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DESIGN, SIMULATION AND IMPLEMENTATION OF FLC FOR AUTOMATIC SPEED CONTROL OF VEHICLES

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ABSTRACT

Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as distance between vehicles, road condition, climatic conditions and vehicle condition to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value speed of the vehicle. In this context fuzzy logic provides more efficient methods to achieve the same.

Key Words: fuzzy logic controller (FLC), membership functions, input variables and output.

1. INTRODUCTION

1.1. Fuzzy logic

The first applications of fuzzy theory were primarily industrial, such as process control for cement kilns. However, as the technology was further embraced, fuzzy logic was used in more useful applications. In 1987, the first fuzzy logic-controlled subway was opened in Sendai in northern Japan. Here, fuzzy-logic controllers make subway journeys more comfortable with smooth braking and acceleration. Best of all, all the driver has to do is push the start button! Fuzzy logic was also put to work in elevators to reduce waiting time. Since then, the applications of Fuzzy Logic technology have virtually exploded. Affecting things we use every day. Take for example, the fuzzy washing machine. A load of clothes in it and press start, and the machine begins to churn, automatically choosing the best cycle. The fuzzy microwave, Place chili, potatoes, or etc in a fuzzy microwave and push single button and it cooks for the right time at the proper temperature. The fuzzy car, maneuvers it by following simple verbal instructions from its driver. It can even control its speed itself when there is an obstacle immediately ahead using sensors. But, practically the most exciting thing about it, is the simplicity involved in operating it.

This project is all about how the vehicle speed is affected by the various factors on the roads and what effects will occur during the driving of the vehicle.

There are 4 factors that we are considering in this project namely:

1.2. Distance between two vehicles:

Distance between the vehicles is the one of the major factors that affects the speed of the vehicle system. If there is more distance between the vehicle must slow down irrespective of any conditions. With respect to these functions the membership functions are taken as shown in the below fig 1.

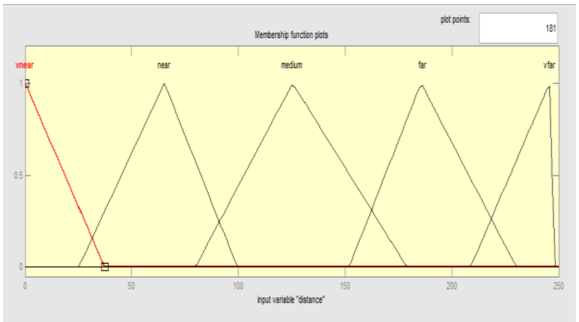

Figure 1: distance between vehicles

1.3. Road condition:

The speed of the vehicle should vary depending on the road condition to prevent the accidents. We can consider five membership functions of road condition. They are very poor ,poor, medium ,good, very good. In the very good condition of road the speed can be very fast in the good condition speed is fast . In medium condition of road the speed may be medium ,in the poor condition speed be slow and the speed should be very low at very poor condition of road to avoid accidents. The fig 2 shows membership functions of road condition.

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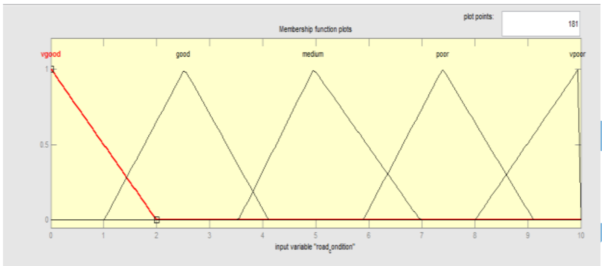

Figure 2: road condition

1.4. Climate:

Climate plays very important role in the drive. If the climate is too rainy or too foggy the conditions are not in the favor of the drive. We can interpret the climate as friendly and non friendly.

If the climate is friendly the vehicle speed can be more and if the climate is non friendly i.e., in rainy conditions the roads will be very slippery and in foggy condition the visibility will be very poor, hence in such conditions the speed of the vehicle should be slowed down. The membership functions are shown in fig 3.

