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Research paper

A novel approach on transport information system for pre-defined routes using traffic estimation framework and open layer JS

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Abstract

The need for effective transportation is a must for a country like India with multiple states and languages. But due to the complex system of public transport effective services was not considered a priority earlier. When we come to a new place, a hurdle to reach your designated place due to a lack of information on public transport is higher. This is a nationwide problem. The manual timekeeping methodology also became obsolete by the growth of public transport and with a growing population. Indian public bus transport has a huge number of 112 thousand buses with the annual growth of 5percent. To make a tracking and monitoring system for this amount of buses is completely a burden for the budget makers. The present-day GPS tracking systems need at least a twenty-five thousand rupees system per bus. This is not going to possible for present-day Indian scenario. So, we came up with a software-based vehicle tracking in pre-defined routes. This is done using various kinds of collectors with mobile applications and sensors. The role of kinematics is kept higher here than the GPS sensor data. Open-source mapping API is used to give the end-users a visualized outlook. This kind of software system reduces the economic burden for the monitoring and estimation process with 90 percent accuracy in the simulation stages.

Keywords: *Open Layer JS; Vehicle Tracking; Traffic Estimation; GPS; Public Transport.*

1. Introduction

In India, public transportation is the backbone for the common people and more than 112 thousand public transport buses are operational. This amount seems huge but compared to the expansion of population in India, it is insufficient. There are many towns and villages not properly connected by the public transport systems present in India. This is not because of the budget constraint or developmental constraint. It is because of poor planning and administration in public sectors. There are many cities with metro trains, urban trains, private transport, and public transport buses. Most of them underutilized or more than they need for those cities. Most of the public transport systems are very poorly managed and administered. There is no check and balance in the system to keep the public transport vigil. The so-called schedules are not a part of daily routine in the public transportation buses. This is because of the traffic congestion in the metro cities. The growing population expands the city's boundary into its extreme. So, the city governance needs to put more effort to connect all the point of the city. The huge burden of this kind of expanding cities finally falls on its public transport.

Tamil Nadu state transport services are the nodal agency of transport in the state of Tamil Nadu. It has the fleet strength of 22 thousand buses and vehicles. It is one of the biggest bus transportation services in the country. It has more than 1.4 lakh employees. There are certain short backs also inevitable with these kinds of huge infrastructural facilities. Lack of maintenance and administration is the major problem here. There is only a manual check and balance in the system for keeping schedules in the field. They are manual timekeepers. But the increasing number of fleet and new routes introduction made the manual system crumbling. The obsolete system of manual timekeeping made this huge transport system slightly untrustworthy. The major demotivation for the people of the state to use public transport in major cities is a time delay in the journey and unpredicted time of arrival and departure. To counter the problem, experts suggested a GPS system on board. But due to the heavy budget cost, it was scrapped very long back. The recent economic scenario of the TNSTC shows that they are not anyway near to the GPS based tracking and monitoring. So alternate approach with less budget and comparably better accuracy is needed. In many ways, a cheap and better system for tracking and monitoring should be developed. Using radio frequency transmitter and sensor monitors on road are also present in the systems for vehicle tracking. But it is a less efficient system with cost funding almost same to the GPS tracking system. It is less efficient because radiofrequency or sensor reading tracking needs a sophisticated communication network and many sub servers to efficiently process the data. And needs a considerable number of workers to maintain the stationary sensor reader and the sensor onboard on the vehicle. And open public cooperation and mobile phone device app-based monitoring methods are also used for traffic monitoring. But this method is good but needs refining. That is what we

have done here. We took the base idea and made a comprehensive framework with an excellent communication module for vehicle tracking.

Here we create a mobile phone application to capture their flow rate, positional data for some extant, directional details from the sensors present on the mobile phone. The mode of collectors is also different here. Because we cannot rely on data collected by a single set of the same collectors. Diversity in the data pool can make an excellent base database for this kind of sophisticated task. The search engine giant Google is also giving this kind of service for the public, but it costs high. And the service provided by Google is also not efficient because it tracks signal by very high amount crowd with GPS points. This makes an iteration problem. There is more unworthy collector than the worthy collectors in this approach. There is no filter for the collector selection here. That is the reason we should develop and tailor our own framework for our own problem. We here use Openlayer mapping API for the visualization for the end consumer. OpenLayers is an open-source JavaScript library for visualization of map data. This is the main reason for the reduced cost budget here. Propriety software needs a hefty budget to purchase their license. And that also for limited periods. When the updated version gets released the support for the existing old software become troublesome. So, the opensource integration here will make the budget less and the future up-gradation also possible without any hassle.

