Traffic Signal Optimization and Flow Control using Fuzzy Logic

Ankit Narendra Patil1, Yash Notani2, Jayshri Fating3, Yashodhan Kumthekar4, Prof. Soumitra Das5

1, 2, 3, 4 Dr. D. Y. Patil, School of Engineering, Charholi(Bk), Lohegaon, Pune- 412105
5 PhD, Computer Engineering, Sathyabama University, Solingalur, Chennai- 600119
ankitpatil24295@gmail.com, yash.notani@gmail.com, jayu020@gmail.com, ykumthekar4929@gmail.com, hod_comp@dypic.in

Abstract

This study proposes an intelligent traffic light system that would be capable of adjusting the traffic light interval based on density of traffic at a particular time. Fuzzy logic could be used to manage the flow of vehicles at traffic signals and ensure efficient flow of vehicles, reducing traffic congestions at peak time. This could be done by analyzing traffic density i.e. Length of vehicle queue, by analyzing inputs via camera/sensor/anything else that could be fitted at signals. This will then be used by microcontroller to set the green signal for varying intervals so as to clear the traffic at signals as efficiently as possible. This approach could be implemented to dynamically manage the traffic signal. Current scenario in cities is that there are large traffic jams everywhere due to the increasing number of vehicles. This study mainly aims to overcome this problem. When the system successfully developed will help to efficiently manage the traffic flow throughout the city.

Keywords— Embedded Software, Fuzzy logic Fuzzy control, Ultrasonic transducers, Zigbee.

1. Introduction

The system will analyze the traffic at four way junction and adjust green light intervals for variable densities of traffic. E.g. If at a traffic signal number of vehicles coming from north & south is too much and that of coming from the east & west is very little, the green light interval for north & southbound traffic will be longer and that for east & westbound traffic will be shorter.

The system will be comprised of sensors and a microcontroller. Sensors will be fitted at appropriate positions at the four way junction. The sensors will measure the density and will communicate the same to a microcontroller. Microcontroller will use these to adjust timing intervals of green lights.

Moreover, we also would implement a feature to ensure integrity of traffic rules at the signal. A spike strip will be introduced at the front of each lane before the zebra crossing. The spike strip will be engaged once the signal goes red. Once the strip is engaged, if any, vehicle tries to cross the strip, the vehicle tire would get punctured and the event will be informed to the nearest police station. Once the light goes green the spike strips will be disengaged and vehicles could move freely.

Thus we develop a system that would ensure efficient flow of traffic on the road and also ensures integrity of traffic laws at the four way junction.

A. Objectives

- Traffic light stalls with intelligent systems
- Capability to optimize the traffic flow efficiently
- Robust and dependent system
- 24 x 7 service capacity
- Ability to sense the density of traffic
- Implement a fuzzy logic controller to operate signal for appropriate intervals
- Engage and disengage spikes to catch signal violators
- Ability to sense signal violation
- Capability to communicate information of signal violation.

2. RELATED WORK

A. Existing System

Since the signal system has been introduced premier development lead to introduction of fixed time signals, i.e. the ones we see today on the road. These signals have preset time intervals and work only according to them regardless of the traffic scenario.
B. International development

International Development: Such a system is implemented in Kuala Lumpur, Malaysia. The system monitors the traffic density using proximity sensors and adjusts the signals dynamically. Kuala Lumpur use to have world’s biggest traffic jams at a time, but now after installation of such systems they have succeeded to control their traffic at a greater extent ensuring lesser traffic congestion scenario.

C. National Development

A Delhi based firm is currently testing same system at one of the junctions in the City. The system comprises of Cameras that monitor traffic density and then processes the camera imaging to determine the traffic density and change the signals. The system results are although good, but the system bears higher installation costs as well as could be expensive to operate.

