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Design, Development and Modelling Of Traffic Light System

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Abstract
Traffic is the chief puzzle problem which every country faces because of the enhancement in number of vehicles throughout the world, especially in large urban towns. Hence the need arises for simulating and optimizing traffic control algorithms to better accommodate this increasing demand. Fuzzy optimization deals with finding the values of input parameters of a complex simulated system which result in desired output. This project presents a MATLAB simulation of fuzzy logic traffic controller for controlling flow of traffic in isolated intersections.
This controller is based on the waiting time and queue length of vehicles at present green phase and vehicles queue lengths at the other phases. The controller controls the traffic light timings and phase difference to ascertain sebaceous flow of traffic with least waiting time and queue length. In this project, the isolated intersection model used consists of two alleyways in each approach. Every outlook has different value of queue length and waiting time, systematically, at the intersection. The maximum value of waiting time and vehicle queue length has to be selected by using proximity sensors as inputs to controller for the ameliorate control traffic flow at the intersection. An intelligent traffic model and fuzzy logic traffic controller are developed to evaluate the performance of traffic controller under different pre-defined conditions for oleaginous flow of traffic. Additionally, this fuzzy logic traffic controller has emergency vehicle siren sensors which detect emergency vehicle movement like ambulance, fire brigade, Police Van etc. and gives maximum priority to him and pass preferred signal to it.

Keywords: Fuzzy Traffic Controller; Isolated Intersection; Vehicle Actuated Controller; Emergency Vehicle Selector

1.0 Introduction

Traffic congestion is a severe problem in many modern cities around the world. Traffic congestion has been causing many critical problems and challenges in the major and most populated cities. To travel to different places within the city is becoming more difficult for the travelers in traffic. Due to these congestion problems, people lose time, miss opportunities, and get frustrated. Traffic congestion directly impacts the companies. Due to traffic congestions there is a loss in productivity from workers, trade opportunities are lost, delivery gets delayed, and thereby the costs goes on increasing. To solve these congestion problems, we have to build new facilities and infrastructure but at the same time make it smart. The only disadvantage of making new roads on facilities is that it makes the surroundings more congested. So for that reason we need to change the system rather than making new infrastructure twice (Fernando, 2014).

1.2 Problem Statement

The monitoring and control of city traffic light is becoming a major problem in many countries. The increasing number of vehicles and the lower phase of highways developments have led to traffic congestion problem especially in major cities.Travel time, environment quality, life quality, and road safety are all adversely affected as a result of traffic congestions. In addition, delays due to traffic congestions also indirectly affect productivity, efficiency, and energy losses (Frayret et al, 2013).
There are many factors that lead to traffic congestion such as the density of vehicles on the

roads, human habits, social behavior, and traffic light system. One major factor is due to the traffic lights system that controls the traffic at junction. Traffic policeman are deployed at traffic intersection every day in order to overcome these congestion during peak hour, thus one of the roots of the problem is due to ineffective traffic lights controllers. With effective control the intersection, it is believed that the overall capacity and performance of urban traffic network could be resolve.

1.3 Aim and Objective

This project is about develop a new practical traffic light control system which the system will solve the traffic congestion issue. To develop the project, there are two objectives that must be accomplished which are:-

i. Develop a new traffic light control system controlled by programmable logic controller (PLC).

ii. Implement the system on a model of a traffic light

2.0 Review of Related Work

According to Hirankitti (2016), research has delved deeply into these two methods with two main concerns:

i. To provide general improvements to the methods in order to enhance their overall performance

ii. To assess their application in different situations, i.e. to determine which of the two methods is best suited to a particular intersection or network of intersections and how the chosen method can best be applied. Hirankitti (2016) continues to note that Adaptive traffic signal control is a relatively new method; research began in the 1970's, has only recently been increasing, and even now, implementation is very sparse in North America. However, if more concentration can be given to adaptive control, it can solve the two problems above. It has the potential to diminish the need for constant adjustments to enhance performance, which is the concern of (I), and can replace both methods, since the signal can be programmed to act as one of the two or as its own signal control paradigm, which is the concern of (II). Vehicle detection devices have also proved to be so expensive to install and maintain, hence the need for a cheaper and reliable technology, which at the same time improves performance at the intersections over some period (Ibrahim et al, 2012).

