Analysis of Different Studies of Intersection Design & Their Optimization by Simulation Software

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Abstract- The increasing of traffic volume at our intersection has been arise a problems like road accidents, conflicts and congestions. These problems can now only be solved by providing an efficient traffic control at intersections and that can be achieved by provision of traffic signal system at intersections for continuous and efficient movement of vehicles through the intersections. According to traffic signal, signal timing is most important which is used to decide green time of the traffic light shall be provided at an intersection and how long the pedestrian walk signal should be provided. Traffic volume studies are to be made to determine the number, movement and classification of vehicles at the given location. These data is used identify normal flow of the road; determine the influence of heavy vehicles or pedestrians on vehicular traffic volume. The length of the sampling period depends on the type of count being taken. In India traffic pattern is heterogeneous, it is necessary to convert heterogeneous traffic to homogenous traffic while designing any signalized intersection. Micro-simulation is a widely used and one of the most effective ways to predict traffic behavior of urban intersections and corridors. As transportation systems have become more complex with frequently congested roads, traffic management has become a worldwide concern. Engineers install traffic signals to provide safe right of way periodically to competing traffic movements. Coordinating two or more signals on a signalized intersection requires cycle length, green splits, phase sequence and offsets and these can be achieved by using various types of traffic simulation model and optimization model. With the progress of technology, many traffic management packages were developed and traffic model and simulation tools are increasingly used for traffic management by using real time date.

Keywords- Traffic signals, Collision, VISSIM, Intersection, conflicts

I. INTRODUCTION

Transportation today assumes a significant job in the financial and physical improvement of any cutting edge city. Today, numerous small scale recreation programming has been made accessible available and utilized as instruments for the assessment of traffic the board and control. Discharged in 1992, VISSIM is a minute, time step and conduct based reproduction model created to demonstrate urban traffic and open travel tasks. It is viewed today as a pioneer in the field of small scale recreation programming.

However the unprecedented growth of vehicles ownership especially the small cars and scooters in recent years, our cities are beset with serious traffic problems like congestion and causalities particularly at road intersection due to land constraints. A multidisciplinary approach is needed in understanding the situation and providing the solutions.

To solve the problem of congestion at intersections, coordination of traffic regulation is required and intersectional area may be expanded or grade separations may be adopted. In order to study and evaluate the congestion at urban intersections, it is important to acquire factual knowledge of traffic characteristics and to carryout studies and analysis the situation for relieving congestion thereby increasing the capacity of intersection.

Micro simulation can be applied to any scenario involving complex vehicle interactions and has been used to model roads, rail, air and sea ports. If validation is not properly performed, a traffic simulation model may not provide accurate results and should not be used to make important decisions with financial, environmental and social impacts. VISSIM is a microscopic traffic simulation software developed by PTV in Germany. It can analyze traffic and transit operations under constraints such as lane configuration, traffic composition, traffic signal etc. Therefore, it is a useful tool for the evaluation of various alternatives based on transportation engineering and planning measures of effectiveness. VISSIM can be used as a useful tool in a variety of transportation problem settings. VISSIM can also be used to select intersection signal control plan in terms of queue and delays to maximize the conservation of resources.

II. LITERATURE SURVEY

1. Qinrui Tang and Bernhard Friedrich in “Design of Signal Timing Plan for Urban Signalized Networks including Left Turn Prohibition” this work is also carried out within the project Optimum (Optimization of Urban Traffic Management towards Environment Friendly and Safe Mobility) which is financially supported by the Helmholtz CAS Joint Research Groups (HCJRG) of the Helmholtz Association of German Research Centers. Urban road networks may benefit from left turn prohibition at signalized intersections regarding capacity, for particular traffic demand patterns. The objective of this papers to propose a method for minimizing the total travel time by prohibiting left turns at intersections. With the flows obtained from the stochastic user equilibrium model, we were able to derive the stage generation, stage sequence, cycle length, and the green durations using a stage-based method which can handle the case that stages are sharing movements. The final output is a list of the prohibited left turns in the network and a new signal timing plan for every intersection. The optimal list of prohibited left turns was found using a genetic algorithm, and a combination of several algorithms was employed for the signal timing plan. The results show that left turn prohibition may lead to travel time reduction. Therefore, when designing a signal timing plan, left turn prohibition should be considered on a par with other left turn treatment options. They propose a method of designing signal timing plan including LTP by minimizing total travel time. The total travel time reduces after Left Turn Prohibition. Types of left turn phasing and relevant left turn flows may be related to LTP. This paper provides an idea of congestion management in urban road networks. Prohibiting left turns should actually

be considered among other left turn treatments in signal timing plan design. Planned future research includes analyzing the other factors influencing Left Turn Prohibition.