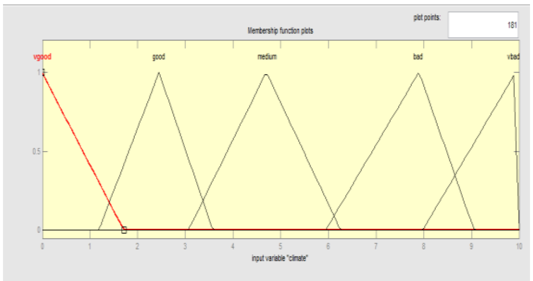

Figure 3: climate

1.5. Vehicle condition:

Vehicle condition matters the most when it comes to speed. Vehicle condition can be measured in terms of vibrations. If the vehicle with more vibration then it cannot go with high speed. If the vibrations are moderate then it can go with medium speed. If the vehicle is in less vibration it will support high speed. We can consider vibrations of vehicle in three membership functions less, medium and more. The membership functions are shown in fig 4.

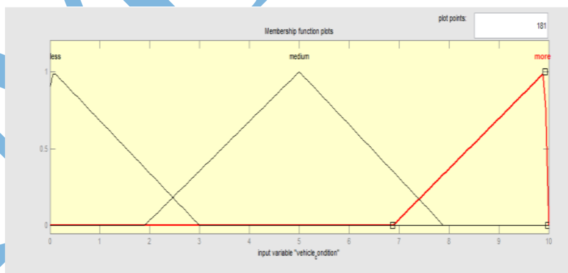

Figure 4:vehicle condition

1.6 Output:

1.6.1. Speed of the vehicle:

Speed the output parameter to lie in the range of 0 kmph to100 kmph.

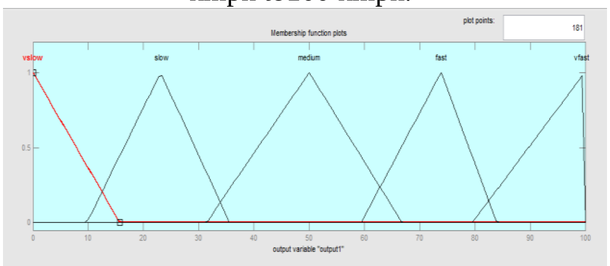

Figure 5: speed of the vehicle

2. DESIGN OF FLC

2.1. Block Diagram

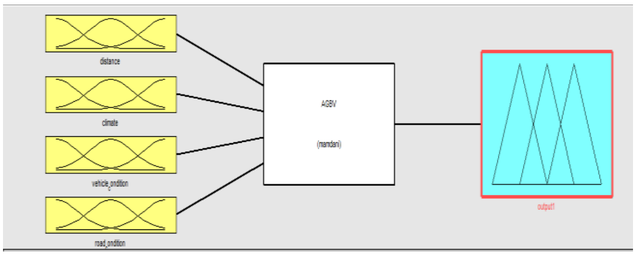

Figure 6: Block diagram of controller

2.2. Explanation

It consists of four antecedents (input variable) and one consequent (output). As shown in fig, 6 the left part indicates the inputs and right part indicates the output speed. The centre block indicates the fuzzy logic controller. In fuzzy logic controller we frame the rules based on the input variables in different combinations. AND and OR operators are used to form the rules. The AND operation makes use of minimum of the membership functions of the given inputs and OR operator makes use of maximum of the membership functions.

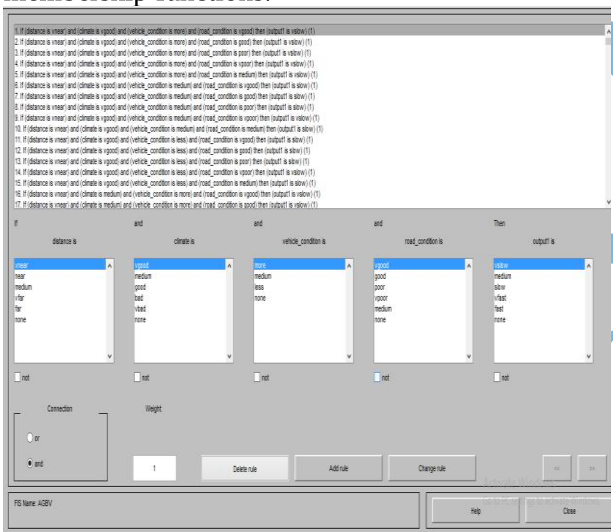

Figure 7: rule editor window

The fig 7. Shows the set of rules designed to get the fuzzy output.

The fig 8. is of the extreme favorable conditions consisting of more distance, less vibration, good climate and best vehicle condition.

