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Fuzzy Logic Based Approach for Possibility of Road Accidents

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Abstract. Deaths and injuries occurring from road accidents remain severe issue globally. Currently, it is estimated by the World Health Organization that deaths from road accident have increased to 1.35 million a year. This shows closely 3700 people are dying on the world's roads each day, every year 50 millions are disabled or injured. These fatalities take a massive toll on families as well as on communities. Some of the reasons for this increase in road accidents are rapid urbanization, lack of enforcement, poor safety standards, people driving fatigued or distracted, influence of alcohol, drugs, speeding, failure to wear helmets, seat-belts etc. The fact is every one of these deaths as well as injuries can be preventable by enforcing operational measures such as safety standards for vehicles and roads. Hence, this paper analyzes the possibility of road accident for different distraction parameters.

1. Introduction

Road accident is most uninvited event happen to a road user. Though people knew about the factors causes road accidents, they are not cautious while driving on the road. The WHO (World Health Organization) has assessed that injuries due to road accidents costs countries probably 3% of their Gross National Product and some low and middle income countries even it may rise to 5%. The cost of health care, insurance, emergency response and human grief is immense. In current period most of the drivers cannot remain continually focused on their primary tasks such as performing maneuvers, monitoring traffic, reading traffic signs they accomplish various kinds of secondary tasks which are not correlated to safe driving. The driving potential can be influenced either by interaction with the built in-vehicle features like entertainment systems and vehicle information (e.g. controlling comfort), and stuffs brought into vehicle such as portable electronic devices [1], passengers, pets etc.

This section describes various research work related to this study. In [2] the researcher has discussed in detail about automotive human machine interface techniques as well as technologies which can lessen driver distraction. In [3] researcher has taken up detailed study about the influence of mobile telephoning on the driving performance and had suggested that in order to reduce the risk involved it is advisable to allow hands-free mobile telephone sets with a voice-activated dialing system. In [4] one can find the author had considered different age groups (novice drivers, young adults and older adults) of the drivers on their ability to recognize risks. Evaluation of driver distraction while having conversation with a passenger was studied in [5]. Data regarding the driver distraction is collected through the camera containing the images of drivers and studied in[6] and then authors have developed a conversational warning system which alerts the driver in real-time. Analysis of road accident in China in [7] indicates

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that professional driver, large vehicle type, fatigue, terrain and overload are the significant risk factors. Driver distraction evaluation was done by tracking eye while having a conversation with a passenger is studied in [8]. Driving performance was evaluated considering gap between vehicles and the velocity of vehicle by considering fuzzy model and probabilistic model in [9]. Researchers in [10] investigated anti-lock braking system and electronic stability program in automotive driving systems to control the vehicle in order to avoid road accidents. Authors in [11] developed fuzzy model to systematically analyze strain index to minimize road accidents. In [12] researchers have designed both obstacle detection using ultrasonic sensors and antilock breaking system using fuzzy logic rules in order to achieve high breaking torque, shorter stopping distance ,optimal slip ratio and time to prevent road accident. Adopting fuzzy context-free grammar authors in [13] have assessed road risk in accident case. Fuzzy based traffic control system is designed in [14] considering high priority vehicles to minimize the road accidents. Authors in [15] have mathematically modeled collision avoidance system using fuzzy inference system via integrating hardware and software. The constructed algorithm works in two stages firstly it cautions the driver and if at all driver fail to react in time it apply the brake automatically. Considering various traffic densities fuzzy logic traffic lights were modeled in [16] and observed fuzzy logic traffic lights controller were effective in avoiding road accidents than the fixed –time controller owing to its flexibility and capability in effective and optimal reducing waiting time. Research shows in [17] that distraction in human drivers adds significantly in the probability of collisions. To avoid collision of vehicles in [18] researchers have modeled vehicle cyber-physical system (VCPS). VCPS notify the driver when the rate of collision is higher.

Thus from decades researchers are investing various driver assistant models to facilitate the drivers towards effectively avoiding road accidents. It is observed that this type of driving assistance models fail to convey exactly when these systems would intervene for necessary action. Thus in [19] researchers have modeled assistants which act like human because of their cognition. Cognitive agents cleverly choose the appropriate act according to the situation. This cognition is included with emotions (EEC) generated theoretically and implanted practically since emotions can directly influence the human propensity to reason, memorize and decision making in [20,21,22,23and24] to evade the road catastrophe. Study in [25and 26] suggest with age and fatigue decline in the attention capacity might occur which would impact driving performance particularly while distracted.