D. Literature Survey

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Paper Description</th>
<th>Year</th>
<th>Summary</th>
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<tbody>
<tr>
<td>1</td>
<td>Intelligent traffic lights control by fuzzy logic</td>
<td>1996</td>
<td>This Paper presents a way to efficiently implement signals using fuzzy logic. They have rules that are similar to that of a human mind, e.g. They will open the signal with a long queue for longer time as compared to that for the road with shorter queue. They have concluded that fuzzy logic can reduce wait times as well as fuel costs to a great extent.</td>
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<td>2</td>
<td>Intelligent traffic light and density control using IR sensors and micro controller</td>
<td>2012</td>
<td>This system uses a microcontroller along with a set of IR transmitters and receivers on either side of road to detect presence of vehicles up to a certain length. This is a basic edge detection technique to determine the length of the queue on a road and then adjusts the green light interval accordingly.</td>
</tr>
<tr>
<td>3</td>
<td>Smart Traffic Signal, Monish Puthran et al, (IJCSIT) International Journal of Computer Science and Information Technologies</td>
<td>2015</td>
<td>This system involves closed loop control imaging of all four roads. Then process the obtained image and apply canny edge detection techniques to determine the length of vehicles and adjust green light.</td>
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<tr>
<td>4</td>
<td>Vehicle density sensor system to manage traffic</td>
<td>2014</td>
<td>This study proposed an approach to determine the traffic at signal using various inputs like sensors, PC, etc and transfer the same microcontroller which then processes the input and gives appropriate input to Signal.</td>
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<tr>
<td>5</td>
<td>Design Of Semi-Automatic Traffic Light Control System</td>
<td>2014</td>
<td>This paper makes use of sensors, microcontroller and GSM modem which provides real time benefit to the system. This system is developed using microcontrollers ATMEGA32. To monitor the traffic light system and make it more efficient, they have designed an intelligent Traffic control system</td>
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E. General discussion of Review Work

We studied above surveys. What we learnt that the system that they have developed are although perfect, but some of the systems are costly as well as complex. One of the study implements camera to capture the image, this is costly as well as involving higher space complexity. One system implements various sensors at
a time as well as various computers to give input to a microcontroller, this system seems to be pretty complex as well. Although one system that use IR sensors seems pretty cost efficient, but IR sensor may misbehave in sunlight. We feel a system must be easy to set up, and must be unaffected by environmental factors and at the same time must also be cost effective.

3. Proposed System

We plan to make a smart traffic signal system that will be capable of adjusting signal timings to efficiently control the flow of vehicles on four way intersection to reduce traffic congestion and reduce travelling time.

We will also ensure that system works efficiently even at peak hours. We plan this by installing sensors and a microcomputer at signals. This will be done by implementation of a fuzzy logic controller, which will be responsible for adjusting traffic lights. Microcomputer will be a Linux based system. It will have the ability to interface and interact with sensors. It would have the capability to communicate with outer world using preferably a wireless medium.

There will be a set of object detection sensors. They will be installed appropriately to calculate the limit of cars in a particular lane. The limit would decide the density of traffic i.e. Light traffic, moderate traffic or heavy traffic. They will communicate the appropriate result to the microcomputer.

Our prototype will be a scaled model of a real life traffic signal situation. It will be consisting of a microcomputer and a set of sensors which will be placed on modelling. The sensors will measure the traffic density and convey the same to microcomputer using ZigBee. Microcomputer will then allot appropriate phase interval to traffic signal.

The same model could be scaled up with greater capacity sensors and ZigBee devices would serve the purpose equally.

4. Scope

- This can be implemented in major cities.
- Further advancements can allow multiple signal interfaces to communicate with nearby interfaces to manage traffic at a greater level.

5. Conclusion

Proposed method of implementation provides a very simple and efficient way to dynamically handle the traffic signal system. The system itself would be cheaper as compared to complex systems and would greatly help to manage the traffic system. It will also help to reduce travelling time as well as fuel consumption of commuters and thus reduce pollution as well.

6. Acknowledgement

We would like to thank our guide Prof S S Das sir to help us finalize the topic, and help to plan our approach to build such a system. Also, we thank our Faculty and our friends to help whenever needed.

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II. References


