Vehicle Monitoring For Road Accident Prevention

Arijit Ghosh, Dr. Rajendra Prasad
(Department of Electrical Engineering, Indian Institute of Technology Roorkee,Roorkee)
Email: arijitghosh85@rediffmail.com)
(Department of Electrical Engineering, Indian Institute of Technology Roorkee, Roorkee)
Email: rpdeefee@iitr.ernet.in)

ABSTRACT
Artificial intelligence have proven to be a vital tool for the improvement of performance of different systems. Several research works have been going on for monitoring of the vehicles in order to prevent road accidents that have become common these days. In this paper we have tried to analyze these parameters that need to be monitored in a vehicle for the prevention of road accidents. The results obtained show the validity of the fuzzy rule base evaluated by the fuzzy inference system.

Keywords *– fuzzy logic controller (FLC), fuzzy rule base(FRB), risk factor, defuzzifier*

1. INTRODUCTION

With the increase in the population, the safety in traffic management have been the major concern. Major accidents can lead to the loss of lives and property where the human beings are the main sufferers. Henceforth by preventing the occurrence of road accidents can boost the economy and health of the country.So far, the various works for monitoring accidents have been carried out are based on driving patterns, behavior of drivers as well as vehicle dynamics[1].The works of Abdulrahaman Abdullah and Faisal Abdullah have been based on detection system for monitoring traffic flow based on real time detection. It employs to monitor the disturbance in traffic flow along with the correct location of cross ratio[2].

The work for development of an automated system in order to detect accidents are also undergoing. The works of Asad Ali and Mohammad Eid have been focused on the reducing the impact of road accidents by reducing the transit time between the occurrence of accidents and carrying out the safety measures[3]. The aim is to prevent car congestion and allow the victims to get escorted to the hospital in a time bound manner as quickly as possible.

However some accidents do occur due the callousness on the part of driver occurring due to his/her weariness. Also with the advent of air conditioned vehicles there have been instances where obnoxious gases like carbon monoxide (CO), sulphur dioxide (SO_2) ,nitrogen dioxide (NO_2) enter inside vehicle cabin through ac vent thereby becoming a possible factor [4-9]. These gases affect driver's health which also becomes a possible factor of accidents.

Previous works in literature have been performed for recording the values of gas sensors. These values are then compared with the threshold values and are controlled according to the fuzzy rule base(FRB) designed inside a fuzzy logic controller(FLC).
Apart from the gas sensors, sensors for monitoring the vehicle dynamics (vibration sensor) as well as infrared light sensor monitors the drowsiness among the drivers.
This paper focuses on monitoring of the sensors that are necessary for averting road accidents.

2. PROPOSED SYSTEM

In this paper we monitor all essential parameters from the sensor output and using and using a two level fuzzy controller evaluate the risk factor which indicates the probability of risk of accidents which the vehicles undergoes. The sensor for gas concentration ,vibration and infrared light intensity are used to monitor their respective parameters. These sensors nodes are programmed by a microcontroller unit to continuously monitor their output and compare with the threshold before being transmitted to the fuzzy logic block.

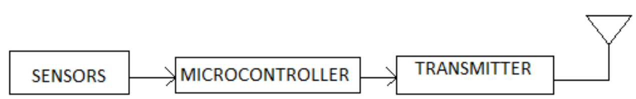

Fig 1. Block diagram of sensor node (transmitter)

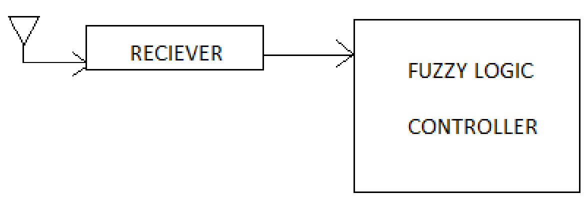

Fig 2. Block diagram of sensor node (receiver)

The merit of the signal transmission scheme is that only that value of sensor output is transmitted that is above the threshold. This reduces false triggering of the fuzzy logic controller and also saving of power.

