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Synchronization of traffic signals system for Nagpur city

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ABSTRACT

In the growing traffic of metropolitan cities, traffic congestion has become the main problem. The problem is even worse at an intersection due to improper signal timings which in turn causes delay, an increase in vehicle operating cost and also pollution is the main concern of recent times. Delays have attributed to various socio-economic and environmental problems. Delays in traffic are caused due to numerous factors like scarcity in road width, driver and pedestrian characteristics, vehicle composition, lack of road infrastructure, road condition and geometry, traffic signal management and many more. Among the above factors contributing to delays in improper signal timing or its management forms the main theft for the delays at a signalized intersection. The main parameter while evaluating a signalized intersection is the delay caused due to the signals. Hence in order to encounter these problems, the traffic signal synchronization is the technique in which vehicle starting at one end of the street and traveling at specific speed can go to another end without stopping for a red light at an intersection. In the study the existing traffic at each junction along the Jhansi square, Dharampeth square, Bajaj Nagar square, and Laxmi square. In which Jhansi square is one of the most important roads having heavy traffic is studied and signal is designed, thereafter the traffic signals are synchronized and benefits are estimated.

Keywords— *Synchronization, Intersection, Traffic, Signalized*

1. INTRODUCTION

In 2016-2017, vehicle registration touched 685 vehicles daily. Sources said that till Oct-Nov 2017, the number of vehicles hitting city roads daily was close 700. This includes all vehicle including private cars, two-wheelers, app-based taxis, buses, school buses, and trucks. Day by day increased in number vehicles, peak hours in city from 9-11 am in morning and 5-8pm in evening is considered to be the highest traffic. Below mentioned figure 1 shows the gradually increasing number of vehicles as people are moving towards a luxurious life.

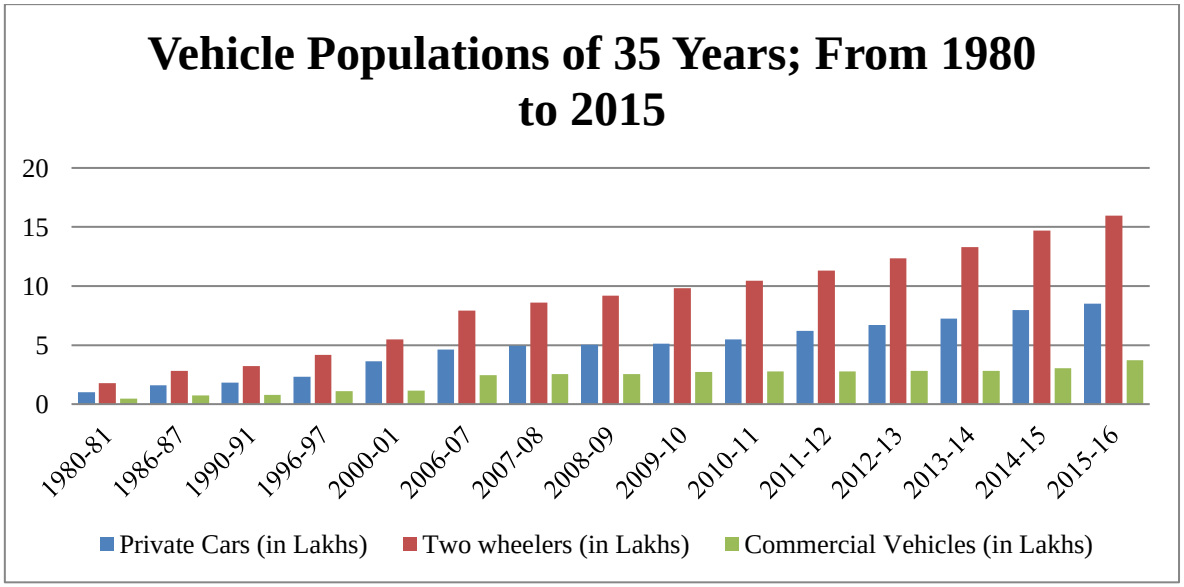

Fig. 1: Count of different types of vehicle year by year; from 1980 to 2015.