It is from this concept of adaptive control that some researchers have looked into the idea of intelligent controls of intersections using agents. The adaptive control illuminate the fundamental concept of adjustments always required at the intersections every time. Therefore, the concept of intelligent control of traffic in relation to the varying demands at the intersections has been, and continues to be studied and cited widely;

Hirankitti et al. (2016) studied the concept of multi agent for intelligent traffic light control. According to their approach, their system consisted of agents and their world. The world consisted of cars, road networks, traffic lights. Each of the agents controlled all traffic lights at one road junction by an observe-think-act cycle. That is, each agent repeatedly observed the current traffic condition surrounding its junction

Jovanis et al. (2012) proposed a decentralized traffic light control using wireless sensor network. They classified their system architecture into three layers; the wireless sensor network, the localized traffic flow model policy, and the higher-level coordination of the traffic lights agents. An intersection control agent in the vicinity controlled traffic lights. An intersection agent coordinates four traffic lights at a time. At each traffic light, there are three nodes with magnetometer sensors. These sensors multi-hop to the access point in its location, lane number, and number of vehicles passed within *t* time. The sensor nodes are positioned at *d* distance from the traffic light to allow for enough time for the data to multi-hop to the intersection agent analyzed and then send to the targeted traffic light.

3.0 Methodology

3.1 Overview of the Traffic Light System

A traffic light control system lies at an intersection with two streets (2 lanes each) that cross at right angles in Figure 3.1. Direction for one street goes only north and south and the other street can only go east and west. Traffic lights consist of 3 lights: green, yellow and red. Traffic lights depending on orientation can be viewed from either direction North/South (N/S) and East/West (E/W). Pedestrian crossing signals (walk/don't walk) are positioned in the middle of the street and depending on orientation can be viewed from either direction (N/S and E/W). Pedestrian push buttons are placed at the corners. There are two at each corner so when pushed the request to have the traffic lights cycle so that the pedestrian can cross in a specified direction (depending on where they are situated) is sent:

North to South

South to North

East to West

West to East

Table 1: Traffic Lights and Pedestrian Crossing Timing

State		N/S Lights	E/W Lights	Pedestrian (N/S)	Pedestrian (E/W)	Delay (sec.)
0	ǂ	R	R	Solid Don't Walk	Solid Don't Walk	1
1	↕	G	R	Walk	Solid Don't Walk	25
2	ǂ↕	Y	R	Flashing Don't Walk	Solid Don't Walk	4
3	ǂ	R	R	Solid Don't Walk	Solid Don't Walk	1
4	↔	R	G	Solid Don't Walk	Walk	25
5	ǂ↔	R	Y	Solid Don't Walk	Flashing Don't Walk	4