3. FUZZY LOGIC

Fuzzy logic was first introduced by Prof. Lofti A. Zadeh as a strong computational tool used for handling data[10-11]. Fuzzy logic is primarily used in the field of engineering for determining results arising out of uncertainty.

Taking the problem of accident prevention into consideration, we use the fuzzy rule base(FRB) for classifying the risk factor for accidents based on the different input parameters. Fuzzy system are based on linguistic rules which are designed by the problem domain expert. In our paper the fuzzy system takes the input values from the sensors that have been employed in the vehicle. These input values have been classified into linguistic membership functions in the fuzzy controller.

3.1 TWO LEVEL FUZZY CONTROLLER

In this paper we have five sensor outputs for classifying the risk factor of accidents which are gas sensors, infrared sensor and vibration sensor[ ]. In order to accommodate the inputs into a single fuzzy controller with three membership function the fuzzy rule base would include 3X3X3X3X3=243 rule base.

Now if we divide the single fuzzy system into a two level fuzzy system then for the first level of fuzzy controller the inputs are for the gas concentration of CO,SO2 and NO2.The controller has three membership function corresponding to the inputs which form total of 3X3X3=27 rule base. Similarly for the second level of fuzzy controller the inputs are the outputs from the first fuzzy controller i.e. toxicity level along with the outputs from the vibration and infrared sensors.

So the total number of fuzzy rule base includes (3x3x3)x2=54.This is the advantage of two level fuzzy system where the no of fuzzy rule base have been drastically reduced i.e from 243 rules to 54 rules, thereby reducing the computational complexity.

In the fuzzy system the linguistic input variables are fed into the fuzzy controller which provide fuzzified output. The fuzzy rule base is a set of IF-ELSE rules formed by all possibilities of linguistic variables. The fuzzy output is converted to crisp output by using the defuzzifier. The defuzzification at two levels is carried out using centroid or centre of gravity (COG) method.

2.2 DATABASE FOR FUZZY LOGIC

TABLE 3.2.1 TERM SET FOR FIRST LEVEL FLC

INPUT PARAMETERS

INPUT VARIABLE	TERM SET	MEMBERSHIP FUNCTION	LIMITS
SO2 CONC.	LOW MED HIGH	TRIANGULAR	{0;0;4} {1;5;9} {6;10;10}
NO2 CONC.	LOW MED HIGH	TRIANGULAR	{0;0;4} {1;5;9} {6;10;10}
CO CONC.	LOW MED HIGH	TRIANGULAR	{0;0;800} {200;1000;1800} {1200;2000;2000}

OUTPUT PARAMETERS

OUTPUT VARIABLE	TERM SET	MEMBERSHIP FUNCTION	LIMITS
TOXICITY	LOW MED HIGH	TRIANGULAR	{0;0;0.4} {0.1;0.5;0.9} {0.6;1;1}

TABLE 3.2.2 TERM SET FOR SECOND LEVEL FLC

INPUT PARAMETERS

INPUT VARIABLE	TERM SET	MEMBERSHIP FUNCTION	LIMITS
TOXICITY	LOW MED HIGH	TRIANGULAR	{0;0;0.4} {0.1;0.5;0.9} {0.6;1;1}
INFRARED INTENSITY	LOW MED HIGH	TRIANGULAR	{0;0;2} {0.5;2.5;4.5} {3;5;5}
VIBRATION	LOW MED HIGH	TRIANGULAR	{0;0;40} {10;50;90} {60;100;100}

