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Research paper



Analysis of heterogeneous traffic volume studies and optimization of signal cycle length by vissim software

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Abstract

Now –a-days the design of traffic signal has become an important factor for controlling traffic movement at intersection in towns and cities. Traffic signals not only reduce the accidents but also enable the road safety to users for an effective use of road at intersection
In the following studies the traffic volume at a particular junction is taken and simulation technique is adopted to reduce the delays, congestion etc. Traffic volume is considered in hourly basis for a week classifying the vehicles into different types and the maximum Peak hour volume is taken and the signal time is designed for the maximum peak hour volume. Signal time can be calculated by Webster's method in which green time, cycle time can be known, and the obtained results are simulated in VISSIM software which gives a total delay occurring at junction by which signal time at a particular leg may be optimized.

Keywords: *Cycle Length; Signal; Webster Method; Peak Hour Volume; VISSIM*

1. Introduction

Transportation today plays an important role in the economic and physical development of any modern city. The traffic signal plays a prominent role in the transportation network. The main objective of signal timing settings is to move people through intersection with safety and in an efficient way.The population of an urban city heterogeneous due to the proximity of residential and commercial activities and increase in demand for relatively short time intervals such as breaks between classes. This usually means a significant amount of interaction between motorized vehicles and bicyclists using intersections. One way to account for the effect of user interactions at the intersections is simulation. Traffic simulation models are becoming an increasingly important tool for traffic control. Simulators are needed to generate scenarios, optimize control and predict network behavior at traffic operations level.
Following are the characteristics of traffic problems in the city especially in the high-volume corridors:

a) In the past five years in Hyderabad has become the second slowest city, where the aspeed of the vehicles used to be 30-40 km per hour which has been reduced to 17-20 km per hour now due to the increase in the population and urbanization in the metropolitan cities [1].
b) Huge delays are caused due to improper planning at the intersection resulting in congestions, increased conflicts
c) Increased number of two-wheelers[1]
d) Carriage widths have been varied from place to place creating turbulence in traffic flow.[2]

The main objective of this study is to reduce the delays and to improve traffic operations at selected sections of signalized intersections that will accommodate both motorized and non-motorized transportation modes. A methodology is planned to get a desired result for the delaysat the intersections with signal controls. In order to achieve the study objective, the following procedure has been identified:

a) Consider a particular junction where the congestions and delays are excess.
b) Traffic volume for the particular junction is taken in hourly basis respectively for a week / month, to understand the peak hour volume.
c) For the obtained peak hour volume, cycle time, green time etc. are calculated.
d) A VISSIM model is prepared for the particular junction to and the values are entered to get the delays.

2. Literature review

A very huge amount of research work has been done in studying and trying to improve traffic intersection. Originally, much traffic intersection research focused on analytical describing vehicles delay in terms of intersection characteristics. One of the most prominent early works is Webster (1958) explain the signal time setting. For more recent analytical delay models and queuing theory approaches Hurdle (1984) and Hagen and Courage (1989) made a comparison of microscopic models for Signalized Intersection
Day et al. (2009) [3]extended the highway capacity Manual's (HCM) intersection saturation metric and Webster's single ring formulation for cycle length and introduced a model for dual ring operation. The authors suggested a tool for evaluating the effectiveness and potency of cycle length at a signalized intersection.
Dowling et al. (2008) [4] presented a way for multimodal assessment of the standard of service for four differing types of users: motor vehicle drivers, transit passengers, bicycle riders and pedestrians. They developed four level-of-service models for every mode

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supported the road cross section, intersection controls and traffic characteristics Ishaque and Noland (2007) [5] used a micro-simulation model to review the results of signal cycle timings on delay and period costs for each vehicles and pedestrians in varied pedestrian phasing situations. They applied varied multi-attribute coefficient criteria to totally different elements of travel delay to look at value trade-offs between pedestrians and vehicles. Their results showed that the policy choice once considering pedestrians might disagree from that once simply considering vehicle traffic

a) Traffic Simulation

Traffic simulation is the mathematical modeling of all transportation systems (for ex: roundabouts, freeway junctions, downtown grid systems. etc.)Through the application of computer software for better help plan and design, also to operate transportation systems. The simulation process in transportation engineering and traffic engineering has been creating a vast change and development from a decade. Simulation in transportation plays a very important role in valuating all analytical results and calculations and can be easily altered if any modifications have to be done.

b) Traffic Simulation Model

There are very many modeling techniques which help to evaluate the transportation facilities. Using simulation in traffic modeling is an effective approach to identify the benefits and limitations of different design alternatives.

