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PREDICTING TRAFFIC VOLUME AT UNSIGNALIZED INTERSECTION USING REAL-TIME MOTION DATA

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ABSTRACT:
In India, population development is a major factor contributing to intersection congestion because each person uses a separate car for transportation, which causes traffic to become out of control and lead to issues like accidents and traffic jams. As is generally known, a lack of traffic control systems causes numerous deaths in traffic accidents every day as not all crossroads have adequate signals. Because of the increased number of vehicles at the intersection, traffic cops are unable to control vehicle movement. As a result, all junctions ought to have adequate traffic signals, including specific ones made for emergency vehicles like fire and ambulances. This is because emergency vehicles experience delays at crossings when there is red light traffic, which is extremely dangerous for our community. Webster's approach and the Indian Road Congress (IRC) are used in this work to design a traffic light. A preferable choice for efficient mobility is a traffic signal. Traffic signal systems are utilized at intersections of multiple roads to regulate traffic flow through the use of traffic lights. Studies of traffic volume are mostly used to determine the number of vehicles that are traveling on a certain stretch of road at a given moment. The greatest method for regulating traffic at junctions to prevent collisions and accidents is to use traffic signals.
Keywords: PCU, IRC, traffic signal, traffic volume, and traffic light

INTRODUCTION

General Transportation

Transportation is of economic growth and development of country. In developing countries like India, Road transportation plays an important role in the development with road network second largest in the world after America, traffic study is very much important. In India, various types of vehicles with different dimension are present on roads and highways. With huge length of road, then also traffic congestion exists in India. To know the traffic capacity at any section or intersection, Passenger Car Unit is used. The traffic nature in India is heterogeneous fast moving vehicle and slow moving vehicle are present in same road which causes congestion To qualify the situation, all vehicle are converted into equal number of standard cars. That conversion is known as passenger car unit. Traffic consists on Indian roads of bi-directional freedom traffic such as two or three wheeled vehicles and unidirectional vehicles such as four wheelers or rejected by various modes of traffic. To prevent traffic accidents, conflicting traffic streams are separated either in space or in time.

Problem statement:

In the present time, road surface was not as improved as today and their maintenance was also not done as accurately in previous time as compared by recent times. The characteristics and dimension of vehicle in India were different from modern day's vehicles. Modern day vehicle on the roads of India is totally different from thevehicles which were present on that time when PCU values were calculated. The behavior of driver is also different from the past as compared with present time. Modern day's driver always tries to take advantage of loose disciplineor laws on the roads.

Speed Gun:

A speed gun is also known as a radar gun. It's a device that uses radar to measure the speed of vehicles or objects in motion. Police use it to find people who are exceeding the speed limit.

A radar speed gun is a doppler effect unit that may be hand-held, vehicle-mounted or static. It measures the speedof the objects at which it is pointed by detecting a change in frequency of the returned radar signal caused by the doppler effect, whereby the frequency of the returned signal is increased in proportion to the object's speed ofapproach if the object is approaching, and lowered if the object is receding. Such devices are frequently used for speed limit enforcement,

Figure 1: speed Gun

Google Earth

Google Earth is a computer program, formerly known as Keyhole Earth Viewer, that renders a 3D representation of Earth based primarily on satellite imagery. The program maps the Earth by superimposing satellite images, aerial photography, and GIS data onto a 3D globe, allowing users to see cities and landscapes from various angles.

Figure 2: User interface of google earth pro software

LITERATURE REVIEW

Tariq Azizr, Er. Neeraj kumar (2021), The purpose of this paper is to design the fixed- timed traffic signal control system for the intersections and to assess performance of the over- time design system. It is compulsory for every vehicle to pass through a signalized intersections for achieve the best performance of intersection without any conflict. Traffic signals give instruction to only one lane users to move at a time while other lane users are stop and wait for their chance by the indication of traffic lights.