2. Prof. C.N. Gawali, Prof. D.R.Naxine and Prof. S.S.Kapgate in "Comparative Study of Signalized Intersection and Rotary for Effective Traffic Management" the comparative study and analysis of signalized intersection and rotary intersection by taking into consideration various parameters such as journey time, delay time, reduction in the distance covered has been done in this study. They studied about the places in the city where there is an intersection of five roads and selected Shankar Nagar Square for our study. They collected the traffic data on the peak hours of the day by video graphic survey method and they counted classified and categorized the vehicles into different classes. As the vehicles are accessing towards the Rotary they are forced to reduce their speed but won't stop as in the case of signalized intersection. This may reduce the extra time spent by the vehicles at the intersections. The initial construction cost of the Rotary is the only cost as the maintenance cost is negligible. For design purpose they use the simulation software PTV VISSIM. This software has helped us to design Signalized Intersection and rotary at Shankar nagar intersection. The present study is conducted for the wide range of control delay and fuel consumption which maintains a high degree of accuracy to be applicable for traffic flow with wider traffic volume from each intersection of the square. A new geometric concept is discussed to design rotaries at intersection of roads. It finds wide application in road work planning and design. The study is conducted on important parameters which control delay as well as collisions. On comparing they concluded that Rotary is much more preferable as compared to the signalized intersection

3. Faisal Mehraj Wani, Raghavendra S.Sanganaikar, Varun Leekha, Rimshi Khan, Sahib Hussain in "Design of Traffic Signal at Kundahallli Junction Bengaluru Karnataka" Traffic Signal must be required which will reduce the chance of an accident, time of travel for the passengers, congestion, conflict, and bottleneck. These problems can be solved by providing an efficient traffic control at intersections and that can be achieved by a provision of automated volume based traffic signal system at intersections for continuous and efficient movement of vehicles through the intersections. The Design of traffic signal is done according to the Indian Road congress (IRC 93) method of signal design by adopting maximum average Passenger count unit (PCU) on the intersection in each direction. The Optimum cycle length was found to be 148 seconds for all the phases. The cycle length at intersection may be considered for up gradation. Based on the calculations done on the PCU values obtained from the traffic survey, the optimum Signal Cycle Length was found to be 148 seconds. The cycle length at the existing intersection is same for three major roads 189 seconds and for the minor road 259 seconds. The waiting time for the minor road is too large, there is a danger the timing of the signal provided at existing system is more than the optimum cycle length which causes delay to the vehicles. If the timing is causing extra delay to the vehicles than the driver will disobey the signal, resulting in cause of accident. Thus the signal timing should justify the movement of vehicles so that extra delay by the RED signal will not affect the total journey time. Main consideration in selecting the cycle length should be that least delay is caused due to the traffic passed through the intersection good portion green time will be used by unsaturated flow of traffic which again leads to inefficiency.

4. Bhupender Pal, Tripta Goyal in "Study of Traffic Characteristics of selected junctions in Chandigarh through simulation" In India, the traffic is of mixed composition and the rate of growth of traffic is very high, but the resources available for giving this growth a suitable base are limited. So the only option left is to make the present facilities highly efficient. The present study aims to study the traffic flow at a junction in Chandigarh using simulation techniques. It is aimed to increase the efficiency of the junction by providing one of the component of Intelligent Transport System, VAP (Vehicle Actuated Programming) signals i.e. variation of the signal timings according to the variation in traffic demand. This has been accomplished with the help of simulation through detectors used in the VISSIM software along with its add-on module VisWalk (for pedestrian movements). The study elaborates the interaction of vehicles and pedestrians while using junction facilities through Simulation in VISSIM. From the study, it was been concluded that by using the VAP programmed signal, the efficiency of the roundabout can be increased by certain percentage in terms traffic flow. Consequently, if traffic flow increases, then velocity and density also attains their optimum values. In this study, the vehicular and pedestrian flows have increased by 21.64 percent and 10 percent respectively using simulation tool VISSIM. But the VISSIM software has some limitations by which it ceases to represents the Indian traffic environmentally. The limitations which it consists are :- (1) two wheelers in VISSIM are represented only by cycles, as there is no dimensional difference between cycles and bikes. (2) There is no such vehicle class which represents the tri-cycle and auto-rickshaws in VISSIM. As these limitations affects the behavior of traffic simulation and the results which are produced by data collection points may also vary from the simulation if taken with actual factors.