2. NEED OF STUDY FOR SYNCHRONIZATION OF TRAFFIC SIGNALS

Due to mixed nature of traffic it becomes very difficult to accommodate the traffic on road particularly at intersection. The loss of time and fuel due to delay and traffic congestion on urban road is phenomenon. Traffic congestion is a severe problem at an intersection in urban, create many critical problems like traffic jam, delay, pollution, accidents etc. It challenges in major and most populated cities around the world, which can be solved by applying traffic signal management and engineering measures. At the time of heavy traffic condition, traffic jam condition is developed on intersection of Nagpur city. Due to more traffic jam the delay of vehicles is more. Excessive fuel is loss due to low running speed and delays. Excessive burned fuel creates excessive smoke in nature which creates air pollution. More traffic jam and delay is also reason of the noise pollution which is the reason of many health problems. Due to these traffic jams intersection traffic handling capacity and road capacity will reduce. The objectives of present study is to reduce the delay and time saving due to synchronization of signal in series, to reduce pollution produced by traffic and fuel loss due to low running speed. For saving the time, money and the human kind by controlling air pollution. 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 48 minutes in Nagpur. We feel that the Dynamic Traffic control should be done by knowing the signal behavior.

Table 1: Details of Square on Google Map

S no.	Name of Square	Indication in the map as symbol
1	Jhansi Rani Square, Nagpur	A
2	Dharampeth Square, Nagpur	B
3	Bajaj Nagar Square, Nagpur	C
4	Laxmi Nagar Square, Nagpur	D

3. OBJECTIVES

Though the overall improvement of the journey along signalized intersections involves providing effective signal timings, proper maintenance of signals, improving pedestrian facilities, proper lightings at intersections, efficient drainage, etc., the study is concerned with reducing delay by providing seamless travel to the vehicles along the arterial road. The main study involves observing the existing conditions, analyzing them thereafter optimizing the signal timings for present peak hour traffic conditions and thereafter synchronizing the study intersections with pre-assigned speed and then evaluating its performance with respect to journey time and journey speed. Thus providing no static delay to the vehicles along arterial road and minimizes the delays at these intersections and consequently improve level of service and also to reduce the pollutants levels emitted to the environment which is of great importance of recent time.

4. METHODOLOGY

4.1 Step1

Collecting the information on the intersection. Researchers can record the road width, road properties, signal timing, queue length, and time delay through surveying and researchers can record the traffic flow in various directions and time segments and save the traffic condition through video recording.

4.2 Step2

Inputting the collected road network data into the AutoCAD to establish static network model accurately. Then the researcher can input the proceed flow data, motorcycle type ratio data and signal timing data, and make analysis for those data to determine the rush hour flow. Moreover, researchers can make analysis and calculations for the rush hour traffic characteristic, the remaining capacity and the saturation through determining the nature and the quantity, and then investigate the vehicle correlation non-vehicle correlation and mixing problem by observing the video recording and surveying.

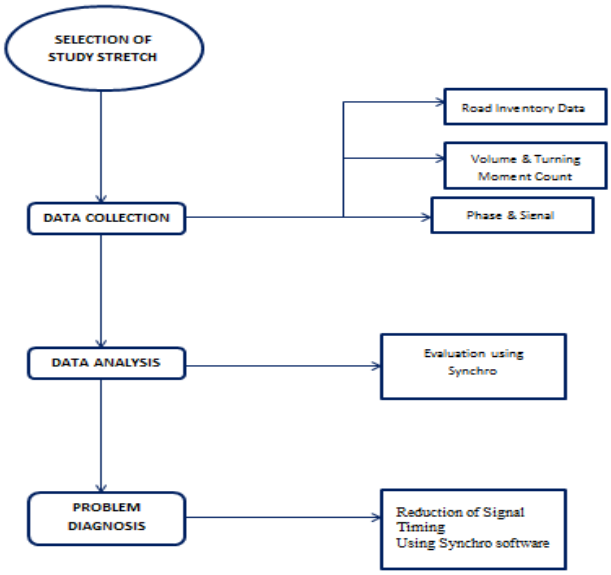

Fig. 2: Methodology Layout

4.3 Step3

Determining the scope and time of the simulation. Then through the orthogonal test, researchers compare and calibrate parameters of the intersection with Synchro simulation. After the simulation, the researchers can proofread the simulation results with the signal timing data, vehicle flow data, queue length, delay time and video recording to ensure the precision of simulation, and then find the way to optimize the intersection system. Researchers can design the synchronization strategy in geometry optimization and signal to time. Then the researcher can input proceed flow data, Motorcycle type ratio data and signal timing data, and make architecture with significant reduction in power consumption.

