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Application of Fuzzy Logic in Traffic System

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ABSTRACT

The purpose of this paper is to develop a fuzzy logic model for traffic system. This model is used to overcome the problem of traffic congestion in cities. Consequently, travelling time, fuel consumption and pollution can reduce. Moreover, traffic flow prediction helps the transport users to plan their time of travel and also in selecting the travelling path depending on the predicted information. In this paper, we used density of vehicles variable to design a system which uses the green signal depending on the number of vehicles in that particular line. Here fuzzy logic toolbox of MATLAB is used. The fuzzy sets and membership functions are chosen in an appropriate manner.

Keywords

Fuzzy logic toolbox, density, signal time, traffic system.

1. INTRODUCTION

The control of Road traffic is becoming a major problem in many countries. The increasing numbers of vehicles have led to traffic congestion problem. The traffic congestion problem during peak hour can resolve by deploying traffic policeman at traffic intersection every day. With effective control the intersection, the overall capacity and performance of urban traffic network could be resolve. There are many solutions to solve the traffic jam. One of them is use of sensors. Furthermore, over the ground sensors like videos and radars were used. Using of these systems has high cost [1]. Conventional methods for traffic signal control based precise models fail to deal efficiently with the complex and varying traffic situations. These systems do not consider that when intersection has more load of traffic, we should kept green more [1]. Fuzzy logic is proved to be well manager of traffic system in such situations. Decisions are taken based on imprecise information and the effect of evaluation is not well known [2].

This paper includes a designed traffic system which works on FIS (Fuzzy Inference System) toolbox. It has 1 input and 1 output. Density of the vehicles in a particular lane is the input. We can measure the density of the vehicles using sensors. We have applied this model for two intersections in the city of Tirana, Albania. The results are interpreted, discussed and conclusion is drawn.

2. FUZZY LOGIC

Fuzzy logic was first introduced after the development of the fuzzy set theory by Professor Lotfi Zadeh in 1965. The tools and applications created by the fuzzy set theory can support all stages of a pattern analysis or knowledge discovery process. Most commercial and economic applications of fuzzy logic is related to process control [3].

The starting point of a fuzzy system is obtaining a set of if-then fuzzy rules from the experts' knowledge or the knowledge of the considered field. The next stage is to combine these rules in an integrated system [4].

Fuzzy logic is a problem solving method, which is referred to as a theory of vagueness; because rather than a fixed true and false concept in traditional logic reasoning, it deals with truth values that range between 0 and 1. In traditional and classical logic reasoning, the answer is defined in true or false statements and the concept of conclusion is black or white. Fuzzy logic is decision-making is not only 0 and 1, but also contains values between 0 and 1 to simulate the mechanism of the human brain in the process of thinking and reasoning. Fuzzy logic can use linguistic variables to facilitate the presentation of facts and rules in fuzzy logic theory [5], [6].

Fuzzy logic has been used in the industry since the 80's, and has been proven effective in making decisions based on expert knowledge [7].

The perception that human beings have of the world around them are often vague and imprecise; this perception is expressed through the language. The fuzzy system deals with linguistic variables accurately, being the only in this mode [8].

The success of fuzzy logic can be realized when [8], asserts that there are thousands of patents in Japan and in the United States

related to technologies that use fuzzy logic. So, the fuzzy logic is a good choice to reflect the opinion of experts.

3. STUDY AREA

Tirana is the capital of Albania. It is located in the center of Albania between the mount of Dajti and the mountains of Mali me Gropa, and a valley to the northwest overlooking the Adriatic Sea. The average altitude is about 110 meters above sea level.

Tirana is the most-populous city in Albania with 2.862.427 inhabitants. Due to the high population, it has heavy traffic congestion. Tirana consists in the coordinates 41.33 ° north and 19.82 ° east.

Figure 1: Map of Tirana

We have studied time of green signal in two intersections of Tirana which are presented in the following figures.