This proposed system is suitable for all environments. But it will excellently perform in pre-defined routes like government bus transport where the stops are marked prior and they are time stamped. School bus tracking is also similar and important like public bus transport. They have pre-defined stops and they carry children so their safety should be given high priority. And involving private players like private school and college will further reduce the budget of the project. And their participation in this data collection will make this system very viable because of their academic tie-ups. New additional upgrades can be done with their research and development partnership. This system gives an edge to the existing system because here the data collection process is done by three types of collectors, they are 24*7 data collector, temporary and voluntary collectors.

Hoang Dat Pham et al [1] proposed a vehicle tracking module using the Mobile network and GPS data. Tripathi [2] proposed an algorithm for the detection of traffic hotspots using the mobile GPS data and k mean algorithm. Kardashyan [3] developed a comprehensive system for traffic management and monitoring using the sensing data, video camera visuals, and GPS data.

2. Proposed software based traffic estimation advantages

2.1. This proposed system is better than the usual gps based tracking system on the following domains

- Device Cost: In the GPS tracking device a standalone GPS and communication device should be fitted with every vehicle that is going to be monitored. Each system of on-board GPS cost at least 25 thousand rupees in Indian currency. On the whole country-wide this is a huge budget. This is not economically feasible. In our proposed system no onboard a is needed. We use a mobile device with minimum sensor requirement. Accelerometer, compass sensor and GPS (optional). So, the cost of this system is almost a quarter of traditional GPS tracking systems. A minimum of seven thousand rupees is needed for a vehicle to participate in the tracking and monitoring framework. And this also included with the software package.
- Start And Stop Of The Vehicle: Traditional GPS tracking system has some shortfalls in the identification of the vehicle in motion because of the time delay associated with their framework. And there is no provision to calculate the kinematics of the vehicle. But in our proposed system we take accelerometer details and directional details from the vehicle. Google does not take any accelerometer data from the user's mobile device; it simply relies on GPS data. So the proposed method is a comprehensive one.
- Proper Following: GPS based Tracking systems and on-board GPS equipment are all delicate systems which need high maintenance and proper following of guidelines given by the manufacturer for better performance and long life. But equipping the staves for this kind of sophisticated maintenance is time taking and less efficient process. Because the minimum qualification for maintenance and operation of such a system is ITI or Diploma. We cannot teach those level skills to an unskilled person in short duration training. So, the integration of such a delicate system in the Indian transport scenario currently is less efficient in the long run. So that only we are proposing the usage of mobile phone platform for the tracking and monitoring of vehicles. In India, at present 75 crores, mobile phones are in operation and most of them are android based smartphones. Smartphones handling is very close to the common people. Using an android/ IOS app is not rocket science. Anyone with experience of using a smartphone can use that. So, this proposal needs almost zero induction training session to the staves of the transport services. A simple pamphlet or manual guide in the vernacular language is enough for the staves to perform daily operation and maintenance.
- Individual Cooperation: We incorporate the public as one of the data collectors. We use permanent data collectors like public transport and private transportation services. And along with permanent collectors, we allow some public to participate in the data collection process. This move is done to get the diversified data pool. Accuracy of the tracking gets increases with the increase in the number of collectors. Public transport alone cannot give substantiate details for the traffic status in real-time. For permanent or 24*7 data collector we do an extensive background study about their pattern for months if possible, for years. With this background study, we get a significant amount of information for the prediction of vehicle status is present. But this prediction is not dynamic. It is an output of a mathematical model with a long background study. The end-user that is public needs accurate real-time updated information for their travel so as to participate in some dynamic entities to the data collection process will yield good results.

2.2. Advantages of the proposed system over the traditional methods

- For map updating, we use open source mapping API, Open Layer JS. Updating the changing topography and adding new construction of roads, bridges can be effectively updated in the open-source platform. It is a cost-effective process because open source software is free of cost.
- Higher collector count and easy collection processes. Verity of collector for all time data feeding.
- Vehicles are addressed with primary ids. If a bus route allotted with a different bus due to some problems with the original bus, we can easily tackle the issue. This proposed framework is also made to edit and do manipulative tasks for the administrator needs. We can switch the primary id easily between fleets.
- The simulation processes were given an excellent report for the framework. So, this framework is highly trustworthy.

- GPS has coverage issues that mean it cannot operate in the dense canopy and Tall building can shade the receiving of GPS signals. There are many topography related problems with GPS. In our process, we use kinematics details fed through network communication which has no difficulties as GPS and Google mapping services have.
- We arrange kiosk-like public visualization for the end-user aka common man. This visualization will be on the open street map platform. In that, they can see the movement of vehicle between nodes and their estimated arrival and departures. And some custom queries can also be made from the end-user to server. This will be processed, and the reply will be sent back to the end user's platform.
- Less Network cost, this proposed system will cost very less network cost than the traditional systems in practice.
- Annual hardware and software maintenance can be done with indigenous persons. The maintenance is so simple. Training can be given to the transport or public engineering department persons. They can effectively perform annual maintenance.

