RADAR Based Vehicle Collision Avoidance System used in Four Wheeler Automobile Segments

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Abstract - The Vehicle collision avoidance system in an automobile is used to prevent the accidents and ensure the vehicle safety and reliability. This system can make the job of driving vehicles easier and ensures to manage traffic efficiently with road safety. The proposed system uses Radar sensors (Short range Radars) placed at its front ,these vehicles can detect presence of moving objects in their path, and predict their speed, direction and calculate how to maintain a safe distance from them.At present all the Intelligent Vehicles are being manufactured with inbuilt collision avoidance system as a proactive crash mitigation system. Ranging and detection of the front end vehicles are accomplished by combining the RADAR sensors, Hardware's, Communication devices and a Risk zone detection algorithm. By combine this makes the use of Vehicle collision avoidance system more perfect and available to the public allowing safe and secure driving experience. The desired speed and distance can be set at several levels according to the situation. The main goal of this proposed work alerts the driver on vehicle positions and will do on auto diagnostic of vehicle**.**

Keywords - *RADAR, Vehicle Collision avoidance, Adaptive Cruise Control (ACC),Intelligent Transportation Systems(ITS), Engine Control Unit (ECU), Surface Transport Act (STA),Original Equipment Manufacturers (OEM)*

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I. INTRODUCTION

The number of automobiles travelling U.S. roads and highways increase on a daily basis. Unfortunately, traffic congestion and the number of automobile accidents also increase. There is an ever-pressing need to regulate traffic flow and make driving much safer. The automobile industry develops more intelligent vehicles every year. These advancements allow many people to foresee a completely autonomous vehicle in the not-so-distant future. There are several organizations that promote the development of safer, more intelligent vehicles. The U.S. Government's support of the development of more intelligent vehicles is evident by the Surface Transportation Act (STA) passed just recently. Intelligent Transportation Systems include advanced technologies that help drivers avoid accidents, reduce traffic jams, and improve traffic flow.

Today, a majority of the population is living in urban areas and has been drastic increase towards the usage of transportation in cities. Road transport is one of the most widely used and 70% of the transportation takes place by this mode only. Cars, Trucks, Buses and Goods vehicles have increased in day to day transport. After the French revolution and World war- II, the automobile sector growth is rapidly changed all over the world. By adopting the various Technology, Standards and Strategies the Manufacturing cost of the vehicle has been reduced.

The Original Equipment Manufacturers (OEM) are continuously upgrade the new features in the vehicles to attract the customers and hence the market retail price of a automobiles is also reduced .Human eye and mind is not enough while driving on today's road traffic scenario and complete concentration cannot be guaranteed by the human mind. The last three decades the vehicle population is increasingly four folded and the various models of the automobiles are been manufactured.

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II. RESEARCH BACKGROUND

India has among the highest number of road accident casualties in the world. A government statistic says that a death occurs every four minutes on Indian roads due to road accidents. The main causes for road accidents are many; the congested city roads, bad road surfaces, flooding of roads, reckless driving, inadequate traffic management and so on and so forth. In the years 2001 to 2011, more than a million people died in road accidents across India. We bring you the top five states that has recorded the highest number of deaths due to road accidents.In India the severity of road accidents, measured in terms of persons killed per 100 accidents, has also increased from 19.9% in 2001 to 26.9 %in 2010.

