# A Survey on Rear End Collision Avoidance System for Automobiles

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***Abstract*—Collision warning and collision avoidance systems are emerging automotive safety technologies that assist drivers in avoiding rear-end collisions. Their function is to allow the driver enough time to avoid the crash and yet avoid annoying the driver with alerts perceived as occurring too early or unnecessary. The purpose of this paper is to review various mechanisms under development or developed rear end collision avoidance of automobiles. Some of the reviewed work include an automatic braking system that safely stops an automobile while approaching an obstruction to avoid collision. Another separate but related system is to have a detection device, which alerts the driver in case the automobile veers off the road by crossing either the centre or side painted lines. The braking system senses an obstacle, calculates the relative distance and applies the variable brakes automatically to maintain a safe distance. Warning devices and sensor mechanisms used in obstacle avoidance systems are also reviewed.**

***Keywords*— Collision Avoidance, Automobiles, Traffic.**

## I. INTRODUCTION

With the expansion in road network, motorization and urbanization in the country, the number of road accidents have surged. Road traffic injuries (RTIs) and fatalities have emerged as a major public health concern, with RTIs having become one of the leading causes of deaths, disabilities and hospitalizations which impose severe socio-economic costs across the world. Motor vehicle population has grown at a compound annual growth rate (CAGR) of 10 per cent 2000-2009, during fuelled by a rising tide of motorization. Concomitantly, traffic risk and exposure have grown. During the year 2010, there were around 5 lakh road accidents, which resulted in deaths of 134,513 people and injured more than 5 lakh persons in India. These numbers translate into 1 road accident every minute, and 1 road accident death every four minutes [1]. The total number of accidents can be reduced through the safety systems installed in vehicles. However, it was found that many traditional safety measures are reducing their effectiveness.

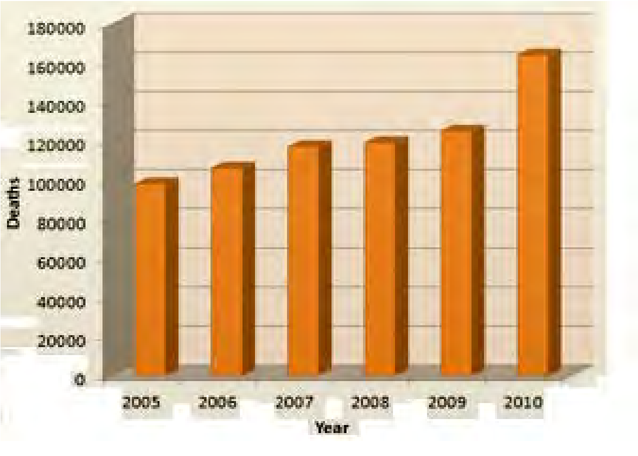


Figure-1: Death in Road accidents in India from 2005 to 2010

However these all traditional safety system are in post-accident action to protect driver and passengers. But these systems do not avoids the probability of accidents. Thus we need a driver assistance system to make vehicle stop in a safety zone if it detects the probability of accident. Also these systems are programmed to assist driver for breaking, acceleration and maintain a safe distance from vehicle ahead. A collision avoidance system operates, generally, in the following manner: a sensor installed at the front-end of a vehicle constantly scans the road ahead for vehicles or obstacles. When found, the system determines whether the vehicle is in imminent danger of crashing, and if so, automatic brakes should be applied. In this paper we are surveying these collision avoidance system and making conclusion out for the further study.

## II. RELATED WORK

There are many systems proposed for driver assistance to avoid collisions, and the intervention in critical situations could help to significantly improve road safety. Based on intelligent sensor technology, driver assistance systems constantly monitor the vehicle surroundings as well as the driving behavior to detect potentially dangerous situations at an early stage. In critical driving situations, these systems warn and actively support the driver and, if necessary, intervene automatically in an effort to avoid a collision or to mitigate the consequences of the accident. We here showing the related work done in past by various authors:

### *A. Mazda Algorithm*

The Mazda overriding algorithm [2] considers a hypothetic worst case, as shown in Fig-2. First, it assumes that initially both the host vehicle and the lead vehicle maintain constant speeds VH and VL respectively. Then the lead vehicle starts to brake after time τ2 at deceleration level −α2, while the host vehicle starts to brake after an additional time τ1 at deceleration level −α1, which continues until both vehicles come to a full stop. The overriding range Ro is computed as the minimum range needed at time 0 to allow the above scenario to happen without collisions, as shown in Equation 1.

