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AN APPLICATION OF FUZZY TRAFFIC CONTROL SIGNAL AT FOUR - WAY INTERSECTION ROAD

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Abstract:

Fuzzy logic is considered to be the highest subject with the experts. It is blended with the conventional control techniques. Fuzzy control system is helpful in regulating the process. Traffic congestion is one of the major issues, which create lot confusion among the public. Shortage of roads and a rise of vehicles on the road are the main reasons for the traffic congestion, which affect gravely productivity, efficiency at the intersection of roads and energy losses. Traffic signal controller is counted to be the major factor for this congestion. This paper deals with the fuzzy traffic control system with the application of fuzzy logic theory. This theory is useful in handling large traffic, which occurs on four ways lane. Here is an attempt to provide some technical devices for the management traffic congestion.

Key Words: Fuzzy Logic Controller, Fuzzy Rule Base Database, Fuzzification, Membership Function & Defuzzification

Introduction:

Traffic congestion is a matter of great concern in the metropolitan cities around the world. It is an issue, which largely affects our booming economy, decreasing the production, development and obstructing our daily chores. There are many reasons, which cause the traffic problems in a city. The major factors, which affect traffic, are increasing number of vehicles, lack of adequate roads and highways and traditional traffic light system. These major factors largely affect our traffic system. One of the major problems is traditional traffic light system. A number of vehicles have been regulated by traffic signals in cities throughout the world. Safety measure at the intersection is the major issue, which requires our attention. The objective is to increase the capacity and reduce the delays. Traffic signals are installed to control the traffic jam at the busy junction. As vehicles have been on the increase in many countries, monitoring and controlling of traffic appear to be a major problem. Highways department fail to take preventive measures. The lifestyle of the people and the density of the vehicles are the main and major reasons for traffic congestion at intersection. Traffic police officers are posted at intersection to regulate congestion at peak hours. This paper proposes to solve this major issue with the implementation of structure of intelligent control system applying fuzzy logic technology.

Fuzzy Traffic Controller:

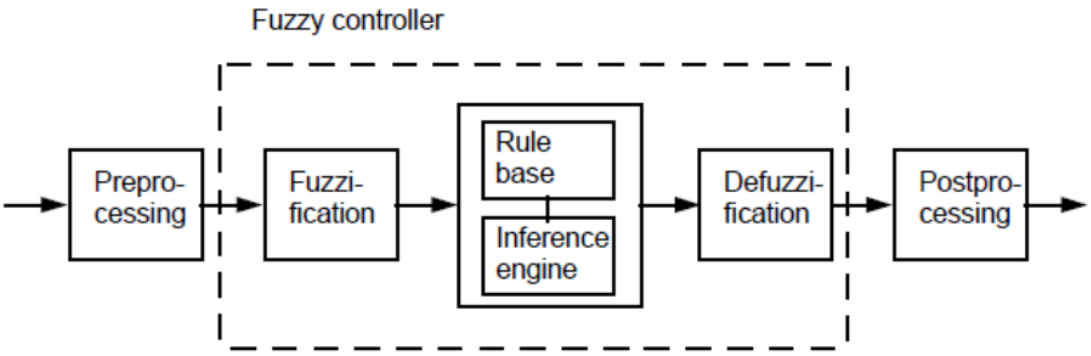

Figure 1: Blocks of a fuzzy controller

The traffic signal comprises the red, green and amber (yellow) phases. These phases are designed to work on their own with the fixed timing interval. Cars, which receive the green signal, are permitted to pass through the intersection going directly, left or right. The cars, which get the red signal, are not allowed to go through the intersection. But, they are permitted to take the right turns with the red signal. The amber phase works from green to red. It is designed to work within the fixed time. The prevailing traffic conditions act as a medium to conclude the duration of green and red phases. Fuzzy logic technology is associated with the rules of human life. This logic is used to regulate the intersection lane. When the intersection is highly congested, it is bright enough to control the traffic. Time is fixed for the signalized intersections to clear the traffic. Fixed timings vary depending on the increasing and decreasing of vehicles. Red and green lights work efficiently with a clear-cut view to all the travelers in all directions. The human knowledge is applied expertly on the basic of fuzzy signal controller. The fuzzy logic theory is incorporated into the traffic controller to work efficiently to the green intervals. Conventional traffic controllers are proved ineffective. The fuzzy logic theory proves to be

highly efficient. The bad traffic situation can be effectively and efficiently handled by a new fuzzy traffic light control system, when the congestion is very troublesome. This system is powerful enough to manage the traffic frequency and the long queue. The green phase duration is properly regulated depending on the vehicles waiting at the red light.