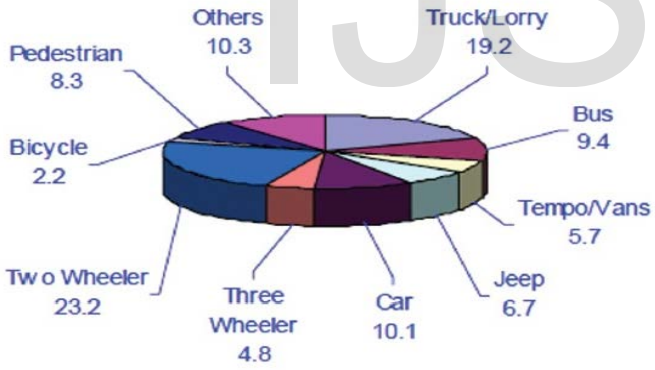

Fig.1 Road accident deaths in India by various modes of transport during 2012

Expansion in the road network, a surge in motorization and the rising population in the country contribute toward the increasing numbers of road accidents, road accident injuries and road accident fatalities. The road network in India, the numbers of registered motor vehicles in the country and the country's population have increased at a compound annual growth rate (CAGR) of 3.4%, 9.9% and 1.6% respectively, during the decade 2001 to 2011. During the same period, the number of road accidents in the country increased at a CAGR of 2.1%. Similarly, the number of road accident fatalities and the number of persons injured in road accidents in the country between 2001 and 2011 increased by 5.8% and 2.4% respectively. The figure 1 gives the statistics about the death toll rate in Indian roads due to road accidents during the year 2012 .From the above bar graph, nearly 51% of deaths during road accidents are caused by four wheelers. The proposed system is mainly focused as a preventive measure and try to minimize the road accidents due to vehicle collision and hence reduce the death and injury rates.

III. RESEARCH METHODOLOGY

A. CONVENTIONAL DRIVING SYSTEM

The conventional system works based on the accelerator input, the rate of fuel flow given to the engine and the speed is controlled accordingly. If the vehicle needs to run at high speed the accelerator pedal has to be pressed more so that it supplies more fuel to the engine. In the conventional method the drivers concentration is much more and always alert to take necessary control actions depends on the traffic situation.

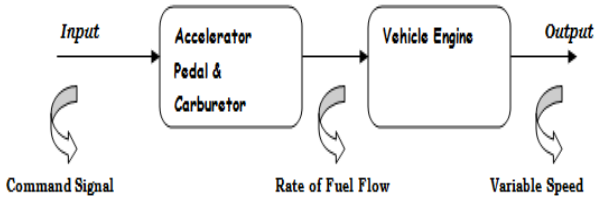

Fig.2 Existing System in Automobile

B. PROPOSED SYSTEM

Vehicle Collision Avoidance system is a new type of speed control method used in the modern vehicles and it is a extension of conventional cruise control systems. In the conventional control systems the control unit compares the actual speed with the desired set speed. If there is any difference is found between these two values, a signal is sent to throttle position actuator to bring the vehicle to the set speed. The Fig.3 explains the proposed Radar based Vehicle collision avoidance system used in a car.

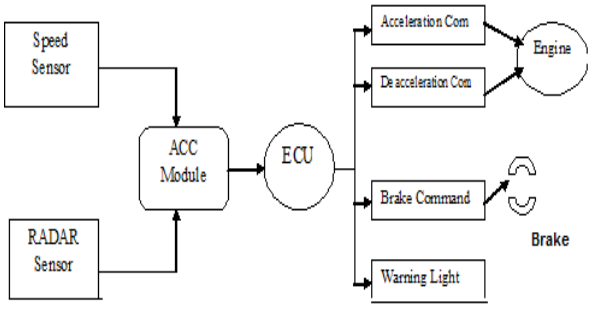

Fig.3 Closed Loop Control System

The system incorporates a Radar-based system that can monitor the vehicle in front (up to 600 feet) and adjust the speed of the vehicle to keep it at a preset distance behind the lead vehicle, even in the extreme weather conditions. These sensors are capable of detecting the presence and speed of other vehicles, and that information is used to maintain a safe following distance. If adaptive cruise control detects an obstruction in the roadway, or the lead vehicle slows down, the system is capable of cutting the throttle, downshifting, and even activating the brakes. The system measures the distance as a function of speed and monitor the traffic ahead while ignoring stationary objects such as road signs and telephone poles and also determine how fast the vehicle is approaching the vehicle ahead. When a slower vehicle ahead with the Collision avoidance present vehicle or a vehicle come closer to the Collision avoidance present vehicle, the system automatically close the throttle or apply the brake pressure to slow down the vehicle and also maintain the distance between the vehicles. The set speed is the desired maximum speed to be regulated by the system on an open road. The system is truly "Hands - off" and performs these functions automatically. The proposed system maintains the vehicle speed at the preset amount, as long as the vehicle path is unobstructed. The control module get the information from the radar sensor, vehicle speed sensors and vehicle steering and yaw rate sensors to determine if the path is obstructed and to adjust the vehicle speed. The radar may be a separate standalone unit or it is incorporated with the control unit.

