



Survey on Pre-Crash Systems

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Abstract-The number of vehicles in transportation system are widely increasing; so it has been a major concern for highway authorities and in cities to facilitate effective control of traffic for collision avoidance. For several highways these demands cannot be fulfilled by extending the existing roads and the current infrastructure. There is a growth in number of vehicles and with narrow roads it becomes very difficult for the driver to drive the vehicle. For even a fraction of time if driver misses his attention then it might lead a crash with the front vehicle, even if the vehicle is at a small speed. In congested traffic sometimes the vehicle owner get frosted and he can't keep the focus or watch on the vehicle in slow moving traffic. In such a situation this pre crash vehicle detection system proved to be an excellent system from preventing a crash. Pre-crash system is a system designed to help prevent rear-end collisions with vehicles which are stationary / travelling in the same direction. Several studies have shown that driver distraction, carelessness or inattentiveness is a factor in majority of rear end accidents. The systems objective is to alert the driver of an imminent rear end collision both at low speeds, typical of urban driving, and at higher speeds typical of rural roads and highways. Pre-Crash systems detect the possibility of collision and reduce the speed of vehicle thus playing a very important role in avoiding the collision.

Keywords- collision avoidance; attention; rear-end collision;

I. INTRODUCTION

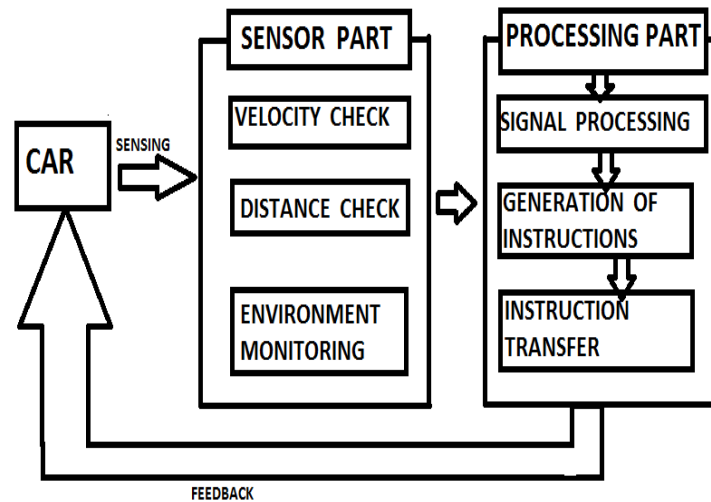
Various methods and steps have been taken to improve and enhance the safety features available in the vehicles, such as the development of airbags, audio alerts etc. Before the implementation of safety features the number of accidents was too high, after introducing these measures the number decreased. Pre-Crash systems/Collision avoidance systems were developed with the aim to reduce the rear-end collision.

A. Active and Passive safety

Generally we can see two kinds of safety systems in automobiles: passive and active. A passive safety is a system which is placed in cars, trucks which sits idle at times and only used only when necessary. A good example of this is a seat belt. Airbag, may also come under passive safety systems. However, you could argue that because they depend on impact of sensors that determine the severity of an accident, and use that information to determine how quickly they have to inflate and how long they should stay inflated, airbags could also fall into active safety category. When we go to speak of pre-crash systems active systems are very different from passive systems safety systems. Active systems work on information gathered or signals and alert the driver of the dangerous situation and also help driver in important maneuvers like steering while braking. These systems take the current information of the vehicle. Although early collision detection systems made use of various techniques to detect objects through infrared waves, but today most of the pre-collision systems today work on radar. Anything that is a wave or like a sound wave can bounce back or echo. We might have experienced this while shouting loudly into a well or over a deep canyon just to hear the sound of our voice being bounced back and reverberate. Here instead of sound, the radar makes use of radio waves. Radio waves, they can travel farther than sound and they are invisible. The Collision Avoiding System / Pre-Crash System is considered as an active safety system which is designed to alert the driver of the upcoming collision and help in avoiding the accidents.

II. DESIGN AND IMPLEMENTATION

Millimeter wave radar is used as a sensor in this system. This sensor is used in sending signals in air and the reflected signals are received back. The information which is obtained in the signals is used to determine the relative velocity and the distance between the vehicles. The processor which is present in the processing unit is used to process the information which is received from the reflected signal and is used to generate instruction which are sent to ECU of the break and also to the information system.



(Figure 1: CAS construction)

A. CAS System Configuration & Components:

a. Millimeter-wave radar:

This radar detects the vehicle within a range of 100meter ahead and in a 16-degree arc.

b. Sensors:

The system determines all possible driving conditions using a range of sensors that are used to detect factors such as wheel speed, brake pressure, yaw rate, and steering angle.