OUTPUT PARAMETERS

OUTPUT VARIABLE	TERM SET	MEMBERSHIP FUNCTION	LIMITS
RISK FACTOR	LOW MED HIGH	TRIANGULAR	{0;0;0.4} {0.1;05;0.9} {0.6;1;1}

TABLE 3.2.3 FRB FOR FIRST LEVEL FLC

Rule	**NO2 conc.**	**CO conc.**	**SO2 conc.**	**Toxicity**
1.	LOW	LOW	LOW	LOW
2.	LOW	MED	LOW	MED
3.	LOW	MED	LOW	MED
4.	LOW	MED	MED	MED
5.	LOW	LOW	HIGH	HIGH
..	….	….	….	….
11.	MED	LOW	MED	MED
12.	MED	MED	LOW	MED
13.	MED	MED	MED	MED
14.	MED	MED	HIGH	HIGH
15.	MED	HIGH	MED	HIGH
..	….	….	….	….
21.	HIGH	MED	LOW	HIGH
22.	HIGH	MED	MED	HIGH
23.	HIGH	LOW	HIGH	HIGH
24.	HIGH	HIGH	LOW	HIGH
25.	HIGH	HIGH	HIGH	HIGH
26.	HIGH	MED	HIGH	HIGH
27.	HIGH	HIGH	MED	HIGH

TABLE 3.2.4 FRB FOR SECOND LEVEL FLC

Rule	**Toxicity**	**Infrared**	**Vibration**	**Risk Factor**
1.	LOW	LOW	LOW	LOW
2.	LOW	LOW	MED	MED
3.	LOW	MED	LOW	MED
4.	LOW	MED	MED	MED
5.	LOW	LOW	HIGH	HIGH
..	….	….	….	….
11.	MED	LOW	MED	MED
12.	MED	MED	LOW	MED
13.	MED	MED	MED	MED
14.	MED	LOW	HIGH	HIGH
15.	MED	HIGH	LOW	HIGH
..	….	….	….	….
21.	HIGH	MED	LOW	HIGH
22.	HIGH	MED	HIGH	HIGH
23.	HIGH	MED	MED	HIGH
24.	HIGH	HIGH	MED	HIGH
25.	HIGH	LOW	HIGH	HIGH
26.	HIGH	HIGH	LOW	HIGH
27.	HIGH	HIGH	HIGH	HIGH

The above fuzzy logic controller (FLC) is implemented in Matlab 7.12.0(R2011a) . The simulation is performed on the simulink platform that is provided by the Matlab.

The image for the first and second level fuzzy inference system is shown in the below figures. One can clearly see the input and output parameters in both the fuzzy logic controllers along with their triangular membership functions and input ranges.

Here both the fuzzy logic controller (FLC) has three inputs and one output with their respective rule base.

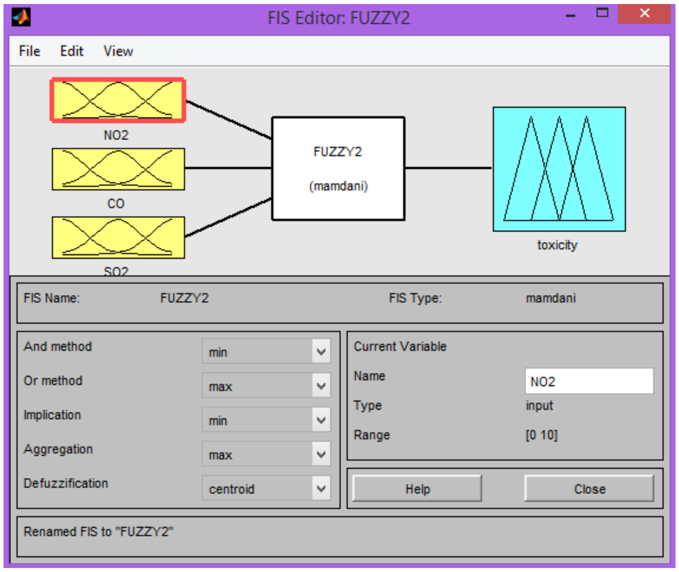

Fig 3.2.1 Images of first level fuzzy controller (FLC)