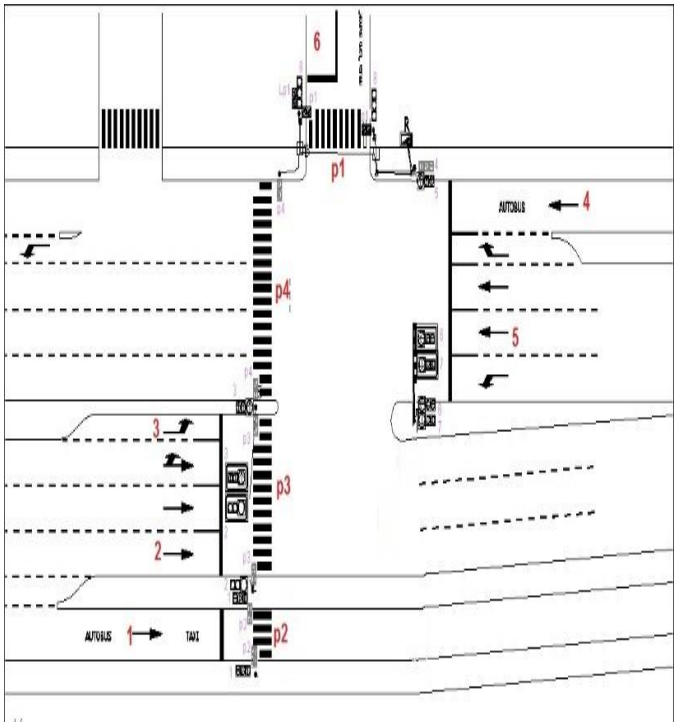

Figure 2: Intersection Road "Dritan Hoxha"- Road "Lord Bajron"

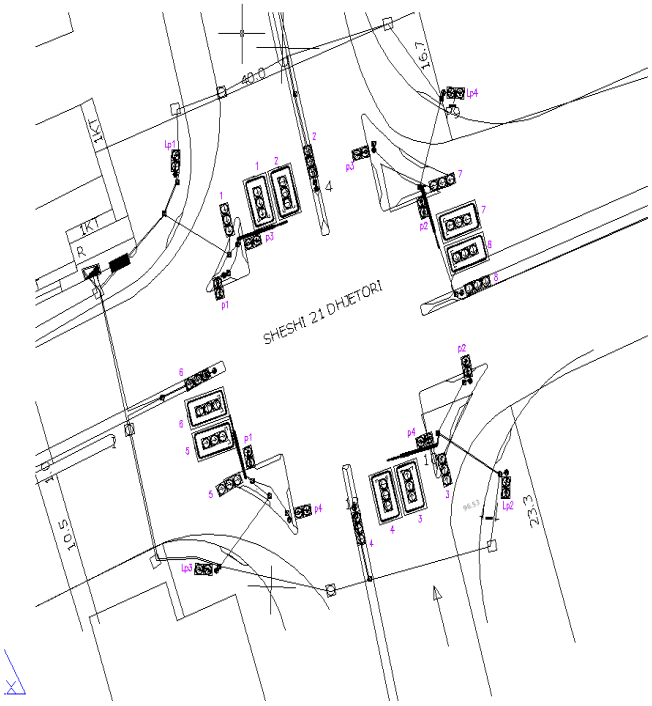

Figure 3: Intersection Road "Muhamet Gjollesha" – Road "Kavajes"

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4. DESIGN STEPS

4.1 Fuzzy Inference System

We have used the "Mamdani Fuzzy Inference System" for our system [10].

