DEVELOPMENT OF DRIVER ASSISTANCE COLLISION AVOIDANCE FUZZY SYSTEM

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In the past century, the number of motor vehicles has increased. The driving behaviors of people have also become dangerous resulting in increase number of accidents. Human behaviors are hard to recognize, predict and handle. In order to avoid these kinds of unexpected accidents, it is necessary to develop an appropriate set of in-vehicle detecting and warning systems that can improve the driving safety. Fuzzy logic is a powerful way to put engineering expertise into products in a short interval of time. It is highly beneficial in automotive industry, where many systems are designed. This is based on the experience of design engineers and drivers. The idea of fuzzy systems is based on the premise that in the real world changes is not catastrophic but may take place from one action rule to another. In this paper, an attempt has been made to develop a fuzzy system that can integrate with other vehicle control systems in order to assist the driver to avoid vehicle collision. The system simulates the actual situation between two vehicles - by representing the relationships between the inputs and outputs in the form of IF-THEN rules - and suggests the deceleration required to avoid the collision. The deceleration can be later on converted to braking pressure and taken as input in another control system that may be mechanical, electrical or a combination of them. The performance of the proposed fuzzy system was tested in a variety of virtual speeds from 25 to 125 km/hr and virtual distances from 5 to 60 meters through 60 different situations and the system gave reasonable results.

Keywords: Fuzzy System Applications, driving behavior, collision avoidance

1. INTRODUCTION

Automotive vehicle control is considered to become a promising way to reduce or even completely avoid road accidents. Several car manufacturers are currently concerned with the development of various detection systems. All drivers are concerned with safety and the need to be aware of what is happening around them. Most of them hesitate when reacting to unexpected situations on the road. Rear-end collisions were the third highest cause of fatalities in multiple vehicle accidents [1]. Rear-end collisions can be classified into two major categories that vary with respect to causal circumstances: Lead-Vehicle Stationary (LVS) and Lead-Vehicle Moving (LVM). These conditions vary greatly with respect to pre-crash dynamics (e.g., closing speeds and distances) as well as a number of parameters relating to driver perception and performance [2].

Fuzzy logic is useful in representing human knowledge in specific domain of application and reasoning with that knowledge to make useful inferences or actions. Fuzzy logic has rapidly become one of the most successful of today’s technologies for developing sophisticated control systems. It was developed by Zadeh in mid of 1960s for representing...
some types of approximate knowledge that cannot be represented by conventional crisp methods. The general inference process proceeds in three steps: fuzzification, inference and defuzzification. Fuzzification is a transformation of the crisp data into a corresponding universe of fuzzy set. Before the data can be fuzzified, it should be first normalized to meet the range of universe of the discourse suitable for controller input. The fuzzification can be follows three basic strategies:

1. Input crisp data are converted into a fuzzy singleton in an appropriate universe of discourse.
2. Input crisp data are converted into a fuzzy vector based on expert knowledge of the characteristics of measurement instruments, A/D conversion and normalization.
3. Input crisp data are distributed and therefore can be converted into fuzzy vector with arbitrary shape (e.g., Triangle, Trapezoidal, Gaussian, Pi, etc.).

The main purpose of this work is to attempt to build a prototype automotive fuzzy collision avoidance system to give a pertinent assistance to the driver in the critical situations by suggesting the decelerations required to avoid collision (reducing car speed or stopping it) in the emergency cases. The performance of the proposed fuzzy system was tested in a variety of speeds from 25 to 125 km/hr and distances from 5 to 60 meters through 60 different states and the system gives reasonable results. The proposed fuzzy system can be considered as a foundation for the conduct of needed future research, and as a framework for supporting the development of a driver assistance collision avoidance system.