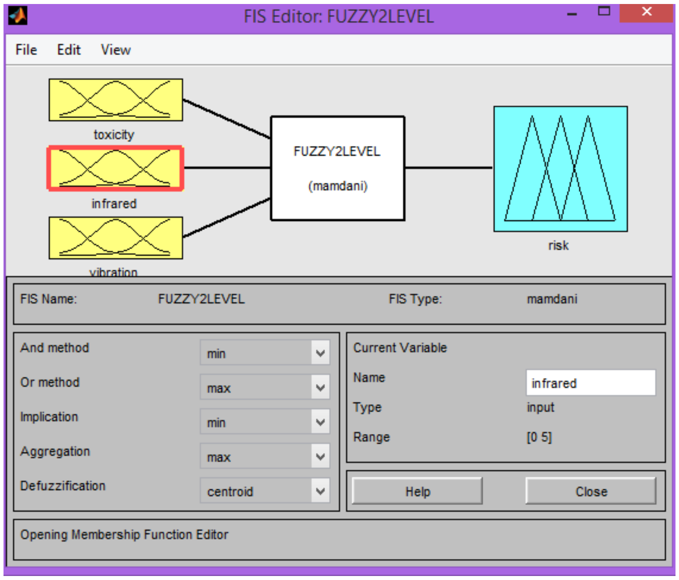

Fig 3.2.2 Images of second level fuzzy controller (FLC)

4. VERIFICATION OF PREDICTION BASED ON FUZZY INFERENCE SYSTEM

The verification of the results is carried out by plotting a graph between the graphs between the risk factor and one of the input parameters keeping other factors same.

This is shown in the plots that are given below. The Fig 4.1 shows that as the concentration of CO gas in the vehicle cabin increases there is an increase in the risk factor too. Here the risk factor is a measure of the probability of risk of accident associated with the vehicle. This is shown by the positive slope of the graph between the CO concentration and risk factor.

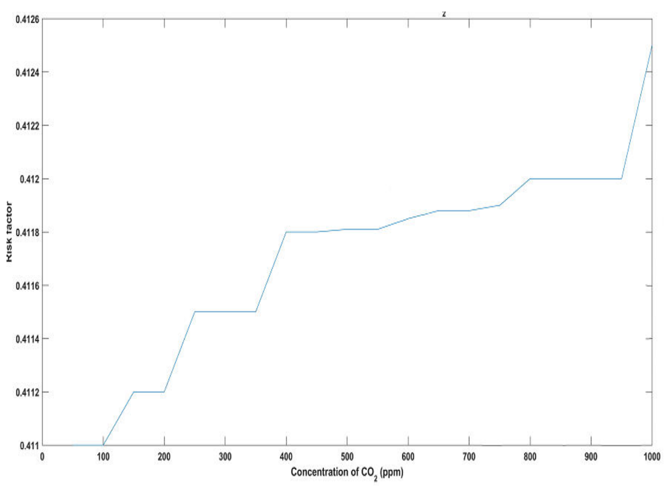

Fig 4.1 Variation of risk factor with CO concentration

Similarly as the concentration of NO2 gas increases inside the vehicle cabin the risk factor also increases. Here the risk factor is a measure of the probability of risk of accident associated with the vehicle. This is shown in the graph in the Fig 4.2.

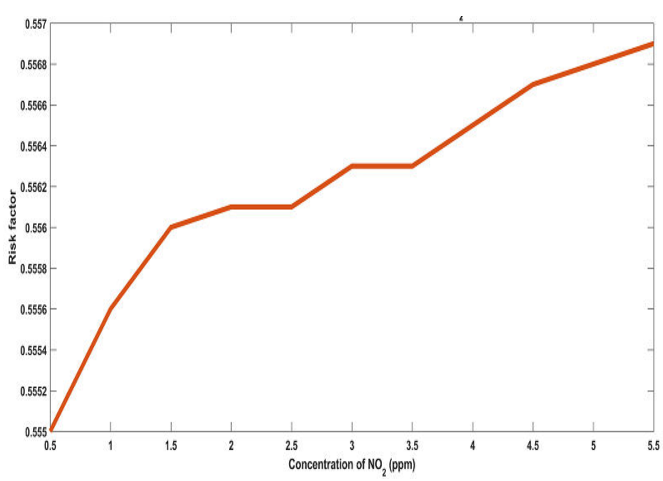

Fig 4.2 Variation of risk factor with NO2 concentration

The infrared sensor is used to detect the drowsiness state of drivers. It transmits the IR radiations in the driver's eyes and the intensity of reflected rays into the IR sensor is recorded. If the drivers eyes are closed then the intensity of light recorded is lowered thereby increasing the risk factor of accidents and vice-versa. This relation is shown in the graph in Fig 4.3

