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Intelligent Traffic Monitoring System

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ABSTRACT

A serious problem is Traffic congestion in the urban areas now days due to increase in vehicles. Travel time, life quality, travel safety and environmental quality are all adversely affected by traffic congestion. This model provides a framework to implement adaptive traffic signal controllers based on fuzzy logic technology. When implemented, it solved various problems such as travel cost, accident, waiting time, traffic congestion.

Keywords: Fuzzy Controller, Traffic Congestion, fuzzy logic, Conventional Controller, Traffic Density.

1. INTRODUCTION

URBAN areas nowadays have a big issue of traffic jams especially when a number of junctions are taken into consideration.

Noise and air pollutions, time wastage, accidents and many other factors are of serious concerns in traffic. There are a number of methods which controls traffic lights in junctions. These methods are useful in minimizing the amount of traffic. Traffic can intelligently be detected by traffic light controller. Fuzzy logic control plays an important role in traffic signals.

To manage the traffic congestion effectively, traffic information such as number of passing vehicles, vehicle speed and travel time should be supplied by various traffic detectors.

The conversional traffic lights helps in traffic congestion since it can detect if there are no cars coming from the other direction to stop that side and allow the side that has much vehicles waiting.

2. REVIEW OF RELATED WORK

Intelligent traffic light monitoring system was designed by Aman Jantan and Abdul Kareem in 2011. The research was motivated by the need to minimize the unnecessary long waiting times for vehicles at regular traffic signal with 'fixed cycle' protocol. The paper proposed monitoring system will be able to determine three street cases (empty street case, crowded street case and normal street case) by using small associative memory to improve the traffic signal configuration.

The experiments presented when the proposed approach was applied in Penang Island in Malaysia. The experiment was done by using a program to monitor one intersection which determine all street states with different weather conditions by using stream images extracted from the street video cameras. A distributed, knowledge-based system for traffic-adaptive control of traffic signals was introduced by 'Findler' and 'et al' (1997).

The fuzzy membership function values 0 & 1 were used to estimate the vehicle speed, uncertain length, different kinds of conditions such as speed, car type, seek time, volume of car were stored.

Inter-arrival time and inter-departure time were adopted by this model to simulate the leaving and arrival number of car on roads. The traffic light efficiency was affected by unexpected events occurrence such as traffic accidents or break-down of vehicles.

The algorithm consisted of motion detection and vehicle detection operations. A decentralized control model was described by Jin & Ozguner (1999). This model was a combination of multi-destination routing and real time traffic light control based on a concept of cost-to-go to different destinations.

Electronic traffic signal has the advantage of being easily visible to the machines which were propagated by Huang and Miller (2004). They presented a basic electronic traffic signal protocol framework with its two derivatives, one for stop sign signals and a reliable protocol for traffic signal intersection.

DESIGN ALGORITHM OF FUZZY BASED TRAFFIC SYSTEM

Data at junction J1 containing traffic flow, traffic light status, road ways, and sensors which are G (for green) and R (for red) are given in Table - 1.

TABLE 1
DATA OF JUNCTION J1

Junctions	J1					
Sensors	S1		S2			
Traffic Flow	100		60		95	
Road ways	w1	w2	w3	w4	w5	w6
Traffic Light Status	G	G	R	G	R	R
	G	G	R	G	R	R
G=Green Y=Yellow R= Red	R	R	G	G	G	G
	R	R	G	G	G	G

Table 2.1 shows the data at junction J2 containing traffic light status, traffic flow, road ways, sensors which is again G (for green) and R (for Red).

TABLE 2.1
DATA OF JUNCTION J2

Junctions	J2					
Sensors					S3	
Traffic Flow	115		50		80	
Road ways	w7	w8	w9	w10	w11	w12
Traffic Light Status	G	G	R	G	R	R
	G	G	R	G	R	R
G=Green Y=Yellow R=Red	G	G	R	G	R	R
	G	G	R	G	R	R

Each road has been assigned a special code, there is ‘u’ for U-Turn written after the code. The road codes and the categorization has been defined in Table 3.