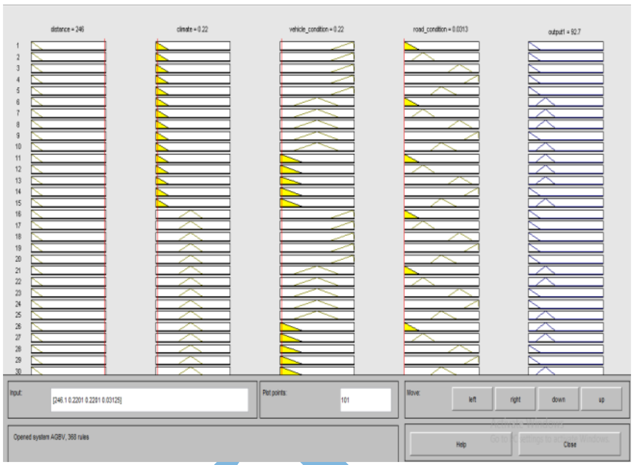

Figure 8: output at all favorable conditions

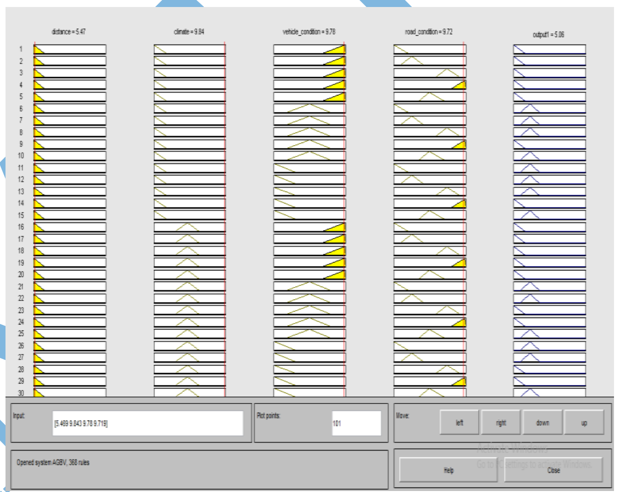

Figure 9: output at all non-favorable conditions

The fig 9 is of the extreme non-favourable conditions consisting of very near distance with preceding vehicle, multiple speed breakers, road with U -turns, non favorable climate and poor vehicle condition.

The fig 10 shows the surface view of distance and climate

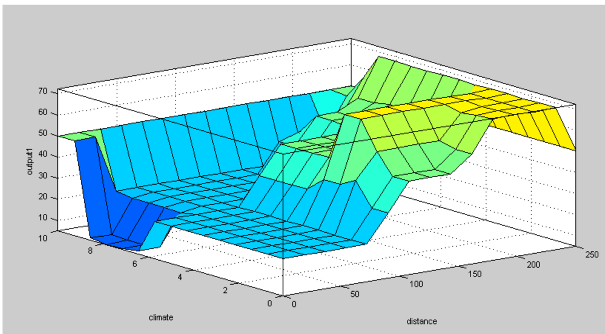

Figure 10: surface view for distance and climate

The fig11 Indicates the surface view of vehicle condition and climate

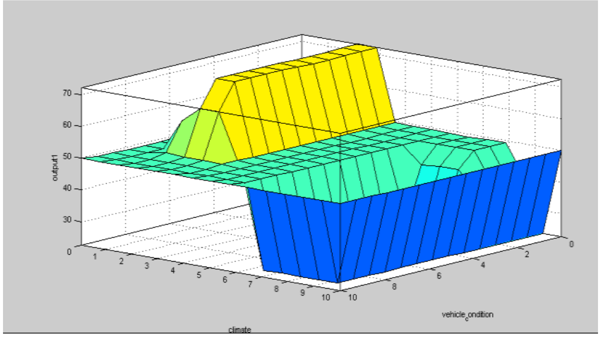

Figure 11: surface view for vehicle condition and climate

The Fig 12 Indicates the surface view of road condition and distance.

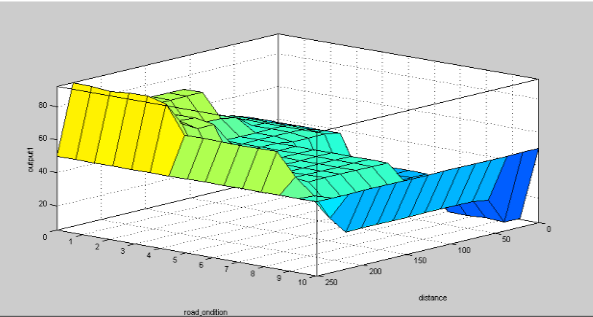

Figure 12: surface view of road condition and distance.