The proposed system provides a visible alert when it senses a reduction in traffic speed in case of any

vehicles ahead. When the danger of a collision is detected, it provides a red warning light that flashes on the windshield. If the driver's response is delayed, the system will pre-charge the brakes to prepare the vehicle for more aggressive braking to help avoid rear-end accidents. If the driver lifts quickly off of the accelerator indicating a desire to slow down, the system will apply the brakes to a nominal level to decelerate the vehicle faster than the driver can move his or her foot to the brake pedal. If the driver hits the brakes rapidly, the system is designed to provide full braking capability of the vehicle to avoid or mitigate the potential threat.

C.SENSING MECHANISM

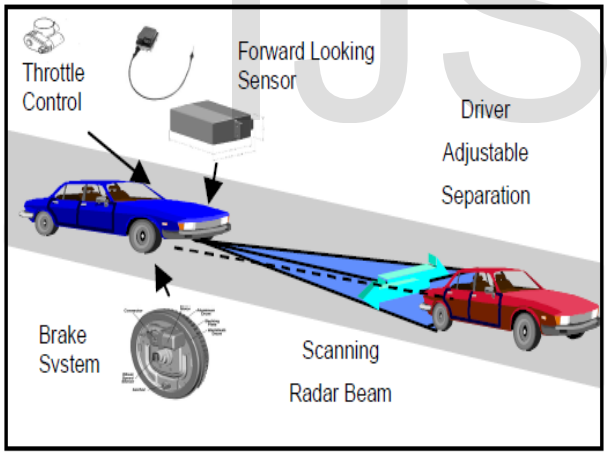

Fig.4 Sub sytems of the proposed vehicle collision avoidance system

Fig.4 infers the following information

1. The proposed method installed vehicle set speed as 70Km/H.
2. RADAR based detection system obtain the slower vehicle ahead and speed of the vehicle is 40 Km/h.
3. If the danger of the collision is detected it provides a alert to the driver.
4. Engine control uint reduces the speed of the Collision avoidance system installed vehicle and it adjust according to the preceding vehicle.
5. Reset to the original speed if the traffic clears.

***D. RADAR* function in Collision avoidance system**

RADAR (Radio Detection and Ranging) is an electromagnetic wave of power Pt is transmitted to a preceding object, for example to a moving car or truck and is partly reflected back to the antenna with the receiving power Pr. From the time delay between the transmitted and received signal the distance to the car or truck can be calculated. Additional information can be gained from the frequency shift of the received signal, which is proportional to the speed of the preceding vehicle.

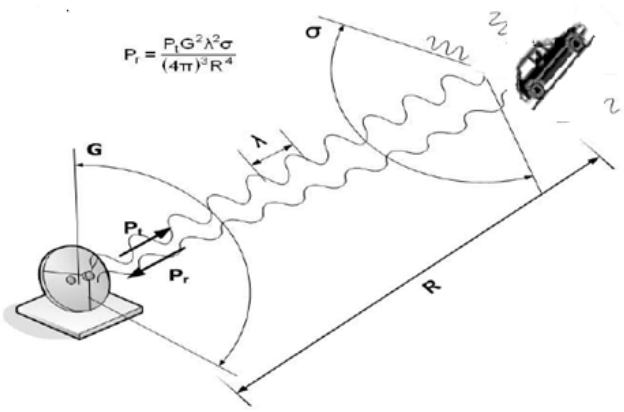

Fig.5 RADAR Ranging and Detection

RADAR range equation is as follows

$$P_r = \frac{P_t * G^2 * \lambda^2 * \sigma}{(4\pi)^3 * R^4}$$

P_t = Power transmitted from antenna in dBm

G = Gain of the transmitting antenna

λ = Wavelength of the transmitted signal in meter

σ = Cross section in m^2

R = distance between the transmitting antenna and reflecting object

P_r = Received power in watts

The ACC system provides an audible alert when it senses a reduction in traffic speed in case of any vehicles ahead. When the danger of a collision is detected, it provides a red warning light that flashes on the windshield. If the driver's response is delayed, the system will pre-charge the brakes to prepare the vehicle for more aggressive braking to help avoid rear-end accidents. If the driver lifts quickly off of the accelerator indicating a desire to slow down, the system will apply the brakes to a nominal level to decelerate the vehicle faster than the driver can move his or her foot to the brake pedal. If the driver hits the brakes rapidly, the system is designed to provide full braking capability of the vehicle to avoid or mitigate the potential threat.

