in actual environment.

The system does not intend to notify other running vehicles except the ones that are following it or is in the lambertian line of sight of the array of IR transmitter lined in the rear bumper. These following vehicles are the most probable cause of all the end collision. Hence IR was chosen over other radiation technologies like RF and Ethernet, etc for its straight line of sight capabilities. Bi- directional broadcasting of message was found to be undesirable in all end collision avoidance of vehicles. The integration of system with the CAN or Flex ray network makes it possible to achieve robust control action to avoid a all end Collision along with its diagnostics. Advanced Collision Time Gap algorithm as steering the vehicle to change lane and advanced cruise control can be incorporated as the future features. An embedded Diagnostic system that can improve the Driver and passenger safety with its diagnostics. It can be further sophisticated with autoregressive tests with on- road test conditions.

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