The rest of this paper is organized as follows. Section 2 discusses problem definition, proposed system, preliminaries of the tools and techniques used. Section 3 describes the measurements obtained from the experiments, conclusion remarks and future directions.

2. Proposed System

In this paper the possibility of a road accident using fuzzy inference system is attempted. Similar studies are available in the literature as brought out above. Four fuzzy input variables or factors have been considered, viz.,

a. Alcohol consumed before driving
b. Speed while driving
c. Usage of audio system during driving
d. Driver's Age

Figure 1 shows the basic approach to the problem [1, 2]. The fuzzy inference system takes linguistic inputs (as stated for simplification), processes the information and outputs the performance. The outputs are turned back to the real numbers using a defuzzification procedure.

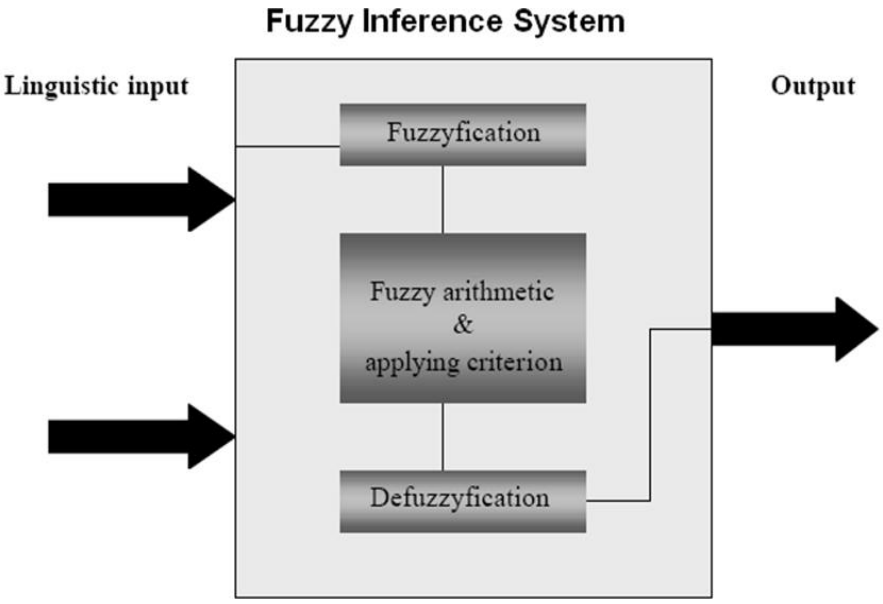

Figure 1. Fuzzy Inference System

2.1 Details about the Set Applied

Before the details of the fuzzy system are dealt with, the range of possible values for the input and output variables are determined. These (in language of Fuzzy Set theory) are the membership functions (Input variable vs. the degree of membership function) used to map the real world measurement values to the fuzzy values, so that the operations can be applied on them. Figure. 2-6 shows the labels of input and output variables and their associated membership functions i.e., trapezoidal membership functions using Mamdani method. The output variables possibility of accident is shown in Figure 6.
Values of input variables: (a). alcohol consumed before driving in terms of percentage as Nil, Medium, High & Very High; (b). Speed while driving in km/hour as Low, Medium, High & Very High; (c) Usage of audio systems in terms of decibel (dB) as Nil, Low Medium & High; and (d) Driver's age in years as Young, Middle aged, Above Middle Aged & Senior. The value of the output variable i.e., Possibility of Accident is expressed in percentage as Low, Medium, High &Very High.

