Improved Intelligent Adaptive Cruise Control for Vehicle using Fuzzy Logic

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***Abstract*— Adaptive cruise control is one of the controlling methods in advanced driver assistant system for car. In adaptive cruise control the minimum distance between the vehicles is maintained. In this project the distance of the front vehicle is determined using ultrasonic sensor, The distance error and relative velocity between host vehicle and front vehicle are inputs to the fuzzy logic controller (FLC). The output of FLC is velocity control and brake control. The velocity of the vehicle is controlled by varying throttle valve .The throttle valve of the host vehicle is changed according to the velocity required. If the distance between two vehicles is in critical zone then auto brake is applied.The Auto brake is controlled by DC motor.**

***Keywords*— Fuzzy logic controller, Electronic throttle Valve ,ADC, Throttle Position Sensor**

I. INTRODUCTION

The Traffic problem is everywhere in the world. every day the vehicles are increasing inturn increases the number of accidents. The survey says the more number of accidents are driver wrong decision. The Advanced driver assistant system plays an important role in the development of vehicle industry.The safety is very important for automobile.Many accidents are occurring due to inability of driver to control in time. The huge traffic in metro cities ,the driver has lot of pressure, due to stress some time not able to control properly this leads to accidents .The number of accidents can be reduced by introducing the new technology for vehicle. First they introduce cruise control for vehicle, here the driver set the speed then the vehicle will maintain the constant speed. Cruise control is not useful in traffic highway. If any vehicle is come in same lane as host vehicle and distance is very less in such case cruise control is not useful .Later they introduced new technique as adaptive cruise control method. It maintains the distance between two vehicles, according to the distance the speed of the vehicle vary.

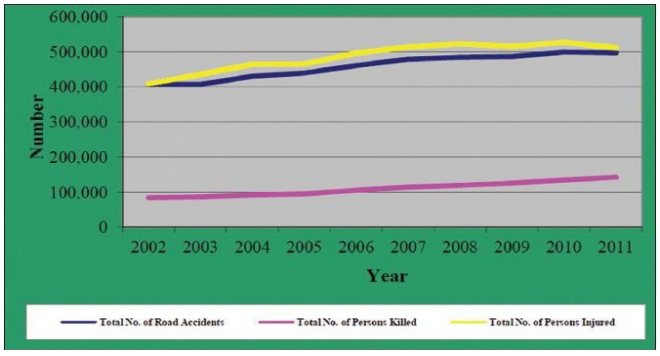

Figure.1 Total number of road accidents, persons killed, and persons injured during 2002-2011

1. Literature Review

The above figure shows that the accidents rate is increasing in spite of using new technologies in automobiles[1]

The Adaptive cruise controller consists of two modes such as velocity control and distance control. In velocity control use the Proportional and Derivative with command compensation and in distance control fuzzy logic controller is used. Distance control mode it maintains minimum distance between two vehicles. The inputs of the fuzzy logic control (FLC) are distance error and Relative velocity ,the output of the FLC are velocity control command or brake control command. In velocity control mode only the velocity of the vehicle is vary by applying control signal to the throttle Valve controller .Dc motor is used to control the throttle valve. Brake control mode automatically brake is controlled by using DC motor[2].

The design of Adaptive cruise control is by Fuzzy Logic Controller. The two inputs for FLC are distance error and relative velocity between two vehicles, these two parameters are derived from the tree parameters such as speed of front vehicle and time headway set by the driver and the distance between two vehicles using laser. The output of the FLC is brake command and velocity command .LPC2119 arm7 based controller is used for control function. In this paper the required distance is multiplication of time heady way and velocity of front vehicle and the actual distance of the front vehicle is measured using laser. The difference between the two is distance error and the velocity of the front vehicle with respect to host vehicle i.e. relative velocity. The velocity of the front vehicle is measured using laser.The velocity of the host vehicle is taken from Electronic control unit. The FLC produce the output according to the inputs [3].

Explains the optimized fuzzy logic by reducing computation time .The fuzzy logic computation time increases by increasing the number of rules. In this Instead of using single FLC, used three FLC1,FLC2 and FLC3.by segmenting the Fuzzy rules computation time is reduced[4]..

Explains the failures of adaptive cruise control. The often failure components are radar and speed sensor .the failures of one of the component fails whole system. If one sensor fails the system bypass and use second sensor by doing this improves the safety[5].

Explains the adaptive cruise control with stop and go for vehicle, the minimum distance is maintained by varying velocity using PID controller. Explain the speed control with MATLAB Simulink[6].

DAS in urban for short range obstacle detection. He used three ultrasonic sensors to detect full view of obstacle. The

signal from each sensor is of unique number of pulses, the receiver detect signal of corresponding sensor. If obstacle finds near the host vehicle a beep sound is generated to alert driver[7].