Madhan Kumar V, Renuka Prasad M (2020), The main purpose of this paper is to Signal Re- Design through IRCand Webster's Technology in Bangalore Metropolitan. There are two intersection needed Re-design traffic signal first one is G. Palya and second one is Jakkur due to more congestion and precaution. There are re- design traffic signal timings for the present vehicular volume count. For the present traffic IRC method is suitable to redesign of traffic signal timings whereas webster's method are not sufficient. IRC method of signal timings implement to avoid the major accidents on particular intersection.

Wei-Hsun Lee and Chi-Yi Chiu (2020), The main purpose of this paper is to design the smart traffic signal to reduce the traffic congestion and improve the public transport efficiency with the help of ITS applications. Smart traffic signal means, no any fault take place at the time of working of signals. In smart cities, traffic signals are also designed for the emergency vehicles like Ambulance, Fire Fighting vehicles. In United States, there were 3708 accidents involving emergency vehicles between 2004 and 2008. Emergency vehicle drivers also slow down the vehicle due to red light at intersection. Therefore, traffic signal design for emergency vehicles is most important for emergency purpose and also give the first priority to emergency vehicles to pass through the intersection without any conflict.

Raghavendra S. Sanganaikar, (2018) In this paper the design of traffic signal is done according to the IRC93 method of signal design by adopting maximum average passenger unit (PCU) on the intersection in every direction. In this paper data have taken of the Kundalahalli junction, which is surrounded by 2 shopping malls, restaurants, corporate offices,

STUDY AREA

3.1 Description of The Study Area

The study was conducted on two lane roads which connected to Alwal junction, it covers Alwal road, Bolarum and old-alwal road. These two lane roads selected because different types of vehicles use these roads to transport. Description of each road is as follows:

Figure 3.: Real time picture of alwal road

Description of Boalrum Road:

The road section is started from old-alwal to secundrabad .It is two lane road, the traffic moving from siddipet towards secundrabad and kompally.The reason of selection of this road is a classic case of pathetic infrastructure at crowded junction. This cross roads emerged a choking point with mainly college commercial complexes and residential colonies springing up all around.

Description of old-alwal Road:

The road section is started from to shapur. It is two lane road, the traffic moving from various routes. The reason of selection of this road is a classic case of pathetic infrastructure at crowded junction. This cross roads emerged a choking point with mainly college commercial complexes and residential colonies springing up all around. There are different vehicles that use this road. These vehicles comes from different zones of secundrabad region and medchal regions.

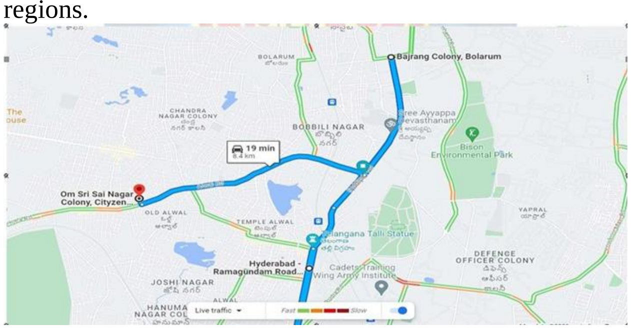
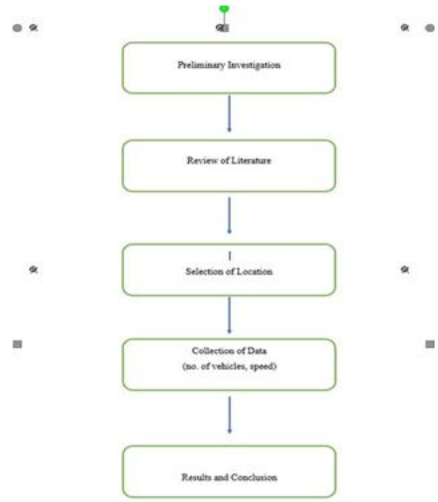


Figure 4: Road profile of old-alwal to Bolarum (source: interne

METHODOLOGY

introduced in the year of (1965) by Highway Capacity Manual (HCM) and that was for the stream of cars and trucks since then good research have been done after publication and many methods have been evolved over the years. Passenger car unit (PCU) defined as the number of passenger cars that are displaced by a single heavy vehicle of a particular type under the specified roadway, traffic, and control conditions.