B. CAS Electronic Control Unit (ECU):

Depending on distance from the upcoming vehicle and relative speed information obtained from radar and the anticipated path is also determined based on the sensor information ,using these parameter the ECU calculates the likely hood of collision and alerts the driver and also activates the breaking functions. The ECU exchanges information with E-Pretensioner ,Meter Unit and Variable Signal Analyzer (VSA) as required.

a. E-Pretensioner ECU:

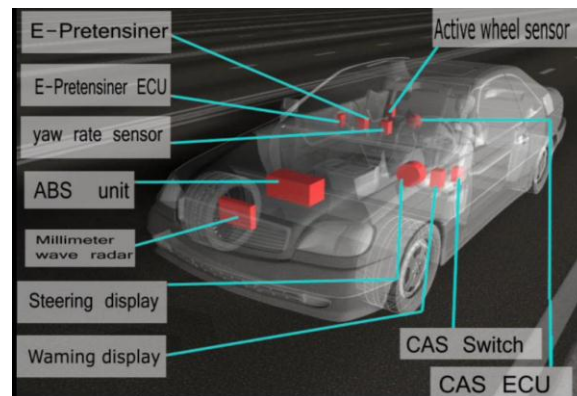
Based on braking instruction signals received from the CMS ECU and from electronically controlled brake assist signals sends instructions to E-Pretensioner to pull back the seatbelt.

b. E-Pretensioner:

, Depending on instructions received from the E-Pretensioner, ECU pulls back the seatbelt with the aid of a internal motor which is in combination with the conventional pretensioner.

c. Meter unit:

Meter unit is used in warning the driver about the potential hazards/danger with audio or visual warning like audio alarm. This unit receives signals from CAS ECU and warns the driver. All these above parts are shown in figure 2: CAS constructions. Collision Avoiding System (CAS).^[2]



(Figure 2: CAS construction)

III. WORKING

STEP 1 : Here a wave radar is used in sending the waves and receives back the reflected signals and the information is used in determining the distance between the vehicles and the relative velocity.

STEP 2 : TTC(time to collision) is used in calculating relative speed and distance which are already known.

STEP 3 : If TTC is greater than the threshold value then no action is taken and it is indicated that the distance between the vehicle is more and the vehicle is safe, but if TTC becomes less then buzzer/alarms are used to warn to driver.

STEP 4 : If TTC still reduces then a small amount of braking is applied to reduce the vehicles speed.

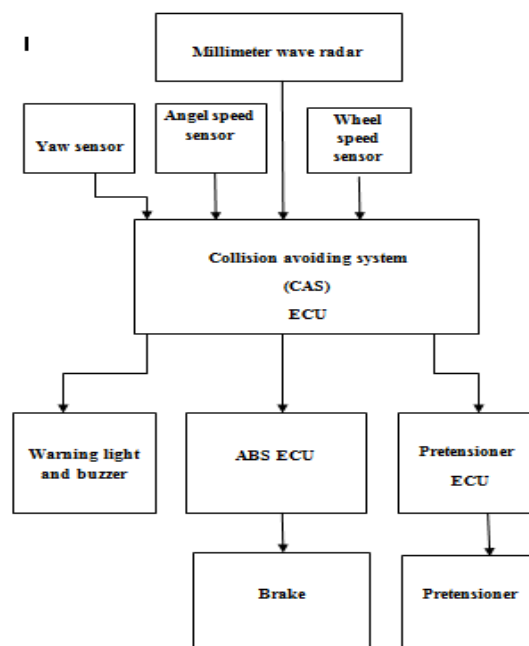
STEP 5 : Further if TTC still keeps on reducing then hard breaks are applied and the vehicle is stopped to avoid the collision.

IV. THREE STAGES CONTROL

There are three stages of CAS operation which will be discussed below.

A. Buzzer and light warning.

The reflected signal is received by radar along with the yaw sensor and speed wheel sensor, the information from all the above parameters are used in CAS ECU, then CAS ECU is used in calculating the time and it is programmed in such a way that if the time found is three seconds then CAS ECU sends signal to buzzer and light warning unit to alert the driver, about the occurrence of the collision and is indicated on the dash board. If the driver gets alerted and applies break then everything comes to normal state, but if he still continues to keep the speed and if it becomes less than three second then next stage is activated.



(Figure 3: block diagram for braking stage)

B. Light braking and tighten the seatbelt

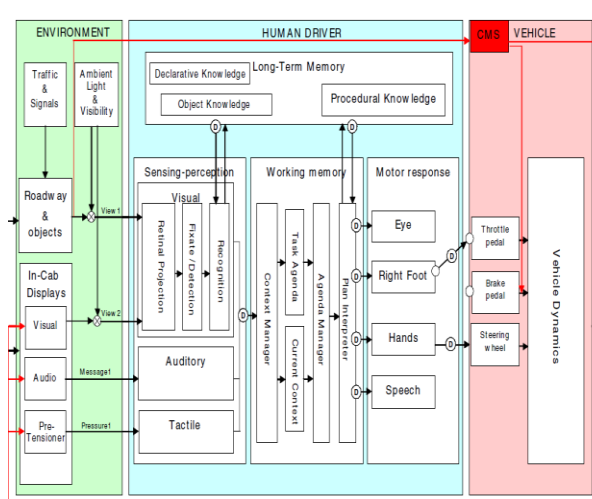
Here in this step ECU finds the time before collision, and if TTC is found to be two second, then electronic control unit(ECU) orders the pretensioner ECU to tighten the belt or to pull back the seat belt and also orders the ABS ECU to open and close the valve so that light braking can be applied.