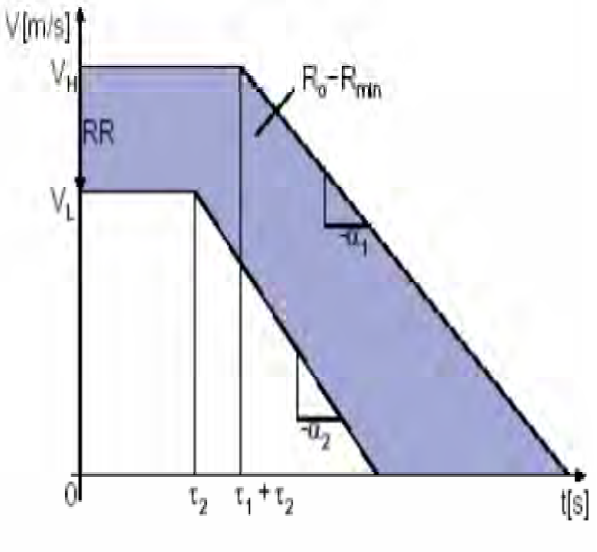


Figure-2: worst case in Mazda algorithm

$$R_0 = \frac{1}{2}\left(\frac{{V_H}^2}{\alpha_1} - \frac{{V_L}^2}{\alpha_2}\right) + V_H\tau_1 + RR\tau_2 + R_{min} \dots\dots\dots\dots.(1)$$

Where RR is the range rate, i.e., the relative velocity between the two vehicles (RR ≡ VL − VH), and $R_{min}$ is a constant headway offset. The shaded area in Figure 2 is the required safety range buffer between the two vehicles should the hypothetic scenario described above happen.

### *B. Berkeley Algorithm*

The Berkeley algorithm [3] proposes a conservative $R_w$ to provide a wide range of visual feedbacks to the driver, and a non-conservative $R_o$ to reduce undesirable effects of overriding to normal driving operations. It is assumed that

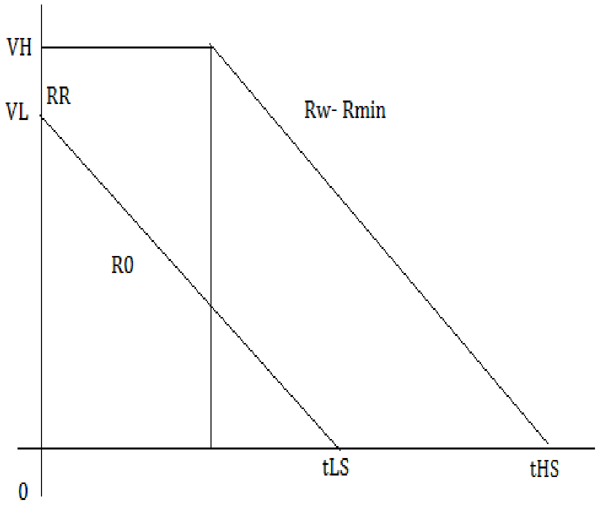


Figure-3: Interpretation of Berkeley Algorithm

the lead vehicle brakes at the maximum constant deceleration level −α, while the host vehicle starts to brake after reaction time τ at the same deceleration level. Note that the reaction time τ here accounts for both driver reaction time and system delay time. The warning range $R_w$ is estimated as the minimum range buffer needed to avoid collisions until both vehicles come to a full stop in the above scenario, while the overriding range $R_o$ only considers the range buffer needed from time 0 to τ as:

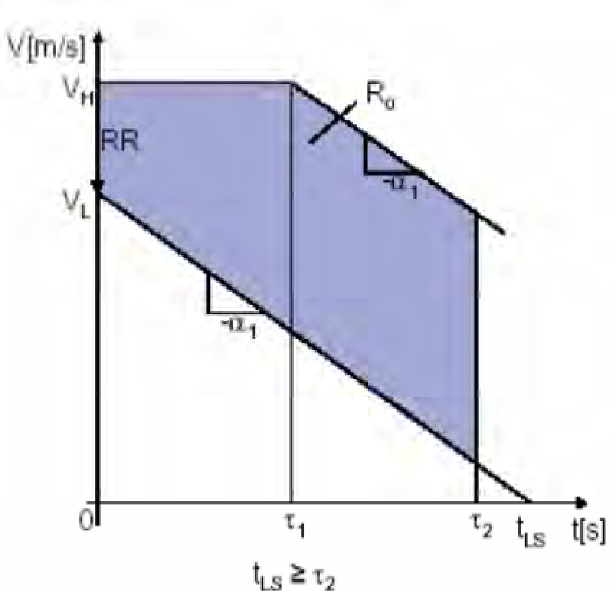
$$R_w = \frac{(V^2{}_H - V^2{}_L)}{2\alpha} + V_H\tau + R_{min} \ldots\ldots\ldots\ldots (2)$$

$$R_0 = -RR.\tau + \frac{1}{2}\alpha\tau^2 \qquad \ldots\ldots\ldots\ldots\ldots (3)$$

### C. *Honda Algorithm*

The Honda’s warning algorithm is a straight line in the range rate-range plane, indicating a time-to-impact consideration. Their braking logic has two parts selected by estimated shortest time-to-lead-vehicle-stop.

