International Journal of Research in Advent Technology, Vol.6, No.12, December 2018
E-ISSN: 2321-9637
Available online at www.ijrat.org

Efficient Real Time Traffic Signal Control using machine learning

Rashid Hussain[1], Baffa Sani Mahmoud[2], Vimmi Kochher[3]
Department of Mathematics and Computer Science, Sule Lamido University, Kafin Hausa, Jigawa State, Nigeria[1]
Department of Mathematics and Computer Science, Sule Lamido University, Kafin Hausa, Jigawa State, Nigeria [2]
Research Scholar, Computer Science, Starex University, Gurugram, Haryana, India[3]
rashid65_its@yahoo.com[1], *baffasani22@gmail.com*[2]
v.kochher1990@yahoo.com[3]

Abstract — The management of the traffic systems is very challenging now a day. Most of the researchers are providing scientifically designed solution for this problem but usually fail to provide a best optimum waiting time for vehicles at an crossing. As long as operational actual-time traffic signal regulator for a enormous and composite rush-hour traffic is an extremely challenging due to distributed problem. In this paper, we designed a multiple intersection management system with synchronization between traffic lights, which provides real time monitoring of the current traffic conditions & adjust accordingly with the help of machine learning algorithms and achieved minimum regular waiting period of the vehicles at the crossings.

Index Terms — A synchronized Combination-Index, Multi-threading, Phase, Sequence and Synchronized, Machine Learning.

1. INTRODUCTION

Approximately, half of the world's people today live in cities and it is thought that this urban concentration may increase to 72 percent by 2050. One of the primary concerns with this is traffic congestion. We can take an example of Japan by predicting the tremendous increase of traffic volume during the upcoming year 2020 Tokyo Olympics and Paralympics with these environmental changes in mind. NTT DATA has developed a system that recognizes and responds to traffic conditions in real time based on vehicle location and velocity data. It uses simulation to predict traffic conditions and determines optimal signal timing in order to relieve congestion the system uses [1]

GPS information from vehicles along with statistical data from research such as road and traffic surveys through high-speed simulation it can rapidly assess a large number of signal options and automatically select the best possible solution it is designed to handle traffic at a massive scale of up to 1 million vehicles an experimental demonstration of this system in Jilin city China showed up to a twenty seven percent improvement in bus transit times as a result the city decided to permanently adopt these traffic light settings based on these promising experimental results we intend to further enhance simulation accuracy in order to apply this concept to aircraft and vessel control [2].

Traffic light control system nowadays people spend too much time on roadway in the USA. Traffic congestion costs to American people is 124 billion dollars each year. In Europe, it goes to the cost of traffic congestion make up 1% of the total GDP [3]. Therefore, People have been making a lot of effort in optimizing the traffic in the cities. The most important factor affecting the traffic is a traffic light, how should we control the traffic light, fix time control and actuator control are two major categories of the strategies. Fixed time control release at a fixed time interval for green and red light while Actuated control use predefined rules to determine the time to change the traffic light. However, all these techniques are suffered from some problems. This paper will show the deficiency of the current traffic light control policies in simulation [4].

In fig. 1, A 4-way intersection is representing the vehicles on the road for simplicity. All the traffic are going straight on the lower right corner, the direction that the green light is current on the most popular policy is fixed time policy. Here the green light switches every 15 seconds when there is only traffic on the vertical direction the traffic light with some time on the either horizontal direction when traffic starts to come from the horizontal direction due to the aggregated vertical traffic it takes some time for the vertical traffic to clear out. When the traffic becomes even heavier on the horizontal direction the intersection starts to become congested. Actuated control policy also suffers with some problems [5-6].

There is only vertical traffic coming the policy performs well when there are also vehicles coming horizontal direction the policy still works fine although start to land up behind the stop line. The policy completely breaks down after the horizontal traffic becomes heavier because it never met the vehicles in the vertical direction pass through in contrast, what will happen if we let an intelligent agent learn from the traffic well.
There is no traffic on the other direction it will only give green light to the incoming traffic when vehicles come in the other direction. The agent will adjust its policies and we can see the new traffic direction is decreasing during the adjusting process. The agent can also do ways the heavier horizontal traffic without letting the vertical traffic wait for long time following this line.