A membership function (MF) is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The input space is sometimes referred to as the universe of discourse, a fancy name for a simple concept. A membership function for a fuzzy set A on the universe of discourse X is defined as $\mu_A: X \rightarrow [0,1]$, where each element of X is mapped to a value between 0 and1. This value, called membership value or degree of membership, quantifies the grade of membership of the element in X to the fuzzy set A.

Design Criteria and Methodology of Intersection of Four Ways Lane:

The following assumptions are used to design the traffic control system.

- Vehicles are from four directions at a four way intersection. The directions are named as north, west, east and south.
- When vehicles move from north and south directions, vehicles from east and west are at a standstill.
- Left and right side are not taken into consideration.
- East-west is a system of approach and south-north is a system of another approach.
- Fuzzy logic controller is used to count the maximum and minimum time for green light. Further, all the directions are monitored by the system.

Structure of Traffic Signal Control:

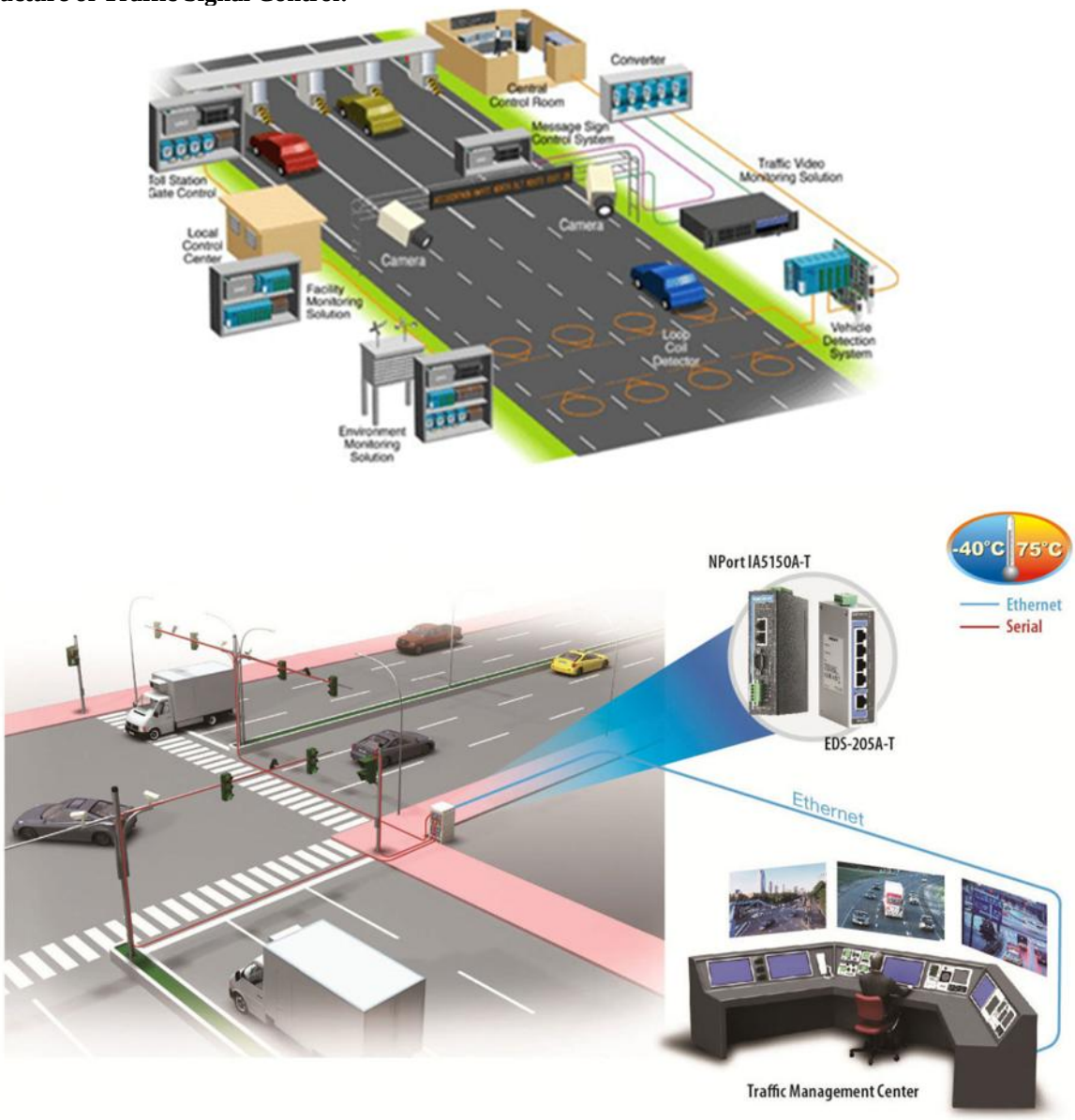

Figure 2: Traffic signal controllers

There are two types traffic lights control system, which is mainly in function at intersection. The first traffic light control system is used to preset the timing for the change of light. The second traffic lights control system changes according to time cycling. The general structure of traffic lights control system is clearly portrayed in figure 2. The following components are the major elements in the traffic lights control systems structures.