3.2 Design of the intersection Overview

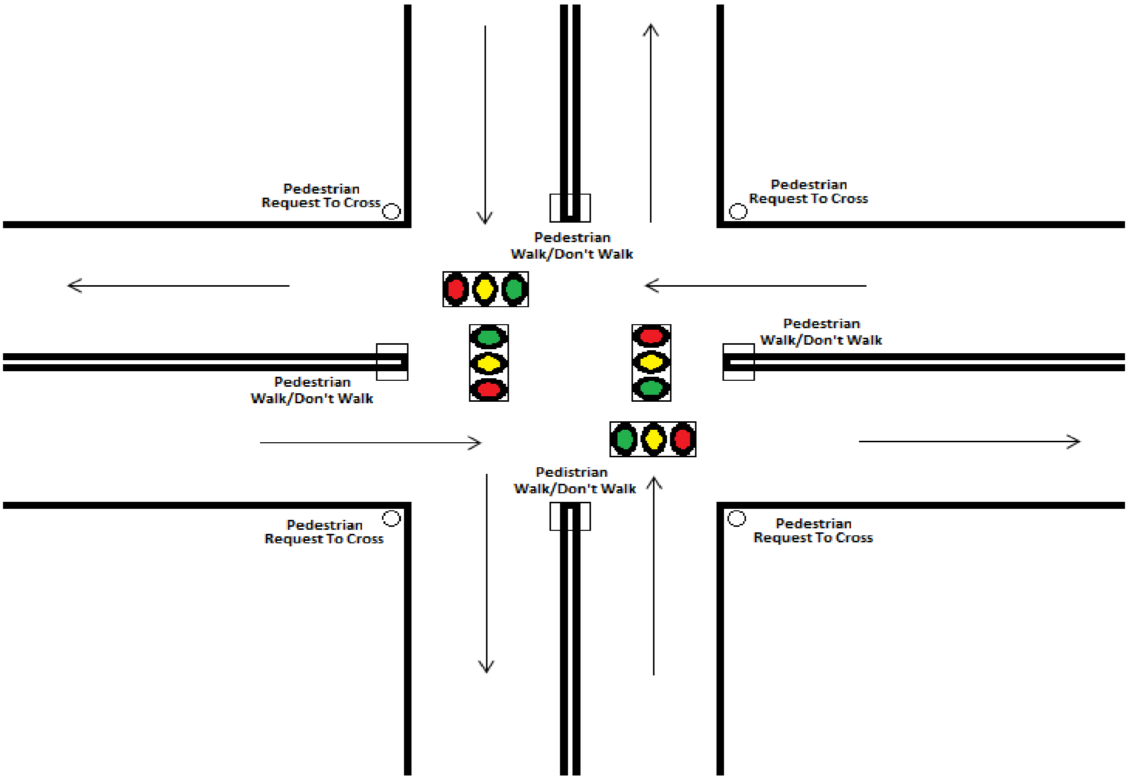

Fig 3.1 **Layout of Intersection with Traffic Light System and Pedestrian Signals and Control**

4.0 Discussion of Result

4.1 Evaluation Environment

The 15 intersections are controlled by 15 signal controllers in neural based approach 1 and controlled by three agents and each agent controls five intersections in system of approach 2. A microscopic traffic simulator of the selected road network has been implemented in VISSIM. The priority control algorithms are implemented in MATLAB/C++ and integrated with the simulation environment via COM (Component Object Model) interface.

4.3 Comparison of Proposed Systems

We compared our proposed algorithms when the traffic flow in the road network is the average daily flow. Tables 3-5 summarize the evaluation results of different controllers when the truck ratio is 3%, 10%, and 20% of the overall flow respectively. As shown in the tables, both proposed controllers improve the network performance including delay and vehicle stops as well as environmental impact compared to the fixed time control that is the commonly used controller. Controller 2 provides less delay and number of stops for all vehicles compared to controller 1 in all three demands but controller 2 gives shorter truck delay for 3% and 20% truck demands and less number of truck stops for all three demands.

Table 3: Road network results (3% Truck)

	Fixed Time	Proposed Controller 1		Proposed Controller 2	
		W/out Priority	*W/ Priority*	*W/out Priority*	*W/ Priority*
Avg. Delay/Veh (sec)	85.4	67.2	59.2	51.5	49.3
Avg. Delay/Car (sec)	85.1	67.3	59.5	52.2	49.1
Avg. Delay/Truck (sec)	88.1	65.2	52.1	63.3	55.5
Avg. Stops/Veh	3.84	2.91	2.73	2.76	2.73
Avg. Stops/Car	3.93	2.98	2.77	2.77	2.74
Avg. Stops/Truck	3.8	2.61	1.88	2.50	2.49
Fuel Trucks (g/km)	452.0	336.0	316.8	362.2	354.7
Fuel cars (g/km)	137.8	110.1	106.2	95.6	93.2
Fuel all veh. (g/km)	163.6	132.7	127.2	117.3	115.0
CO2 Emis. All (g/km)	427.9	347.1	333.0	325.5	316.8
NOx Emis. All (g/km)	1.01	0.82	0.78	0.80	0.76

