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Pune Navigator: The Real Time Bus Monitoring And Passenger Information System

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Abstract

Intelligent Transportation Systems (ITS) are gaining recognition in developing countries like India .This research paper describes the various components of our prototype implementation of a Real-time Passenger Information System (RTPIS) for a public transport system like a fleet of buses. Pune Navigator is a concept project for better Municipal Transport. It proposes to install GPS devices on city buses for Real Time Passenger Information (RTPI). The Real Time Bus Monitoring and Passenger Information bus tracking device is a standalone system designed to display the real-time location(s) of the buses in Pune city. This system will enable the tracking device to obtain GPS data of the bus locations, which it will then transfer it to centralized control unit and depict it by activating LEDs in the approximate geographic positions of the buses on the route map. Specific software's will be used to interface the data received to the map. Using the real time updates from bus about its location Pune features Navigator will provide following.

1. RTPIS rolling display on bus stops – expected time of arrival in real time.

2. Web based interface for control room to monitor buses in real time.

3. Mobile application for end user to find out bus schedules and RTPIS.

***Keywords*- GPRS, public transportation system, RTPIS, ETA, link updater**

I. Introduction

A passenger in Pune often faces the decision of whether it would be quicker to wait for the next bus or to walk or to hire a cab/rickshaw to reach his/her destination. Many passengers are often late to work, students are late for classes because they decide to wait for the bus instead of just simply using a alternate transportation. The design team surveyed 30 students about their opinions on the current bus transportation service, and the following conclusions were extrapolated from the results:

I. 75% of the population asserted that they had been late to their destination because the decided to wait for a bus instead of walking.
II. 96% of the population affirmed that knowing the position of the buses on campus would be beneficial in deciding whether to walk or wait for the bus.
III. 96% of the population also affirmed that knowing the location of the buses is more indicative of wait time than an approximate arrival time.
IV. The overall approval rate of the current transportation notification service was 38%.

With the advent of GPS and the ubiquitous cellular network, real time vehicle tracking for better transport management has become possible.These technologies can be applied to public transport systems,especially buses, which are not able to adhere to predefined timetables due to reasons like traffic jams, breakdowns etc.The increased waiting time and the uncertainty in bus arrival make public transport system unattractive for passengers.A Real-Time Passenger Information System (RTPIS) uses a variety of technologies to track the locations of buses in real time and uses this information to generate predictions of bus arrivals at stops along the route.When this information is disseminated to passengers by wired or wireless media, they can spend their time efficiently and reach the bus stop just before the bus arrives, or take alternate means of transport if the bus is delayed. They can even plan their journeys long before they actually undertake them. This will make the public transport system competitive and passenger-friendly. The use of private vehicles is reduced when more people use public transit vehicles, which in turn reduces traffic and pollution.

II. LITERATURE SURVEY:

A considerable amount of money is spent on IT-based applications such as real-time, at-stop displays on public transport, but actual knowledge about the behavioural effects these have on customers or potential customers in real life is quite sparse. This paper presents a review of relevant literature, focussing specially on user response to public transport information via telephone, mobile devices, the Internet and at-stop displays.

There are a lot of projects currently underway implementing new or expanding existing IT-based applications for the delivery of information to public transport (PT) systems. There are numerous terms used for these systems, such as telematics, ATIS (Advanced Travelers Information Systems) and ITS (Information Technology Systems). These systems provide information to customers via the Internet and electronic real-time information in transit. Integration of mobile phones into the transit information systems is also ongoing. A considerable amount of money is spent providing real-time information, Internet information desks, information to individual mobile phones and related technology. Passenger attitudes towards these new systems are often positive, but what are the real benefits provided by this information?

The Scientific Advisory Committee to the German Ministry of Transport, Construction and Housing reported that it would be unwise to maintain inflated expectations of the effectiveness of telematic solutions in transport systems. Acceptance of these by PT users is still uncertain. While multi-modal travel information is a desirable development, the influence it has on modal shifts—especially towards PT—is very often overestimated. The same committee stressed the importance of conducting objective evaluation studies to estimate the benefits of telematic systems in transport, concentrating on acceptance and effect studies. Do passengers use the information available to them to maximise their travel efficiency? This question relates directly to the main issue, which is what behavioural effects if any do IT-based public transport information applications have on existing and potential PT users?

