Fuzzy Controlled Simulation For Traffic Flow

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Abstract-Fuzzy optimization deals with finding the values of input parameters of a complex simulated system which result in desired output. Traditional techniques may require an enormous amount of simulation runs to evaluate the system. To alleviate this problem, the proposed work provides the means of incorporating knowledge, expressed in natural language, that is often available among analysts and decision makers. Using convenient linguistic representations, the proposed mechanism can satisfy vaguely stated goals to a high degree.Moreover, Fuzzy optimization is more flexible than Traditional techniques.

Keyword: Simulation;Optimization;Fuzzy logic;Traffic Flow

1.INTRODUCTION

Simplicity and accuracy of models are crucial criteria of their construction in general and in road traffic systems especially. The quality of models is indeed a trade off between them because to complicate models are computational inefficient and can not be used in on line control and simulation of large systems and accuracy has tendency to saturate. These goals fulfil the group model of traffic flow (Kaczmarek;1986), in which vehicle moving dependently are grouped in one object. At the level of abstraction, meso-models constructed on vehicle group approach are enough detailed for control and simulation purposes. The group model was successfully applied in traffic control on roundabouts (Kaczmarek ;1990and Kaczmarek;1990) and in open street networks (Kaczmarek;1994). This paper presents the design and evaluation of a fuzzy logic traffic signal controller for an isolated intersection. The fuzzy controller is designed to be responsive to real-time traffic demands. The controller uses vehicle loop detectors, placed upstream of the intersection on each approach, to measure approach flows and estimate queue These data are used to decide, at regular time intervals, whether to extend or terminate the current signal phase. These decisions are made using a fuzzy logic procedure. In the first stage, observed approach traffic flows are used to estimate relativetraffic intensities in the competing approaches. The performance of this controller is compared to that of a traffic-actuated controller for different traffic conditions on a simulated intersection.

2. Fuzzy approach for simulation of the traffic

Fuzzy logic systems have been widely applied to control non-linear, time-varying and ill-defined systems in which they can provide simple and effective solutions. The system model, which is a standard regulating system. The parameter q0 is the expected queue (EQ) length. The instantaneous queue length is obtained by sampling. Generally speaking, the sampling frequency is higher, the control is more accurate, but sampling at every packet arrival, just like in RED implementation, is overkill and provides no perceptible benefit. For the 12 500 packets/s (100 Mbps, the default size of packet is 1000 bytes) bottleneck link, the maximum queue variance could be 125 packets when the sampling frequency is 100 Hz. In order to observe this maximum variance, only requirement is to have enough buffer space. In a general router, it should be very usual that the buffer accommodates hundreds of packets. In FLC implementation, we fix the sampling frequency at 160 Hz. Of course, another consideration is convenient to compare with PI controller. The error of queue length e (e=q0−q) and the error varying rate Δe are used as the input linguistic variable of the FLC, the latter can effectively predicate and describe the local dynamic of the difference between the arrival rate and the service rate. The chosen output is linguistic variable u that represents the increment of the packet dropping or marking probability p.

The model of fuzzy system, comprising the control rules and the term sets of the variables with their related fuzzy sets, was obtained through a tuning process that started from a set of the initial insight considerations and progressively modified the parameters of the system until it reached a level of performance considered to be adequate. In particular, both of the output variables have tow fuzzy term sets, which are short (S) and long (l). The output variable is greater than three term sets, they are(a),(M),(f). EQ stands for the expected value of queue length, i.e. q0. BS is the router buffer size. VQ represents the estimated value of the maximum range that the queue length variation can reach during one sample interval. Through many simulation experiments, it is finally fixed at 0.5BS. When BS=500 packets, VQ=250 packets, which is sufficient for observing queue variance according to earlier discussion.

(a) queue length, (b) variance of queue length, and (c) control variable.