2. APPLICATIONS OF COLLISION AVOIDANCE SYSTEMS AND FUZZY LOGIC IN AUTOMOTIVE FIELD

Fuzzy logic is an important emerging technology and is undoubtedly becoming one of the most successful of today's technologies for design and development of complex control systems. Fuzzy logic has found many applications in diverse fields such as pattern recognition, image and signal processing, artificial intelligence, expert and decision support systems, and so on. One of the areas where fuzzy logic is a common design technology is the automotive industry. In Japan, Germany and France, cars with fuzzy logic controlled components are sold very successfully. Many firms in USA like Boeing, General Motors, Allen-Bradley, Chrysler, Eaton and Whirlpool have worked on fuzzy logic, used in low power refrigerators. This has improved automotive transmissions and energy efficient electric motors. Researchers also have made many contributions in this field. Bernhard et al. (1997) discussed the use of fuzzy logic for the analysis of environmental conditions such as road surface condition, visual range and weather conditions detected by local sensor stations and road sensors. They suggested traffic control system depends on four fuzzy logic modules: Road Moisture Module, Road Temperature Module, Precipitation Type Module and Visual Range Module. Ralf et al. (1997) proposed fuzzy ABS algorithm based on wheel slip and vehicle acceleration; Godbole et al. (1997) formulated the lane changing maneuver for obstacle avoidance problem as an optimal control problem. In an emergency lane changing situation, the lateral and longitudinal control inputs are calculated to minimize the longitudinal distance between the vehicle and the obstacle. Whereas, Bascunna (1997) determined the conditions for safe and unsafe lane changing. He considered four cases for vehicles in two neighboring lanes. Shiller and Sundar (1998) developed — clearance and stopping curves “that specify the collision avoidance maneuver. These curves divide the phase-plane into three regions. In Region I, the vehicle performs normal full stop or normal lane changing maneuver. In Region II, the vehicle performs normal lane changing maneuver only, and in Region III, the vehicle performs full stop maneuver in the same lane. Lu, (1998) proposed a fuzzy neural network (FNN) based approach to construct an individual-oriented car-following system. The feature of that system was firstly to incorporate a personal risk-taking factor in addition to other mechanical factors as the input parameters and then the fuzzy logic rules can be properly constructed. Dravidam & Tosunoglu (2000), developed a rear-end collision avoidance system for automobiles. The system was concentrated on objects in front of the vehicle. A sensor mounted in front of the car measured the distance; the relative acceleration was calculated from this measurement.

The data used in the analysis were acquired experimentally on a 1991 Toyota Corolla. Jansson & Gustafsson (2002) presented a decision support system to compute the risk for collision, taking into account measurement uncertainty and driver maneuvers. The system was based on the probability density function for the relative position from the own vehicle to the most dangerous other object for the moment. González-Rojo et al. (2002) proposed a new approach, based on fuzzy modelling to estimate the main parameters of the basic car following model taking into account the main parameters influencing the behaviour of the driver and allows a formal verification of local and global stability of the simulated traffic flow. Börner & Isermann (2003), proposed a lateral vehicle model detection system for critical driving situation to aid the driver by preventing any unstable or unpredictable vehicle behavior. This model is based on a deterministic approach for the online calculation of different driving conditions (i.e. stability, under-steering, over-steering, and neutral-steering). Chang et al. (2003) proposed an approach to restrain the car accidents by equipped in-vehicle...
vision-based system that monitors the sight in front of the car and issues certain necessary warning [17]. Sun et al (2004), developed a fuzzy logic inference system to perform online collision prediction, which was the core for the implementation of intersection collision alerting/avoidance technologies [18]. Song et al, (2005), developed method to evaluate safety degrees on a road section, and suggests’ Level of safety’using fuzzy logic system based on microscopic driving behaviors. Each safety degrees are aggregated using membership function values of each safety degree, and average speed [19].

3. FACTORS AFFECTING COLLISION AVOIDANCE

Automatic collision avoidance systems are those systems that have the ability to take partial or full control of the vehicle in the event that the driver is not responding properly to an unsafe situation. In practice, the possibility of merging collisions can be reduced by adjusting relative velocities and increasing the longitudinal inter-vehicles’spacing. Since roadway capacity is proportional to vehicle speed and inversely proportional to longitudinal inter-vehicle spacing, a large reduction in speed or a large increase in spacing leads to a low capacity highway system. For a high capacity highway system, the headway setting should be as small as possible. Since safety cannot be easily traded off, the choice of minimum safety spacing (MSS) between vehicles for a collision free environment is important both from safety and capacity point of view [20]. Different design parameters may be used as variables in a system to describe a potential rear-end collision scenarios. Rear-end collisions are often due to the bad visibility with foggy weather, road conditions (wet or icy), the speed and relative distance, the braking factor and driver distraction level.