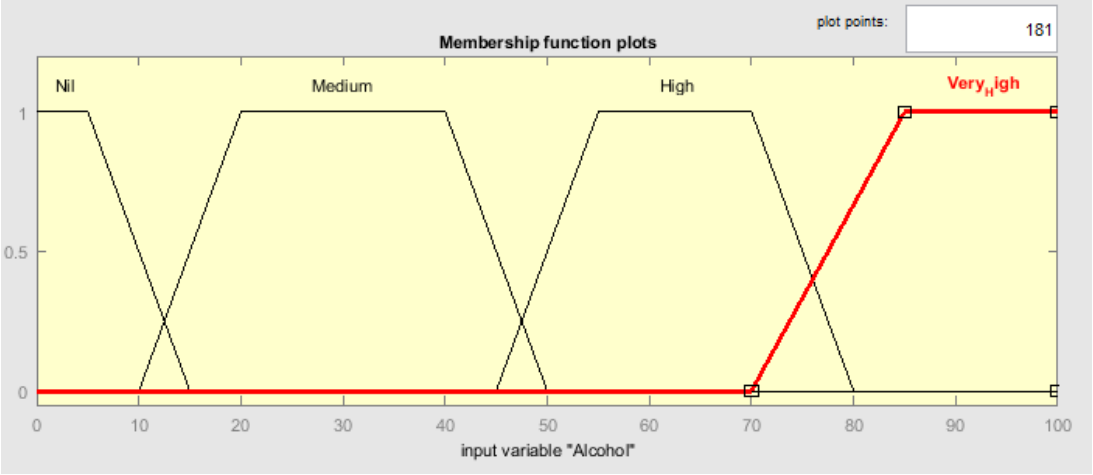

Figure 2. Fuzzy Membership Function for the Input Variable –Alcohol

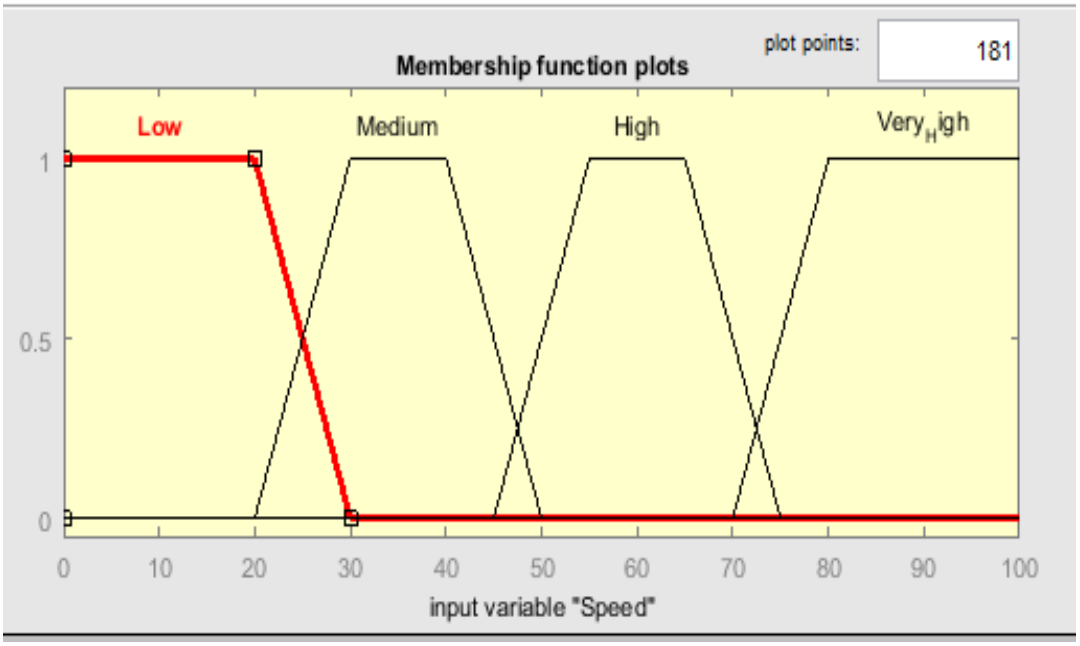

Figure 3. Fuzzy Membership Function for the Input Variable – Speed

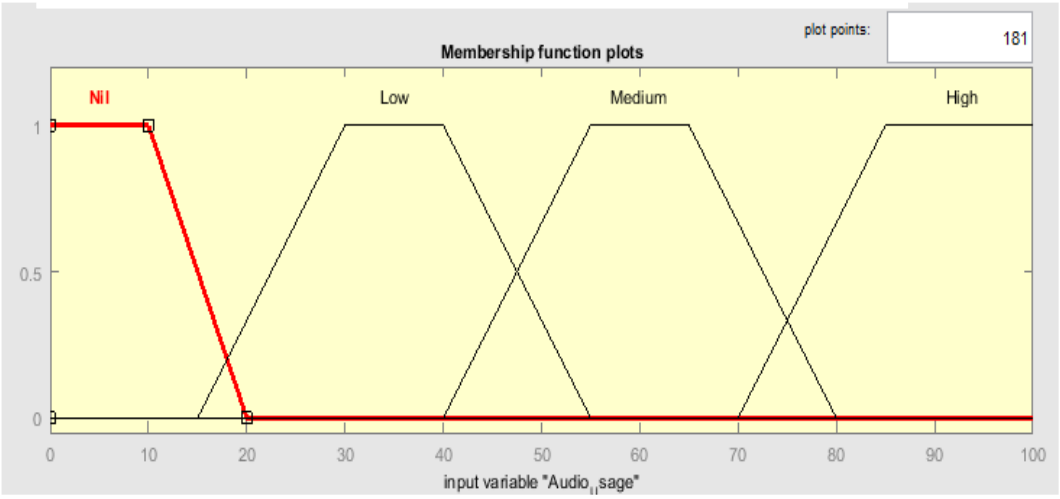

Figure 4. Fuzzy Membership Function for the Input Variable – Usage of Audio system