3. SIMULINK MODEL

In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available, such as transfer functions, summing junctions, etc., as well as virtual input and output devices such as function generators and oscilloscopes. Simulink is integrated with MATLAB and data can be easily transferred between the programs. In these tutorials, we used Simulink library to build the model, build controller, and simulate the system. Simulink is supported on Unix, Macintosh, and Windows environments and is included in the student version of MATLAB for personal computers.

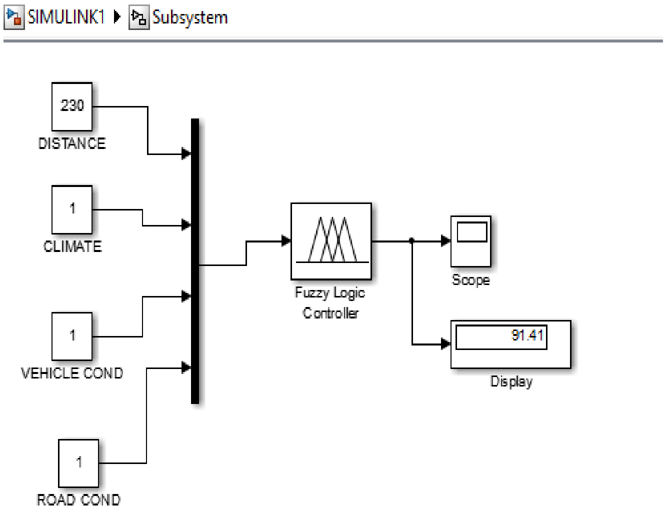

Figure 13:Simulink model of the system

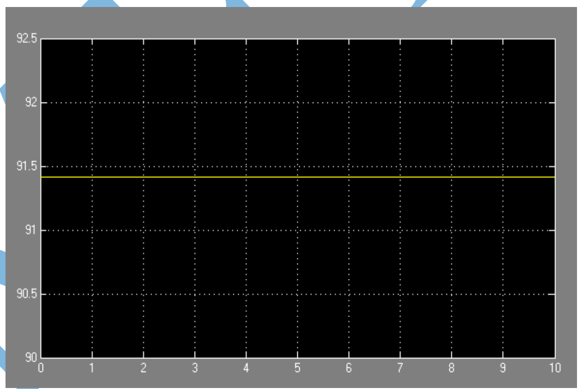

Figure 14:output of simulink model

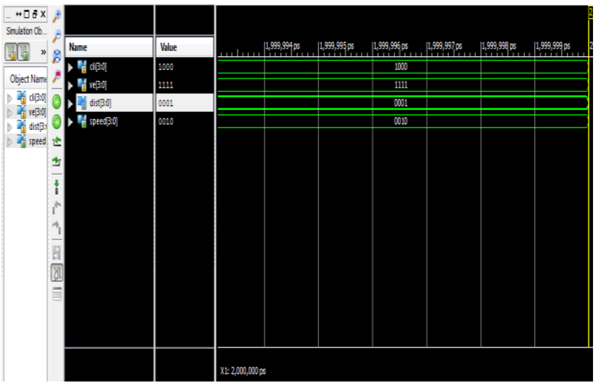

Figure 15: simulation in xilinx

Figure 13 shows the Simulink model of the FLC system. Figure 14 shows the output of simulink model. Fig 15 shows the simulation of FLC in xilinx using hardware description language and fig 16 shows the implementation on SPARTAN 3E FPGA.

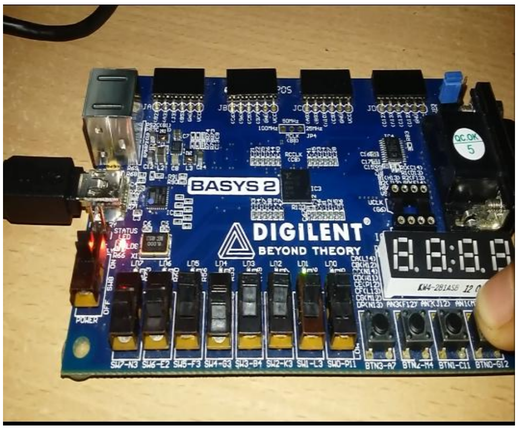

Figure 16: implementation on SPARTAN 3E

CONCLUSION:

This project makes use of four input variables that affect the speed of the vehicle. FLC is used to form the rules taking different combinations of the inputs and simulation is done using fuzzy logic tool box. Then the simulink model of the same FLC is made and simulated to get the expected correct output. The FLC is implemented on FPGA SPARTAN 3E. The main intension is to prevent the accidents on roads.

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