The Honda algorithm [4] considers a hypothetical scenario. It consists of two parts, depending on whether the lead vehicle is expected to stop within the considered time range $\tau 2$. It is assumed that the lead vehicle brakes constantly at deceleration level $-\alpha 2$, while the host vehicle starts to brake after reaction time $\tau 1$ at deceleration level $-\alpha 1$. Then the safety range *Ro* is estimated as the minimum



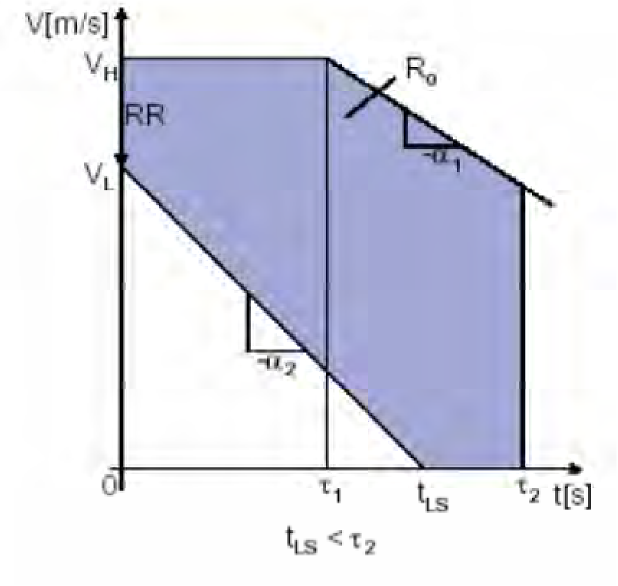


Figure-4: Interpretation of Honda Algorithm

range buffer needed to avoid collisions until $\tau 2$ at both situations, which Automatic brake is applied to assist collision avoidance if the current range *R* is within *Ro*.

$$R_0 = \begin{cases} V_H\tau_2 - \frac{1}{2}\alpha_1(\tau_2 - \tau_1) - \frac{{V_L}^2}{\tau_2} & \tau LS < t_2 \\ -RR.\tau_2 + \alpha_1\tau_1\tau_2 - \frac{1}{2}\alpha_1\tau & tLS \geq t_2 \end{cases} \quad (4)$$

*D. NHTSA Algorithm*

The NHTSA Alert Algorithm [5] considers slightly more complicated scenarios. It assumes that the lead vehicle brakes constantly at current deceleration level aL , while the host vehicle, with a current constant acceleration level aH , starts to brake constantly at the maximum deceleration level aHmax (aHmax ≤ aL < 0) after reaction time tr . Two different situations are considered, depending on whether the lead vehicle stops first or the host vehicle stops first under the above assumptions.

Here the system tries to estimate the relative acceleration (aR ≡ aL − aH ) in real time from the time derivative of range rate (RR) data measured by radar sensors, then the lead vehicle deceleration level aL is computed from aR estimation and aH measurement, in contrast to previous algorithms where aL is a pre-selected parameter. The driver reaction time tr, which includes both the driver and system delays, is normally set to 1.5 s, and is reduced to 0.5 s when brake is applied.

*E. CRISS Driving Simulator*

A statistical analysis was conducted by Francesco and Roberta to obtain a new collision warning algorithm that reflects the car-following driver behaviour during simulator testing. The multiple linear regression technique was used in model estimation. The following model was found by them:

$$distance = 125\Delta V + 155\ V_F \ldots\ldots\ldots\ldots.(5)$$

Where ΔV and $V_F$ are expressed in m/s.

The distance (d) given by the model can be considered as a threshold which should trigger an alarm system for driver assistance. An alarm is provided when the driver is in the middle of the crash alert timing zone (in other words when t is 1.35s). The independent variables used in the model were significant at the level of 5%. The model is consistent as the distance to which the drivers take evasive manoeuvres of the car-following condition, increases as the speed of the driver ($V_F$) and the relative speed between the following and leading vehicle (ΔV) increases. The experimental study carried out at the CRISS driving simulator was aimed to analyse the driver behaviour during car-following manoeuvres [6].

*F. CAMP Alert Algorithm*

The CAMP Alert Algorithm [7] considers essentially the same scenarios with the same assumptions as the NHTSA algorithm. The only differences are that $D_{thresh}$ is set to zero and that $a_{Hmax}$ is replaced by required deceleration $a_{Hreq}$. Hence $a_{Hreq}$ varies according to the different underlying dynamic scenarios, and is not a prefixed parameter. The Crash Avoidance Metrics Partnership (CAMP) was established to accelerate the research in advanced automotive collision avoidance systems to improve traffic safety.  CAMP developed basic elements of Forward Collision Warning (FCW) systems, which provide alerts intended to assist drivers in avoiding or mitigating rear-end crashes. Crash alert timing and crash alert modality (auditory, visual and/or haptic) requirements as well as driver reaction time and braking behaviour were studied by conducting a series of closed-course human factors studies using a “surrogate target” methodology, where drivers were asked to perform last second braking manoeuvres while approaching a slowing or stopped vehicle.

## III. CONCLUSIONS

In this paper we presented a review of some standard algorithms for anti-collision avoidance system. The parameters given in the models above can be considered as a threshold which should trigger an alarm system for driver assistance in order to advise the driver when he is in the crash alert timing zone. These algorithms reflects the real risk perception by drivers. Therefore it should minimize false alarms and should help to avoid a potential collision. These algorithms were verified in past and its implementation in real time is being carried out. Further research is recommended focused in developing a more reliable system for potential applications.

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