5. DATA ANALYSIS AND RESULTS

5.1 Delay along the journey from Jhansi rani junction to Laxmi Nagar

Table 2: Delay along the journey from Jhansi rani junction to Laxmi Nagar

Junction	Delay/vehicle for 6.1min of journey time, s	Delay/vehicle per hour of journey, s	No of vehicle	Delay/hr, s	Delay/hr, hrs
Jhansi Rani	22	216.4	2588	560026.2	155.6
Dharampeth	48	472.1	2980	1406950.8	390.8
Bajaj Nagar	27	265.6	2944	781849.2	217.2
Laxmi Nagar	71	698.4	3444	2405154.1	668.1
				Total delay	1432

5.2 Travel cost along the journey from Jhansi rani to Laxmi Nagar junction

Table 3: Travel cost along the journey from Jhansi rani to Laxmi Nagar junction

Type of vehicle	2 Wheelers	AUTO	Car	LCV	HV
Fuel Type	Petrol	LPG	Petrol	Diesel	Diesel
Fuel consumption duringidling, ml/hr	138	700	563	690	920
Delay, hours	1432	1432	1432	1432	1432
Fuel for idling delay, ml	197616	1002400	806216	988080	1317440
Fuel for idling delay, liters	198	1002	806	988	1317
Cost, Rs/liters	72.10	65.53	72.10	68.45	68.45
Cost, Rs	14276	65661	58112	67628	90148
The total cost of fuel loss per day (1hour), Rs	295825				

5.3 Delay along the journey from Laxmi Nagar to Jhansi Rani Junction

Table 4: Delay along the journey from Laxmi Nagar to Jhansi Rani Junction

Junction	Delay/vehicle for 5.4min of journey time, s	Delay/vehicle per hour of journey, s	No of vehicle	Delay/hr, s	Delay/hr, hrs
Laxmi Nagar	39	433	2822	1222866.7	339.7
Bajaj Nagar	19	211	3198	675133.3	187.5
Dharampeth	61	678	2227	1509411.1	419.3
Jhasi rani square	37	411	3390	1393666.7	387.1
				Total Delay	1334

5.4 Travel cost along the journey from Laxmi Nagar to Jhansi Rani Junction

Table 5: Travel cost along the journey from Laxmi Nagar to Jhansi Rani Junction

Type of vehicle	2 Wheelers	AUTO	Car	LCV	HV
Fuel Type	**Petrol**	**LPG**	**Petrol**	**Diesel**	**Diesel**
Fuel consumption during idling, ml/hr	138	700	563	690	920
Delay, hours	1334	1334	1334	1334	1334
Fuel for idling delay, ml	184092	933800	751042	920460	1227280
Fuel for idling delay, liters	184	934	751	920	1227
Cost, Rs/liters	72.10	65.53	72.10	68.45	68.45
Cost, Rs	13266	61205	54147	62974	83988
The total cost of fuel loss per day (1hour), Rs	275580				

6. DISCUSSION AND CONCLUSIONS

6.1 Discussion

- It is observed that significant system delay of 1432 hours and 1334 hours occurs along Jhansi to Laxmi Nagar and Laxmi Nagar to Jhansi rani square respectively due on Coordination between the traffic signals which in turn causes static delay at each junction.
- It is observed that there will be huge total savings in fuel cost along Jhansi to Laxmi Nagar, also in opposite direction can be achieved for the period of one year considering peak hours of 8AM-11AM(3hours) and 5PM-8PM(3hours).

- The redesign of signal phases is done by limiting the cycle length to 120sec without any partial green time by IRC method.
- Speed and Delay studies are carried out by floating car method by traveling along the study area and Average Journey speed of 17.7Kmph is observed, with a total Average static delay of 2.7min for Average journey time of 5.8min along the study stretch.
- Synchronization is carried out by offsetting the green time of each junction by Time-Space principle for pre-assigned speed of 35Kmph, however slight change in green times are made from original designed green times to ease synchronization.

6.2 Conclusions

The present study is conducted for a wide range of control delay, fuel consumptions and saturation flow rates to maintain high degree accuracy to be applicable for the traffic flow with wider traffic volume data, signal timing and fuel consumptions level data from each intersection. Experimental and analysis has been carried and following conclusions are drawn:

- In the study area the parameters like traffic volume, its composition and saturation flows are dynamic in nature which substantially contributes to delay and VOC, hence design is required for periodic variation of traffic.
- Two-wheelers which occupy the front positions of the roads during red signal which causes queuing, results in increased saturation flow during initial green time compared to ideal saturation flow curve.
- Standard saturation flow rates, fixed cycle length by IRC guidelines are not suitable since traffic volume, saturation is dynamic in nature due to heterogeneous traffic scenario.
- Considerable savings in delay and fuel cost have been noticed from present synchronization work.
- The overall travel time will have a significant decrease and increase in operating speed as well.

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