ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

TRAFFIC SIGNAL CONTROL FOR URBAN AREA: A SURVEY

Bhushan S. Atote, Dr. Mangesh Bedekar, Suja S. Panicker
Department of Computer Engineering, Maharashtra Institute of Technology, Pune, India

ABSTRACT

Traffic congestion is evolving as a big problem day by day, is has the main drawbacks like if you stuck in traffic you lose your time, at the same time gases evolved from the vehicles leads to pollution which in turn leads your wastage of fuel at respective signals.

So, by concerning these factors, we need to optimize the traffic on the signals. In this paper we have made the survey on traffic signal methods, strategies and different algorithm used to control it. Through that we got to know that most of the algorithm have been developed for particular area or region and the other methods are complex, which itself takes time to generate the accurate time for the signal. This paper shows the survey on different methods of traffic signal control.

KEYWORDS: Traffic Signal Control, Traffic profiling, Traffic simulators.

INTRODUCTION

Serious traffic congestion and associated air pollution are major social problems in many countries. There has been considerable research on controlling the timing of traffic signals, in two prominent categories of research. The first category is Dynamic Route Guidance (DRG), which is mainly aimed at improving car navigation systems. The second category is Traffic Signal Control (TSC).[10]

Traffic signal control strategies have gone through various development from fixed-time to adaptive strategies, from single junction to coordinated multi-junctions. Fixed-time cycle controlling utilizes the predetermined measured phase timing plans which vary by the time a day; conversely the real-time cycle controlling determines an adaptive phase and cycle timing by considering the traffic density near the intersection.[8]

The fixed-time algorithm was developed by Webster MAXBAND, developed by Little, considers the synchronization of traffic signals so that a car, starting at a main artery and traveling with free speed, can go through several junctions without stop for a red light. TRANSYT (TRAffic Network StudY Tool), developed by Robertson, is the most well-known and frequently applied fixed-time traffic signal strategy. SCATS and SCOOT are the most popular adaptive coordinated traffic strategies. SCATS (Sydney Coordinated Adaptive Traffic System), is a model-free distributed strategies with predefined signal plans. SCOOT (Split Cycle Offset Optimisation Technique), is almost like adaptive TRANSYT strategy with three kinds of optimizer: Split Optimizer, Offset Optimizer and Cycle length Optimizer. OPAC (Optimized Policies for Adaptive Control) strategy is a real-time distributed signal optimization algorithm with three control layers to optimize cycle, split, offset and phase sequences. RHODES (Real-time Hierarchical Optimizing Distributed Effective System) is an adaptive traffic control systems developed by P. Mirchandani et al by using conservation model to predict traffic dynamics. Dynamic programming is employed for OPAC and RHODES to make them not real-time feasible for large-scale traffic networks. Back Pressure (BP) was proposed in traffic signal control and it leads to maximum network throughput with global optimality.[4]

With the survey of all these traffic control methods and strategies we came to know the following drawbacks of these methods :

1) Only applicable for limited routes, junctions and no. of vehicles
2) cycle time, offset and splits, which can work cooperatively to get the more appropriate signal time
3) To deal with complicated traffic conditions by introducing time varying control parameters

4) Not considered different types of traffic models and transportation problems for the specific area

As per the air pollution concerned with the traffic congestion we have taken the survey conducted by the Maharashtra Pollution Control Board, they have located pollution control network in 18 major cities. The detailed description is given under the section Literature survey.

NEED

For saving the time, money and the human kind by controlling air pollution. The cities include Mumbai, Pune and Kolkata. Traffic Index which is a composite index of time consumed in traffic due to job commute, estimation of time consumption dissatisfaction, CO2 consumption estimation in traffic and overall inefficiencies in the traffic system. According to the index, it takes a person an average of 66.18 minutes to reach his/her destination in Mumbai, 60.82 minutes in Pune and 58 minutes in Kolkata. We feel that the Dynamic Traffic control should be done by knowing the signal behavior.

LITERATURE SURVEY

The table 1 shows the detailed survey of different traffic control methods, strategies and algorithm. Some are implemented in real time and others having their results in different simulators.

Table 1. Survey of different traffic control methods, strategies & algorithms

Sr. No.	Paper Name	Yr. of paper	Algorithm Used	Simulator Name	Traffic Control Method	Future Work
1	Modeling Traffic Control Agency Decision Behavior for Multimodal Manual Signal Control Under Event Occurrences	Feb. 2015	Search algorithm for calibrating parameters.	VISSIM	-	This control system can be extended to decision support systems for urgent events, such as traffic incidents, inclement weather and natural disasters, under which prompt TCA deployment and traffic control response are needed. More real-time traffic information and coordination will be required to such responsive conditions, which leads to more challenges and research problems to be addressed.
2	Throughput Optimality of Extended Back-pressure Traffic Signal Control Algorithm	June 2015	extended back-pressure traffic signal control algorithm	VISSIM	-	To deal with complicated traffic conditions by introducing time varying control parameters.
3	Biologically-Inspired Neural Network for Traffic Signal Control	Oct. 2014	-	Synchro	Biologically-Inspired Neural Network	The control of multiple intersections of the urban network through excitatory and inhibitory neural connections. Therefore, the optimization of performance indicators will be based on the study of emergent cooperative and competitive behaviors among different intersections.