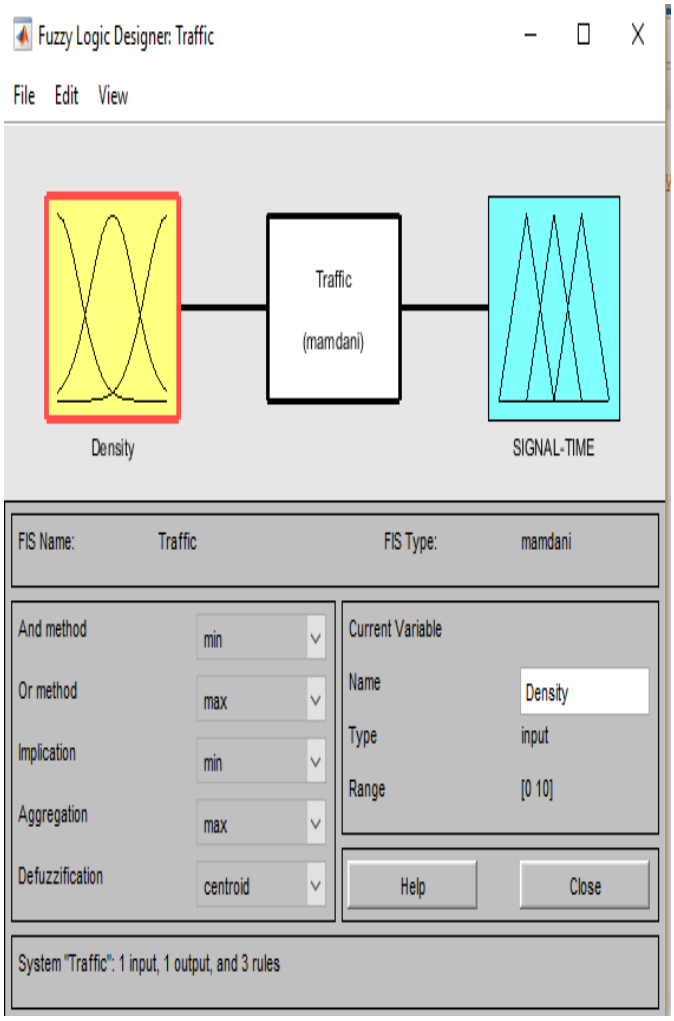

Figure 4: Mamdani FIS Model

The above figure shows the input and output of our system. They are explained below in detail.

4.2 Input

We have applied density of the vehicles as the input to the model [10].

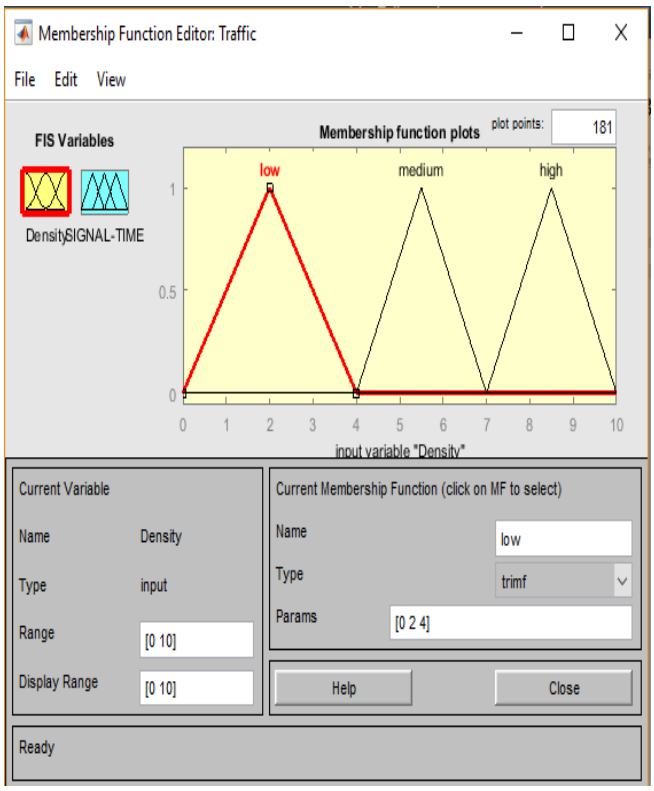

Figure 5: Membership Function of Input Variable Density

4.3 Output

Output of our designed system is the signal time or the time for which the green signal will remain ON [10].