3. Software based transport information system

Fig. 3.1: Basic Architecture of Software-Based Transport Information System for Pre-Defined Routes Using Traffic Estimation Frame Work and Open Layer JS.

This research consists of five modules. Those are as follows, Data Collection: It is the primary process of gathering vehicular information in real-time from the various collectors. It is the first step for the Traffic information system module.
Cloud Data Publishing: It is the step where the collected data from the data collectors are fed to the cloud data storage. It is a communication process between the data collector to the cloud server. Communication protocols were designed for speedy upload and effective storage and transfer system.
Data Verification and Testing: It is the heart and brain of the project. Here the gathered data were processed using the traffic estimation algorithm and the effectiveness of data is validated.
Data Visualization: This part is specifically for the end-user, the public. Here the processed information from the collected data is presented in the way so that the public can easily read. Various ways of representation are used to visualize the processed information to the public.
User Portal Testing: Here, the user end portal is tested for its overall performance. Many factors regarding the visualization technique and the designed software interface are validated and tested using performance evaluation algorithms and tests.
Almost all large-scale systems should support their users' access. E-commerce website to telecommunication services all are facing large-scale user access in millions. Many studies have shown the inability of these systems to scale to the demands of its users. Weyuker et al [4] discussed the situation of why all systems are compelled to do the load testing. Firefox incident of meltdown and the importance of stress load test discussed in Firefox incident report [5]. If an inefficient system placed in a place of high demand access site then the user access requests will overpower the system so there is a chance of getting a meltdown or a complete shutdown. (example Apple MobileMe incident[6], Stolberg healthcare issue US health care government website[7], herald [8] road map for testing case study). A Load test is a combination of procedures like unit test and integration test. Functional testing has a clear testing objective unlike the unit testing [9]. Avritzer et al discussed the Load testing also called a performance test or stress test [10]. Bayan et al [11] proposed an automatic control and stress-based load test. Gheorghiu et al [12] discussed a comprehensive comparison of load and stress test of applications. Meier et al [13] processed web application-based test on a load of web applications.
Load testing is the process of accessing the system in the various extreme load-related process and responding scenarios. The rate at which the various service request is given is called SUT (system under test). SUT and load are interchangeable terms [14]. Deadlocks, butter overflow, racing are the functional problems happens in the high-profile systems [15]. There are some nonfunctional problems occur at the systems namely stability of applications on load test discussed by Menasce et al [16], reliability of the test results of load and network test discussed by Bayan and Cangussu [17] robustness of structural framework is discussed in Yang et al [18].
A load test can only be tested in a prototype or real system. A load test cannot be applicable in the framework or architectural modules. The load test is mostly binary in type so they can note as pass/fail criteria. There is a universal phrase or formula for load testing "no worse than before ". It is called no worse than before because every time any improved version tested against an older version. The result should be no worse than before and not the other way around Beizer et al [19]. There is a general rule for the load test that is the system should be tested against the real-world load access, Avritzer et al [20], discussed the stress load scenario where the threshold of the system is tested in which extreme access request and handling scenarios were given. Because every system should contain their threshold details in it. This extreme and field like test will bring the nonfunctional cases into the light. The load test is the process of making or devising a load plan for the system test. There are two types of load design methods to achieve optimum result stage.
Designing a realistic load. There is an outlook that systems should be tested as per the real-world conditions and resemblance. If a system handles SUT without any functional and nonfunctional problems then the system can be put in the real-world scenario. And it can be claimed as load tested. But here the time frame for this testing is not clear anywhere. So, the real world SUT test can be done for days or months to record their optimum performance and analyze the data for the complete picture of the load testing.
Another outlook is accumulated called workload design approach, for example, e-commerce websites are designed to handle registration of an account, purchase request handling and browsing the items. These three requests should be handled simultaneously for a various number of requests. It may be 10 thousand purchase request per minute and million browsing per minute, 25 thousand registration per minute. So, the performance test should be conducted according to the type of request and its size. This should be in accordance with the type of request and the load associated when they are combined in the real world.
The use of case-based load design approach, this approach is based on the real-world request manner. The test requests were drawn from the existing real-world request from another existing system. For example, a website is designed to book reading than the test requests will be drawn from some kind of book reading websites and the test will be conducted for how many pages can be loaded in a minute and turn around, scrolling speed, etc.,
Designing fault inducing loads, unlike the realistic tool testing approaches, this fault inducing load tests are designed to test the functional and non-functional problems arising. These test results are very crucial and very simple in a manner to test.

