Homogeneity Transformation for Mixed Traffic Scenario

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ABSTRACT

This paper presents study of a traffic system to bring out the best performance in terms of service to maximum vehicles in a limited infrastructure. The increase in number of vehicles using the same traffic facility day by day poses challenge to the transportation planners to design and operate comprehensive systems for large traffic operations, in view of ever increasing transport demand in cities. The limitations are from various directions like no space for lane increasing, no control over number of vehicles permitted in the study road, non-availability of road infrastructure for conversion of heterogeneous traffic to homogenous traffic, non-implementation of Intelligent transportation measures to monitor lane discipline, the demand for pedestrian crossing, road side parking demand etc.,. The present study is a limited effort to suggest few cost effective measures to the study route of transport duly considering the present traffic demands from the existing road network which is contributing to the main stream traffic from all directions in the study area of five kilometer radius. The delays observed during the study pointed out at the necessity of introspection to be made on the present system and fair idea of quantum of congestions and its impact on wastage of human resources and congestion pricing. The need of traffic surveillance systems for detecting and tracking moving vehicles to implement lane discipline and to monitor homogeneity transformation of heterogeneous traffic is presented in this paper.

KEYWORDS*:* Heterogeneous traffic, Lane Discipline, Traffic flow, Capacity, Homogeneity

INTRODUCTION

In a developing country like India, due to rapid urbanization in the cities there is tremendous increase in the road traffic. The traffic condition is highly heterogeneous in nature and as vehicles do not follow the lane discipline, it is contributing to severe congestion there by increasing the delay which leads to poor level of service. The Indian roads traffic scenario is quite different from other developed countries. The conditions of the roads are more varied, the traffic is unstructured and there is lack of lane discipline and numerous types of vehicles. This type of traffic scenario is challenging for the current techniques of traffic estimation. Poor lane discipline is the main cause for traffic congestion in most of the cities. Lane discipline is important to ensure smooth flow of traffic and safety on any road. The application of computer vision techniques to road transportation system for the purpose of improving safety and efficiency is also one of the important aspects. Transforming the current heterogeneous traffic which is non-lane based to the homogeneous traffic of lane based by the implementation of the flare section near the intersections is one of the best possibility to reduce congestion and minimize the delay.

The present study aims at introducing the flare section, separating the different classes of vehicles using lane markings which lead to the capacity enhancement near the intersections there by increasing the v/c ratio.

A. **Need of Study**

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, having 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 the main road. 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 are to reduce the delay and time saving due to synchronization of signal in series, to enhance the capacity near the intersections there by increasing the volume capacity ratio.

Fig (1)

LITERATURE REVIEW

Wei et, al (2005)used a personal computer software called Vehicle Video-Capture Data Collector-VEVID which uses AVI file, generated from data collection infrastructure. It can capture various vehicle trajectories on the complete width of road simultaneously at any instant of time along with various microscopic parameters of a traffic stream. The major advantage this software had over other data collection methods are the capability to vary a number of frames per second and producing data without any manual observation with a very low cost. The only limitation of data collection system lies in the limit of a camera to record only limited length of the road.

Arasan and Koshy (2005) consider vehicle generation, vehicle placement, and vehicle movement as major modules of a simulation model. They classify the data with most accuracy as no categories are merged together and speed was calculated with the values of acceleration on the stretch of road under consideration. Thereafter they validate the model for homogeneous as well as heterogeneous traffic by simulating the speed-volume relationship. They did not consider the effect of passing or intersection in between the stretch under consideration.

Deyet, al (2006) collected the traffic speed data at 17 different sections and plotted unimodel and bimodal distribution curve for speed rather than using conventional normal distribution. They introduced a new factor Spread Ratio while considering both slow and fast moving vehicles traversing the same road space. They observed that as the congestion increased the proportion of slow-moving vehicles increased due to reduced LOS and space available for free manoeuvring of the driver.

Chunchu and Rao (2009) developed a system to process offline images which can classify and track vehicles successfully even under extreme congestion or heterogeneous traffic. It is named as Traffic Analyzer and Enumerator –TRAZER. It used a cascade of boosted classifiers for vehicle detection and have an accuracy of 95% moreover in classification it came down to 85%. It

produces the data of various microscopic parameters with acceleration and retardation under the detection zone. This can be upgraded to use for real-time and online image processing with increased accuracy.

Chunchuet, al (2010) used TRAZER for the collection of microscopic data for heterogeneous traffic. They collected the trajectory data of vehicles which are classified in four categories named two-wheeler, auto, LMV, and HMV. Thereafter considering microscopic characteristics they generate two parameters occupancy and area occupancy which are used to understand the gap maintaining behavior of vehicles under heterogeneous traffic.