5. Vikram Kumar, Neeraj Kumar in "Study of Design Traffic Signal" The increasing of traffic volume at our intersection has been arise a problems like road accidents, conflicts and congestions. These problems can now only be solved by providing an efficient traffic control at intersections and that can be achieved by provision of traffic signal system at intersections for continuous and efficient movement of vehicles through the intersections. According to traffic signal, signal timing is most important which is used to decide green time of the traffic light shall be provided at an intersection and how long the pedestrian walk signal should be provided. Traffic volume studies are to be made to determine the number, movement and classification of vehicles at the given location. The increasing of traffic volume at our intersection has been arise a problems like road accidents, conflicts and congestions. These problems can now only be solved by providing an efficient traffic control at intersections and that can be achieved by provision of traffic signal system at intersections for continuous and efficient movement of vehicles through the intersections. The scope of the study encompasses appreciation of identifying the road sections for conducting necessary traffic studies and to quantify problems with view to suggest improvement measures. The conclusions and recommendations from these studies will be helpful in better understanding of the problems and finding of the effective measures to overcome all those problems.

6. Nyame-Baafi et al. (2018) established study of volume warrants, based on a delay threshold, to guide the installation of left turn lanes at un-signalized Tintersections by calibrating VISSIM model using traffic flow, delay, average and maximum queue length data obtained from a two-hour video recording during the morning peak period. Measured data were recorded and averaged over 10 simulation runs. After calibration, the VISSIM tool was used to perform two simulation experiments which were designed for the development of the minor road left turn volume warrant and major road left turn volume warrant based on delay threshold. This study serves as a guide that can be used by metropolitan and municipal road engineers to assess the need for left turn lanes. The conclusion was made that the VISSIM intersection model of the study T-intersection was successfully calibrated to reflect field flow conditions indicating that there was no significant difference between the field and the simulated results.

7. Siddharth S M Pa et.al (2013) ANOVA was used to find the sensitive parameters from a set of eight parameters that were to be calibrated The time taken to run a trial of ANOVA was 6 hours and 20 minutes while time to run for a trial of EE method was 6hrs and 30 minutes. Both these analysis were done in the same computer system having configuration of 32GB ram. The parameters from sensitivity analysis were
suitable for Indian heterogeneous conditions their values calibrated. Automated calibration in the same computer system took about 35 hours. Automated calibration process reduces manual effort required to calibrate.

8. Rakesh Kumar Chhalotre.they study the traffic condition in Prabhat square Bhopal an attempt was made to solve the problem of traffic congestion and unusual delay to the traffic movement by suggesting the design of Fixed time signal in place of Rotary intersection first day conducted a traffic survey and data collection then converted the value into

PCU 7 days data was collected in a week of different time interval from morning to evening peak hour from their analysis they conducted that the traffic approaching at the intersection is very high 3000 PCU per hour.

9. Xuejin Wen study an isolated intersection with a short shared through and right-turn lane. The intersection locates at the upstream of two consecutive on-ramps, one to the interstate highway I-290 West and the other to the I-290 East. This paper proposed three optimal solutions for the long queue problem at one specific intersection caused by the vehicles going to the I-290 highway through the downstream on-ramps. Each solution is tested by building corresponding VISSIM models and compared with the original intersection. A few observations include:

1. An intersection with actuated signal control VISSIM model can be established easily. Besides, VISSIM also provides a few evaluation criteria, like the queue length, delay time;

2. For assessment and comparison of the VISSIM intersection models, the vehicle input should be controlled by COM interface to make sure the number of vehicles arriving at the intersection is equal at the same time;
3. Adding a new diverging link for the right-turn only vehicles can effectively improve the quality of service of this intersection. Meanwhile, the other two solutions, increasing the length of the short shared lane and making the short shared lane right-turn, can only reduce the delay time for the vehicles in one lane.
For the future study, the nearby intersections close to this one will be included in the VISSIM model, and the coordinated signal control will be tested as well. Besides that, this paper focuses on how to improve the layout of the intersection, the configuration of traffic signal could also be considered.