An operational profile is the expected field usage in the operational field. For example, in an e-commerce website, there will be a concurrent request like purchase and register or purchase and browse, the system should be efficient to handle these concurrent requests. Extracting the original workload on the field is termed as workload characterization.
The aggregated workload can be divided into three load components they are steady load test, stepwise load test and extrapolated load test. The objective of these three types of load test is to find the functional and nonfunctional problems under the load scenario. Steady load test takes the operational profiles and past usage data as its data source. The output will be a configuration of workload mix and intensity mix. Stepwise load test has the same objective as of the steady load test detecting functional and nonfunctional problems under load, the data sources will be operational profiles and past usage data. The desired output of this test is multiple configuration and mixed workload intensities [21]. The extrapolated load's objective is also the same, and it takes beta user usage data and interviewing domain experts, competitions data as its source. The desired output of the extrapolated load is one or more configurations of mixed load and workload intensities.
The user case-based load design approach is divided into four models. 1) Testing loads derived from UML models, the objective of this test is detecting functional and nonfunctional problems. UML use case diagrams and activity diagram, operational profiles are the data sources for this test. The desired output will be UML diagrams branded with a rate of requests. 2) Testing the loads based on Markov model results. The data source here is past usage data. The objective of this test is the same as the previous test. The output will be Markov chain models. 3) Stochastic form-oriented models for load testing, the objective is to detect functional and nonfunctional problems. The data source is an operational profile, business requirements, and user configurations. The output of this test will be stochastic form-oriented models [23] 4) Tests loads based on the derivation of probabilistic timed automata, the objective is same as the earlier test to detect the functional and nonfunctional problems. Lee et al, on the urban data case study showed that the data source is user configuration. The output will be probabilistic timed automata [24].
The importance and usage of the Simulated Annealing [SA] with Fuzzy Inference System in WSN [Wireless Sensor Network] are discussed in the paper [25]. Sequential model for missing object location finding in Monte Carlo Method is discussed in [26]. A multidimensional optimization technique is used to estimate the location of the missing object, using updated object position, velocity and the extensive simulations [27]. Data aggression algorithms gather and cumulate the data in an energy-efficient manner to increase the validity of the network to a new extent [28].

3.1. Importance of software based traffic monitoring system

Traffic information systems primarily invented for the purpose of the effective journey experience. Effective journey experience is all about knowing the journey duration, traffic condition along the route, and alternate vehicle route in case of any problem happened during the journey. Across the globe, traffic information systems bring a lot of effective changes in the transport systems. There are new algorithms designed to monitor and process the traffic data validation and testing data accuracy, the primary motto of these algorithms is to give information with at most accuracy. Error-prone traffic data can impact the whole traffic information system's credibility.
Algorithms designed to filter the fed data with pre-defined data selection criteria for the elimination of unworthy data from the pool of data. The heavily used traffic estimation method all along the globe is GPS based traffic estimation method. But this is an expensive method and it has many shortfalls. GPS for public usage has many inbuilt error features and GPS coverage is not the same for topography. GPS coverage is a big problem in the hilly regions and metro cities with high raised building, the deep canopy and the tall buildings, bridges can shade the GPS receiving. So, there is a need for alternative methodologies for traffic estimation and monitoring. That is why we propose a methodology with an algorithm on kinematics data of the vehicle to find the traffic updation. This non-GPS based methodology can effectively give the live updation of the traffic and vehicular positional detail.
In this methodology, we concentrate on the node to node vehicular traffic estimation and monitoring. The node can be street to street traffic monitoring or a junction to junction vehicle monitoring. We capture the vehicle speed via its accelerometer and compass sensor details. With the speed and direction details of the vehicle, we estimate the vehicle's movement and its speed in the journey. This can be done on the node to node basis to enhance the information accuracy. This methodology is the best alternate for the highly budgeted GPS based traffic systems. This methodology is completely automized, the data collection is also completely on the mobile sensor, the process and validation everything is on the digital platform. Human interference is completely reduced here. So, manipulation of data is completely zero in the whole propose of this proposed process. In the algorithms itself, there are some checks and balances to select the data and validate the data. So, the result will be highly credible and the proposed algorithm is an amalgamation of vehicular based traffic estimation algorithm and link-based traffic estimation algorithm. This amalgamation is done to counter any sophisticated monitoring process on the real-time. Any vehicle participating in this vehicular monitoring program can be monitored effectively whatever may be the vehicular route and whatever terrain it picks for the route. The network coverage and topography related issues were fully and effectively addressed here in this approach.
The network communication between the collector, server and the end-user are designed using the latest mobile networks. This was designed with the idea of reduced computational and network load even when the huge number of participants sending data to the server and high number requests from the end-user portals. Here many performances and load tests were carried out to test the designed framework for the real-world request scenario and some extreme scenarios.
The end-user experience is the most important part of this module. The whole system is designed to build for its end-user so the visualization and user information sharing portal is the most important aspect of this proposed model. An effective visualization model (user interface) and information sharing model should consist of effective pictorial representation and effective presenting techniques for a good experience of the user. Here the traffic information was presented in the form of map overlay. An effective and interesting mapping API concept is selected for the data visualization process. The processed information is integrated on an open street map. An open street map is an open-source platform and it is very dynamic future updation and increasing the boundary of the monitoring systems are all can be effectively done using the open street map. This is the alternative method to the existing GPS based prediction methods.