So the present study attempts to figure out the number of passenger cars displaced by a specific type of vehicle, based on a traffic parameter as the equivalency criterion. From the literature survey, it is understood that methodsbased on speed are the most effective and commonly used for estimating PCU. In this respect, the definition of PCU as given by the Transport Research Laboratory (TRL) becomes handy. As per this definition, on any particular section of road under prevailing traffic conditions, the addition of one vehicle of a particular type per hour will reduce the average speed of the remaining vehicles by the same amount as the addition of, say x cars per hour, then one vehicle of this type is equivalent to x PCU. This definition of PCU based on speed is utilized in thepresent study to estimate PCU values for urban roads. If there is a linear relationship between speed and volume, the computation of the PCU value of any vehicle type becomes simple, as per the TRL definition. It gives a reasonable estimate of PCU when linear relation between speed and flow is assumed. i.e. the signal control is independent of demand



4.1 Passenger Car Unit:

It is common practice to consider the passenger car as the standard vehicle unit to convert the other vehicle classes and this unit is called passenger car unit or PCU.

The PCU may be considered as a measure of the relative space requirement of a vehicle class compared to that ofa passenger car under a specified set of roadway, traffic, and other conditions.

The PCU value of a vehicle class may be considered as the ratio of capacity of a roadway where there arepassenger's cars only to the capacity of the same roadway when there are vehicles of that class only.

Effect of traffic characteristics on PCU

A number of studies emphasized on the influence of traffic flow parameters on PCU. The influencing parameterswhich were considered in these studies are speed, volume, traffic composition and level of service (LOS).

Effect of road geometric factors on PCU:

Geometric factors such as carriageway width, gradient, horizontal curvature, etc. also have a considerableinfluence on PCU

Controlling condition:

Speed Limit, no access of heavy vehicles these types of controlling condition can also affects the PCU values.

PCU VALUES

TABLE 1

BIKES	0.25
CARS	1
HEAVY VEHICLE	2.8
BUSES	3.6
AUTO	0.6
CYCLES	0.25

Webster's Method of Traffic Signal Design :

Studies have shown that the length of the signal cycle affects both the average delay and the overall delay experienced by the cars at a signalised intersection. When the cycle length is very short, the average delay per vehicle is large because a significant number of vehicles might not be cleared during the first cycle and might continue into following cycles. There is a "optimum signal cycle time" that corresponds to the least overall delay, as the average delay per vehicle drops as the signal cycle time increases up to a specific minimum value and thenthe delay starts to grow. The intersection's geometry and the amount of traffic entering the intersection from all directions determine the ideal cycle time. The field work consists of determining the following two sets of values on each approach road near the intersection: (I) the normal flow, q on each approach during the design hour and (ii) the 'saturation flow', S per unit time.

Basic Concepts of Delay Models at Isolated Signals:

As stated earlier, delay models contain both deterministic and time is that portion of green where flows are sustained at the stochastic components of traffic performance. The deterministic saturation flow rate level. It is typically calculated at the component is estimated according to the following assumptions: displayed green time minus an initial start-up lost time (2-3 a) a zero initial queue at the start of the green phase, b) a seconds) plus an end gain during the clearance interval (2- 4 uniform arrival pattern at the arrival flow rate (q) throughout the cycle

c) a uniform departure pattern at the saturation flow rate (S) while a queue is present, and at the arrival rate when the queue vanishes, and d) arrivals do not exceed the signal capacity, defined as the product of the approach saturation flow rate (S) and its effective green to cycle ratio (g/c). The effective green seconds depending on the length of the clearance phase). A simple diagram describing the delay process in