3.1 Relative Distance and Speed

An important part of the analysis concerns verification of the safe distance between vehicles. The collision avoidance range (distance), \( R_{ca} \) is the closest predicted possible range that the driver can make the decision to stop (or steer), assuming the normal equations of motion, and still avoid a collision for parameters \( (V_f, V_l, a_l, Tr, a_f) \). These parameters may be measured, assumed or a combination of measured or assumed values. The collision avoidance range \( \alpha \), as shown in Figure 1, is computed as [21,22]:

\[
R_{ca} = f( V_f, V_l, a_l, Tr, a_f) 
\]  

where  
\( V_f \) = following vehicle speed  
\( V_l \) = lead vehicle speed  
\( a_l \) = lead vehicle acceleration  
\( a_f \) = host (following) vehicle acceleration

Safety distance can be classified into braking distance (solid) and/or the steering away distance (dotted) and cross somewhere around 50 km/h, as shown in Figure 2. This means that for low speeds, braking is the most efficient countermeasure and for high speeds steering away is more efficient. If full braking is applied at the point where collision becomes unavoidable (for low speeds at the braking distance and for high speeds at the steer away distance), then the collision speed as a function of the initial speed will be according to Figure 3 [14].

3.2 Road Conditions and Braking Factor

The significant variable associated with weather and road conditions appears to be its effect on the vehicle’s ability to brake effectively. According to 1990 General Estimates System (GES) statistics, 72 percent of rear-end collisions occurred on dry pavement and around 25 percent occurred on wet
pavement. Snow and ice were listed as a contributing factor in less than four percent of rear-end collisions, while fog was listed as a factor in less than one percent of all rear-end collisions[2]. If the wheel rotates exactly as fast as it corresponds to the speed of the car, the wheel has no braking effect at all. If the wheel doesn’t rotate at all, it is blocked. The point of optimum brake effect is in between these two extremes. The speed difference between the car and the wheel during braking is called braking factor (S) and defined as shown in equation no. (2). The optimum brake effect (control region) lies between S=0.05 for ice or snow roads and S=0.2 for dry roads [23].

\[
S = \frac{(V_C - V_W)}{V_C} (2)
\]

where:

- S : Braking factor (S=0 when no braking, S=1 when blocking).
- VC: Actual car speed during braking.
- Vw: Measured speed during braking.

Due to the low percentage of collisions occurred on snow and ice pavement and minor effect of braking factor in dry conditions, these factors would not be considered in the proposed system.

3.3 Driver Distraction

The driver is constantly scanning the environment; looking out forward windshield, side windows, scanning mirrors and attending to stimuli in the vehicle. Although it is possible for a driver to —look but not see“, attention in driving is generally directly related to where a driver looking at any time [2]. Driver distraction level, based on the strength of 1stAct, is the duration relates to the current given cycle of activation of control and is quantized as long, normal, short, or off; according to the strength of 1stAct, as off, weak, medium, or strong [24]. In fact, human behaviors are indeed hard to recognize, predict and handle. In order to avoid these kinds of unexpected accidents, it is necessary to develop an appropriate set of in-vehicle detecting and warning systems that can improve the driving safety [25]. The main objective of the proposed system is to eliminate driver distraction, so this factor will not be considered as input in the proposed system.

4. PROPOSED FUZZY COLLISION AVOIDANCE SYSTEM

The driver assistance collision avoidance system consists of three main systems as shown in Figure (4):

1. Real Time Image Processing (RTIP) System. When a vehicle is moving on a road (highway), the data gathered from image processing system includes two parameters; relative speed and distance regarding objects ahead of the vehicle and the existence of objects beside it.