10. R. Vinod Kumar presented a paper in which they studied the population in tirupati the pilgrim city in Andhra Pradesh The traffic is growing rapidly and by studying the road traffic of the city they analyzed that the major accident cause is collision of vehicles at the intersections. The collision may be rear shunt on approach to junction, right angled collision, principle right turn collisions and pedestrian collision. These collisions can be avoided if proper design of signal is done so that the main objective of the dissertation is to provide better and safe movement of traffic through signal design at the intersection. The signal is designed as per IRC guidelines so that the signal can justify the proper movement of the traffic and also The effect of the signal design can be seen in reduction of accident cause by which the reduction in fatal injuries at the intersection, thus provide a better and safe movement of the traffic. The signal design can also help the pedestrian to cross the road safely. The signal timing plays an important role in traffic movement. Thus the timing of the signal should be such that it does not cause delay to the vehicles. Vehicles will consume less amount of fuel if they don't have to wait at signalized intersections for a longer time. It also helps in reducing annual fuel consumption cost and environmental pollution.

11. Ravi Kumar R analyzed the traffic flow in Katapady and Mattu **.** They told that structure of traffic sign will help in propelling transportation system to give ease and security to the utilizing it. They will give simple and effective power over the development of vehicles at Intersections. It will prompt least time delay bringing about sparing in fuel and henceforth the expense of voyaging will limit accomplishing economy. Additionally there will be less contamination as vehicles need to hang tight for no such longer time than previously. Traffic signs will likewise diminish the contention focuses at crossing points will limit the mishap. In this way bringing about in general proficiency and economy will help the street client for better experienced. They have given a short belief system for the various parts of sign procedure and give our proposed technique to determine the three most significant issues related with traffic for example cost, time and fuel sparing of vehicle We can accomplish a superior possibility by utilizing the proposed technique. As future work they can continue towards the vehicle robotization of vehicle particularly substantial vehicle by utilizing the remote sensor system and web convention.

i. Avoid traffic congestion.
ii. It's very economical.
iii. As per IRC the traffic volume more than 2.5 PCU then we adopt signal for Katapady junction.
iv. No need of providing traffic signal, increase the road width in Mattu junction
v. Reduce accidents.
vi. VISSIM is a program with capacities to show and imagine complex traffic stream in a graphical manner.

12. Thomas Gabel et. Al analyzed that the optimization of traffic flow on roads and highways of modern industrialized countries is key to their economic growth and success. Besides, the reduction of traffic congestions and jams is also desirable from an ecological point of view as it yields a contribution to climate protection. This article, describes to a microscopic traffic simulation model and interpret the task of traffic flow optimization as a multi-agent learning problem. In so doing, adaptive agents to each of the vehicles and make them learn, using a distributed variant of model-free reinforcement learning, a cooperative driving behaviour that is jointly optimal and aimed at the prevention of traffic jams. Approach is evaluated in a series of simulation experiments that emphasize that the substitution of selfish human behaviour in traffic by the learned driving policies of the agents can result in substantial improvements in the quality of traffic flow. A novel multi-agent learning approach to microscopic traffic flow control is proposed. Both formal grounding of the approach taken as well as an empirical evaluation of its properties is provided. The latter has shown that a significant improvement of traffic quality – in terms of jam prevention, flow optimization, and fuel consumption minimization – can be achieved, if the selfish behaviour of human drivers is replaced by the vehicle controlling policies learned by the agents. Another interesting challenge is the transfer of ideas to a simulation with multiple lanes and passing manoeuvres which are also supported by the Krauss model, as this would also increase the relevance of this approach to a practical application.

13. Ratrout and Rahman reviewed the features of traditionally used macroscopic and microscopic traffic simulation models along with a comparative analysis focusing on freeway operations, urban congested networks, variations in delay and capacity estimates. The increasing use of virtual reality system in simulation will greatly benefit traffic safety related simulation. Newly developed object-oriented programming approaches were found to be very suitable for modelling transportation system. Authors suggested the suitable tools or approaches for the local condition of Saudi Arabia. The analysis revealed that AIMSUN, CORSIM and VISSIM are suitable for congested arterials and freeways, but AIMSUN is less user friendly compared to others.