Signalized intersections are the interrupted traffic flow facility in a roadway network. The efficiency of traffic operations at the signalized intersection is expected to improve during inter- green intervals. To improve the quality of service at an intersection the traffic control devices are used widely over the world. The time intervals defined for traffic signal operation help to reduce severe traffic conflicts, delay, and improve driver's decision for making turns. The present study evaluates the performance of traffic operations under with and without signal countdown timer (SCT) conditions based on field data collected

Methods for the Design of Traffic Signal: -

Traffic signals are the best way to control the congestion at intersections. Instructions are given to driver with the help of traffic lights (Red, yellow and green).

Here, we are using two - methods for the design of traffic signal at non-signalized intersection. Webster's method

IRC method

Design Procedure for Traffic Signal by Trial Cycle Method: -TRIAL CYCLE METHOD:-

In This method traffic volume is taken per 15 minutes

Design steps :-

Assume a cycle time of Tse

No. of vehicle approaching the intersection on one cycle time xA=nA/15*60*p Where , nA – Traffic volume on road per 15 minutes

xA – No. of vehicles approaching the intersection from road A

XB=nB/15*60*T

Where , nA – Traffic volume on road per 15 minutes

xA – No. of vehicles approaching the intersection from road A Average time required for one vehicle to cross the intersection = timeheadway(tn)

RESULTS AND DISCUSSIONS

Survey Data:

Graph 1: Representation of percentage of different category of vehicle Per Hour in .

In this project, we have obtained the total count of vehicles per hour using PCU. The total count of vehicles per hour is shown in the pie chart below. As we can see, bikes had the highest count at 64.44%, followed by cars at 15.06%. Heavy vehicles accounted for 15.4%, which is expected on national highways where they have a higher presence. Buses had a count of 3.525% and autos had 1.28%

Table 5.1: Number of different categories of vehicles at intersection:
The following table explains the total count of different vehicles at Professor Jayashankar Statue Alwal Junction over a 10-minute time period.

TYPE OF VEHICLE	No. of Vehicles		
	Phase – 1	Phase -2	Phase – 3
BIKE	804	348	2750
CAR	188	156	812
AUTO	16	92	524
HEAVY VECHICLES	196	NA	48
BUS	44	24	76
TOTAL	1248	620	4210

Table 2

CALCULATIONS:

Webster's Method:

Webster's method is a rational approach for designing traffic signals. It is simple and is based on the formulaegiven by Webster.

Webster's method of traffic signal design is an analytical approach of determining the optimum signal cycle time,Co corresponding to minimum total delay to all the vehicles at the approach roads of the intersection.

Design Procedure for webster's Method

Normal Flow of Vehicles on Road, Denoted by q. Saturation Flow of Vehicles on Road, denoted by S.

Critical Flow Ratio of Vehicles on Road, denoted by Y and Y= q/S.

Total Lost Time L= 2n+R (n- number of Phase, R- All Red Time for Pedestrian, 12 Seconds) Optimum Cycle time, Co= 1.5L+5/1-Y (seconds)

Effective Green Time Per Cycle= Co-L

VEHICLES APPROACH ON ROAD-1

Bikes - 804×0.25 = 201 PCU (30%)
Cars - 188×1.0 = 188 PCU (28%)
Autos - 16×0.6 = 118 PCU (17%)
Buses - 44×3.6 = 158 PCU (23%)
Heavy vehicles - 196×2.8 = 45 PCU (2%) Total = 710 PCUVEHICLES APPROACH ON ROAD-2
Bikes - 348×0.25 = 87 PCU (23%)
Cars - 156×1.0 = 156 PCU (41%)
Autos - 92×0.6 = 55 PCU (14%)
Buses - 24×3.6 = 86 PCU (2%)
Heavy vehicles = -NA- Total = 384 PCUVEHICLES APPROACH ON ROAD-3