4	Iterative Tuning Strategy for Setting Phase Splits in Traffic Signal Control	Oct. 2014	-Pattern Checking Algorithm -Pattern Updating Algorithm	VISSIM + MatLab	Iterative Tuning (IT) strategy	Iterative Tuning Strategy with cycle time, offset and splits, which can work cooperatively to approach the suitable traffic signal schedules.
5	A Robust Multi-objective Compatible Optimization Control Algorithm for Traffic Signal Control	Oct. 2014	robust multi-objective compatible optimization control(RMOOC) algorithm	Personal Simulator	min-max robust optimization model	-
6	Multi-agent Reinforcement Learning for Traffic Signal Control	Oct. 2014	-Q-learning algorithm -multi-agent reinforcement learning (MARL) algorithms	VISSIM	Markov decision process (MDP)	one could develop MARL algorithms accounting for these practical difficulties. While we did not prove convergence of Q-learning in the muli-agent setting, we intend to do this in the future.
7	Online Distributed Network Traffic Signal Control using the Cell Transmission Model	Oct. 2014	ADMM algorithm	Gurobi	Cell transmission model	Extending the developed method to different traffic models and transportation problems will be examined in future work.
8	Intelligent Traffic Signal Control for Urban Central Using Vehicular Ad-hoc Network	Aug. 2014	-	VEINS (SUMO + OMNET+ +)	Vehicular Ad-hoc Network (VANET)	-
9	Latent Factor Model for Traffic Signal Control	2014	-	SUMO	latent factor model	To focus on the following aspects: I) the establishment of database which contains enough data of various traffic states and timing plans, 2) the usage of other models and algorithms in RS and the optimization of them.
10	GreenSwirl: Combining Traffic Signal Control and Route Guidance for Reducing Traffic Congestion	2014	- GreenDrive Algorithm - k-shortest time paths algo	SUMO	Green-Swirl	To evaluate the performance of our methods in other cities such as Beijing (China), San Franciso (Bay area). We will also evaluate the scenarios in morning and evening rush-hour traffic.

We are considering the real time survey provided by Maharashtra Pollution Control Board(MPCB) for getting the detailed information about the air pollution at specific location. MPCS has planted pollution control network in 18

major cities viz, Mumbai(Ambarnath, Badalapur, Dombivali, Navi Mumbai, Tarapur Thane, Bhiwandi, Kalyan, Ulhasnagar, Panvel, Taloja, Mahad, Roha), Pune, Nashik, Sangli, Solapur, Kolhapur, Ratnagiri, Raigad, Thane, Aurangabad, Jalna, Jalgoan, Akola, Amravati, Nagpur, Chandrapur, Nandeed and Latur.

They have total 83 stations divided in three parts:

1) NAMP-71
2) CAAQMS -8
3) SAMP -4

SIMULATORS

Table 2. Survey of different traffic simulators

Sr. No.	Simulator Name	Yr. of paper	Advantages	Features
1	VISSIM	2015	-Faster network commissioning -Off-line tuning and controller optimization -Operator training for smoother network operation	-OpenSource Simulator *-Optimize Control Parameters* *-Perform Operator Training*
2	SUMO	2014	-Off-line tuning and controller optimization	-OpenSource Simulator -Microscopic simulation -Vehicles, pedestrians and public transport are modeled explicitly -Simulation of multimodal traffic, e.g., vehicles, public transport and pedestrians -Time schedules of traffic lights can be imported or generated automatically by SUMO -No artificial limitations in network size and number of simulated vehicles -Supported import formats: OpenStreetMap, VISUM, VISSIM, NavTeq
3	Gurobi	2014	It offers all the powerful conventional optimization capabilities of Premium Solver Platform plus Monte Carlo simulation, decision trees, simulation optimization, and stochastic optimization capabilities	-Build a prototype or a full model of virtually any size -Identify and understand trade-offs in alternative solutions
4	VEINS(SUMO + OMNET++)	2014	It extends SUMO & OMNET++ to offer a comprehensive suite of models for IVC simulation	OpenSource Simulator
5	Synchro	2014	It has different software modules like Warrants, TripGen and SimTraffic CID	-Adaptive system performance monitoring -Assign User profiles and restrictions

				-Support upto 150 intersections

The above table shows the different simulator used for traffic simulation. The most effective simulator among all is SUMO as it is free source simulator one can developed his project using SUMO, it is written in C++. More information about these simulator is given in [13],[14],[15] & [16].

