INT 246 PROJECT : INTELLIGENT TRAFFIC LIGHT USING FUZZY

Project Submitted To

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INTRODUCTION

Monitoring and control of city traffic is becoming a major problem in many countries. With the ever increasing number of vehicles on the road, the Traffic Monitoring Authority or the Transport Ministry as the authority is known here in Malaysia, has to find new ways or measures of overcoming such problem. Among them are developing new roads and flyovers in the middle of the city, building several ring roads around the city such as the inner ring road, middle ring road and outer ring road, introducing city trains such as the light rapid transit (LRT), and monorails, restricting large vehicles in the city during peak hours, and also developing sophisticated traffic monitoring and control systems. In the city of Kuala Lumpur, the registration of new vehicles each year increased by about twenty per cent.

This increment is rather alarming and even with the development of the LRT and new roads other measures have to be stepped up and introduced as quickly as possible. In Kuala Lumpur the problem of traffic flow during peak hours has somewhat been under control by city traffic policemen. Last February the movement of traffic in the city was chaotic when traffic policemen were taken off their duties of manning the junctions.

It was learnt that the Kuala Lumpur City Hall wanted to test their automatic traffic control system that had recently been installed which was still in its initial stage. It is understandable that automatic control systems should relieve humans from manual control, however, such automatic system does not work well in many circumstances especially during oversaturated or unusual load conditions which could be due to limitations of the algorithms or sensing devices.

In this respect manual control seems to be better due to the intelligence of the traffic policemen in understanding the traffic conditions at the respective junctions.

TRAFFIC LIGHTS CONTROL SYSTEM

Basically, there are two types of conventional traffic lights control system that are in used. One type of control uses a preset cycle time to change the lights. The other type of control combines preset cycle time with proximity sensors which can activate a change in the cycle time or the lights. In the case of a less traveled street which may not need a regular cycle of green lights, proximity sensors will activate a change in the light when cars are present. This type of control depends on having some prior knowledge of traffic flow patterns at the intersection so that signal cycle times and placement of proximity sensors may be customized for the intersection.

Fuzzy logic traffic lights control is an alternative to conventional traffic lights control which can be used for a wider array of traffic patterns at an intersection. A fuzzy logic controlled traffic light uses sensors that count cars instead of proximity sensors which only indicate the presence of cars. This provides the controller with traffic densities in the lanes and allows a better assessment of changing traffic patterns. As the traffic distributions fluctuate, the fuzzy controller can change the signal light accordingly.

FUZZY LOGIC TRAFFIC LIGHTS CONTROLLER DESIGN

A fuzzy logic controller was designed for an isolated 4-lane traffic intersection: north, south, east and west as shown in Fig. 2. In the traffic lights controller two fuzzy input variables are chosen: the quantity of the traffic on the arrival side (Arrival) and the quantity of traffic on the queueing side (Queue). If the north and south side is green then this would be the arrival side while the west and east 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 the current green time, the state of the traffic lights will immediately change to another state, allowing the traffic from the alternate phase to flow.

Input and Output Membership Functions

For the traffic lights control, there are four membership functions for each of the input and output fuzzy variable of the system. Table 1 shows the fuzzy variables of Arrival, Queue and Extension of the system. The right hand notations are used to shorten these variables.

Arrival		Queu		Extensio	
Almost	AN	Very Small	VS	Zero	Z
Few	F	Small	S	Short	S
Many	MY	Medium	M	Medium	M
Too Many	TMY	Large	L	Longer	L

The graphical representation of the membership functions of the linguistic variables . It can be observed that the y-axis is the degree of the membership of each of the fuzzy variable. For the input fuzzy variables the universe of discourse (the x-axis) is the quantized sensor signals which sensed the quantity of the cars. For the output fuzzy variable the universe of discourse is the length of time to be extended in seconds. It can be observed that six cars have been assigned as a strong "Too Many" or "Large" fuzzy subsets in this simulation which have a full membership. For "Many" or "Medium" fuzzy subsets, a full membership is 4 cars and so on. For the output fuzzy variable, a strong "Long" fuzzy subset with a membership of "1" would be in the region of 6 seconds, whereas a strong "Medium" fuzzy subset would be in the region of 4 seconds, and so on. The configuration of these membership functions is done according to expert observation of the system and environment.

Fuzzy Rule Base

The inference mechanism in the fuzzy logic controller resembles that of the human reasoning process. This is where fuzzy logic technology is associated with artificial intelligence. Humans unconsciously use rules in implementing their actions. For example, a traffic policeman manning a junction say, one from the north and one from the west; he would use his expert opinion in controlling the traffic more or less in the following way:
IF traffic from the north of the city is HEAVY AND traffic from the west is LESS THEN allow movement of traffic from the north LONGER.
No of Cars AN F MY TMY 1 0 Input Fuzzy Variable 1: Arrival 0 2 4 6 Output Fuzzy Variable: Extension Time Time (Sec) Z S M L 1 -2 0 2 4 6 8 Arrival Queue Extension Almost Few Many Too Many AN F MY TMY Very Small Small Medium Large VS S M L Zero Short Medium Longer Z S M L No of Cars VS S M L 1 0 Input Fuzzy Variable 2: Queue 0 2 4 6 Another opinion would be: IF traffic from the north of the city is AVERAGE AND traffic from the west is AVERAGE THEN allow NORMAL movement of traffic for both sides.

IF Arrival is TMY AND Queue is VS THEN Extension is L IF Arrival is F AND Queue is VS THEN Extension is S IF Arrival is AN AND Queue is VS THEN Extension is Z

Queue \ Arrival	AN	F	MY	TMY
VS	Z	S	M	L
S	Z	S	M	M
M	Z	Z	S	M
L	Z	Z	Z	S

Fig. 4 Configuration of the fuzzy rules in matrix form for the traffic lights control.