Sensors: There are two sets of inductive loop sensors in the fuzzy traffic light control system. Each set has two electromagnetic sensors. They are set on each lane. The first set is situated before the intersection of the cross point. Further, it is behind each traffic light. The second sensor is located behind the first sensor. When the vehicles come, the second gathers the information of the vehicle.

Fuzzy Logic Controller: The fuzzy logic controller receives the information of the traffic statistics that it may extend duration of the green light phase. The information which has been collected from the fuzzy logic controller for is transferred to Programmable Logic Controller (PLC). Sensors and PLC are connected with the traffic lights. Fuzzy logic controller has the responsibility of lengthening the green light timing, which is based on traffic congestion. The two traffic sensors are at work. They are variable at the length of time. Simulation is in use for the fuzzy logic controller. It is to be noted for the extension of green light time. Fuzzy rules are applicable to the queue with analysis. It is extended to the green phase extension.

State Machine Controls: The state machine control is held responsible for the controlling of the fuzzy traffic controller system. Whenever the traffic is found out on the busy lane, red signal is on. State machine is activated with the application of green light through incoming traffic.

Fuzzy Controller Design: Fuzzy logic controller is mainly activated on a four-lane intersection. This system is further useful with input arrival and queue variables. The first sensor and queue variables are useful in identifying the green light and second sensor. When north and south have vehicles, they are activated green signal. This aspect of function is applicable to east and west. Extension time is dependent upon the output variables. It is based on fuzzy rules. Green light and extension agree with green light. The fuzzy logic controller clearly given in figure 3.

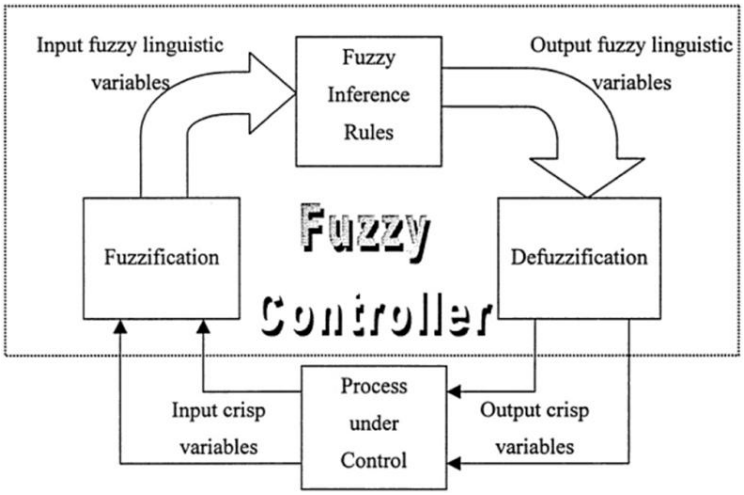

Figure 3: Structure of Fuzzy Control system

Fuzzification: Fuzzification is transferring the crisp input into fuzzy input. This conversion is called fuzzification. The vehicles are numbered by the sensors in an order. And the calculation is passed on to the fuzzification system. The number is set from 0 to 1. This is in turn framed into crisp number to fuzzy number. The fuzzy variables are queue and extension. These are used in traffic lights. They alter between 0 and 1. The converted number is considered fuzzy value.

Fuzzy Decision Making: Fuzzy value involves the arrival and queue which are calculated to be fuzzy decision making. Database, decision making knowledge is considered to be fuzzification through output variable. Fuzzy component comprises rules from knowledge base and fuzzy rules database. This method is called fuzzy inference system.

Knowledge Base: The main objective of knowledge base is determined by the best policy, which decreases in a number of vehicles at intersection lane. The traffic simulation is based on the knowledge base. It is completely founded on the rules with algorithm like a heuristics. Input and output variables are the means of the universe of discourse. Input and output variables contain traffic light control. It is a matter of membership. The membership variable is given in the Table 4.1

Table 1: Fuzzy Variable and their membership function.

Arrival	Queue	Extension
VS	VS	Zero (Z)
S	S	Short (S)

M	M	Medium (M)
L	L	Longer (L)
VL	VL	Very Longer (VL)

The membership algorithm value contains intuition, logical reasoning, procedural method, portioning input and output space. Fuzzy variable and the relationship of membership are shown in Fig-4.2The diagram clearly shows the membership of fuzzy variable a y-axis and x-axis as universe of discourse in the input variable. The amount of vehicles are considered to be output variable.