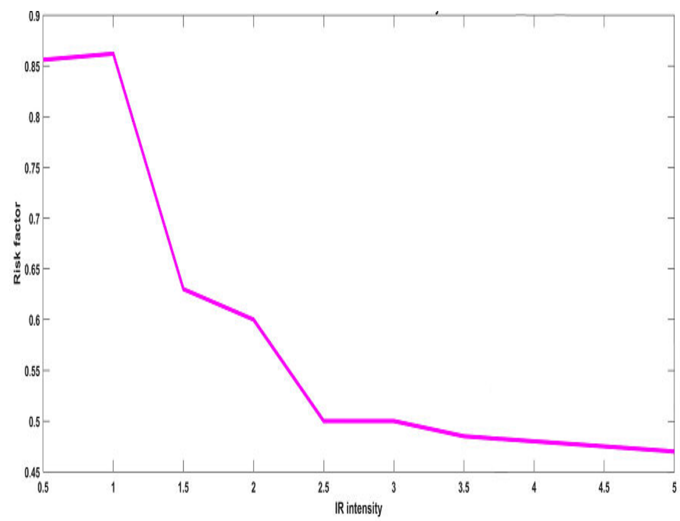

Fig 4.3 Variation of risk factor with IR intensity

5. CONCLUSION

The aim of this paper has been to develop a strategy to encounter any situation of road accident occurrences that occur by monitoring of the critical parameters. Also there are plots that determine the variation of risk factor of road accidents with respect to different parameters.

The fuzzy rule viewer along with the surface viewer is also presented to show the relation between the input parameters and risk factor.