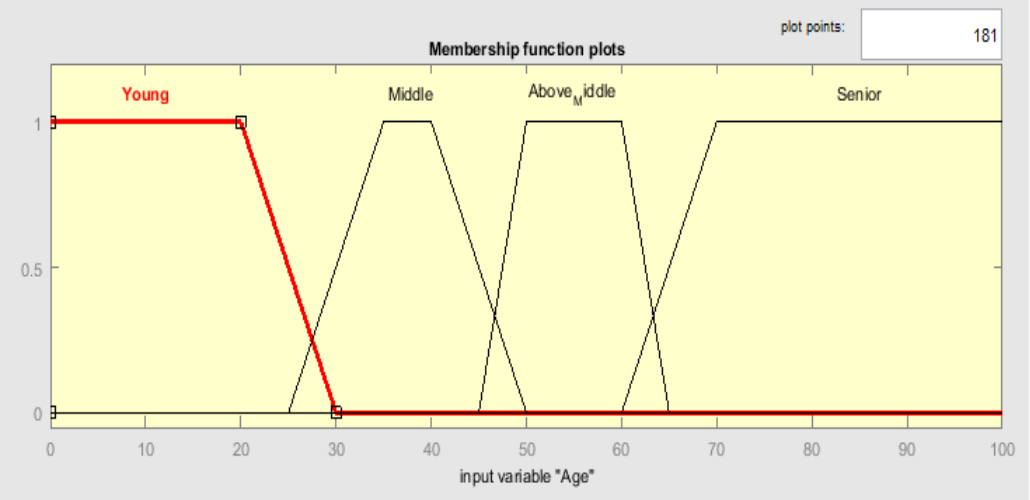

Figure 5. Fuzzy Membership Function for the Input Variable – Driver's Age

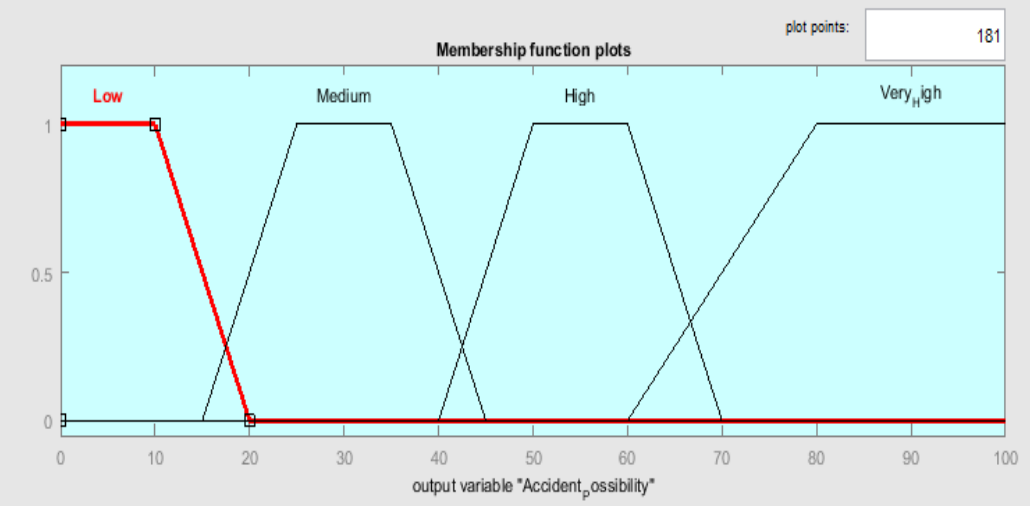

Figure 6. Fuzzy Membership Function for the Output Variable –

The decision which the fuzzy inference system makes is derived from the rules which are stored in the database. These are stored in a set of rules. Basically the rules are if-then statements. Rules used in this paper are derived based on literature survey and concerned government agencies. The set of rules used here to derive the output is inputted in the MATLAB software and is depicted in Figure 7. The rules too have been defined in imprecise sense and hence they too are not crisp but fuzzy values. The four input parameters are fuzzified as per the membership function of the respective variables.