Therefore most of the commonly used traffic micro-simulation software in field today has all the basic features except MITSIM which an experimental simulator is set up by MIT. Among the three-commercial software's namely AIMSUN, PARAMICS and VISSIM, both VISSIM and PARAMICS provide the traffic simulation environment required to model heterogeneous mixed-traffic condition. Hence for this study, VISSIM is chosen as the traffic Micro-simulation package to be used.

3. Methodology

The details that are mentioned above can be used discover different solutions to the potential improvements on traffic operations at intersections serving any class of vehicle. This kind of methodology can be introduced in junctions in Metropolitan cities and urban areas.

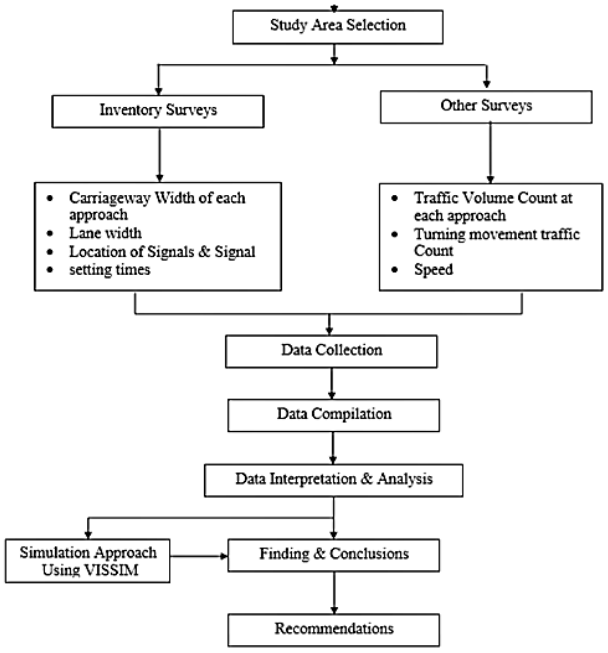
a) Identify a Junction for study

Transportation planning can be planned usually done at the regional areas or at the urban areas or in metropolitan cities. For planning at the urban level, the study area should include all the facilities which have existing built-up areas.

The imaginary line which is marked along the boundary of the study area is termed as the 'external cordon'. The study area inside the external Cordon line shows the travel pattern of all the vehicles to a large extent to get the actual number of the vehicles.

In the following case, the study area at this particular junction is taken as it paves a way for the IT corridor of Hyderabad city, and immense traffic flow is observed during the weekdays both in the mornings and evenings. Vehicles are mostly heterogeneous when they move on the roads and the pedestrians also constitute to the increasing growth in traffic flow.

Following flow chart shows the Methodology adopted for study area:



Methodology for VISSIM software

- Google Image is taken as the background to create the inventory of the intersectionand the image was scaled appropriately
- Road links were laid, for the junction, and link description, i.e., width of the road, number of lanes and type of the road
- And the link were connected with each other
- The vehicle inputs were given in Veh/hr. to each lane
- Vehicle classification was done to each lane based upon the classes of vehicles i.e., 2 wheeler, Bus, Cars, and multi axle vehicles
- Vehicle speeds at the junctions were given___
- 3D Signal head is designed from the data i.e., cycle time and effective green time obtained from volume studies by Webster's method.
- Nodes are kept covering the junction to acquire the delays after vehicle simulation

b) Details about the Study area

The above given flow chart helps us to understand the different steps involved in this study, a particular study area is selected accordingly from the above description. This study area was used to understand the necessary changes that can be possibly done on traffic operations at the intersections. The intersections of study area are Hitex-city (cyber towers), Biodiversity, Gachibowli, and Kondapur. Hitexcity, biodiversity, Gachibowli, Kondapur, is located in Rangareddy district of India. These areas are located in the state of Telangana. Hitex city is often termed as one of the major IT corridor in the state of Telangana. This area consists of large number of well-established International companies some of them are IBM, ACCENTURE, TCS, COGNISENT etc.

c) Data Collection

After the selection of study area, the next step is to collect the required data from the chosen junctions. The manual count involves human error, especially when an observer needs to be observe more than one movement at high volumes. Since observer can concentrate only on a single movement it is common that they may miss some vehicles when conducting real-time data. So, in order to overcome the human error, the video footages of these intersections were used. Therefore, the observer can concentrate on a single movement and then the video can be reviewed and at the second time can observe another movement.