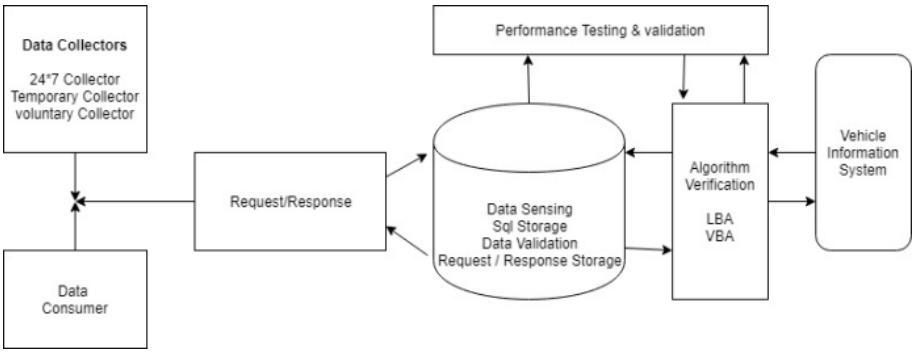

Fig. 3.2: Working Principle of Software Based Traffic Estimation System.

The Architecture of software-based traffic estimation system is designed with four major components. Data collectors and consumer end, Data processing and validation part, algorithm verification and testing, vehicle information system. On collector and consumer end, collector and consumer have different roles and they are similar in the way with their interaction with the server. There are three types of collectors involved in this process.

- 24*7 collectors are all-time permanent collector they gather data in real-time and send to the server in all parts of the day. They are the main participant in the data collection process.
- Temporary collectors collect data for a part of the day say an hour of the evening or an hour in the morning and evening. They collect the data for a certain period. They are not a regular data collector. Their reputation in the data collection process in less. But they constitute almost 10 percent of the total data collectors.
- The voluntary data collector is active participating collector in this data collection process. The reputation of this data collectors is at the bottom of the list. But they cover areas were our permanent data collectors missed to collect. They greatly participate in the diversity of the data pool and the accuracy of the result.

The collected data is shared with the server by request and response layer. This is a communication layer between the mobile device platform to the server-side as well as the end-user side. The communications are done through advanced communication layers.

The next part of the system is the server end. Here the collected data are stored and used for further processing. The fed data are validated using data validation techniques and the request/responses made by the collector and consumer are getting stored here. The gathered data (accelerometer data, compass sensor, and time data) are fed. The traffic estimation algorithm and the final output of vehicle speed and direction, positions are all calculated. This algorithm is tested and validated with the older data iterations. This is done to maintain the data accuracy of the final output.

Performance Testing and validation is the process of testing and monitoring the performance of overall software and hardware interfaces used in this system. Every system is designed to serve a purpose. Keeping a benchmark for the performance of the system against the desired purpose is performance testing or evaluation. Network load test also conducted to test the effectiveness of the system under extreme stress. Stress is the number of request and response the system can handle in a minute.

The vehicle information system is the part where the processed information is overlaid with the spatial platform to give a meaningful representation for the vehicle and traffic condition. This part is designed to meet the end-user requirements.

4. Case study “real time traffic status monitoring”

Existing Data source for traffic estimation (For public use)

- Google Map

Google map services provide real-time traffic status and journey time estimation. Accessing the data on google for commercial purposes is highly-priced in google map services.

- Concerned Competent authority data on traffic

Metropolitan transport services monitor public bus transport services data. They monitor travel time and flow rate all around the city.