2. Fuzzy Decision Processing (FDP) System. The fuzzy system concentrates on objects in front of the vehicle. The system receives the data from Real Time Image Processing (RTIP) System. When the unit measures an unsafe following distance or an unsafe change in relative velocity, the fuzzy system compares the relative speed and the relative distance. When one of these values exceeds, warning is issued and display one the following scenarios [26,27]:
   - Constant Cases: The target speed of the LV is less than the target speed of the FV (V_LV < V_FV). As the FV driver closes in on the LV, the FV avoids colliding into this vehicle by either braking in the same lane or steering to the left.
   - Stationary Cases: For this scenario, the LV is stopped at a distance down the road in the same lane; the FV closes in on this stopped vehicle. The FV driver either brakes in the same lane or steers to the left lane to avoid colliding with the stopped vehicle.
   - Last-Second Braking and Steering Trials: For this scenario, the LV is stopped suddenly in the same lane; the FV closes in on this stopped vehicle. The FV driver tries to brake in the same lane or steers to the left lane to avoid colliding with the stopped vehicle. Last-Second Braking and Steering Trials: For this scenario, the LV is stopped suddenly in the same lane; the FV closes in on this stopped vehicle. The FV driver tries to brake in the same lane or steers to the left lane to avoid colliding with the stopped vehicle according to one of the following: —Normal “Brake: Brake at the last second possible to avoid colliding with the lead vehicle using NORMAL braking intensity or pressure. —Normal“ Steer: Change lanes at the last second to avoid the lead vehicle without braking.— Hard“ Brake: Brake at the last second possible to stop to avoid colliding with the lead vehicle using HARD braking intensity or pressure.—Hard“ Steer: Change lanes at the LAST SECOND possible to avoid colliding with the lead vehicle without braking.

3. AUTOMATIC CONTROL PROCESSING (ACP) SYSTEM.

The relative acceleration is calculated from these measurements and the controller actuates the automatic braking mechanism. In this work, we will focus on the Fuzzy Decision Processing (FDP) System. The proposed fuzzy system has been designed independent of the other systems (Real Time Image Processing (RTIP) System and Automatic Control
Processing (ACP System). It based on three main inputs and one output. Four degrees of relative speed, three degrees of relative distance and two degrees of rear vehicle relative distance are the inputs to a fuzzy system having seven output options according to the safety distance.

4.1 Fuzzy Sets Definition

Fuzzy logic starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. Four fuzzy set variables are used (speed, relative distances & deceleration). These variables are defined as follows\([2,14,21,22]\):

- **Speed (km/hr):**
  - Low (L): (10-50)
  - Medium (M): (25-75)
  - High (H): (50-100)
  - Very High (H): (75-125)

- **Relative Distance (m):**
  - Small (S) = (0-60)
  - Sufficient (Su) = (4-100)
  - Large (L) = (20-120)

- **Rear Vehicle Relative Distance (m):**
  - Small (S) = (0 œ 90)
  - Sufficient (Su) = (30 œ 120)

- **Deceleration:**
  - Slight brake (S) = (-.5 : 0.0)
  - Normal brake (N) = (-3.54 : -0.47)
  - Normal brake with Steer to another lane (N & St) = (-3.11 : -0.191)
  - Medium Hard brake (MH) = (4.34 : -1.14)
  - Medium Hard with Steer to another lane (MH & St) = (-3.92 : -0.819)
  - Hard brake (H) = (-5.78 : -1.94)
  - Hard brake with Steer to another lane (H & St) = (-4.83 : -1.6).

4.2 Fuzzy Rules Definition

Designing the antecedent part of a rule base involves deciding how to partition the input space; also, designing of the consequent part of a rule base involves the action value of each rule. In this work, the if-then rule statements are used to formulate the conditional statements that comprise fuzzy logic. The rule base consists of sample of 38 rules (as shown in Appendix A) in the form of:

- **IF Speed is (L) and between 10 - 25 km/hr**
- **IF Distance equal to (S)**
- **THEN Check the Rear Vehicle and IF Distance less than (Su)**
- **THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.**