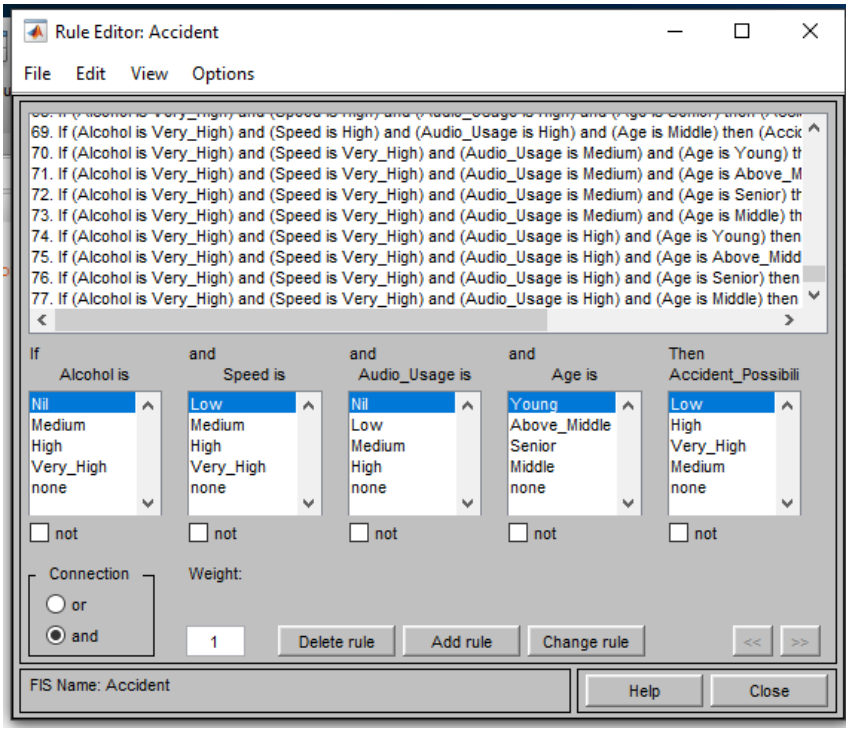

Figure 7. Fuzzy Rule Base

3. Results and discussion

By differing the scale values of all the input variables alcohol, speed, usage of audio systems, and age factor results are obtained according to the rules as shown in Fig 4. Range membership functions , i.e., from 'nil' to 'very high' varies from 0 to100 Via increasing the values of input variables the value of the possibility of accident as percentage also increased as shown in Table 1. The fuzzy toolbox of MATLAB software is used for obtaining the output value - Possibility of Accident in terms of percentage.