Thankappanet, al (2010)attempted to develop an empirical traffic stream model to simulate heterogeneous traffic on the road without considering the lanes on the road. They used video graphic technique to collect data and extract parameters like flow, speed, and occupancy in attempt to establish a relationship between occupancy and density. This relationship is intended to bring the effect of heterogeneity in the equation to make the model more acceptable and accurate for simulation and forecasting.

Mallikarjuna and Rao (2011) described a method for modeling of heterogeneous traffic using customized video image processing based data collection technique to generate a model based on cellular automation. They consider various types of vehicles in their model like 2-Wheeler, 3-Wheeler, car etc. with consideration of lack of lane discipline to accurately model heterogeneity of traffic. TRAZER had been utilized for collection and classification of traffic data therefore including new micro and macroscopic parameters such as area occupancy, lateral and longitudinal gaps with lateral distribution and trajectory became possible.

Thankappan and Vanajakshi (2015) used video graphics technique for collection of traffic data and classify it manually to plot the relation between basic parameters of traffic. They attempted the various combinations of two regime models to simulate the flow and able to find fairly accurate results but they remain unable to express the heterogeneity of traffic stream flow in their model. They conducted the study in Chennai which had highly heterogeneous traffic and congestion so the results became less effective for any kind of implication.

Chow et, al (2015)conducted dynamic traffic stream modeling of the first order and highlighted the modeling difficulty during congestion on road with prepared fundamental diagrams of flow, density, and speed. They found more than 20% variation in projected data in dynamic CTM simulation which force them to consider Cassidy's approach to aggregating the traffic data. This resulted in considerable improvement in the accuracy but create a problem of loss of information in the recording of transient traffic behaviour on the stream. The challenge is establishing the balance between accuracy and size of an interval in set allowed.

Verghese et, al (2016)used the Kalman filter approach to increase the efficiency of a signal to control the congestion by using traffic density and speed data of downstream and midblock sections in the macroscopic modeling. They use an integrated VISSIMMATLAB simulation environment to check the developed model and found it suitable to use it for real-time traffic congestion control.

Study area

Cyberabad is a rapidly growing IT corridor with many MNC's located on the west zone of the Hyderabad city. The study area comprises of 5km radius with cyber towers junction as its centre. Two major corridors were selected for analysis of traffic scenario in the existing transport system. The details of the road network is digitised through GIS mapping. An overall road network of 329.25km length is found in the subject area of 78.54 sqkm. The composition of present road network consists of BT road length of 164.34km and CC road length of 104.27 km.

Two major routes were identified for data collection and analysis. Data collection primarily involved videographic survey to record samples on traveltime, delay and headways during peak and off peak hours of the selected route from JubleeHills to Kondapur junction via cyber towers. The delay time is recorded during each trip in the selected route using floating car method. The factors causing delay were identified during each trip with a view to arrive at optimal changes for better traffic flow and operations.