14. Manraj Singh Bains et al. analyzed that the micro-simulation model VISSIM is suitable to simulate and hence studying heterogeneous traffic flow in expressways to a satisfactory extent. It is found that, the estimated PCU values of the different categories of vehicles of the heterogeneous traffic are accurate at 5% level of significance. For all categories of vehicles, the PCU of a given vehicle category decreases with increase in volume capacity ratio. This is due to the decreasing speed difference as volume increases from free flow to that at capacity. The PCU value of all categories of vehicles decreases when their proportion increases in the traffic facility is found to be approximately 7595 PCU/hour/direction as simulated under heterogeneous traffic conditions in VISSIM. It is found that due to the complex nature of interaction between vehicles under the heterogeneous traffic condition, the PCU estimates made through simulation for different types of vehicles of heterogeneous traffic, significantly changes with change in traffic volume level.

15. T. Ahmed designed a traffic simulation system for minimizing intersection .Incorporation of exclusive motorcycle lane resulted in the reduction of overall capacity and average speed of vehicles, however improved the capacity and performance of motorcycles. Unless motorcycles share a significant part of the vehicle composition, the facilitation of an exclusive motorcycle lane is redundant and unsatisfactory from only this study. Detailed study needs to be undertaken regarding the safety aspects of motorcycle riders. Growing share of crowdsourced ridesharing app-based motorcycle riders, demand more public facilities such as dedicated lanes, dedicated pickup-drop off spots, as well as policies that ensure safety. The hurriedly nature of passengers and riders generate dangerous manoeuvres and unwanted interactions with other vehicles. Therefore, a socio-economic analysis is mandatory to justify the necessity for exclusive motorcycle

lanes. Conflict analysis before and after the incorporation of the exclusive lane could show the improvements in overall road discipline

III. CONCLUSION

We observed that study introduced a new methodology for determining the optimal signal timing plans for intersections in an urban street network to overcome limitations of the existing methods that mainly focus on isolated intersections or multiple intersections in a corridor and also lack simultaneous treatments of vehicle and pedestrian delays. It contains a basic model handling vehicle delays only and an enhanced model simultaneously addressing vehicle and pedestrian delays using two pedestrian delay estimation methods. Also, an iterative process based on the kinematic wave theory was developed to compute the wave speeds of vehicles traversing through intersections for under saturated and oversaturated traffic conditions. The basic model and the enhanced model were incorporated into an agent-based regional travel demand forecasting tool capable of conducting large-scale simulation on a second-by-second basis for detailed traffic assignments on the basis of daily O-D travel demand classified by trip purpose and by hour of the day. The two models were separately applied for intersection signal timing optimization using data on Chicago regional travel demand, field vehicle and pedestrian counts, geometric designs, and signal timing plans for nearly 1,000 major intersections. Specifically, the green splits for all phases of the existing timing plans for a.m. peak, p.m. peak, and rest of the day time periods were adjusted iteratively based on the assigned hourly traffic volumes entering individual intersection approaches without changing the existing cycle lengths and signal coordination to achieve minimized vehicle delays per cycle only and weighed sum of vehicle and pedestrian delays per cycle. Sensitivity analyses were conducted for the enhanced model application to examine the impacts of assigning different weights between vehicle and pedestrian delays on vehicle travel time and delay reductions after signal timing optimization. The computational experiment revealed that vehicle delays in the area can be reduced by 13% when considering vehicle delays only for signal timing optimization and 5% when simultaneously considering vehicle and pedestrian delay

a. As future work we can continue towards the vehicle robotization of vehicle particularly substantial vehicle by utilizing the remote sensor system and web convention.
b. VISSIM avoid traffic congestion, conflicts, it's very economical and reduces accidents.
c. By using the VAP programmed signal, the efficiency of the roundabout can be increased by certain percentage in terms traffic flow and if traffic flow increases, then velocity and density also attains their optimum values
d. The wide range of control delay and fuel consumption which maintains a high degree of accuracy to be applicable for traffic flow with wider traffic volume from each intersection of the square. And also control delays and collision on intersection.
e. The major accident cause is collision of vehicles at the intersections. The collision may be rear shunt on approach to junction, right angled collision, principle right turn collisions and pedestrian collision. These collisions can be avoided if proper design of signal is done so that the main objective of the dissertation is to provide better and safe movement of traffic through signal design at the intersection.
f. The signal timing plays an important role in traffic movement. Thus the timing of the signal should be such that it does not cause delay to the vehicles.
g. Public transport system need to be strengthened so that use of individual vehicles is restricted, thereby reducing traffic density.

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