Table 4: Road network results (10% Truck)

	Fixed Time	Proposed Controller 1		Proposed Controller 2	
		W/out Priority	*W/ Priority*	*W/out Priority*	*W/ Priority*
Avg. Delay/Veh (sec)	89.0	70.0	67.3	52.7	49.3
Avg. Delay/Car (sec)	88.7	70.2	67.6	51.6	48.2
Avg. Delay/Truck (sec)	91.8	68.0	64.1	62.7	59.3
Avg. Stops/Veh	4	2.95	2.71	2.72	2.67
Avg. Stops/Car	4.09	3	2.76	2.70	2.65
Avg. Stops/Truck	3.9	2.65	2.04	2.85	2.82
Fuel Trucks (g/km)	470.9	350.1	330.0	377.3	369.5
Fuel cars (g/km)	143.6	114.7	110.7	99.6	97.1
Fuel all veh. (g/km)	170.5	138.3	132.6	122.2	119.8
CO2 Emis. All (g/km)	445.8	361.6	346.9	339.1	330.1
NOx Emis. All (g/km)	1.06	0.86	0.82	0.84	0.80

Table 5: Road network results (20% Truck)

	Fixed Time	Proposed Controller 1		Proposed Controller 2	
		W/out Priority	*W/ Priority*	*W/out Priority*	*W/ Priority*
Avg. Delay/Veh (sec)	93.4	73.5	59.9	53.8	50.3
Avg. Delay/Car (sec)	93.1	73.7	60.3	51.8	48.8
Avg. Delay/Truck (sec)	96.3	71.4	56.6	62.5	56.8
Avg. Stops/Veh	4.22	3.10	2.82	2.73	2.65
Avg. Stops/Car	4.31	3.15	2.87	2.68	2.66
Avg. Stops/Truck	3.96	2.55	2.13	2.95	2.62
Fuel Trucks (g/km)	494.4	367.6	346.5	396.1	387.9
Fuel cars (g/km)	150.7	120.4	116.2	104.5	101.9
Fuel all veh. (g/km)	179.0	145.2	139.2	128.3	125.7
CO2 Emis. All (g/km)	468.0	379.6	364.2	356.0	346.6
NOx Emis. All (g/km)	1.11	0.90	0.86	0.88	0.84

The two controllers have the following differences.

1. Controller 1 works on the intersection level to make decision while controller 2 works on both the network and intersection levels.
2. Controller 1 does not need an online simulator to compute real time control input after the training of the NN delay predictor. However, controller 2 needs an online simulator to find the baseline signal for active module when the traffic demands change. As a result the controller will face a time complexity problem when the controlled road network is large scaled. The training of the neural network however may have to be repeated occasionally in order to capture changes in the dynamics of the system.
3. Controller 1 could deal with more traffic input scenarios including oversaturated traffic flows. The performance of controller 2 under oversaturated traffic flows will be limited due to the fact that the simulation time will become significantly longer when the number of vehicles in the network is increased.