Rush-hour traffic indicators are planned to cope motor vehicle engagements at crossings, assigning time between the conflicting rush-hour traffic which must share the usage of the juncture. The reason by which the indicator regulator assigns procedure of the joint can range from simple fixed-time techniques to smart approaches that discover and reply to traffic situations in genuine time. At a complex level, however, rush-hour traffic indicators can part of a bigger regulator approach [8].

In this paper, multiple intersections are modelled using a simulator developed in the language Python ver 3.6. The traffic lights at these intersections are synchronized with each other. This synchronization is aimed to lower the regular wait-time of the vehicles at the crossings. The reduction in the average waiting time leads to the smoother movement of traffic [9-10].

As shown in fig 1, There are six traffic light combinations/phases modelled at each intersection in the simulator. The sequence, consisting of a series of combinations/phases, at any traffic intersection can be chosen as desired [11].

Now, in this paper, we propose a synchronizing technique using machine learning base to traffic light control agent. This agent can learn from the environment and conduct online updates [7].

2. Modelling the Traffic Simulator

The simulator of traffic is modelled of entirely synchronized simulator of cars and traffic indicators interaction at the two crossings [12-13]. The purpose is to take use of the Python 3.6 language, which includes parallel and concurrent multithreading primitives as part of the language itself and as part of package for manipulating threads in a portable manner across platforms. Meanwhile, the simulator would also need to respect the properties of the real traffic control situation, such as safety (without car collision), lively-ness (without long-time jam at the intersection) and random concurrency (cars have random speed and type).

Traffic simulator consists of two four legged parallel intersections with parallel all rush-hour traffic lights for monitoring straightforward and right turn traffic flow, while the left-hand is free. The sequence of phases at the respective intersections can be changed as desired. The car speed selection and car type selection are random [14].

The rush-hour traffic emulator implies stable sequence dimension and stable phase order to certify that all the transportations get their opportunity and no path is ignored for a very extensive time. The simulator conducts the investigation and shows the data to calculate the total regular waiting time.

The cars moving with average speed are colored green and the cars moving with random speed are colored red [15].

3. Modelling the Traffic Control Problem

The intersection is assumed to be six-phased and the time sequence ensures for not changing from sequence basis. The cycle time remains fixed. The issue is to develop a strategy which minimizes the total normal waiting time of the cars at the crossings. The cars move with either average speed or random speed to model real world scenario.

The cars moving in east to west direction are generated from the right most lane. The car type selection is random and so is the speed of the cars which do not move at regular speed.

Each intersection models six phases that are shown below:

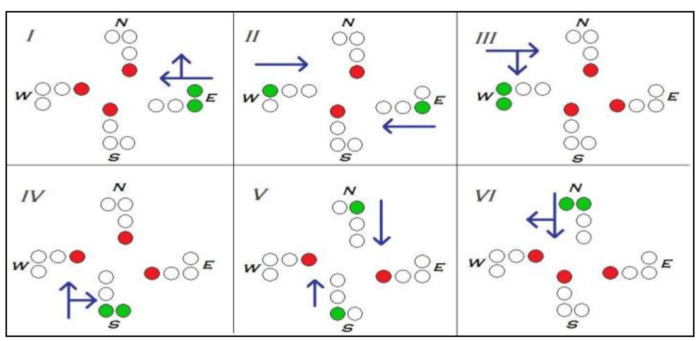

Fig. 1 – Six traffic light phases

4. Proposed Solution to the Problem

Synchronization can be achieved when the cars moving with average speed start from the right intersection and move towards the west. When these cars (moving with average speed) reach the second intersection they should see a green light to minimize average waiting time.