TABLE 3
ROADWAYS AND THEIR RESPECTIVE ROADCODES

Road Ways	Road Codes
w1	00001
w2	00001u
w3	00002
w4	00002u
w5	00003
w6	00003u
w7	00004
w8	00004u
w9	00005
w10	00005u
w11	00006
w12	00006u

The code 00001 for instance contains five digits. The first digit defines the existence of emergency vehicle. If the code is like 00001, it means no emergency vehicle is detected. The code 10001 means that there is an emergency vehicle on this route. It is basically OFF and ON. The 2nd digit defines the existence of OFF and ON of traffic light, which is 1 (for green) and 0 (for red).
In case any emergency vehicle coming towards the road having code 00001 (for instance) will be of the form 11001 which again indicates the existence of emergency vehicle on the route and the traffic signal status is green. A popular simulation s/w MATLAB is used to fuzzy control.

Membership functions for both outputs and inputs have been defined in Table 4 and Table 5.

TABLE 4
INPUTMEMBER FUNCTIONS

0 – 20	Slow
0 – 40	Below Medium
20 – 60	Medium Fast
40 – 80	Fast
60 – 100	Very Fast

TABLE 5
OUTPUTMEMBER FUNCTIONS

0 – 20	Very Long
0 – 40	Long
20 – 60	Medium
40 – 80	Short
60 – 100	Very Short

Three inputs in the form of Ambulance, Police, and Fire Brigade vehicles with their green time as their outputs are shown in Fig. 3

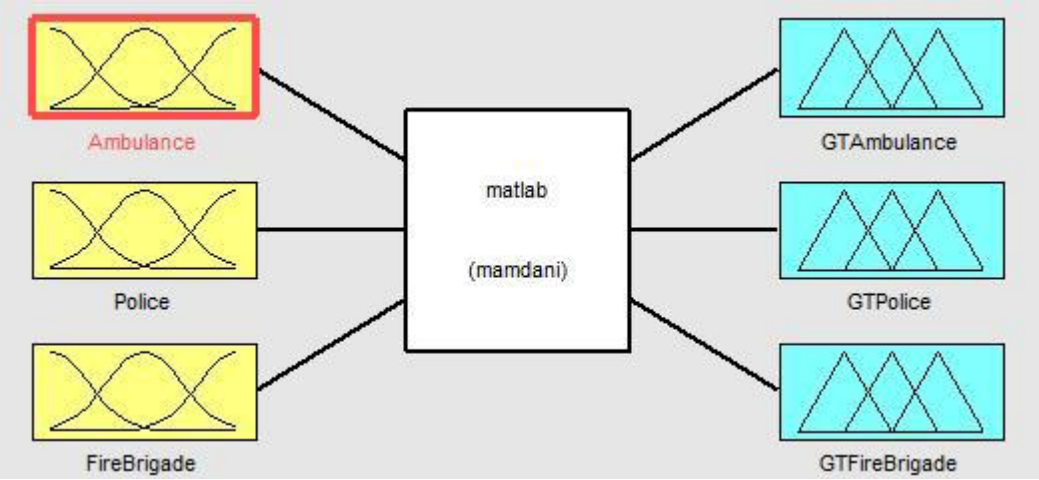

Fig.3 Inputs & Outputs

Five membership functions for each of input and output have been created. Fig. 4 shows the membership functions for input variable "Ambulance".