Bikes - 2750×0.25 = 690 PCU (31%)
Cars - 812×1.0 = 812 PCU (37%)
Autos - 524×0.6 = 314 PCU (14%)
Buses - 76×3.6 = 274 PCU (12%)
Heavy vehicles - 48×2.8 = 134 PCU (6%) Total = 2224 PCU

Width of road-1 (w1) = 7.5+2.5 = 10m Width of road-2 (w2) = 7.5+2.5 = 10m Width of road-3 (w3) = 7.5+2.5 =10m

Saturation flow (s): Saturation flow on road-1 (s1) = 525 × w1= 525 ×10 = 5250 PCU/hourSaturation flow on road-2 (s2) = 525 × w2= 525 ×10 = 5250 PCU/hour

Saturation flow on road-3 (s3) = 525 × w3= 525 ×10 = 5250 PCU/hour Saturation flow on

Total cycle time = 86.02 seconds Total Green time (G): Gi = yi/y($C0 - L$)G1 = 14.6 seconds

G2 = 7.9 seconds G3 = 45.49 seconds R1 = 69.42 Seconds R2 = 76.12 Seconds R3 = 38.57 Seconds

Using the Webster method, we determined the signal timings as follows:

For Road 1, the red time is 69.24 seconds and the green time is 14.6 seconds. For Road 2, the red time is 76.12 seconds and the green time is 7.9 seconds. For Road 3, the red time is 38.57 seconds and the green time is 45.49 seconds.

TRIAL CYCLE METHOD:-

In This method traffic volume is taken per 15 minutes, is a technique used in traffic signal timing design. It involves selecting an initial set of signal timings and evaluating their effectiveness through observation or simulation. Based on the observed results, adjustments are made to the signal timings, and the p

Design steps :-

Assume a cycle time of Tse

No. of vehicle approaching the intersection on one cycle time xA=nA/15*60*p Where , nA – Traffic volume on road per 15 minutes

xA – No. of vehicles approaching the intersection from road A

CONCLUSIONS AND FUTURE SCOPE

Installing a traffic signal at an intersection helps to reduce traffic congestion.

Installing traffic signals at intersections facilitates safe, collision-free traffic flow.

Traffic signals lessen the frequency of collisions on the roadways, such as collisions between two vehicles at a right angle and pedestrian accidents.

When traffic signals are installed, intersections may handle more traffic when there are no traffic cops present.

At intersections, an automatic traffic signal is cost-effective, precise, safe, and efficient day or night.

The heavy traffic was seamlessly managed by the traffic signal at regular intervals. The goal of this project is to improve vehicle mobility at intersections and reduce traffic congestion.

Since traffic congestion has peaked, we have created a lot more sophisticated and intelligent infrastructure traffic network for our project.

In contrast to the trial cycle approach, the webster method calculates the signal timings and total cycle timings. The Webster approach produces precise findings.

The intersection's total cycle duration is 86.02 seconds. Road 1's green and red times are 14.6 and 69.42 seconds, respectively.

The green time for route 2 is 7.9 seconds, while the red time is 76.12 seconds. The green time for route 3 is 45.49 seconds, and the red time for all roads is 38.57 seconds. The amber duration is two seconds, and the red time is twelve seconds, which includes the pedestrian time.

6.1 FUTURE SCOPE:

Based on the results of this study, it is thought that intersections with higher traffic capacity can benefit from improved analysis.

Since this project is being used at every intersection in places like London, America, Russia, Japan, and China, it is helpful in emerging nations and has a promising future.

Without traffic police, traffic signals assist us in controlling the flow of vehicles.

At intersections, three traffic light signals—Green, Amber, and Red—are shown. Therefore, there is no trouble at all for the driver of a vehicle.

The driver of the vehicle saw the intersection's traffic light indication immediately and crossed it without incident or delay.

Increased technological developments as a result of this initiative will benefit individuals in various ways.

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