Explains adaptive cruise control by considering the dynamic model of vehicle.PI controller is used to control speed of the vehicle. There are two loops concepts explained such as outer loop and inner loop, outer loop is driver model it senses the external behavior and determines action to be taken .The inner model explains vehicle model[8].

Shortcoming of the existing Methodologies: In existing methodologies the reliability is not considered. In the proposed model have the reliability into consideration.

II. METHODOLOGY

A: Distance controller using Fuzzy logic

In adaptive cruise control consists of two modes such as velocity control and distance control mode .In velocity control mode only velocity of the vehicle is controlled as per the set velocity by the driver. If there is vehicle in front of host vehicle then it switch to distance control mode .In distance control mode maintains the minimum distance between two vehicles. According to distance between two vehicles the speed of vehicle varies. The distance Error and Relative velocity between two vehicles are fed to fuzzy logic controller, it process and produce two outputs such as velocity command or brake command. If velocity command the speed of vehicle vary by varying throttle valve and if brake command then auto brake is applied using DC motor

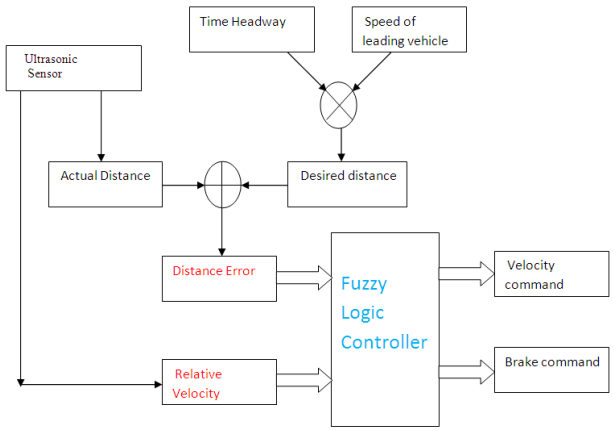

Figure2.Fuzzy logic based Distance control

Desired distance=THW x V(leading Vehicle)
Actual distance=measured using ultrasonic sensor
Distance error=Actual distance-Desired distance
Relative speed =Vl-Vh

B: Electronic throttle Valve

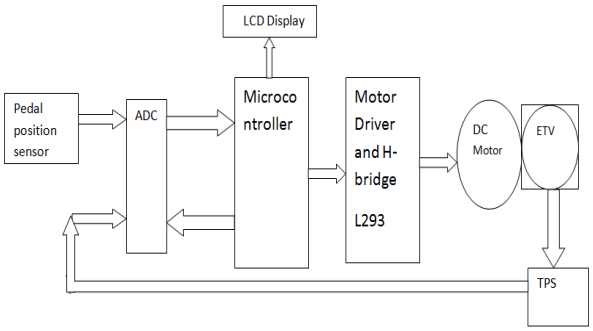

Figure3.Electronic throttle Valve control

In above figure3 shows how the throttle valve is controlled. The speed of the vehicle can be increased or decreased electronically by drive by wire. In this method the pedal position is measured using pedal position sensor and current throttle valve position is measured using Throttle position sensor. The error between two sensors is used control the position of throttle valve through dc motor in turn control the speed.

C. *Throttle valve controller diagram.*

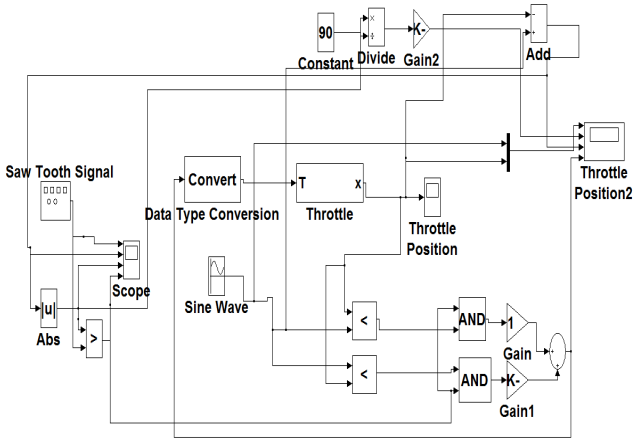

Figure 4 Throttle valve controller diagram

In above figure 4 shows Throttle Valve controller using MATLAB Simulink designed and simulated