C. Hard braking and retract seatbelt

When the information signal comes from radar, speed wheel sensor and yaw sensor are into integrated hydraulic unit ECU, and then this integrated hydraulic unit ECU sends the signal to CAS ECU, then this CAS ECU unit calculates the time before impact and if it about one second then CAS ECU orders pretensioner ECU to pull back the seat belt tightly or strongly and also orders the ABS ECU to apply hard breaks as shown in figure (3) pre-crash sensor for pre-crash safety^[3]

V. SIMULATION MODEL

Figure (4) shows concept of simulation model which is structurally similar to NASA's MIDAS program and the model has three main components they are : the human driver ,the vehicle ,and the environment.



(Figure 4: the concept of simulation model)

A. Environment Model

This model shows the world outside the driver's vehicle. The model contains the drivers intended path along with other vehicle involved in the scenario. It also has in-cab displays which are available to the driver, which contains the audio ,pretension warnings and visual.

B. Driver Model

This model contains four major sub modules they are: long-term memory, motor response, working memory, and sensing-perception. The sensing perception module processes information from the environment into sense-organ and does all basic processing of the information. Here the current model has three modules in sensing perception they are: speed sensing, collision detection and look-ahead path prediction. The current collision detection module is only sensitive to CAS warnings, which helps the module in recognizing the imminent collision. Working memory module performs high-level processing of information and it has a "current context" where in the current state of the world is maintained such as weather , lighting conditions ,level of traffic etc. "Task agenda" is a list of all the tasks that a driver wants to perform. These tasks are weighted relatively to the current context, which creates a vector of weights for the tasks, where each one has their own priority of being performed. Tasks which have lower priority cannot be performed due to limited capacity. The Traffic Alert and Collision Avoidance System^[4]

VI. ADVANTAGES

1. Avoids collision-the collision avoidance system prevents collision between vehicles and vehicular collisions with trains, stationary objects and pedestrians by controlling , reporting, documenting and monitoring the speed and position of vehicles.
2. Saves life- the life saving potential of crash-avoidance system is great enough to save life. This system can let a car see other vehicles or pedestrians well before they are in your line of sight.
3. Provides safety to vehicles-Pre crash safety systems detect an imminent crash and deploy safety devices such as seat belt pretensioners. Some systems react immediately during the crash optimize occupant safety.

VII. DIS-ADVANTAGES

1. **Limited range of millimeter wave** radar-the radar is limited to only 100m,one of the millimeter wave radar is its limited range. The law physics says that the shorter the wavelength, the shorter the transmission range for a given power.
2. **Small objects cannot be detected**-small object like small object, stones, humps etc cannot be detected by millimeter wave radar, and is also immune to weather.
3. **High initial cost**- at high frequencies the circuit design will be complex and expensive.

VIII. EXTENDED APPLICATIONS

A. Lane-keeping systems

Lane Keeping system this systems alerts the driver when the vehicle is about to deviate from the lane or move away from the lane. The system also works with Radar Cruise Control system to help the driver in steering and keep the vehicle on course.

B. Blind Spot Information System (BLIS)

The **blind spot system** is used in detecting other vehicle which are located on drivers side and rear. This system is also referred to as vehicle-based sensor device .Warnings can be audible, tactile, visual or vibrating. Blind spot monitors are optional that may include monitoring the sides of the vehicle. It can also include "Cross Traffic Alert,"

C. Cross-traffic alert

Cross-traffic alert which alerts drivers in backing or moving out of a parking space when huge traffic is impending from the sides. And is also a part of the blind-spot monitoring system, same sensors are used which were used for vehicle detection. Its main objective is to detect vehicles that might be crossing your backward path.

D. Active park assist

Active park assist is an autonomous car-management system. Which helps in moving the vehicle from a traffic lane into a parking spot and assist the driver to perform perpendicular, angle parking or parallel actions. The aim objective of active park assist is to enhance the comfort and safety of driving in forced environments which in a driver must be attentive and have a good experience in car steering actions. By having good coordination between the steering angle and speed, parking scheme can be achieved and ensures a collision free motion within the available space.

IX. CONCLUSION

Therefore by making use of Pre-crash systems it is possible to avoid collisions by automatically stopping the vehicle without human intervention. In addition to his we can use highly functional compact millimeter wave radar to increase the range and reduce the severity of crash. In this development millimeter wave radar that can be applied to the safety systems along with crash determination algorithms that are used in determining unavoidable crash more reliably has been developed. As a result of all this , there is a production in systems that activates safety devices prior to an actual crash to occur has been accomplished. Today not many systems have implemented these technologies yet and this development may just be one small step, but it is possible that this while lead to a step forward in the field of active safety systems.

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