As mentioned above in the modern methods the video camera method is the best and accurate method of data collection, so by approaching the concerned CYBERABAD POLICE COMMISIONERATE for the CCTV footage at the junctions (HITEX, BIO-DIVERSITY, KONDAPUR, GACHIBOWLI) for a period of

1 week from 12-02-2018 to 18-02-2018, during peak hours in the morning 8am-10am and in the evening 6pm-8pm.And the data has been shared by the group members, by playing the video footage in the systems the traffic count such as the total no. of two-wheeler, three-wheeler, four-wheelers, also buses and heavy commercial vehicles crossing at their respective junctions has been noted in the data sheets.

d) Webster's method of signal Design

The conflicts that usually come from movement of traffic in different directions is solved by time sharing of the principle. In a traffic signal the following may include

- Traffic flow movement in order.
- Increase in the capacity of the intersection.

But, the drawbacks of the signalized intersection are it affects larger congestion, and the design requires the complex consideration. The overall delay which is observed in a rotary intersection for high volume may be less yet the user is worried about the larger congestion at the intersection.

The design of signal involves five major steps:

- Design of phase.
- Calculation of amber time and clearance time.
- The cycle length at that particular junction.
- Setting of green time.
- Evaluation of the above model.

The main objective of phase is to understand the conflict areas in the intersection and to set up different movements of vehicles into different phases to avoid congestions; this is only followed for one phase.

In order to do the same for all the phases we require different movements for each phase to avoid congestion, which in real-time situation is impossible.

When such scenario arises, the target is to design the phases with the minimum conflicts. The right methodology for the planning of phases isn't potential and depends on the geometrical conditions of the intersection, the flow of vehicles and also the right turners and left turners.

Therefore, a Trial and error procedure is used. However, some part of design is extremely necessary as a result of it affects the any design steps. Further, it's easier to vary the cycle time and inexperienced time once flow pattern changes, wherever as a forceful amendment within the flow pattern might cause confusion to the drivers.

Cycle time helps us to understand about the time taken by the vehicles to move in the intersection in all the directions onceit is denoted by 'C'.

Optimum Cycle time is given as

$C^0 = 1.5L+5 /1-Y$

Where Lost time per cycleL=n (I-a) +n*l sec

n= number of phase

I=intergreen period

a=amber time

e) VISSIM (Verkehr in Stadein-SIMulation):

VISSIM (PTV Germany)-VISSIM is a microscopic, behavior-based on multi-purpose traffic simulation program. This type of simulation is generally done in roundabouts, unsignalized and signal-controlled; grade separated interchanges.

In VISSIM, vehicles activities are determined by the acceptable vehicles gap and desired speed of drivers. If not hindered by other vehicles, a driver will travel at his desired speed if current speed is less than the desired speed, a driver will accelerate and at a specific acceleration to reach the desired speed. And if the vehicles gap is small, a driver will decelerate to correspond with the vehicle at its front. The lane change logic also replicates individual driver behavior characteristics.

In summary, VISSIM model can capture the real operations of vehicles following and lane changing behaviors. There are two kinds of data required for establishing a VISSIM network:

Static traffic volume data showing the road way infrastructure, which include links with start and end points, link length, width, grade, lane number, and location of stop lines, etc.,

The dynamic traffic volume data which is acquired from data collection of the study area is required for traffic simulation applications, which includes:

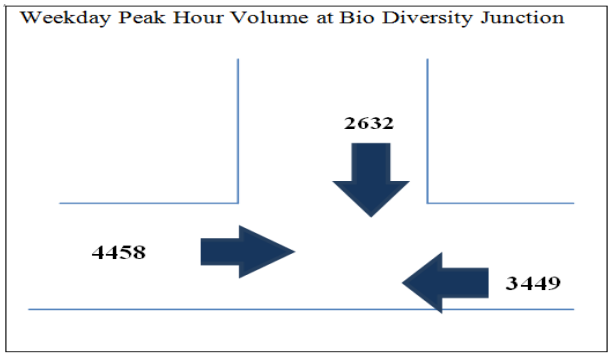
Departure times and dwell times,

Public transport routing,

Priority rules and signal timing plans at interactions

Types and classes of vehicles are also observed from the study area.

4. Analysis and calculations



Analysis by VISSIM

Webster's Method Calculations:

Signal design by Webster's method:

The optimum signal cycle is given by

$C_0 = 1.5L+5 /1-Y$

Where Lost time per cycle L=n(I-a) +n*l sec

Amber time, a=3sec.