III. SIMULATION RESULTS

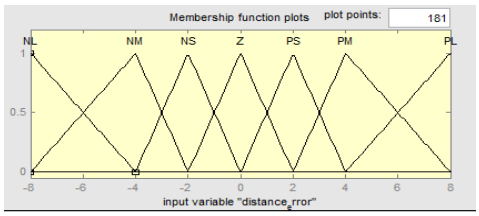

Figure 5 Distance error

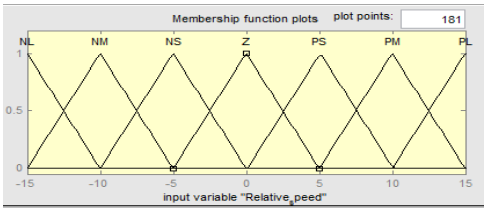

Figure 6 Relative speed

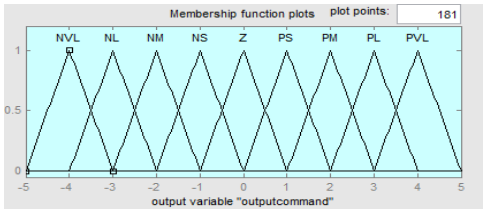

Figure 7 Fuzzy controller output

The membership functions of the output are shown in Fig7. The outputs are divided into two sides. The negative side represents the braking command. The positive side represents the velocity ratio command.

NVL : negative very large
NL : negative large
NM : negative medium
NS : negative small
Z : zero
PS : positive small
PM : positive medium
PL : positive large
PVL : positive very large

$$\text{Final Output} = \frac{\sum_{i=1}^{N} w_i Z_i}{\sum_{i=1}^{N} w_i}$$

Final Output = Average of all outputs
wi = Weight of membership function of Zi
Zi = output i

The expected result for the simulation as a reference we taken as a pedal signal in figure 8 is send to controller and butterfly valve position signal in figure 9 is illustrated. some vibrations has been existed in up and down border sides of butterfly signals. The mixing of figure 8 curve and 9 curves is accommodated in figure 7.the error signal as demonstrated in figure10.

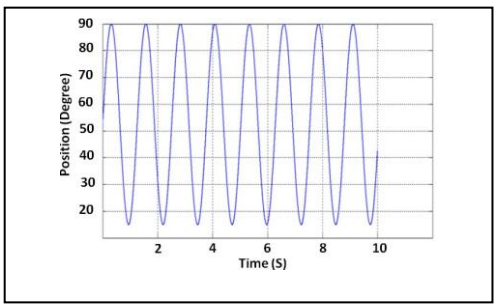

Figure 8 Pedal Position Signal

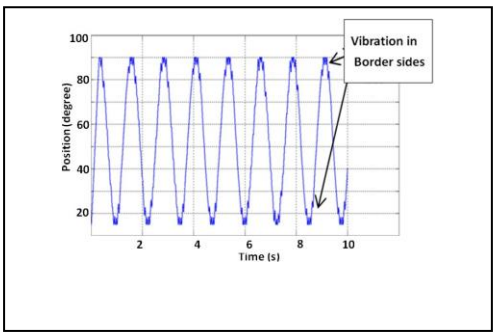

Figure 9: Butterfly Portion

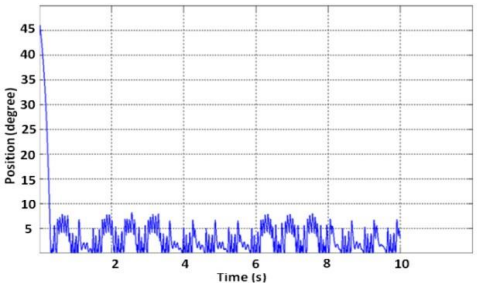

Figure 10: Error signal

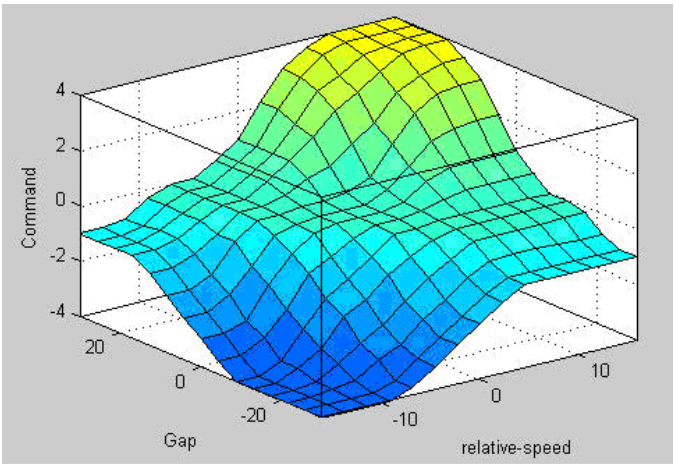

Figure11 Fuzzy control surface

CONCLUSION

The fuzzy logic is used to determine the velocity or brake command output from the distance error and relative velocity. The distance control mode and throttle valve controller are simulated using MATLAB and also designed using hardware for throttle valve controller.

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