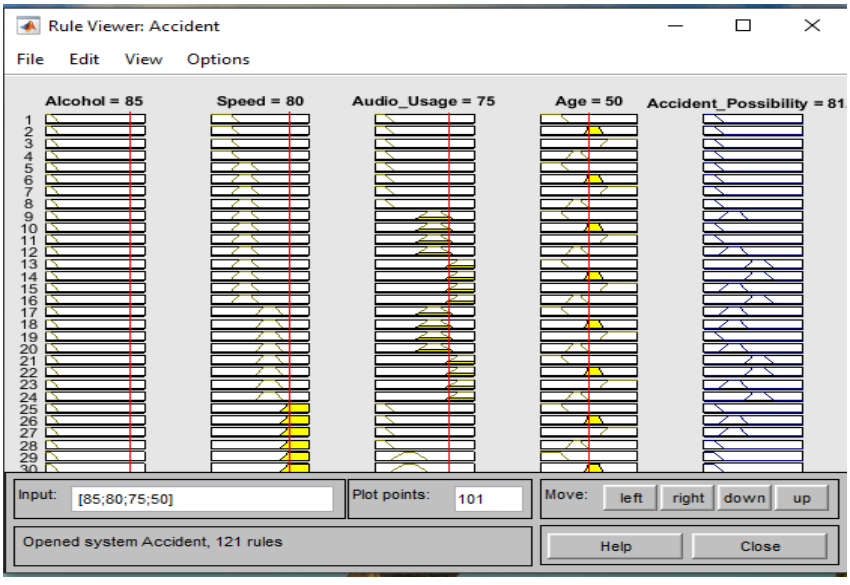

Figure 8. Fuzzy system output representation for Possibility of Accident.

Table 1: Possibility of Accident in terms of percentage for Different Input Values

S/N	Alcohol consumed (%)	Speed of the Vehicle (km/hour)	Usage of audio systems (in dB)	Driver's Age (in years)	Possibility of Accident (%)
1	40	60	50	40	30.00
2	70	50	30	50	50.00
3	80	60	70	60	55.00
4	85	80	75	50	84.70
5	90	90	95	50	81.87

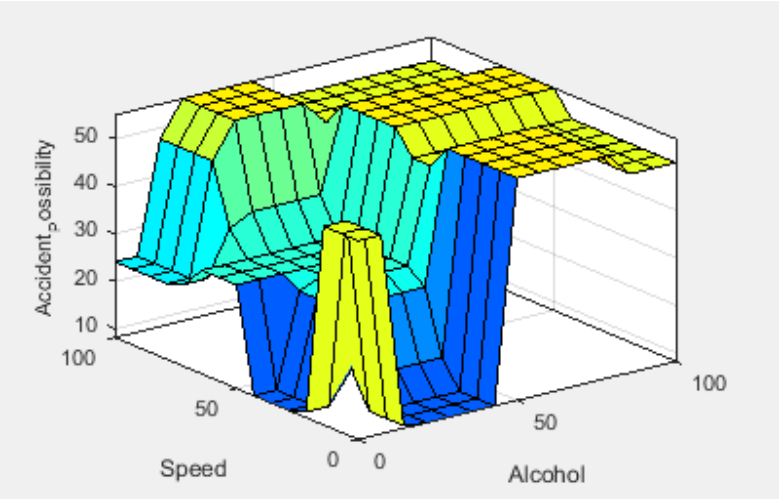

Figure 9. Speed and Alcohol vs Accident possibility

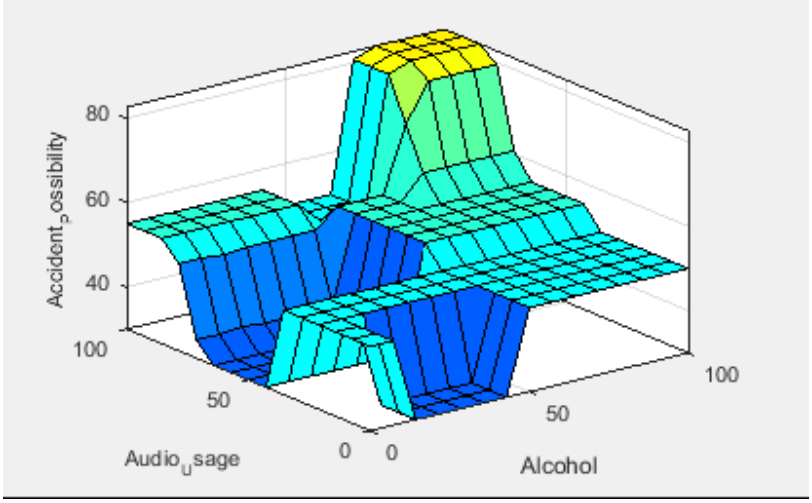

Figure 10. Audio usage and Alcohol vs Accident possibility

Figuare 9. portray that when speed and alcohol level is high the possibility of accident is also high and Figuare 10. shows when audio usage and alcohol is high the possibility of accident cannot be ignored.

4. Conclusion

By the use of fuzzy inference system in this study possibility of road accident for different distraction parameters are analyzed. It has been verified that driver distraction plays a vital role in accidents. The purpose of this study was for only analysis not recommending any counter scheme. This study might be useful for developing latest safe accident solution for the automakers.

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