FUZZY LOGIC BASED TRAFFIC LIGHT CONTROLLING SYSTEM

A.A.C.N. Atapattu[1] and J.V. Warnakulasooriya[2]

[1]*Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya*
[2]*Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Peradeniya*

Introduction

As the number of vehicles and the needs for greater transportation has grown in recent years, city streets and highways frequently face serious road traffic congestion problems. Due to this factor, traffic signals now become a common feature of cities controlling heavy traffic. Careful planning of these traffic signals systems is important to increase the efficiency of traffic flow on road. Controlling traffic on over-saturated intersections is a big issue.

Conventional methods for traffic signal control based precise models fail to deal efficiently with the complex and varying traffic situations. They are modelled based on the preset cycle time to change the signal without any analysis of traffic situation. Due to fixed cycle time, such systems do not consider that which intersection has more load of traffic, so should kept green more or should terminate earlier then complete cycle time. In case of intersections, conventional control systems only consider waiting time of signals on different directions but not the vehicle directions.

In this paper, a new fuzzy traffic lights control system that can be effectively used for a complex traffic junction with multiple intersections. The system allows communications with neighboring controllers and manages phase sequences and phase lengths adaptively according to traffic density, waiting time of vehicles and congestion. The simulator compares the proposed fuzzy traffic lights system to the existing Preset Cycle Time or PCT-types of traffic lights controllers which are available in many parts of the world. (Tan, 1996).

Methodology

At first the problem domain was modeled using suitable data structures. Then the whole system was broken into three modules, Next State Module, Extending Current State Module and the Decision Making Module. Next State Module takes three inputs and gives the next most suitable state of traffic light configuration and the urgency level for having that state.

A fuzzy module was used to calculate the urgency. The Extending Current State module takes two inputs and gives the urgency level of having that state for the next time lap. Here also a fuzzy module was used. The outputs of those two modules were given to the Decision Making Module as inputs.

It decides whether to change the current state or not. The decision making module is also a fuzzy module. Modeling the fuzzy systems was done using the MATLAB fuzzy tool box.

The real word problem domain is modeled virtually in order to test and simulate the system Major task is to model the traffic flow in each road. Each road consists of six lanes and each of those roads has its own traffic flow pattern. It was assumed that each lane has a mean value of the frequency of the traffic flow. Here the number of vehicles for a defined time period is taken as the frequency, but the mean frequency of traffic flow do not exists all the time in the real word situation. There are deviations from the mean.

To model the above traffic flow the normal distribution was used with a particular mean to model the mean frequency and a standard deviation to model the deviations from the mean frequency. A vehicle generator function was introduced for each incoming lane and another function was developed to handle the outgoing lanes. The vehicles generated by the generator function are added to the corresponding incoming queue and the vehicles generated by the function for the outgoing lanes are subtracted from the corresponding outgoing queue.

For a lane, characteristic of that lane was defined by the mean flow value and the standard deviation. Those values are stored in separate matrices in which the columns are corresponding to the related link.

Results

InQuality is the characteristics for the incoming queues and the outQuality is the characteristics for the outgoing queues. In both of the matrices the first row indicates the mean flow and the second one represent the standard deviation. Here the flow is taken as number of vehicles for a period of one minute.

The variation of out queue length of a intersection can be plotted with the time. (Fig. 1).

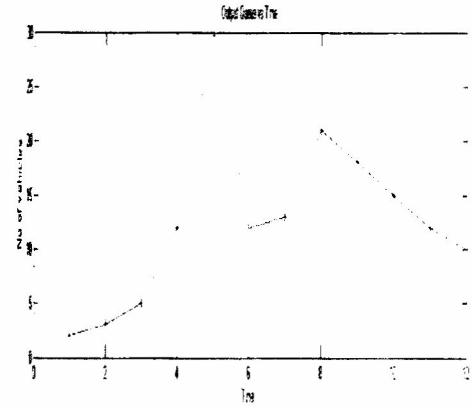

Fig. 1. out queue length variations against time

The variation of in queue length of a intersection can be plotted with the time. (Fig. 2).

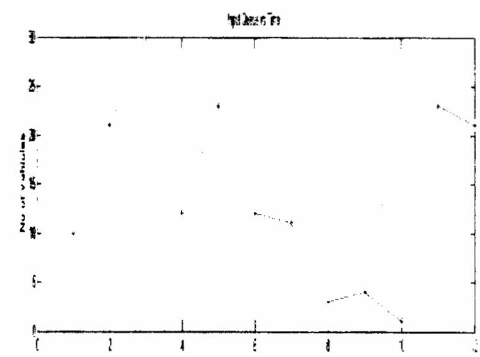

Fig. 2. In queue length variations against time

In this case only one time output queue reaches the mark of 30 vehicles. The upper limit of the output queue is 30 vehicles. Average of the out put queue length is less than 15 vehicles.

In this case only one time Input queue reaches the mark of 30. The upper limit of the Input queue is 30 vehicles. Average of the Input queue length is less than 15 vehicles.

The variation of WaitingTime of a vehicle behind red light at a intersection can be plotted with the time. (Fig. 3).

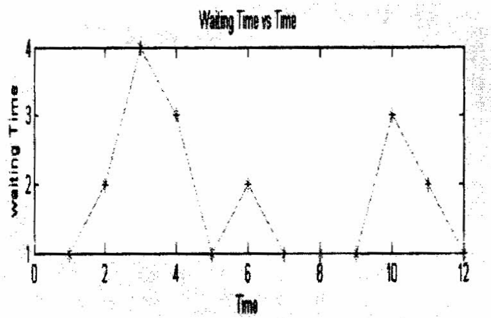

Fig.3. Variations of waiting time

In this case only one time waitingTime reaches the mark of 4 seconds. The upper limit of the WaitingTime is 5 seconds. Average of the Waiting Time is less than 3 seconds. Another main thing is if there any special vehicle rotation such as peak hours special vehicle rotation that can be arrange without disturbing to the system. Only thing to do is change the mean values and standard deviations assign to each road.

Discussion

Most of the traffic light systems fail in a case of a sudden difference of the traffic. The proposed system always makes the decision according to the current situation. The system effectively controls the traffic in a junction at real time by observing the traffic of the incoming lane and the capacity of the outgoing lanes. (Cao, 1999)

It prevents the congestion in a one junction transfer to another junction according to the capacity of the road that is heading to another junction. By using this system can be used to optimized the city the traffic flow for all the intersections. (Shen, 2002).

The system was developed without considering the pedestrian crossings. It is expected to upgrade the system by inserting pedestrian crossings at each road. The waiting time of the pedestrians can be taken as an input to the system. The system will become more realistic by considering pedestrian crossings because the effect of the pedestrians is a major factor that causes traffic congestions.

References

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