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Travel time optimization between source and destination, containing traffic signals, using traffic signal timer

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Abstract- **Travel time optimization is the minimum amount of time spent by a person (driving a car), while going from source to destination on a particular route containing traffic signals in a city. This is achieved by calculating the time spent on traffic signals, when they are red, calculating time to cover distance between consecutive traffic signals, calculating time from source to first traffic signal and calculating time from last traffic signal to destination and adding the above time spent to find the overall time. Using an algorithm, the total time spent from source to destination is optimized.**

The above approach will tell the user that he/she will reach his/her destination by this time if he/she starts now from the source at a particular time of day. This approach would also tell the user the minimum time, he/she spend on road, to reach his/her destination if he/she starts his/her journey with a delay (approximately 5-10 minutes).

I. INTRODUCTION

Metro cities in India (Delhi, Mumbai, Bengaluru, Kolkata, Chennai, etc.) are facing the problem of growing traffic. Long traffic jams are common in these cities especially in rush hours. Apart from some problems on existing roads like accident, vehicle breakdown, road maintenance etc. the traffic jams are caused by vehicles queuing up on road due when traffic signal turns red on a particular side of road. Due to long queues, only some vehicles that are relatively near to the traffic signal can pass through the traffic signal when it turns green for some time (usually 30 secs to 2 minutes). After this, again vehicles queue up. Traffic jams are long in rush hours. Office reaching time (usually 9 - 10 am) and home reaching time from office (5 – 7 pm) are generally considered rush hours where huge traffic could be seen on traffic signal waiting for their turn. Traffic jams are relatively less in other time of day. Daily commuters face lot of difficulty due to traffic jams.

Some traffic signals have a display timer, where the number of seconds a particular signal light is green is displayed, while some traffic signals have a faulty display timer or no display timer at all. Display timer could only be seen by vehicle drivers who are near to the traffic signal. Other vehicle drivers who are far from traffic signal cannot see the display timer. At traffic signal where there is no display timer or faulty display timer, vehicle drivers could not estimate the amount of time they have to wait at the traffic signal. When display timer shows time more than 30 seconds generally vehicle drivers shut the engine of their vehicles. In the situation when display timer is faulty or not present at all vehicle drivers couldn’t estimate the time required to stop at the traffic signal therefore they keep the engines of their vehicles running. This leads to increase in air pollution. The vehicle drivers who are relatively far from the traffic signal and are somewhere in the middle of the traffic couldn’t get to know whether they can clear the traffic signal within the time limit of green signal now. This leads to panic for vehicle drivers who are in hurry especially.

This work is mainly focused to reduce the time a person spends in traffic by providing an optimal time to start their journey. For example,a person has to go to some destination within a city. He/she has to start the journey at around 6 pm in the evening which is considered rush hour. This work will tell the user the approximate time he/she can reach his destination considering the factors of display timer, average speed to cover distance between the traffic signals, average speed from source to first traffic signal, average speed from last traffic signal to destination and the estimate of traffic at the traffic signal in rush hour. The estimate of traffic could be found from google maps live traffic data. The similar time estimate calculation from source to destination is also done by google maps with the help of its satellite data. This work can be an alternative to the time estimate provided by google maps. In this work there is the requirement of traffic signal timer data which has to be collected one by one from each traffic signal. The information of distance between consecutive traffic signals, distance from source to first traffic signal and distance from last traffic signal to destination has to be collected also. The above data is required as an input to this work. In this example if a person starts at 6 pm in the evening then with this work the person should his destination by 6:45 pm. This work could also give the information to the travelling person that if he/she starts at 6:05 pm then also he/she can reach his destination by 6:45 pm.

The next part of this work would be to give real time display of traffic signal display timer on the device (laptop, smart phone etc.) carried by travelling person. This would assist the user in knowing traffic signal display timer of all traffic signals from source to destination.

II. BRIEFLITERATURESURVEY

WORK IN THIS AREA

With reference to [1], the work done there is to predict a velocity of the vehicle so as to avoid the red traffic signal as much as possible. For this a signal-phase prediction model is used that uses historically averaged timing data and real-time phase data to determine the probability of green for upcoming traffic lights. In an optimal control framework, the

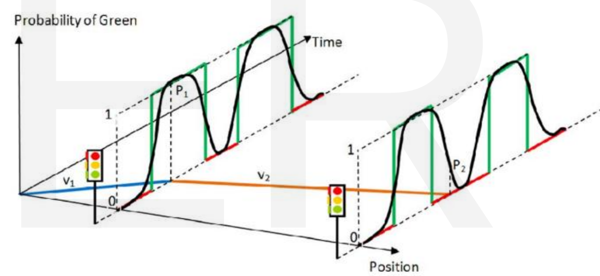

Fig. 1. Schematic of velocity planning based on probability of green for two consecutive lights.

best velocity trajectory, that maximizes the chance of going through green lights, is calculated.

Figure 1 is taken from [1].

With reference to [2], the optimal traffic signal setting problem is settled by using bi-level optimization framework. The drivers’ average travel time is minimized from the upper-level problem that determines the traffic signal settings. The lower-level problem aims for achieving the network equilibrium using the settings calculated at the upper level. Genetic algorithm is used here.