4.3 System Building

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The process of fuzzy inference involves all membership functions, fuzzy logic operators, and if-then rules. There are two types of fuzzy inference systems that can be implemented in the Fuzzy Logic: Mamdani-type and Sugeno-type [28]. Mamdani's fuzzy inference method is the most commonly seen fuzzy methodology. The method used in this work is based on Mamdani's fuzzy inference method. The system is very simple; it receives the data from Real Time Image Processing System as statements (mainly numbers) and maps it to the appropriate membership.
functions and truth-values (fuzzification). The system then combines the results of the values (inference mechanism) and converts the combined results back into specific warning statements or actions (defuzzification), which send to speed controller module. To build the system, there are two ways: build the system from scratch using basic programming language, or rely on a fuzzy logic development shell. In this work, MATLAB fuzzy logic shell is used to plot the membership function for the different variables as shown in Figures 5-a, b, c & d, whereas Figures 6 and 7 show the Rule Editor and Rule Surface using MATLAB fuzzy logic shell.

4.4 System Testing and Tuning

After building the fuzzy system, the system should be tested and tuned to examine whether it meets the required specifications or not. Examining and analyzing the actual situation clearly is not a simple task; it is too costly to conduct a field test. In this work and due to resource limitation, an actual road test results -previously made by U. Dravidam & Tosunoglu (2000) -are compared with the system results as shown in Table 1 and in Figure 8.

The system results fall between the normal and hard brakes as recommended by the researchers. The results obtained from the proposed fuzzy system may be acceptable and successful at this moment; but the field tests with continuous system tuning would satisfy the practical experiments.

5. RESULTS AND DISCUSSIONS

In fact, there are a lot of complicated and changeful states out of vehicles on the highway from time to time. The performance of the proposed fuzzy system was tested in a variety of speeds from 25 to 125 km/hr and distances from 5 to 60 meters through 60 different states. The system gives reasonable results with speeds between 50 and 100 km/hr and distances between 10 and 55 meters. The system results are summarized in Table 2 and shown in Figure 9.

6. CONCLUSIONS

This paper reviews and examines the applicability of using fuzzy logic in Rear-End collisions. In addition to a review of the literature, a detailed Rear-End collision avoidance fuzzy system has been discussed. A simple prototype fuzzy system is included as a foundation for future research. This may be used as a framework for supporting the development of a driver assistance collision avoidance system.
The performance of the proposed fuzzy system was tested and it obtained reasonable results. It is important to emphasize that the fuzzy collision avoidance system (FCAS) examined could potentially reduce the incidence of rear-end crashes, as well as the harm caused by such crashes, in primarily two different ways. First, the system could reduce the amount of tailgating behavior, that is, the amount of time drivers spend at short headways when following a vehicle ahead during steady state car following conditions. Secondly, the (FCAS) system may at times (e.g., when the driver is distracted) alert the driver to an approach (or closing) conflict earlier than the driver would have detected such a conflict. Vehicle type and weight, Vehicle conditions (braking system, steering, etc.) and Road crowdedness had not been addressed in the system and by improving these factors the proposed system can come closer to optimal performance. Another factor that limits the system performance is the knowledge base used to define the fuzzy set variable. In order to design a good collision avoidance system, two issues are required to be resolved. One is the availability of actual and authorized knowledge base (relation between speed, distance and deceleration). The other is the decision to be considered in each particular case.

7. RECOMMENDATIONS

1. In light of these results, a number of recommendations might be to worth of consideration.
2. Future research is recommended to conduct further speed vs. distance vs. deceleration surveys to determine the actual relationship between those parameters, based on the environment, human behavior, vehicle condition, road conditions and location (highways, shopping area, school and residential zones) etc.
3. Further research is also recommended to integrate the three systems together (Real Time Image Processing (RTIP), Fuzzy Decision Processing (FDP) and Automatic Control Processing (ACP)).

