Fuzzy Logic Based Traffic Light Control System

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Abstract

In our day to day life, increase in the number of vehicles like motorcycle, car, bus, van and truck etc. is very rapid. As a result of traffic blocking and enormous problems in metro cities. Due to traffic jamm problem, some large issues are found such as pollution, wastage of time, and accidents. Traffic jamm arises terribly often time which in the contemporary world that has an effect on the means of life and introduces a large amount of issues and challenges. To resolve this problem, using traffic signal timing optimization is the better solution. This research work proposes a fuzzy logic controller for multiple intersection model. The issues in traffic trade are mostly characterized by the uncertain and unsure parameters. A fuzzy logic traffic control simulation model is developed and tested using MATLAB software. The Performance of fuzzy logic based on traffic signal timing optimization compared with fixed time controller using the research field. The performance of Fuzzy Logic Controller is found to be similar to that of the fixed controller in normal traffic conditions. However, in heavy traffic conditions, Fuzzy Logic Controller results shows 30% decrease on average delay of cars waiting at the intersection and 10% improvement on total number of cars served at the intersection over the same simulation period compared to the fixed time controller. The results show that there is a huge improvement that can be realized by using Fuzzy Logic Controller in controlling traffic flow at multiple intersections.

Keywords–Fuzzy traffic controller, signal timing optimization, traffic simulation, fixed time controller.

1.1 Introduction

Traffic problem is one of the major problems in many metropolitan cities around the world. This traffic problem can affect the economy, slow down the development, and reduce the production, pollution, wastage of time, fuel, and accidents. There are several causes that can create traffic problem in a big city. Among them increasing number of vehicles, shortage of sufficient roads and highways, and traditional traffic light system. All of these factors can create traffic congestion in the intersection but among them traditional traffic light system is one of the major factors. Traffic signals are common features of urban areas throughout the world, controlling number of vehicles. Their main goals are improving the traffic safety at the intersection, maximizing the capacity at the intersection and minimizing the delays. Fuzzy logic controller allows linguistic and inexact traffic data to be manipulated in controlling the traffic signal timings. A fuzzy control system is a rule-based control system which is characterized by expressing control rules of an expert using a fuzzy theory and determining a control command by a fuzzy inference. A fuzzy logic controller describes a control protocol by means of if - then rules. In 1965 Zadeh planned the conception of fuzzy logic that's terms for fuzzy sets .It is the best solution which deals with real time problem by developing the precise conclusions the most and basic components of fuzzy set theory are knowledge domain within which the operating of fuzzy system is keep within the type of if-then rules, inputs in crisp manner, outputs that are in crisp manner associated an abstract thought system that compares with input variables and the information keep primarily based at that time the output is decided. The basic of fuzzy logic traffic controller is to model control strategy based on human expert knowledge. In a conventional traffic light controller, the traffic lights change at constant cycle time which is clearly not the optimal solution. It would be more feasible and sensible to pass more cars at the green interval if there are fewer cars waiting behind the red lights or vice versa. The fuzzy logic theory is introduced in the traffic controller to provide an intelligent green interval response based on traffic load inputs. A fuzzy logic control scheme is proposed to overcome

the inefficiency of traffic controller. In this paper we proposed a new fuzzy logic controller system that can effectively handle the bad traffic situation when there are congestion and long queue of vehicle waiting at red light. It can manage green phase lengths adaptively according to the traffic load and waiting queue. By controlling the green phase duration it can effectively reduce the vehicle waiting time at red light. To give a graphical view of the proposed system we developed a simulation by using MATLAB, which explains all the membership functions and fuzzy inference rules used for the system.

1.2 Problem Definition

In the recent increase in number of vehicles on the road and inability of the government to create new roads has led to traffic congestion problem in many cities. This traffic problem usually affect the economy, slow down the development, and reduce the production, air pollution, wastage of time, fuel, and accidents. One major factor of this congestion is the traffic light system that controls the traffic light at intersections. Most of the regular traffic system does not consider variance in traffic light time duration and cannot optimize the performance. The proposed fuzzy logic traffic controller system can provides better solution of traffic congestion. Instated of fixed time duration it considers different time length for the green light time duration depending on the current traffic density of the intersection. By optimizing the green light time duration our system can handle the congestion better than other regular systems.

1.3 Objectives and scope of the paper

The detailed objectives of this work are:

1) To present fuzzy logic controller as a control method in traffic signal control.

2) To optimize the traffic signals timings for multiple intersection.

3) To derive and introduce a general rule base for traffic signals timings optimization for multiple intersection in different cases.

4) To test the efficiency of fuzzy signal control using simulation.