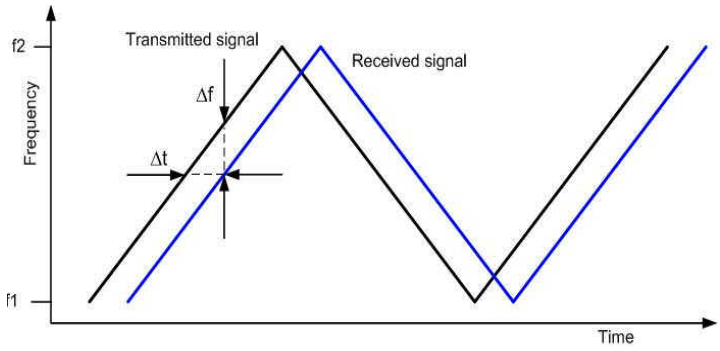

Fig.5 Radar Transmitting and Receiving signal

The figure 5 provides the Radar signal transmitting and receiving patterns on the Vehicle collision avoidance system. Black line represents the transmitted signal and blue line represents the received signal. The time differences between these two signals are measured as Δt and this time period is used to calculate the distance between the preceding vehicles.

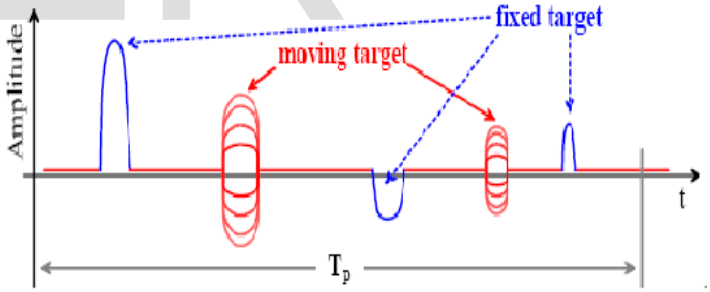

Fig.6 Target identification using Radar

The figure 6 gives the actual information's based on the current traffic conditions on the road. The transmitted signal from the proposed method implemented vehicle are reflected as moving fixed objects. The received signals are in the form of moving target and fixed target and the Δt provides the distance between the objects. Based on the real

time information's the proposed method Hardware's and Safe distance algorithm decides the vehicle speed and when the braking to be applied.

IV. RISK ZONE DETECTION ALGORITHM

Vehicle collision avoidance system implements Radar based transmit and receive sensor module is mounted in front of a vehicle. The sensor includes a sensor antenna system which comprises a transmit antenna for emitting or transmitting an Radar signal and a receive antenna for receiving portions of the transmitted signal which are intercepted by one or more objects within a field of view of the transmit antenna and reflected back toward the receive antenna.

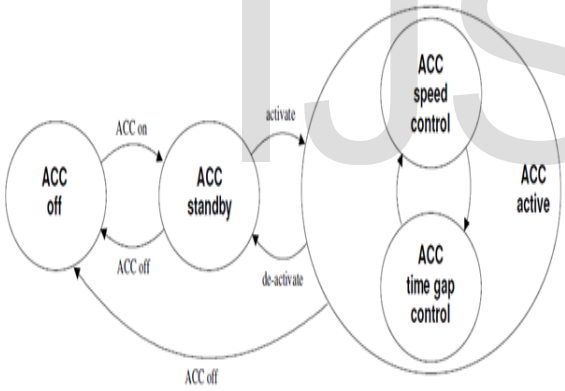

Fig.7 States and Transitions

Fig.7 describes the following System States

ACC off state – direct access to the 'ACC active' state is disabled.

ACC standby state – system is ready for activation by the driver.

ACC active state – the ACC system is in active control of the vehicle's speed.