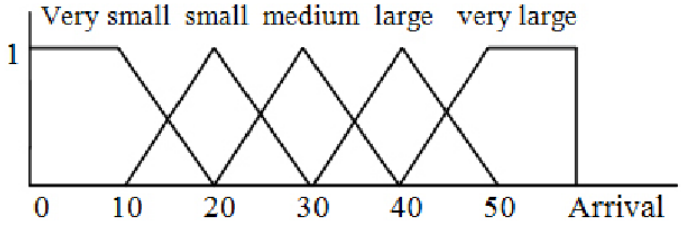

Figure 4: Membership functions for the arrived vehicle

In figure 4 show as Member ship functions for number of vehicles for arrive at the intersection point of lane in traffic lights. In figure 4 show as Member ship functions for number of vehicles for standing or queuing in the line at the traffic lights system.

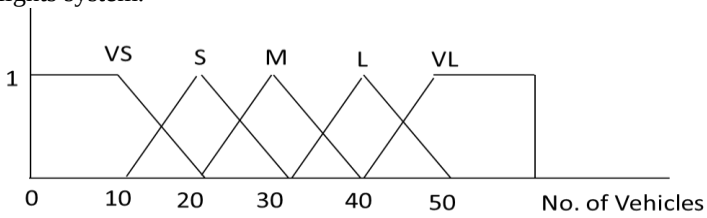

Figure 5: Member function for queueing vehicles

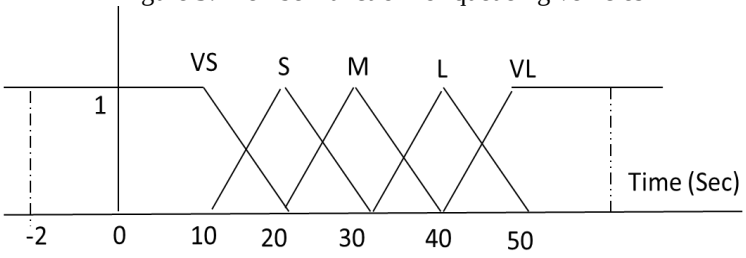

Figure 6: Membership function for extension time

In figure 6 show as Member ship functions for allocated time for extension time for green single.

Fuzzy Rule Base: The human reasoning process is similar to the inference machine in the fuzzy logic controller. The artificial intelligence is closely connected with this fuzzy technology. This system is checked with warning and overcrowding details. In addition, the appropriate action is with human reasoning.

IF-THEN policy is the norm of fuzzy rule. The skilled knowledge is the fundamental objective of IF-THEN rule. Moreover, it is combined with AND /OR logical operator. If the traffic from the north of the town is extra AND, the traffic from the west is fewer. It further allows the movement of the north.

Input and output variable determine the fuzzy logic controller. Membership function is also based on expert knowledge intelligence. Fuzzy rules are associated with output variables. They are closer to basic various approaches. The following table shows the difference.

Table 2: Fuzzy Control Rules

Queue (Q) Arrival(A)	**VS**	**S**	**M**	**L**	**VL**
VS	D	D	D	D	C
S	D	D	D	C	C
M	D	D	C	C	I
L	D	C	C	I	I
VL	C	C	I	I	I

Example:

- When the vehicles are on the queue (Q), the number of vehicles which come are considered as (A). Then the decreasing of the green light (T)
- If there are a large number of heavy vehicles (Q), the small green light is seen as (A). (T) is constant.
- There is an increase of (T) with the arrival (A) of the large of vehicles (Q)

De-Fuzzification and Extension Time:

It is technique, which makes the conversion from the fuzzy output values of fuzzy inference to actual crisp value which is an extension of mathematical number. It receives output value. The second numerical value consists of a green single timing as a second means fuzzy value.

Conclusion:

Finally we discuss the general approach of fuzzy traffic control system. Fuzzy control system proves to be a major complex system from case studies. This performance is evidently found in many literatures. This study shows that regular traffic system can be largely improved using this system. Decision support system and component of fuzzy controller are implemented on a four-way road in cities. Sensor is the fundamental equipment of controller. Fuzzy controller comprises the traffic information, which is based on database. Fuzzy database is gained through database rules. Traffic difficulties have been on the increase. The main objective of this research is to present fuzzy logic in the traffic signal. The following achievements are remarkable.

- The improvement of traffic security at the junction
- Making the facilities for smooth journey at the junction
- To reduce the vehicles on the waiting

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