REFERENCES

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Appendix: Sample of Rule Base

1. IF Speed is (L) and between 10 - 25 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.
2. IF Speed is (L) and between 10 - 25 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance equal to (Su) THEN Reduce Speed with Medium Hard Brake (MH).
3. IF Speed is (L) and between 10 - 25 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Normal Brake (N).
4. IF Speed is (L) and between 10 - 25 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Slight Brake (S).
5. IF Speed is (L) and between 25 à 50 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance more than (Su) THEN Reduce Speed with Hard Brake (H) and check and Steer to another Lane.
6. IF Speed is (L) and between 25 à 50 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance more than (Su) THEN Reduce Speed with Hard Brake (H).
7. IF Speed is (L) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.
8. IF Speed is (L) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Medium Hard Brake (MH).
9. IF Speed is (L) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Normal Brake (N).
10. IF Speed is (L) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Medium Hard Brake (MH).
11. IF Speed is (M) and between 25 à 50 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Hard Brake (H) and check and Steer to another Lane.
12. IF Speed is (M) and between 25 à 50 km/hr and IF Distance equal to (S) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Hard Brake (H).
13. IF Speed is (M) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.
14. IF Speed is (M) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH).
15. IF Speed is (M) and between 25 à 50 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Slight Brake (S).
16. IF Speed is (M) and between 25 à 50 km/hr and IF Distance more than (L) THEN Reduce Speed with Slight Brake (S).
17. IF Speed is (M) and between 50 - 75 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.
18. IF Speed is (M) and between 50 - 75 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Normal Brake (N) and check and Steer to another Lane.
19. IF Speed is (M) and between 50 - 75 km/hr and IF Distance more than (Su) THEN Reduce Speed with Normal Brake (N).
20. IF Speed is (M) and between 50 - 75 km/hr and IF Distance more than (L) THEN Reduce Speed with Slight Brake (S).
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IF Speed is (H) and between 50 -75 km/hr and IF Distance equal to (S) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.

IF Speed is (H) and between 50 -75 km/hr and IF Distance more than (S) and less than (Su) THEN Reduce Speed with Normal Brake (N) and check and Steer to another Lane.

IF Speed is (H) and between 50 -75 km/hr and IF Distance more than (Su) and less than (L) THEN Reduce Speed with Normal Brake (N).

IF Speed is (H) and between 50 -75 km/hr and IF Distance more than (L) THEN Reduce Speed with Slight Brake (S).

IF Speed is (H) and between 75 -100 km/hr and IF Distance equal to (S) THEN Reduce Speed with Hard Brake (H) and check and Steer to another Lane.

IF Speed is (H) and between 75 -100 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance more than (Su) THEN Reduce Speed with Hard Brake (H).

IF Speed is (H) and between 75 -100 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.

IF Speed is (H) and between 75 -100 km/hr and IF Distance more than (Su) and less than (L) THEN Reduce Speed with Normal Brake (N).

IF Speed is (H) and between 75 -100 km/hr and IF Distance more than (L) THEN Reduce Speed with Slight Brake (S).

IF Speed is (VH) and between 75 -100 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance more than (Su) THEN Reduce Speed with Hard Brake (H).

IF Speed is (VH) and between 75 -100 km/hr and IF Distance more than (S) and less than (Su) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.

IF Speed is (VH) and between 75 -100 km/hr and IF Distance more than (Su) and less than (L) THEN Reduce Speed with Normal Brake (N).

IF Speed is (VH) and between 75 -100 km/hr and IF Distance more than (L) THEN Reduce Speed with Slight Brake (S).

IF Speed is (VH) and between 100 -125 km/hr and IF Distance between (S) and (Su) THEN Reduce Speed with Hard Brake (H) and check and Steer to another Lane.

IF Speed is (VH) and between 100 -125 km/hr and IF Distance more than (Su) and less than (L) THEN Reduce Speed with Medium Hard Brake (MH) and check and Steer to another Lane.

IF Speed is (VH) and between 100 -125 km/hr and IF Distance more than (L) THEN Check the Rear Vehicle and IF Distance less than (Su) THEN Reduce Speed with Normal Brake (N) and check and Steer to another Lane.

IF Speed is (VH) and between 100 -125 km/hr and IF Distance more than (L) THEN Check the Rear Vehicle and IF Distance equal to (Su) THEN Reduce Speed with Normal Brake (N).