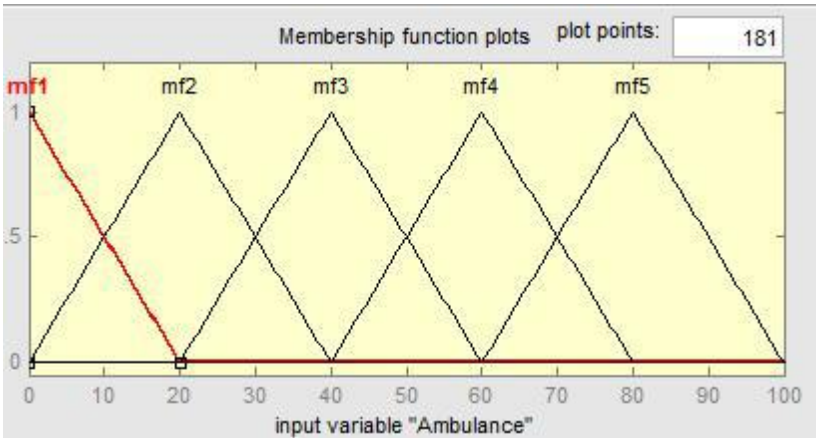

Fig. 4. Membership functions with their respective range.

A total number of 60 rules have been generated. The rules were defined firstly by considering a single emergency vehicle with all possible speeds. The rules were then defined by considering two emergency vehicles with all possible speeds and, rules were finally defined for three emergency vehicles with all possible speeds. Also by assigning the speed of our inputs, the rule viewer shows the respective green time for our outputs.

Simulation Result

A fuzzy logic controller is designed for an isolated 4-lane traffic intersection: North, South, East and West. In the traffic lights controller, 2 fuzzy input variables are chosen: the quantity of traffic on the queuing side (Queue) and the quantity of the traffic on the arrival side (Arrival).

If the south and north side is green, then this would be the arrival side while the east and west side would be considered as the queuing side, and vice-versa. The output fuzzy variable would be the extension time needed for the green light on the arrival side (Extension). Thus based on the current traffic conditions, the fuzzy rules can be formulated so that the output of the fuzzy controller will extend or not the current green light time.

If there is no extension of current green time, the state of the traffic lights will change to another state immediately allowing the traffic from the alternate phase to flow.

Following are the benefits of fuzzy logic controllers that make it different from the conventional control could be summarized:

1. Fuzzy controller system are more robust than conventional controllers as they can cover much wider range of operating conditions than conventional.

2. Developing these are cheaper than developing a model-based controller to do the same thing.

3. These are customizable, since they modify their rule and are easier to understand which not only use a strategy of a human operator but also are expressed in natural linguistic terms.

4. It is easy to learn how fuzzy controllers operate and how to design and apply them to a concrete application.

Conclusion

Fuzzy Controller can be used for traffic light monitoring due to the flexibility of the fuzzy logic in dealing with uncertainty.

In this paper, we work on the fuzzy controller of a 4-phase traffic light. The performance of this approach was evaluated by comparing it with the fixed-cycle time (conventional control system) using the same input data to allow a consistency check and cross-validation.

Moreover, fuzzy logic control system provides better performance in terms of efficiency by reducing the waiting delay time of vehicles on traffic signals. Less waiting time as well as less traffic congestion at red traffic lights will reduce the air pollution, fuel consumption, time, sound pollution, and energy waste.

Traffic signal control using fuzzy logic model for full intersections with four ways was developed. The strategy of this model simulates the control logic of experienced humans such as police officers directing traffic who often replace signal controls when intersections experience unusually heavy traffic volumes (e.g., during special Events.)

The Fuzzy logic model controller makes the decision whether to terminate or extend the current green phase based on a set of fuzzy rules and real-time traffic information. This model was compared with actuated control strategies and conventional fixed time using a typical intersection with varying traffic volume levels. This model showed substantial improvements over actuated control strategies and conventional fixed time for all 'Measure of Effectiveness' under heavy traffic volumes. Measures of effectiveness including speed, throughput-to-demand ratio, delay, time in queue were examined.

Overall, the simulation results indicated that Fuzzy Logic model has the potential to improve operations at oversaturated intersections.

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