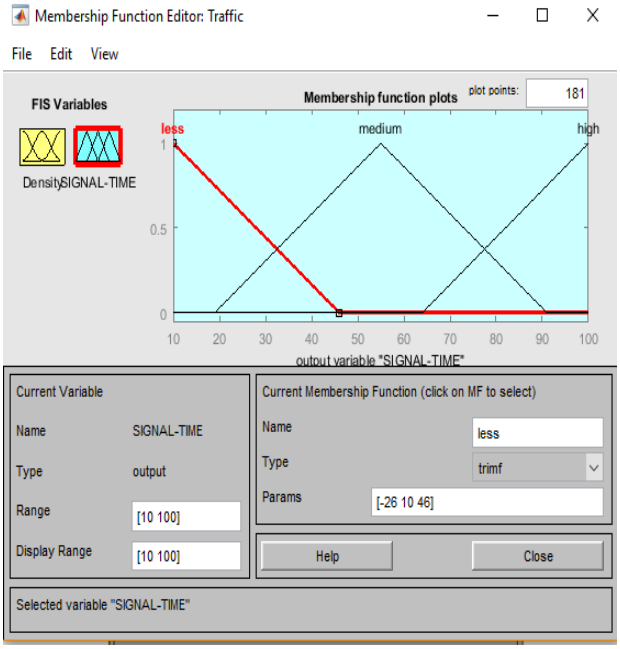

Figure 6: Membership Function of Output Variable Signal Time.

5. DESIGN RULES

Considering the input and output, we have defined 3 rules according to which our system will work.They are as follows: [10]