The steps involved in the traffic control algorithm of the system:

Step 1 – Distance between two intersections fixed to a certain value

Step 2 – Based on average speed and distance, time required to reach next intersection is calculated

Step 4 – After the calculation of time, the traffic lights at the two intersections start in parallel

Step 5 – Signals at the intersection on right side start with phase I

Step 6 – Phase sequence at the left intersection is delayed in accordance with the time calculated above

To model real world scenario, the car type (whether moving with average speed or not) selection is kept random. Also, the car speed, if it does not move the average speed, is kept random.

5. Simulation Result and Justification

In this section, we calculate and relate the effects achieved from the proposed model method above with the a synchronized rush-hour traffic light system. Both the mimic systems are tested on the setting of stable green indicator time of 10sec. The evaluation of factors measured is the total regular waiting time of the vehicles at the crossings.

The synchronized system is initialized with combination index value set to 3. This value indicates the phase number with which the traffic light intersection on the left hand side starts.

Table 1: - Simulated Results of Synchronized and Synchronized traffic

Combination Index	No. of Asynch. Cars	Asynch. cars avg. waiting time	No. of Synch. Cars	Synch. cars avg. waiting time	Total avg. waiting time
1	3	9.33	2	15.5	24.83
1	4	15	1	17	32
2	3	17.66	2	5.5	23.16
2	4	21.75	1	6	27.75
3	3	10	2	0	10
3	3	12	2	0	12
4	2	10	3	0	10
4	3	10	2	0	10
5	1	0	4	24	24
5	3	1	2	26	27

*No. = Number, Asynch. = Asynchronized, avg. = average, Synch. = Synchronized

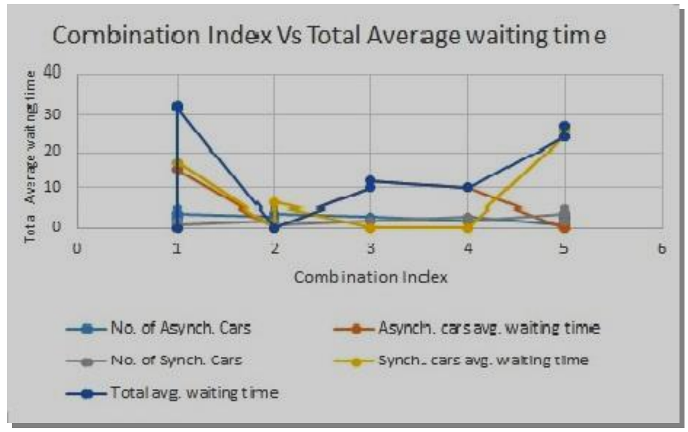

Fig 2: - Results of total Average Waiting Time in respect with combination Index

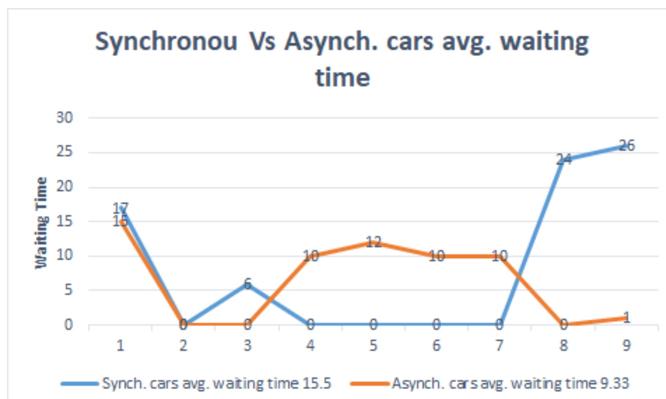

Fig 2: -Compared results between Synchronized and Asynchronized waiting time.

As shown in Fig 1 and Fig 2, The compared results show that the average waiting time with unsynchronized lights is 19.86 second. Whereas, the average waiting time with synchronized lights is 11.00 second. The percentage improvement achieved over unsynchronized system is 44.61 %.