Features of sumo:
The simulation platform SUMO offers many features:

- Microscopic simulation - vehicles, pedestrians and public transport are modeled explicitly
- Online interaction – control the simulation with TraCI
- Simulation of multimodal traffic, e.g., vehicles, public transport and pedestrians
- Time schedules of traffic lights can be imported or generated automatically by SUMO
- No artificial limitations in network size and number of simulated vehicles
- Supported import formats: OpenStreetMap, VISUM, VISSIM, NavTeq
- SUMO is implemented in C++ and uses only portable libraries

Applicability:
SUMO has been used within several projects for answering a large variety of research questions:

- Evaluate the performance of traffic lights, including the evaluation of modern algorithms up to the evaluation of weekly timing plans.
- Vehicle route choice has been investigated, including the development of new methods, the evaluation of eco-aware routing based on pollutant emission, and investigations on network-wide influences of autonomous route choice.
- SUMO was used to provide traffic forecasts for authorities of the City of Cologne during the Pope's visit in 2005 and during the Soccer World Cup 2006.
- SUMO was used to support simulated in-vehicle telephony behavior for evaluating the performance of GSM-based traffic surveillance.
- SUMO is widely used by the V2X community for both, providing realistic vehicle traces, and for evaluating applications in an on-line loop with a network simulator.

Components:
The SUMO package contains the following applications:

- SUMO: command line simulation
- GUISIM: simulation with a graphical user interface
- NETCONVERT: network importer
- NETGEN: abstract networks generator
- OD2TRIPS: converter from O/D matrices to trips
- JTRROUTER: routes generator based on turning ratios at intersections
- DUAROUTER: routes generator based on a dynamic user assignment
- DFROUTER: route generator with use of detector data
- MAROUTER: macroscopic user assignment based on capacity functions

CONCLUSION
The Traffic Signal is to be optimized for solving the issues like wasting time, air pollution etc. To carried out the traffic simulation SUMO is the best simulator that we are going to use in our future research work.

REFERENCES

[1] Nan Ding, Qing He, "Modeling Traffic Control Agency Decision Behavior for Multimodal Manual Signal Control Under Event Occurrences", IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, 2015
[2] Nan Xiao, Emilio Frazzoli, "Throughput Optimality of Extended Back-pressure Traffic Signal Control Algorithm", 23rd Mediterranean Conference on Control and Automation (MED), June 16-19, 2015.
[3] Guilherme B. Castro, José Sidnei C. Martini, "Biologically-Inspired Neural Network for Traffic Signal Control", 17th International Conference on Intelligent Transportation Systems (ITSC), October 8-11, 2014.
[4] Yu Wang, Danwei Wang, Nan Xiao, "Iterative Tuning Strategy for Setting Phase Splits in Traffic Signal Control", 17th International Conference on Intelligent Transportation Systems (ITSC), October 8-11, 2014.
[5] Juan Chen, "A Robust Multi-objective Compatible Optimization Control Algorithm for Traffic Signal Control", 17th International Conference on Intelligent Transportation Systems (ITSC), October 8-11, 2014.
[6] Prabuchandran K.J., Hemanth Kumar A.N., "Multi-agent Reinforcement Learning for Traffic Signal Control", 17th International Conference on Intelligent Transportation Systems (ITSC), October 8-11, 2014.
[7] Stelios Timotheou, Christos G. Panayiotou, "Online Distributed Network Traffic Signal Control using the Cell Transmission Model", 17th International Conference on Intelligent Transportation Systems (ITSC), October 8-11, 2014.
[8] Erfan Shaghaghi, Ali Jalooli, "Intelligent Traffic Signal Control for Urban Central Using Vehicular Ad-hoc Network", APWiMob 2014, August 2014.
[9] Y.-F. Zhao, H. Gao, Y.-S. Lv, "Latent Factor Model for Traffic Signal Control", 2014.
[10] Jiaxing Xu, Weihua Sunt, "GreenSwirl: Combining Traffic Signal Control and Route Guidance for Reducing Traffic Congestion", IEEE Vehicular Networking Conference (VNC), October 8-11, 2014.
[11] Kai Zeng, Yue-Jiao Gong, "Real-time Traffic Signal Control with Dynamic Evolutionary Computation", 3rd International Conference on Advanced Applied Informatics, 2014.
[12] http://mpcb.gov.in/envtdata/envtair.php
[13] http://sumo.dlr.de/wiki/Main_Page
[14] http://veins.car2x.org/
[15] http://vision-traffic.ptvgroup.com/en-us/products/ptv-vissim/
[16] http://www.trafficware.com/synchro-studio.html