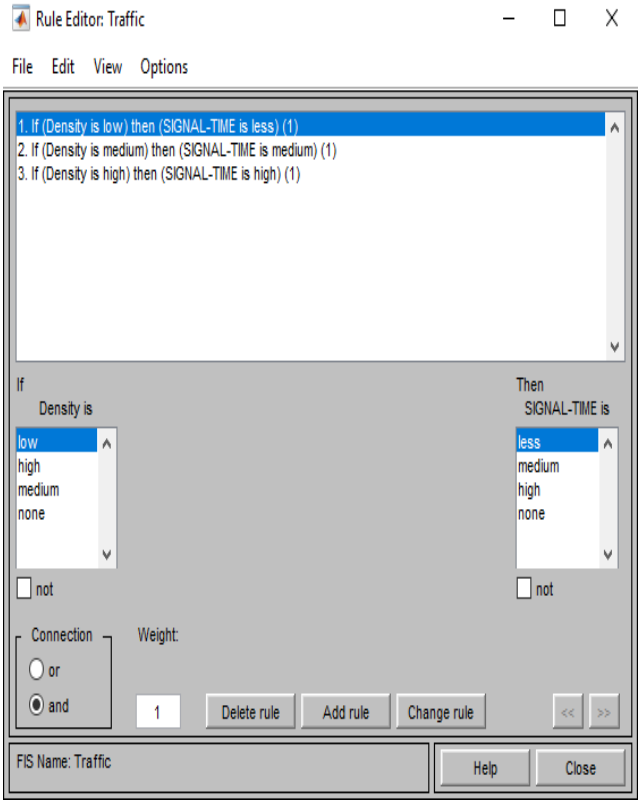

Figure 7: Rule Editor

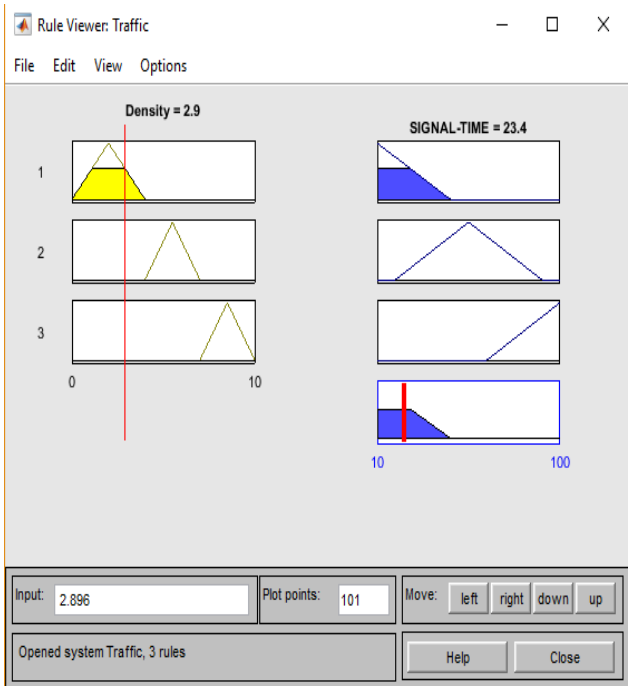

Figure 8: Rule Viewer

6. RESULTS

In this study the density of vehicles in a particular lane and time of green signal are used to construct fuzzy model. These data are taken for two intersections in the city of Tirana, Albania, and are presented in Table 1 & Table 2. The Fuzzy model was constructed according to Mamdani type. To develop the Mamdani FIS model for traffic system the density of vehicles, constitutes the antecedent variable with three fuzzy subsets. This implies, in general, that there are 3 mechanical rules. Based on evaluated input , the density of vehicles, the model forecasts the time of green signal output. The fuzzy model calculations were performed using fuzzy toolbox in Matlab.

Table 1: Lane "Zogu i Zi"-Sheshi "Shqiponja", Intersection Road "Dritan Hoxha" – Road "Lord Bajron"

Peak hour	No.of vehicles	Density	Time of green signal ON (seconds)	Time of green signal ON from Fuzzy model (seconds)	Relative error (%)
00:00	1356	1.27	22	22.9	4.1
00:05	1584	1.49	22	22.4	1.8
00:10	1440	1.35	22	22.7	3.2
00:15	1848	1.73	22	21.9	0.45
00:20	1476	1.39	22	22.6	2.73
00:25	1908	1.79	22	21.8	0.91
00:30	1716	1.61	22	22.1	0.45
00:35	1320	1.24	22	23	4.54
00:40	1752	1.64	22	22.1	0.45
00:45	1176	1.10	22	23.4	6.36
00:50	1416	1.33	22	22.8	3.64
00:55	1344	1.26	22	23	4.54

Average=2.76

Table 2: Lane "Zogu i Zi"-Sheshi "21 Dhjetori", Intersection Road "Muhamet Gjollesha" – Road "Kavajes".

Peak hour	No.of vehicles	Density	Time of green signal ON (seconds)	Time of green signal ON from Fuzzy model (seconds)	Relative error (%)
00:00	1680	3.8	26	26.9	3.4
00:05	1608	3.65	26	26.2	0.8
00:10	1464	3.33	26	25	3.8
00:15	1476	3.35	26	25	3.8
00:20	1308	3.97	26	27.5	5.8
00:25	1176	2.67	26	22.8	12.3
00:30	1092	2.48	26	22.3	14.2
00:35	1128	2.56	26	22.5	13.4
00:40	1332	3.03	26	23.9	8
00:45	1356	3.08	26	24	7.7
00:50	1392	3.16	26	24.3	6.5
00:55	1272	2.89	26	23.4	10

Average = 7.47

7. CONCLUSIONS

So, we have found an efficient solution to the problem of traffic congestion using Fuzzy logic. Through this project, our goal of reducing traffic by displaying the green signal based on the real time density of vehicles on road has been achieved. The problem of traffic congestion at intersections has become one of the most serious problems in cities. Not only does it waste time and money but has become an environmental problem. The timing of the traffic lights are calculated and embedded in to the controllers. The main aim of the development of a fuzzy logic controlled traffic lights system is to minimize the congestion at an intersection. Fuzzy logic enables us to put human intuition into computer systems. This would be similar to having traffic at an intersection being controlled by a human. The system has default timings for the traffic lights. The fuzzy controller calculates increases to these timings. This intelligent technique of fuzzy controlling, when integrated into the fuzzy logic traffic light control systems prove to be more efficient and intelligent than the existing traffic light control systems.

ACKNOWLEDGEMENTS

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