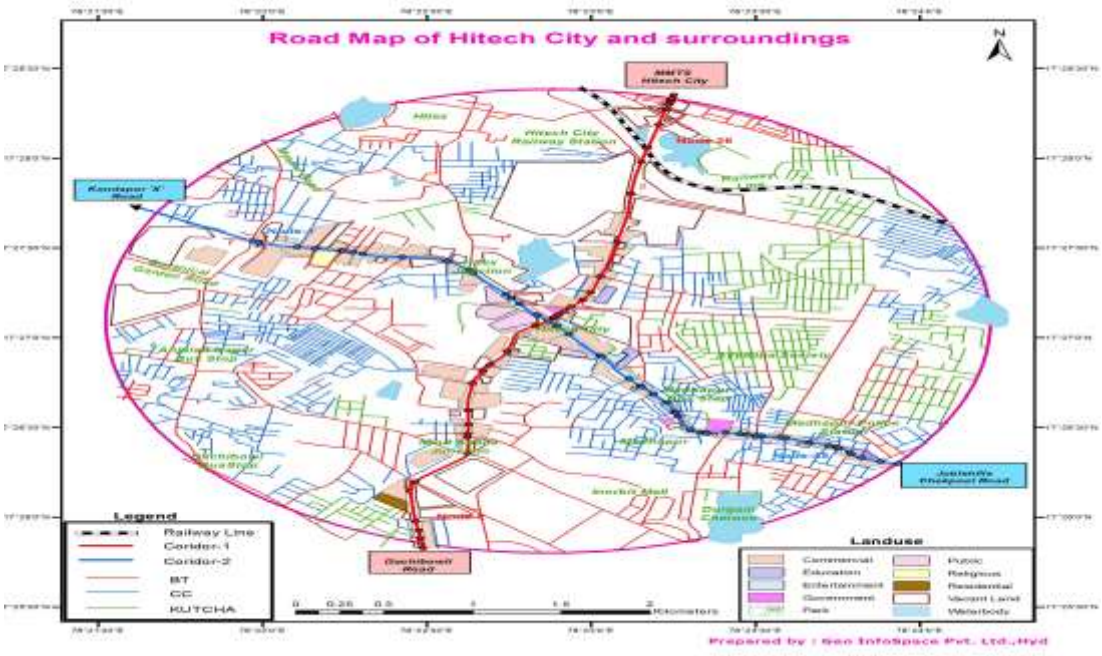

Fig (2)

Proposed Improvements

1. Implementation of flared sections at both sides of the three main traffic signals to bring homogeneity in traffic flow.

The more homogeneous the traffic, the lower the risk of (severe) injury. According to the homogeneity principle, it is necessary to apply measures to minimize the speed in situations with large differences in driving speed and direction. If there are also large differences in mass measures must be taken to separate the different road users, e.g. separate fast motorized traffic from bicycles and light mopeds. At those locations where road users with large mass differences still use the same traffic environment, speeds must be as low as possible. These are all possible ways to reduce the number of conflicts with serious or fatal consequences. Given the possible conflicts in different situations, Wegman & Aarts (2005), following the Swedish 'Vision Zero', have proposed safe speeds for different road situations (Table 1).

Table 1. Safe speeds dependent on road situation and conflict types.

Road situation by road user	**Safe speed (km/h)**
Roads with conflicts between cars and slow traffic	30
Intersections with lateral conflicts between cars	50
Roads with possible frontal conflicts between cars	70
Roads without frontal or lateral conflicts	≥ 100

2. Implementation of computer vision technology to monitor and implement lane discipline on road users.

Computer vision plays a key role in the transportation evolution. The application to road transportation system for the purpose of improving safety and efficiency and to assist law of enforcement. Computer vision in the context of traffic surveillance addresses problems such as vehicle detection, pedestrian detection, tracking, traffic flow measurement, lane changing etc.

Computer vision techniques rely on video sensors as the main source of data. Video sensors are arguably one of the most powerful methods for collection of road user positional data. Video data is rich in detail, recording devices are becoming less expensive, and

automated analysis is possible using techniques developed in field of computer vision. Furthermore, many jurisdictions are installing video cameras at traffic intersections for monitoring purpose. The ultimate goal of adopting computer vision technique is the automated extraction of road users positions as they navigate the field of video sensors.

Numerous road safety measures can be obtained from analysing road user positions. Extracting road users tracks from video sequences enables positional analysis at a comparable precision using manual observations is tremendously time consuming. By informed application of computer vision technique, automated and precise positional measurement is possible in a time and resource efficient way. In an analogy to the well-established research stream that tries to confer "intelligence" to transportation systems, the use of computer vision technique can be seen as an attempt to equip transportation system with a visual sense.

3. Explore the possibility of signal synchronisation for increasing the traffic discharge in the given study stretch.

A major objective of Traffic Signal Synchronization at intersection is to clear maximum number of vehicles through the intersection in a given length and time with least number of accidents, at maximum safe speed and with minimum delay.

Traffic signal synchronization allows a series of lights along a street to turn green based on synchronized timers set and preassigned speed to current traffic patterns and congestion levels. It is a cost effective way to reduce overall stops and travel delays.

Implementation of Intelligent transportation systems and advanced technologies like signal synchronisation is a must for highly populated cities.

OBSERVATIONS:

1. It was observed that expected delays are highly unpredictable due to various influencing factors which are specific to the time of travel and the road connectivity.
2. The traffic stream in the selected road was influenced by the merging traffic at service road junctions and U turns.
3. The absence of sufficient space for Bus stops and lack of parking areas is also causing congestion.
4. The movement of pedestrians was forced towards the central carriageway as the foot paths were closed at many stretches and there are no signals at the pedestrian crossings.
5. The observed delays indicate the necessity of changes in traffic operating system in view of alarming growth in road users especially in peak hours.
6. It was also observed that, the traffic was also highly heterogeneous and brining homogeneity in traffic could yield better results for all the other developments that can be planned and implemented in the present system.

SUGGESTIONS

The functionality of the transportation system in highly populated cities is affected by several of contributing factors. However, the capacity of the roads can be enhanced to a greater extent by providing flare sections near the intersections and by the application of traffic monitoring and surveillance systems like computer vision technologies. Homogeneity brings in sustainable level of service into the transportation system.

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