4.4 ***Demand-actuated traffic light operation in an intersection:***

This simple demand-actuated traffic light control system consists of an intersection where heavy traffic flows on main road and very light traffic is present on auxiliary road. Therefore, the lights on main road are always set to green whereas those on auxiliary road are set to red. When a car approaches on auxiliary road, sensors (either *S0* or *S1*) detect that car, and traffic lights on main road turns from green-to-yellow and then yellow-to-red after a predetermined time. Following red light on main road, the lights on auxiliary road turn from red-to-green (no yellow light). After a fixed time delay, the lights on auxiliary road turn from green-to-red and those on main road turn from red-to-green. The timing sequence can be summarized as follows:

1. Initially all traffic lights must be off.
2. The traffic light system will start when either switch *S2* (green button) or *S4* (yellow button) is momentarily pushed on.
3. Pushing *ON* switch *S2* will turn on green lights for main road and red lights for auxiliary road.
4. Pushing *FLASHING* switch *S4* will activate flashing operation where yellow lights on main road and red lights on auxiliary road are flashing at a rate of 1s with 0.5s on followed by 0.5s off. Please note that flashing light on each road must be flashing alternately – not at the same time, i.e., when yellow lights on Main Street are on for 0.5s red lights on Auxiliary Street must be off and when yellow lights turn off for 0.5s red lights must turn on for 0.5s. Flashing operation is usually activated during very low traffic hours such as after midnight until dawn.
5. At any time, pushing *OFF* switch *S3* will turn off all lights.
6. When traffic light system is operating with *ON* mode, i.e., green lights on main road are on while red lights on auxiliary road are red, pushing either *S0* or *S1* will initiate traffic light change after a 10s delay.
7. After pressing either *S0* or *S1* the system will wait for 10s, then green lights on main road will change to yellow lights (duration of yellow lights is 3s) and to red lights. At this instant there must be an overlap time where all lights are set to red for time duration of 2s (this is required for safety reasons).
8. After this 2s overlap delay red lights on auxiliary road are turned to green (no yellow light).
9. The yellow lights on auxiliary road will stay on for 15s to allow vehicles cross into main road.
10. After 15s, the green lights on auxiliary road will turn to red and those on main road will switch from red to green.
11. Under no circumstances, all green lights are turned on at the same time as this definitely results in a vehicle collision.

Conclusion and Recommendation

A color sensor is used to recognize the color of the ball. If there is a red ball in front of the sensor, then “ R “ output of the sensor becomes 1. “G” output becomes 1, if the ball is green and “B” becomes 1, when the ball is blue. Four valves are used to run the process properly. In this report, we proposed two truck traffic light priority systems whose performance is demonstrated using a microscopic simulation model of an actual road network. The first system uses a neural network approach to predict the average delay of vehicles by taking into account different classes of vehicles

This project is based on a very effective way of optimizing traffic, with redefinition of threshold values for a real time application. This proposed system will be able to build a developed country with less traffic jams and it will also help the emergency vehicle to reach in time to the destination. So, this intelligent system will help us to control traffic in more autonomous way.

Reference

1. Fernando, E. (2014). Microcontrollers Fundamentals and Applications. New York: CRC Press & Francis Group.
2. Frayret, J.-M. And Santa-Eulalia,, L.A. (2013), Basics of Multi-Agent Systems, availableat:http://www.forac.ulaval.ca/fileadmin/docs/EcoleEte/2004/EcoleEte1405200402.pdf.
3. Hirankitti, V., Krohkaew, J. and Hogger, C. (2016), “A Multi-Agent Approach for Intelligent Traffic-Light Control”, World Congress on Engineering, Presented at the WCE 2007, London, U.K, Vol. 1, available at: http://www.iaeng.org/publication/WCE2007/WCE2007_pp116-121.pdf.
4. Ibrahim, L. and Taha, M.A. (2012), “Traffic Simulation System Based on Fuzzy Logic”, Computer Science 12 (2012) 356 – 360, Presented at the Conference Organized by Missouri University of Science and Technology, Elsevier B.V. Selection and/or peer-review, Washington D.C, doi:10.1016/j.procs.2012.09.084.
5. Jovanis, P.P. (2012), “Traffic control”, Encyclopaedia Britannica, available at: http://www.britannica.com/EBchecked/topic/601854/traffic-control.