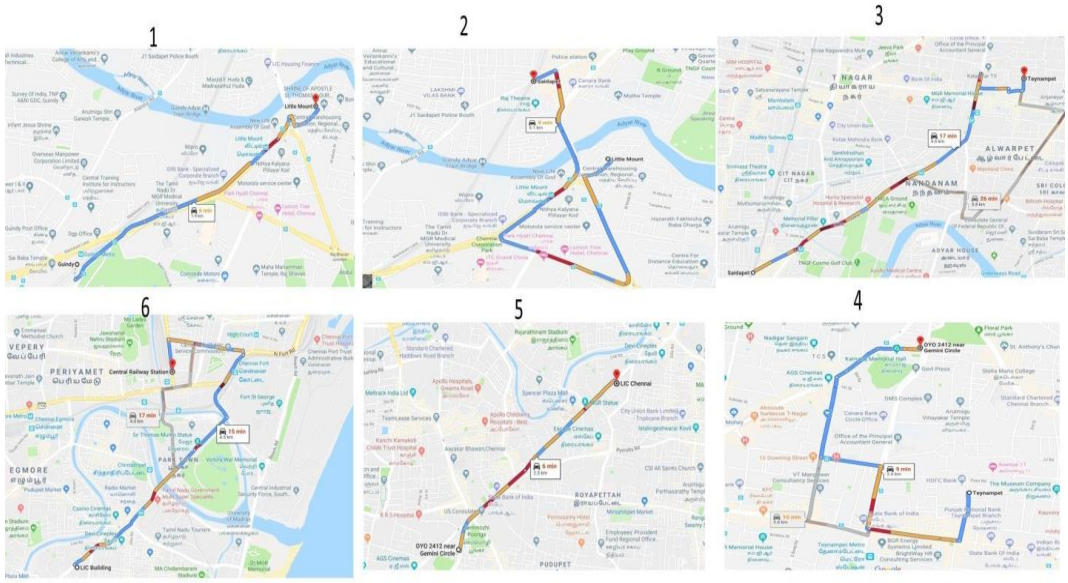

Fig. 4.1: Google Traffic Estimation Map between Guindy (1) To Parrys (7).

Table 4.1: Table of Bus Stops and Distance, Travel Time Details

S.no	Source	Destination	Distance(km)	Travel Time Peak Hour(in min)	Non-Peak Hour(in min)	Weekend(in min)
1	Guindy	Little Mount	1.7	7	5	4
2	Liitle Mount	Saidapet	3.1	10	9	7
3	Saidapet	Teynampet	2.4	12	11	8
4	Teynampet	Gemini Circle	3	13	12	9
5	Gemini Circle	LIC	2.6	8	9	7
6	LIC	Central	2	14	11	10

Fig 4.1 shows the google traffic estimation services. It shows the traffic pattern between Guindy to central stations bus stations. The google map uses a color-coded system for representing the traffic condition along the routes. Google traffic estimation framework uses GPS data to analyze the traffic flow all around the city. But the google mapping API is not free of cost they are pretended for proprietary usage only. The amount for the purchase of a license is a hefty one. It cannot be viable for large-scale traffic estimation. The number of patterns given in the map fig 4.1 is in accordance with the serial number published in table 4.1.

Table 4.1 is the traffic estimation raw data calculated manually by the timekeepers of the metropolitan transport services. It is a raw data on traffic estimation and flows. But this data is very limited. The available traffic data and the flow rate is only for the peak, non-peak and weekend time. There is no real-time updation here. These data are prepared by a yearlong routine pattern of the metropolitan buses on the mentioned bus stops. Both the existing data is either costly or inadequate. So, the need for an adequate and cheap methodology is evitable for the Indian scenario.

A case study is done for this proposed software-based traffic estimation system. The location chosen is Guindy to Central station bus stops in Greater Chennai metropolitan city. The total length of the case study location area is 14.8 kms and the number of bus stops is six. A comparison is done between the existing data on traffic estimation. The data compared are estimated data from the metropolitan transport services, existing Google traffic estimation services data and our proposed software-based traffic estimation method data.

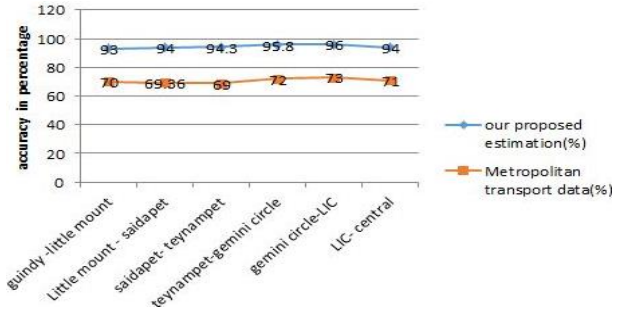

Fig. 4.2: Comparison between Accuracy of Metropolitan Transport Services Data vs. Our Proposed Software-Based Traffic Estimation Data.

The comparison showed that Google traffic estimation data is considerably accurate. The data received from the metropolitan services shows poor inaccuracy. It is 70 percent accurate. Which will be obsolete in real-time. Because a trustable prediction estimate should have at least 80 percent accuracy. The comparison also revealed that our proposed software-based traffic estimation methodology gave an accuracy of over 95 percent which is a very good data for real-world usage.

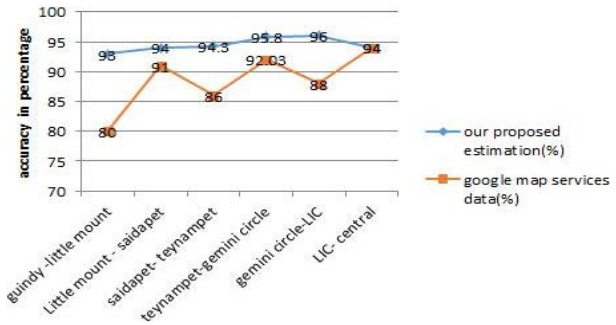

Fig. 4.3: Comparison between Accuracy Google Map Services Data vs. Our Proposed Software-Based Traffic Estimation Data.