ACC speed control state – a sub state of 'ACC active' state in which no forward vehicles are present such that the ACC system is controlling vehicle speed to the 'set speed' as is typical with conventional cruise control systems.

ACC time gap control state – a sub state of 'ACC active' state in which time gap, or headway, between the ACC vehicle and the target vehicle is being controlled.

Target vehicle – one of the forward vehicles in the path of the ACC vehicle that is closest to the ACC vehicle.

Time gap – the time interval between the ACC vehicle and the target vehicle. The 'time gap' is related to the 'clearance' and vehicle speed.

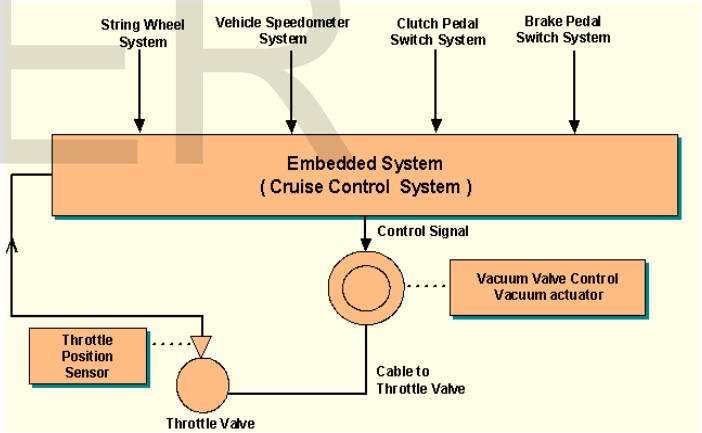

Fig.8 Signals and Information flow

Fig.8 describes the how the various sensor signal information's are being processed and how the control signals are generated to achieve the vehicle stability.

V. BRAKE SYSTEM

Major components of the Brake System in the proposed system is Brake control module, Solenoid vale assembly, sensors in wheels

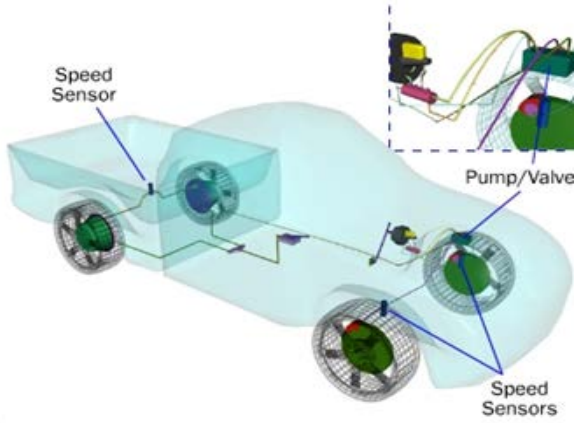

Fig.7 Brake System

Brake control module:

As per the Fig.7 the brake control module is receives information from the speed sensor and compares it to the speed of other wheels. When one wheel is approaching lock-up pressure can be vented allowing the wheel nearing lock-up to speed up. If a wheel is to fast pressure can be increased to slow down the wheel. If both wheel are approximately the same speed the brake control module can enter a pressure hold mode of operation.

Pump Valve assembly:

It consists of pair of valve assembly and doing increase pressure, decrease pressure and hold pressure steady. During pressure increase mode of operation fluid is allowed to flow through both solenoids to the brake caliper. During pressure hold mode of operation both solenoids are closed and no additional fluid is allowed to flow to brake calipers. During pressure vent mode the pressure increase solenoid is closed. The vent solenoid opens allowing fluid to vent into an accumulator chamber.

VI. CONCLUSION

This paper provides an approach to avoid the collision between the vehicles in traffic busy roads. In future this concept can be implemented in four wheelers and prevent the vehicles from accidents and save the peoples from severe injuries. This is not for only based on vehicles collision at the same time if any obstacles like wall, trees, people, etc are coming on the road lane means the system will detects all things and send the message to the unit and then we can save the vehicles from accidents. So simply we can say if this concept was implements in real time systems it will get success means we can say as Accident free vehicle collision system. Hence usage of this system can highly increase safety and efficiency of transportation system, while improvements in this system can bring out the more reliability and safety in the vehicular manufacturing technology.

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