Traffic Signal Coordination for Effective Flow of Traffic: A Review
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Abstract—A coordination of vehicles flows is usually reached by a cyclic operation of traffic lights and by synchronizing these cycles. During the past decades metro cities grows rapidly with industrialization, urbanization. This leads to the development of cities and a nation as well. Traffic jams, congestion becomes a major problem these days due to increase in number of vehicles. To cater these problems many approaches has been put forward to reduce the delays, congestion, stops and reduce the fuel consumption also. Particularly there is large fluctuations in number of vehicles arriving at green times which are too short or too long. In these paper attempt has been made to study various intersections so as to minimize the delays, stops and reduce fuel consumption to make a safe and healthy environment to some extend.

Key words: Delays, Fuel-Consumption, Green Times, Intersections, Traffic Congestion, Traffic

I. INTRODUCTION
Transportation has always been a crucial aspect of human civilization, but it is only in the second half of last century that phenomenon of traffic congestion has become predominant due to the rapid increase in the number of vehicles and in the transportation demand in virtually all transportation modes. Traffic congestion appears when too many vehicles attempt to use a common transportation infrastructure with limited capacity. In the best case, traffic congestion leads to queuing phenomenon while the infrastructure capacity is fully utilized. In the worst case traffic congestion leads to a degraded use of the available infrastructure thus contributing to an accelerated congestion increase which leads to further infrastructure degradation and so forth. Traffic signal coordination is a method of timing groups of traffic signals along a major roadway to provide smooth flow of traffic with minimal stops. Coordinated traffic signals also result in less stop and go traffic, this can reduce driver's potential to take risks on the road. The comparison of corridor or network optimization for pre-timed signal system using different software was done many times by many authors.

II. PRINCIPLE OF TRAFFIC SIGNAL COORDINATION
Traffic signal coordination is a method of establishing relationships between adjacent traffic control signals using offsets. Traffic signal coordination reduces delay and unnecessary stops at traffic signals. The benefit of traffic signal coordination is based on the relationship between the prevailing speed of vehicles on the main street, the spacing of distance between traffic signals, the hourly volumes on the side streets, and number of non-signalised intersections along the roadway system. Travel speed along a roadway system is dependent on the signal spacing and the cycle length at traffic signals. Travel speeds are lower when traffic signals are closely spaced and operate under a short cycle length. Conversely, higher travel speeds are a result of long cycle lengths and large spacing between intersections. Traffic signal coordination can be achieved at short signal spacing, such as 0.25 mile, as long as the traffic volumes are low and short cycles 70 second or less can be used. As arterial and cross-street traffic volumes increase, longer cycle lengths must be used in order to increase capacity by minimizing lost time. As a result, cycles lengths of 90 to 120 seconds are commonly used in those areas. A spacing of 0.5 miles will enable traffic flow at a wide range of speeds, with cycle lengths ranging from 60 to 120 seconds.

III. NEED OF TRAFFIC SIGNAL COORDINATION
Traffic signal coordination is needed for the efficient flow of traffic through intersections. Traffic signal coordination may delay or even eliminate the need of roadway widening also reduction in accident potential. In addition to traffic & safety concerns, the need for signal coordination is justified by high levels of vehicles emissions and poor air quality. Some study may be required for the proper effective signal coordination by detailed investigations of intersections.

A. Types of Coordinated Signal Systems
The selection of type of signal systems based on the resources available and applicability of the system in the given area.

The various types of signal systems used are as follows-
- Urban traffic control systems (UTCS).
- Closed loop systems.
- Time based coordination (TBC) system.
- Traffic adaptive signal control systems.

All these various types of systems work differently.

TBC systems operate on a time clock that is used to take actions automatically based upon time of day and day of week.

UTCS & closed systems react to real-world conditions as they are happening based on actual volume and signal timing data stored in the system.

UTCS & closed systems, traffic signals are interconnected using different types of cables or communication mechanisms. Electric cables are the most commonly used method of signal system interconnection. Fibre-optic cables are slow getting recognition in signal systems. Connection cables are not needed in the TBC system, as adjacent intersection is coordinated by the timing of their individual controlling clocks.

Traffic adaptive signal control systems are designed to develop coordination patterns in real time based on traffic flow data gathered, processed and communicated to control computers. The traffic flow data is gathered using a detector located in each lane at the signalized intersections.

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Advantages of signal coordination

- Reduces vehicle accidents in area.
- Reduces energy and fuel consumption.
- Reduce stops.
- May control travel speeds.
- Improves mobility and access through the area.
- Provides environmental benefits from reduced vehicle emissions.
- Ability to monitor daily traffic operations (UTCS & closed loop).

IV. TECHNIQUES USED IN IMPROVING TRAFFIC SIGNAL COORDINATION

An approach to reduce traffic jams based on swarm-inspired method of selecting signal plans. Some approaches were presented to reduce traffic jams, focusing on signal plan selection, either via classical approach or via more flexible ones. There is a clear need of even more flexible approaches in which the preferences of the traffic lights regarding the coordination or synchronization do not have to be explicitly stated. This paper describes bottom-up simulation approach where each traffic light is an agent and behaves like a social insect. Their approach is simulated using a microscopic model, with a scenario adapted from a city in Brazil. In their approach each junction treated as an agent and behaves like a social insect that ground its decision making on mass recruitment mechanisms in social insects. Henceforth, we use the term crossing, junction and traffic light indistinctly. These is so because in fact in each crossing or junction. Only one signal plan runs in a set of traffic lights so the set of traffic light must be seen as single entity. Signal plans are seen as tasks to be performed by the insect thus form a metaphor of social insects, in our approach the ability of changing task in order to suit the colony needs is located in each crossing or junctions. Stimuli to perform a task or sometimes to change tasks are provided by the vehicles that while waiting for their next green phase continuously produce some “pheromone” thus the volume of traffic coming from one direction can be evaluated by the agent and this may trigger some signal plan switching. No other information is available for intersection agents. Our approach was realized on a microscopic traffic simulator. This is necessary in any agent based approach since it is desirable that the objects of the simulation are modeled at individual level. Bonabeau et al. gives mathematical model that formalizes a hypothesis of how the division of labour may happen in colonies of social insects. (Denise De et al., 2006).