During the designing of AQM FLC, the two conflicting requirements must be taken into consideration at the same time. The first requires the controller to have good transient response, such as, the regulating time is rather short and the overshot is very small. The second emphasizes the steady performance, such as small steady error and accurately tracking capability. For the perfect trade-off between two requirements, we eventually chose the sets depicted in next section as the membership function of the control variable u. The section [−8.75×10−5, 8.75×10−5] is evenly divided into 11 intervals. All triangles used to define the membership functions of nine fuzzy term sets have the same shape, whose bottom equals to 3.5×105. As well as, the control rules are also very crucial. Moreover, they are coupled with the parameters of the membership functions, so the parallel and cooperative tuning is needed in order to get better AQM FLC.

Each rule can be presented as the following:

Rk: if Qi andQRj then Uij i=1,2,…,7 j=1,2,…,7

So we have:

$$R = \bigcap_{k}^{N} (Q_i \otimes QR_j) \oplus u_{ij} \qquad (2)$$

The membership function of the fuzzy relationship R is:

$$\mu_R(q, qr, u) = \wedge \mu_{Q_i}(q) \wedge \mu_{QR_j}(qr) \vee \mu_{u_{ij}}(u) \qquad (3)$$

The fuzzy output variable is got using 'max–min' reasoning:

$$u = (Q \otimes QR) \otimes R \qquad (4)$$

The membership degree of the control variable *U* is:

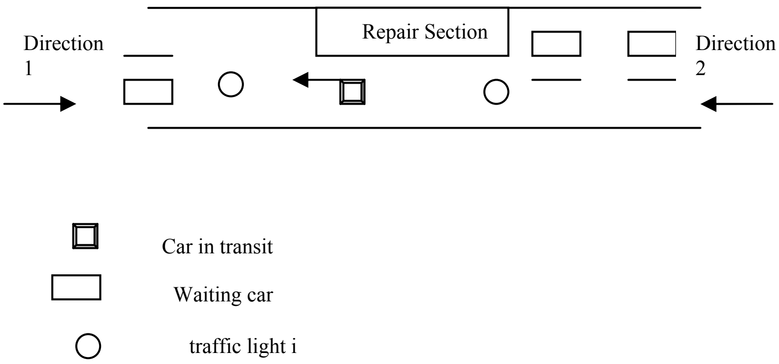
$$\mu_u(u) = \underset{q \in Q, qr \in QR}{\wedge} \mu_R(q,qr,u) \vee \left[\mu_Q(q) \wedge \mu_{QR}(qr)\right] \qquad (5)$$

In order to obtain the final output control value, the *center of gravity method* is used:

$$u = \frac{\int u\mu(u)du}{\int \mu(u)du} \qquad (6)$$

3.Case Study

The system to be modeled in this study consists of the traffic flow from two direction along a two-lane of which has been closed for 500 meters for repairs. Traffic light have been placed at each end of the closed lane to control the flow of traffic through the repair section.the lights allow traffic to flow for a specified time interval from only one direction.this arrangement is depicted in below figure.



Fuzzy system planned have three inputs and two outputs.three input shown rate of vehicle in three section and two output show time interval from light in any direction.the point that consideration is that to empty repair section both light can be red at the same time.all input linguistic variable define as few, average and many. Tow outout linguistic variable define as short, mean and long.if xi indicate ith input and yi indicate ith output,there are some important rules that shown below.

- If x1 is few and x2 is few and x3 is many then y1 is long and y2 is short.
- If x1 is many and x2 is few and x3 is few then y1 is short and y2 is long.
- If x1 is $\begin{pmatrix} few \\ average \\ many \end{pmatrix}$ and x2 is long and x3 is $\begin{pmatrix} few \\ average \\ many \end{pmatrix}$ then y1 is long and y2 is long.

4.Conclusions

This paper presents a fuzzy logic-based adaptive traffic signal controller for an isolated intersection. The controller has the ability to make adjustments to signal timing in response to observed changes in the approach flows. Using upstream vehicle detectors, the controller measures approach flows and estimates approach queues at regular time intervals. This information is used in a fuzzy logic procedure to determine, at any given time, whether to extend or terminate the current signal phase for through movements. In the first stage, the controller estimates the traffic intensity on each approach. The duration of the green is based on traffic-actuated control.

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