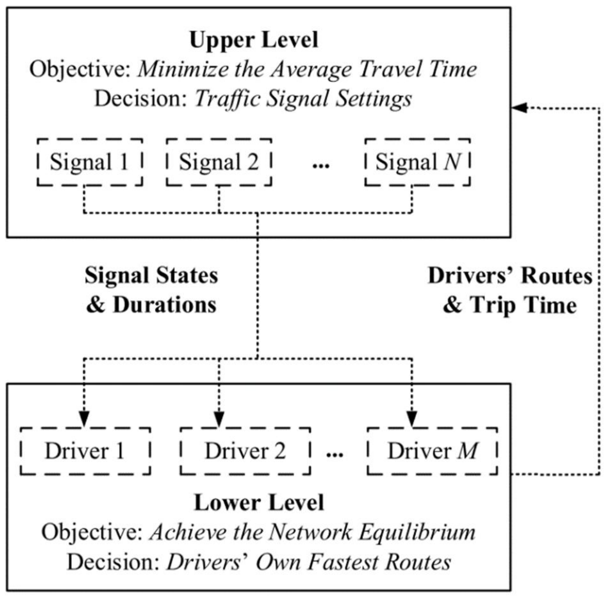

Fig 2. Bi-level optimization framework

Figure 2 is taken from [2].

In [3], the intersection signal cycle and the green splits are optimized simultaneously, and the system total travel time is selected as the optimization goal. The distribution of the vehicle's link travel time is the combined results of the flow composition, road marking, the form of control, and the driver's driving habits.

COMPARISON

In [1], the velocity of vehicle is optimized in such a way that red traffic signal can be avoided most of the time. In our work average speed of vehicle is assumed to be following:

- The average speed of vehicles moving in less traffic is assumed to be 30 km/hr. This is also the average speed of vehicles that have cleared the traffic signal and are about to stop at next traffic signal.
- The average speed of vehicles moving in more traffic is assumed to be 15 km/hr. This is also the average speed of vehicles that about to clear the traffic signal.

The objective of our work is to optimize travel time from source to destination in fixed traffic signal control. This is done by calculating the travel time in one second till 600 seconds from the time of start and then taking the minimum time. That time is taken as the time to start the journey. Fig. 3 below depicts that if a daily commuter wants to start his journey at 06:00:00 pm, then our work calculates the travel time in one second till 06:10:00 and then finds the minimum. In this example lowest travel time is 779 seconds and that is achieved when journey is started at 06:02:00. This work is very helpful for the daily commuter who wants to spend less time traffic every day.

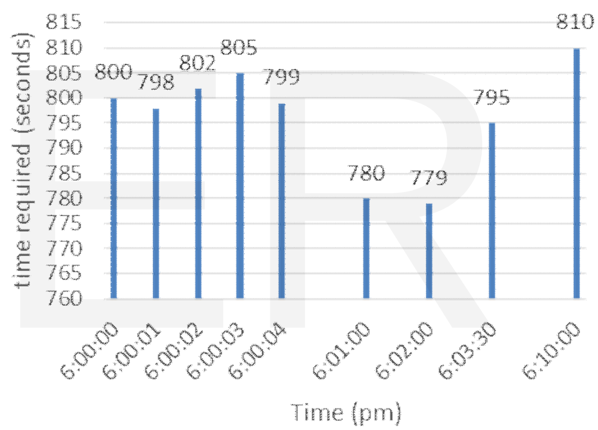

Fig 3. Time required at particular time of day

Following time estimates are calculated and then added to get the final time estimate:

- Time to cover the distance from source to first traffic signal and last traffic signal to destination at an average speed of 30 km/hr. This is simple calculation time = distance/speed.
- Time spent at traffic signal. This time estimate is variable since it depends on traffic density at road junction at different time of day. In rush hour the traffic density on roads is more; this leads to queuing of vehicles at traffic signals. The vehicles at the farther end of this queue would require

2 or more green traffic light to clear the junction. Hence the time is added.

After the above time estimate calculation, the time taken at each second is calculated till 600 seconds from estimated time of start. The minimum time is chosen as the optimized time. It happens with anyone, who commutes daily especially, that someday he/she spends less time in traffic than other days, even though he/she starts the journey at approximately same time in same traffic conditions. This happens due to timing. This happens when a commuter reaches the traffic signal it turns green; then again at another traffic signal similar phenomenon happens. Thus time spent in traffic becomes less.

[2], [3], [4], [5], [6] and [7] uses their respective methods to adjust the traffic signal duration so as to have less traffic density on road. Traffic signals are adjusted based on the traffic conditions on the road.

Our work works on fixed traffic signal control. Here actual traffic signals timer at each traffic signal from source to destination has to logged and then has to be used. Traffic density at each road junction also has to be logged. Then optimized time estimate is calculated.

III. CONCLUSION

This work is mainly useful to daily commuters whose spend their considerable time in road traffic. From this work they can optimize their time spent in road traffic.

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