An attempt to study various intersections, so as to minimize the delays at these intersections and consequently improved level of service. They concluded the signal design and synchronization has been done and journey time, fuel consumption, speed delay can be reduced. The detailed measurements have taken for analysis of road. Video survey have higher accuracy than manual data collectors methods, this method has been used to determine traffic survey at each intersection of road. (Goliya et al., 2012).

A study determines the coordination system pattern of traffic signal for intersections using a simulation model TRANSYT7F. A comparison of the traffic parameters after modeling system is performed and recommendation for improvement and further study are offered. Because of consecutive short distance signalized intersections in the site, the performance of parameters are not appropriate, so one of the methods for improving the network performance is coordinating traffic signal at intersections. (Mahmood et al., 2009).

A study proposed for the variable adjustments not only the duration, but also of the order of green phases, while it reaches at least the same intersection throughput capacity as an optimized fixed time controller. They reaches the stabilization of queues and red time duration by decentralized supervision of locally optimized traffic light controllers. Due to limited prognosis horizons and dynamic feedback loops in the network, locally optimizing control strategies are facing problems to find optimal solutions for a traffic network. Therefore we have proposed a decentralized stabilization mechanism which ensures that all traffic flows gets at least the same green time as a stable fixed time schedule would attribute to them. (Lammer et al., 2010).
Studies proposed that the effect of green/red asymmetry is studied for the single car traffic model proposed in (D.Pasten, V.Munoz, B.Toledo J.Villalobos, R.Zarama, J.Rogan, J.A Valdivia modeling traffic through a sequence of traffic lights phys. Rev. E 70 (1) (2004) 016107) on two different signal synchronization strategies namely, all signals in phase and green wave. This paper shows that this asymmetry alone adds great complexity to city traffic, but at the same time the universal behavior observed around resonance is preserved, except for very large and very low green times. This shows that the critical behavior around resonance is not only universal with respect to the street length sequence and car density but also with respect to the time difference between traffic light states an observation which could be of relevance for actual traffic flow control strategies (Pasten et al., 2012).

The objective function used in his work is a weighted sum of the delays caused by the signalized intersections. In his paper he apply generalized surrogate problem methodology that is based on an on-line control scheme which transforms the problem into a ‘surrogate’ continuous optimization problems and proceeds to solve the latter using standard gradient based approaches while simultaneously updating both actual and surrogate system states. In his paper he discuss procedures for solving the traffic signal synchronization problem to minimize the total delay (L. Adacher, 2012).

The goal of study was to develop traffic signal management and synchronization recommendation to reduce traffic delays, pollutants, emissions and petroleum fuel consumption, other goals included determining the optimal frequency of retiming the signals and resources needed to do so and comparing the performance of the traffic signal operation in salt lake city to other cities with similar characteristics (KOA corporation, 2011).

This report documented the existing traffic signal operation analysis, optimized time plan development, field fine tuning and implementation, performance improvement and fuel consumption savings associated with the signal retiming efforts within the greater CBD area in salt lake city this report also surveyed and compared traffic signal system operation and management of other agencies, and provided the recommendation for the next 3 to 5 year signal retiming efforts.

In this paper traffic light synchronization method, which is exploited in reality widely is studied with popular double ring road structure. Some interesting patterns between light periods and time delay are found in experiments. The “green light wave” phenomena, which decreases waiting time sharply could only happen in appropriate conditions furthermore, some experiments with special density are also made to explore deeply (Kanping wang et al., 2012).

Although the double ring road network is complicated and densities are different, the benefit of light synchronization with proper time delay can be observed in these experiments. However it can be seen that from later experiments that the benefit of traffic light synchronization depends on the uniformity of traffic flow. In this scenario that the flow is not uniform, some improvements can be done in future.

Traffic signal coordination planning report; the report set forth flexible plan that will guide us in our efforts to improve traffic signal coordination along our heaviest travelled arterial streets have grown rapidly due to the community growth and dependence on the automobile. To address this growth, we need to continuously examine our plans, practices and policies to improve our performance. This report provides a brief discussion on the benefits of coordinating traffic signals timing efforts, influencing factors, complementary system operations, and short range improvement.

V. CONCLUSIONS

The traffic signal coordination is the critical issues nowadays for metro cities or cities of growing traffic. These techniques lead to the improvement of traffic flow for major cities installation of traffic signals at the right place where it is needed. But for the small cities where traffic flow is not so heavy and where vehicles are increasing day by day. Small cities have narrow streets, small intersections and two lane roads normally be seen. But for future concerns they also have to look out and not be ignored. There is a need of proper regulation of traffic rules and installation of signals at the intersections and synchronizing it with the growing traffic of lanes. Traffic flows also affect environment also to a greater extend emissions of fuel from vehicles, CO, NO, VOC emissions are harmful for atmosphere. So there is still great work & study, analysis and solutions required for the rapidly increasing traffic. Signal coordination required some more effective methods to improve the traffic flows.

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