6. Conclusion

In this paper, an efficient real time traffic control system was developed. The Machine Learning System model appear to be very encouraging. This proposed model shows noteworthy act of enhancement related to a synchronized rush-hour traffic lights within trial limits (power of computation, speed selection at random time, simulator surroundings) under the given norms. The synchronized system results in lower regular waiting time of the vehicles at the crossings and thus leading to smoother movement of rush-hour traffic.

REFERENCES

[1] Dipti Srinivasan, Senior Member, IEEE, Min Chee Choy, and Ruey Long Cheu, Member, IEEE , "Neural Networks for Real-Time Traffic Signal Control", IEEE Transactions on Intelligent Transportation Systems, Vol.7, No.3, pp 261-263, 2006.

[2] Lijun Suna, Xiangpei Hu, Yongxian Li , Jun Lu and Deli Yang, "A Heuristic Algorithm and a System for Vehicle Routing with Multiple destination in Embedded Equipment", in 7th International Conference on Mobile Business, Liaoning Normal University, P.R.China, p.p. 1-8, 2004.

[3] Xiuzhong CHEN, Dongwei QIU, "Application to Vehicle Routing Optimization Problem Using Information System Based on Intelligent Optimization Algorithm," in 2009 International Conference on Information Technology and Computer Science, Beijing, China ,p.p. 1-4, 2009.

[4] Jitesh Shivnani, Amritraj Boruah and Amit Verma ,"Real Time Signal Control Strategy using Genetic Algorithm", International Conference on Sensors, Signal Processing, Communication Control and Instrumentation (SSPCCIN-08),p.p.167-171, 2003C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[5] Konstantinos Aboudolas, Markos Papageorgiou, and Elias Kosmatopoulos, "Control and Optimization Methods for Traffic Signal Control in Large-scale Congested Urban Road Networks", in Proceedings of the 2007 American Control Conference, New York City, USA, p.p. 1-2, 2007.

[6] Huawei, GuanjieZheng, HuaxiuYao, ZhenhuiLi,"IntelliLight:AReinforcementLearningApproachforIntelligent TrafficLightControl", Published in proceeding KDD '18 Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining Pages 2496-2505, London, United Kingdom — August 19 - 23, 2018, doi 10.1145/3219819.

[7] BaherAbdulhai,RobPringle,andGrigorisJKarakoulas, "Reinforcement learningfortrueadaptivetrafficsignalcontrol. Journal of Transportation Engineering" 129,3(2003),278–285.

[8] Itamar Arel,Cong Liu,TUrbanik,and AGKohls, "Reinforcement learning based multi-agent system for network traffic signal control. IET Intelligent Transport Systems 4,2(2010),128–135.

[9] BramBakker,ShimonWhiteson,LeonKester,andFransCAGroen, "Traffic light control by multiagent reinforcement learning systems.", In Interactive Collaborative Information Systems.Springer,475–510.
Seung-BaeCools,CarlosGershenson,andBartD'Hooghe.2013. Self-organizing trafficlights:Arealisticsimulation. InAdvancesinappliedself-organizingsystems. Springer,45–55.

[10] FrancoisDion,HeshamRakha,andYoun-SooKang.2004.Comparisonofdelayestimatesatunder-saturatedandover-saturatedpre-timedsignalizedintersections. Transportation Research Part B: Methodological 38,2(2004),99–122.

[11] TheEconomist.2014. The cost of traffic jams. https://www.economist.com/blogs/ economist-explains/2014/11/economist-explains-1.

[12] SamahEl-Tantawy,BaherAbdulhai,andHossamAbdelgawad, "Multiagent reinforcement learning for integrated network of adaptive traffic signal controllers(MARLIN-ATSC):methodology and large-scale application on down town Toronto. IEEE Transactions on Intelligent Transportation Systems 14, 3 (2013), 1140–1150.

[13] RichardSSuttonandAndrewGBarto.1998. Reinforcement learning: An introduction.Vol.1. MITpressCambridge.

[14] MAWiering.2000. Multi- agent re-enforcement learning for traffic light control. In Machine Learning: Proceedings of the Seventeenth International Conference (ICML'2000).1151–1158.