Traffic congestion data on-peak hours, non-peak hours and weekend hours data are drawn from the metropolitan transport services (in table 4.1). The average accuracy of the peak hours, non-peak hours and weekend hours data from metropolitan data and google map services data were calculated and compared with our proposed software-based traffic estimation data.

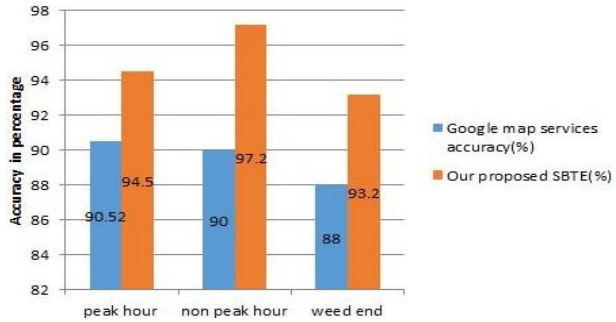

Fig. 4.4: Comparison between Google Map Services Accuracy and Our Proposed Software-Based Traffic Estimation Accuracy (SBTE) in Various Time Periods.

Fig 4.4 showed that our proposed software-based traffic estimation data on peak, non-peak and weekend hours accuracy is greater than the google map service's accuracy.

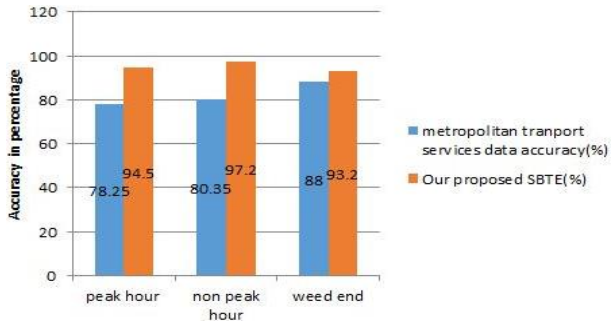

Fig. 4.5: Comparison between Metropolitan Transport Services Data Accuracy and Our Proposed Software-Based Traffic Estimation Accuracy (SBTE) in Various Time Periods.

Fig 4.5 showed the proposed software-based traffic estimation accuracy and it is outclassed the manually taken metropolitan transport data accuracy. But when comparing metropolitan and google services accuracy data, google map services gives better results.
Integration of open layer mapping API opens many avenues in the visualization and map processing part. We can create our own vector platform for the map overlay or we can use the satellite view to overlay the processed information on a map. We can visualize a moving marker or icon for representing vehicle in motion. In this way, we can tell the end-user that the vehicle they asked is in motion and we can also add some thematic values like estimated time of arrival or stoppages on the map screen using open layer mapping API.

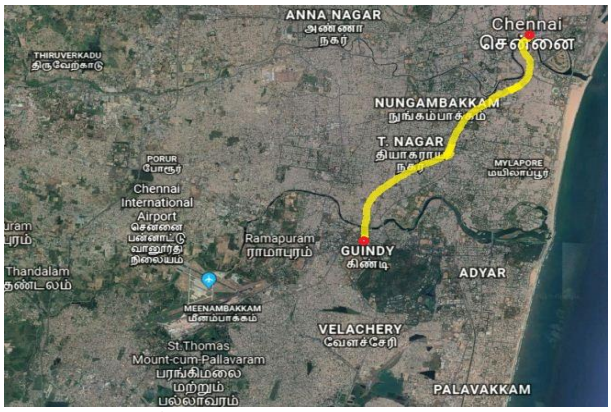

Fig. 4.6: Pictorial Representation of Openlayer Mapping Marker Animation – Map Move Marker at Rest.

Script for the bus movement

```
if (animating) {
  Bus Animation(false);
} else {
  animating = true;
  now = new Date (). Bus get Time ();
  speed = High speedInput.value;
  start Button. Text Content = 'Cancel Animation';
  geoMarker.setStyle(null);
  map. get View (). set Center(center);
  map. On ('post compose', move Feature);
  map. Render ();
```

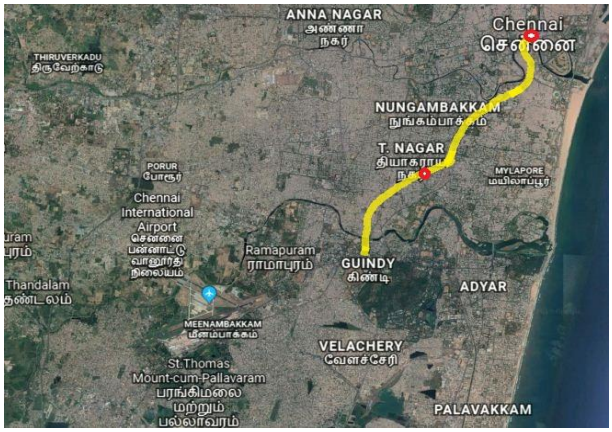

Fig. 4.7: Pictorial Representation of Map Marker in Moving On Openlayer Mapping API.