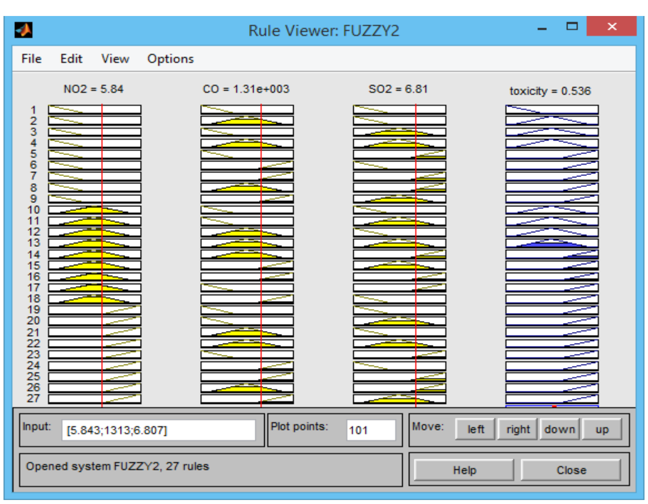

Fig 5.1 Fuzzy rule viewer for first level FLC

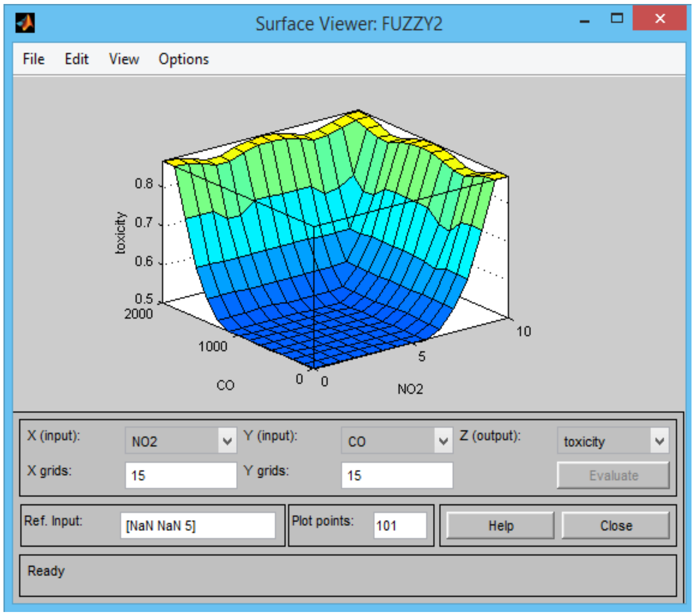

Fig 5.2 Fuzzy surface viewer for first level FLC

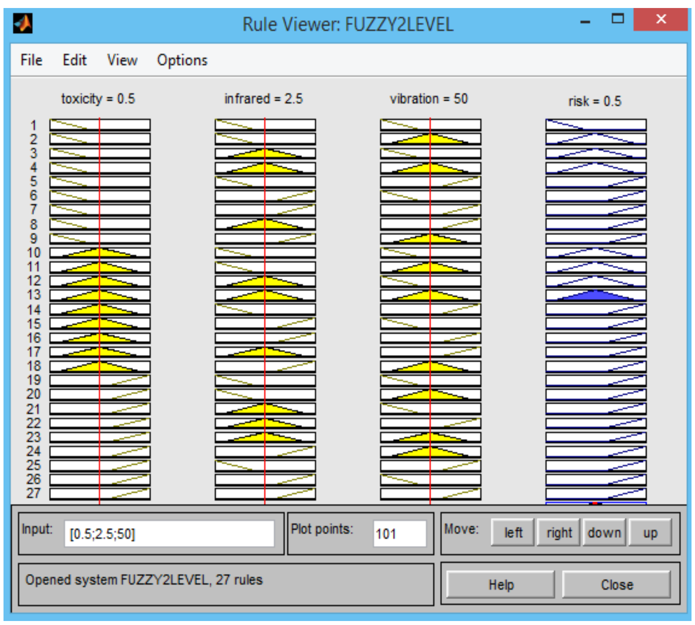

Fig 5.3 Fuzzy rule viewer for second level FLC

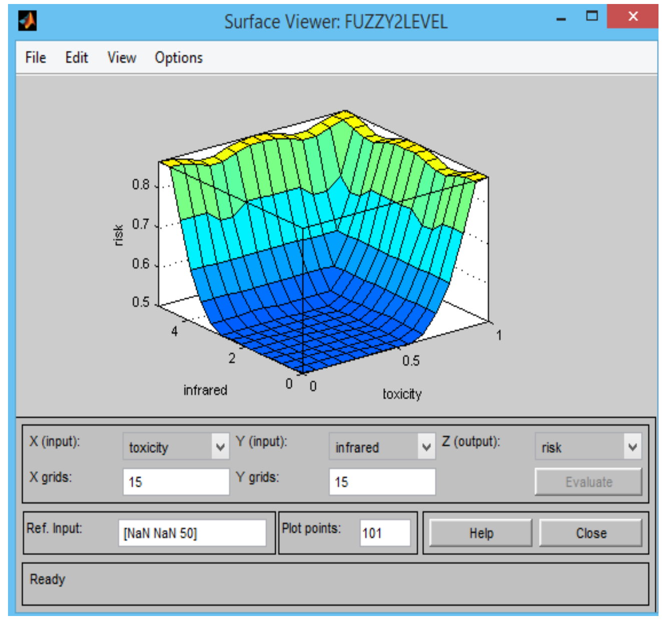

Fig 5.4 Surface view of input output relation of the second level FLC

The prediction is made using the Fuzzy Logic of Mamdani's type-1 system.

Also an extension of the paper can be provided by interfacing an alarm with the fuzzy logic controller. This alarm gets activated whenever the risk factor is high. Such a feature will enhance the feasibility of the entire idea.

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