1.4 Proposed Method

Developing an intelligent traffic signal control system can help to solve the traffic congestion problem in many cities. Most of the regular traffic light control systems are based on the fixed time duration of the green phase, which can change the traffic signals at constant cycle time. This type to traffic control system cannot extend the current green light time duration based on the current traffic situation and cannot reduce the vehicle's waiting time at the red light. A traffic light controller based on fuzzy logic can be used for optimum control of traffic volumes such as over saturated or unusual load conditions. This research work talks about the implementation of fuzzy logic controller system that can be used to control a traffic signal control at multiple intersection model. The proposed fuzzy traffic light controller, introduced in this research, will be able to manage the congestion better than fixed time duration based traffic control system. This fuzzy traffic control system can minimize the vehicle waiting time at red light. It can extend a current green phase by adding different time duration by applying some fuzzy rules.

1.5 Multiple Intersection Model.

The traffic signal controllers for multiple intersection model as shown in Figure 1 are designed based on the traffic model from Che Soh et al. The multiple traffic intersection model developed in MATLAB using Image Processing Toolbox and Fuzzy Logic toolbox.

1.6 Design Of Fuzzy Logic Traffic Controller

The Fuzzy Logic Toolbox in Matlab which has a graphical user interface (GUI) to efficiently design and implement fuzzy control system. Although it's possible to use the Fuzzy Logic Toolbox by working strictly from the command line, in general it's much easier to build a system graphically reported in. There are five primary GUI tools for building, editing, and observing fuzzy inference systems in the Fuzzy Logic Toolbox are Fuzzy Inference System or FIS Editor, the Membership Function Editor, the Rule Editor, the Rule Viewer, and the surface viewer. They are dynamically linked as any change done to the FIS eventually reflected to the system. At first we use the FIS editor to design the system. By typing Fuzzy in the command prompt let us open the FIS editor where seven inputs (Road 1, Road 2, Road 3, Road 4, Road 5, Road6, Road 7) and one output (greentime) are set as discussed above in the section Description.

1.7 RESULT

In this section, the performance of fuzzy logic controller is compared with fixed time controller is evaluated and simulated by using MATLAB software. The performance is equated in terms of no of vehicles served and average delay. The simulation parameters and their description is given in table 1.Table 1. Simulation parametersSr. No Simulation Parameters Previous Controller Proposed Controller1. Technique Fixed Time Controller Fuzzy Logic Controller2IntersectionMultiple Intersection Multiple Intersection3.Simulation Time(Sec)2002004.Vehicle Insertion Rate(No./Sec)10105.Vehicle Avg Speed(Km/hr)1001006.Vehicle Width(m)1.51.57.Vehicle length(m)2.52.58.Gap between Vehicles(m)119.Signal On Time(Sec)151510.Signal Yellow Time(Sec)33Fig 6. GUI of simulation of Fixed Time Controller Fig 7.

GUI of simulation of Fuzzy Logic Controller Analysis

The performance comparison between fixed time controller and fuzzy traffic controller is summarized in Table 6.2. As can be seen, the fuzzy logic controller shows about 28% decrease in time on average vehicle delay at the intersection and about 15% increase on the total number of cars being served at the intersection. as traffic volume increases the fixed-time controllers perform much poorer that the fuzzy controller. The fuzzy controller is able to increase the green time to cater for the increasing traffic. When handling low volumes of traffic, both controllers perform more or less the same with the fixed controller. However, as the traffic volumes increased considerably, the performance of the fixed-time controller reduces compared to that of the fuzzy logic controller.

1.8 Conclusion

In this research work, traffic model and traffic controller are developed using MATLAB software. The fuzzy logic traffic controller system is presented that optimally manages the traffic flow would be achieved at the multiple intersections. To test the effectiveness of fuzzy logic controller to control the traffic flow at multiple intersection, MATLAB simulation has been done. The Comparison of the proposed controller with the fixed-time controller has shown overall, fuzzy logic controller shows better performance than fixed time controller for controlling traffic flow. As can be seen, performance of fuzzy logic controller is better than fixed-time controller in terms of average no. of vehicles and average delay. The extension time of the green phase of the traffic lights is adjusted using Mamdani inference.

1.9 Future Work

In future, pedestrian control logic can be added with this fuzzy logic traffic controller. All the traffic controller in the city can be connected by creating network connection and can communicate with each other with sending information about current traffic situation of their intersections, which will be using as inputs for the fuzzy logic controller. On the basis of these inputs the controller will produce output to better control of the congestion considering the current traffic situations of other neighbor traffic controller's intersection of the network. Multiple intersection is considered in this research, and the next step is to apply Fuzzy logic controller to a five intersections network with a central intersection and four surrounding intersections. The other direction of future work is to combine Fuzzy logic controller with other traditional algorithms for best performance with different traffic demand

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