Lost time due to starting delays, L=2sec.per phase

No. of phases, n

Inter green period, I=4.0sec

Saturation flow: Y =Y1+Y2 +Y3

Effective Green time:

G1= y1/Y (C_0-L),

G2=y2/Y (C_0-L),

G3=y3/Y (C_0-L),

BIODIVERSITY JUNCTION:

Normal flows:

Phase1= 1808PCU/hr,

Phase2 = 1316PCU/hr

Phase3 = 2465PCU/hr

Saturation flow for all phases=525*12=6300 PCU/hr

Y1= 1808/6300 = 0.28

Y2=1316/6300= 0.20

Y3= 2465/6300 =0.39

Y= Y1+ Y2+Y3 = 0.28+0.20+0.39 =0.879

Lost time per cycle L=n (I-a) +n*l sec

Where, Amber time, a=3sec.

Last time due to starting delays,

L=2sec.per phase

No. of phases, n=3

Inter green period, I=4.0sec

Therefore l=3(4-3) +3*2=9.0seconds

C_0 = 1.5L+5 /1-Y

=1.5*9+5/1-0879

=155sec.

Calculation of Green Time:
Phase 1:

G1 = Y1/Y *(C_0−L) = (0.28/0.879) *(155-9) = 50 Seconds.

Phase 2:

G2 = Y2/Y *(C_0−L) = (0.20/0.879) (155-9) = 35 Seconds.

Phase 3:

G3 = Y3/Y *(C_0−L) = (0.39/0.879) (155-9) = 65 Seconds



Fig. 1: Vissim 3d Simulation with Pedestrian Traffic.

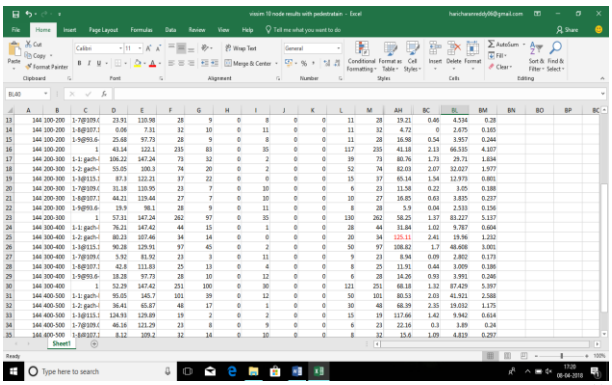


Fig. 2: Excel Sheet Showing the Vehicular Delays with Pedestrian Traffic.



Fig. 3: Vissim 3d Simulation without Pedestrian Traffic.

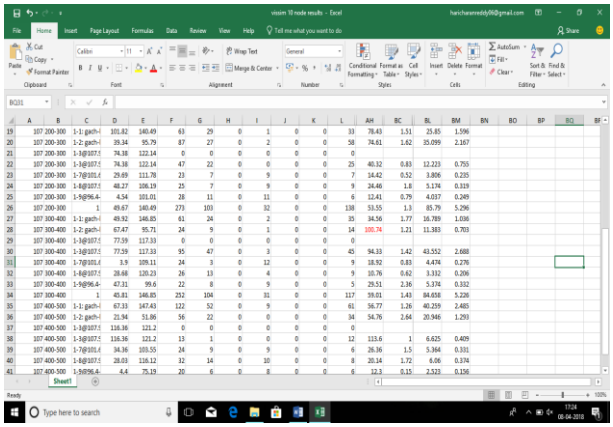


Fig. 4: Excel Sheet Showing the Vehicular Delays.

5. Results and discussion

Cycle times green times and delays are found for Bio Diversity intersection with and without pedestrian traffic, and the relative delays were found out to be 125.11 sec and 100.74sec respectively. Here in this junction the three wheeler vehicles have been not taken into account as the VISSIM trial version does not support that vehicle type.

6. Conclusion

[1] The Biodiversity intersection is designed for a 3phase signal and obtained optimum cycle time of 155sec. Effective green time for Phase1, Phase2, and Phase 3 are 50, 35 & 65 sec.
[2] Maximum vehicle delay with pedestrian traffic is obtained at movement from phase-1 to 2.i.e. 125.11
[3] Maximum vehicle delay without pedestrians traffic is obtained at movement from phase-1 to 2.i.e. 100.74
[4] Maximum vehicle delay with and without pedestrians traffic is obtained at movement from phase 1 to 2.i.e. from Mehdipatnam to Bio-diversity.
[5] It can also be suggested that, since the green time for phase 3 is 65sec, and the green times for both the phases 1 and 3 can be adjusted to reduce the delays in phase 1

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