We can also create a vector wms file for own to represent the nodes of the vehicle moving. This can give more benefits to the pre-defined route vehicle monitoring systems. Because we can digitize the routes that we are wanting to monitor and use an animated marker on them to show the moving vehicle.

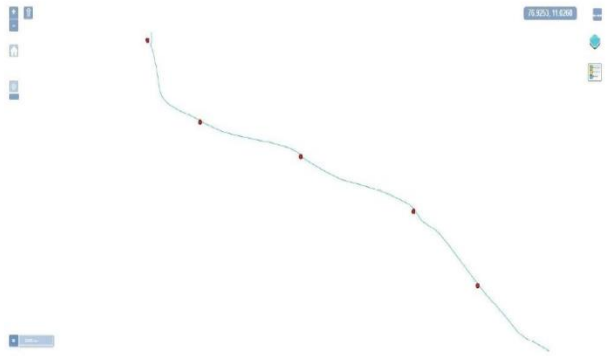

Fig. 4.8: Vector WMS File for the Bus Stoppages on Open Layer Mapping API.

This provision can be very useful for small scale monitoring or specified vehicle monitoring like school, college and public bus services tracking and monitoring systems.

5. Performance analysis and evaluation

To test the algorithms and system's efficiency, we did a series of performance evaluation and analysis with various criteria. To find the accuracy of mean speed and find the traffic estimation in a real-world scenario we used map matching criteria points to conduct a performance evaluation of the proposed algorithm. The map matching criteria points taken as two collectives: one 6 criteria selection and another one 4 criteria selection. These two collectives are formed to evaluate the algorithm's effectiveness in the abundance of details and in a scarcity of details.

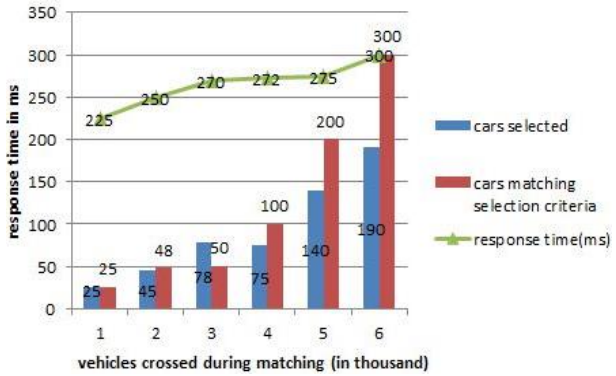

Fig. 5.1: Map Matching Algorithm- 6 Selection Criteria.

Fig 5.1 represents the 6 selection criteria map-matching algorithm. Those six selection criteria are device availability, accuracy, proximity, battery status of the device, reputation, capability of data collection.

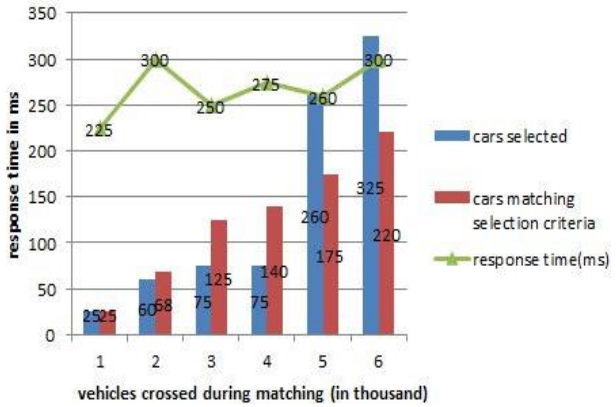

Fig. 5.2: Map Matching Algorithm – 4 Criteria Selection.

The four selected criteria are proximity, battery level, availability, and accuracy. When comparing the 6 selection criteria with 4 selection criteria, the former has the maximum accuracy with the high response time. The later has lesser accuracy with the minimum response time. We need greater accuracy, so we opt 6 selection criteria map matching.

6. Conclusion

In this proposal, we proposed a software-based traffic information system. In today's growing population and growing economy, the need for public transportation is blooming. So, there is a need for modernizing public transport and managing the traffic at a massive level. Countries like India have a thriving tourism industry so the public information systems on the transport get high priority to safeguarding the interest of the local and international tourist. An effective transport monitoring system can give an economic boost to the nation and low carbon emission. This proposed framework has many advantages when compared to existing traffic management system especially google map services. Google offers a real-time traffic estimation to the public view but accessing their traffic estimation data commercially needs a substantial priced license from google. So, there is a need for a cheap and effective alternative. The performance evaluation and other system evaluations showcased a significant pro in the proposed system. The proposed system has low error and high accuracy when compared to other traffic management systems. This proposed software-based traffic management system gave an average of 95 percent accuracy, which is a great output in the non-GPS based traffic management system category.

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