III.ARCHITECTUREAND MODELLING:

The main parts of RTPIS are application simulators, bus simulator and central data processing server. The architecture is shown in figure . These parts are briefly described in the subsequent sections

I. Application simulator

Pune Navigator has 3 applications as, the bus stop billboard display, the mobile application and the control room application. These services will request for the real time updates to the centralized server. The mobile application is android based application.

II. Bus simulator

The main functions of the bus simulator are as follows.

- To download names and coordinates of stops and points of interest from the server
- To compute current location, direction.
- To transmit the computed information to the central server using GPRS.

It operates as follows – the GPS receiver in this unit computes the current location of the vehicle which is stored in bus simulator. The latitude, longitude of the bus are transmitted periodically to a central server using GPRS. The bus simulator unit initially downloads the names and coordinates of stops and POIs on the current route from the server. The Real time bus analyzer and computation contains the algorithm which calculate bus arrival time for each bus going through the corresponding route.

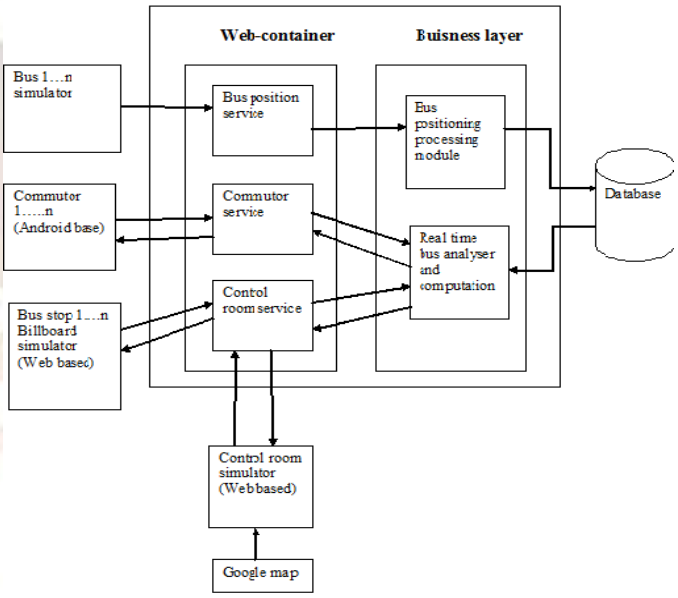

Fig. 1 Architecture

III. Server

The server is at the center of RTPIS. The functions of the server are listed below:

- To maintain a database of all the routes, the buses that ply on a route, the stops along each route etc.
- To continuously receive location and speed from the vehicle units of all the buses .
- To calculate the ETA of all the buses at their next and subsequent bus stops.
- To reply to android google map-based queries requesting ETA of buses running between the the two specific stop from users; a GSM mode connected to the server transfers these queries to the server which processes them and reply the time.

- To host Internet web pages, which allow administrator to track buses in real time, see the route map of any route, and get the ETA for any route-stop pair and plan trips from any source to any destination stop,at any time.

The server maintains a database of information pertaining to the buses, routes and stops in the form of tables . The server database can be organized in many ways, to reduce memory requirement, improve access speed, or reduce the number of queries. To improve the query speed, the tables related to buses are partitioned into static and dynamic ones. The Bus table stores static data while the bus position and log tables store dynamic data. The relation between the unique bus id, bus type (ordinary/luxury/…) and route number is stored in the Bus table. The position updates from the bus are stored in the Bus Position and the Bus Position Log tables. The direction is calculated in the vehicle unit by comparing time-separated position values with route details. The status of the bus changes to invalid, when its driver signals a breakdown. This helps the transport company to take suitable actions. The bus is excluded from ETA calculations based on this field. The Bus Position Log table stores a copy of the position update.

III. Algorithm

I.Route creation

A novel method has been developed to automate the process of creating new routes and populating the database, with little human intervention. To create a route, we are considering a bidirectional graph. This graph will be used in ETA for calculating the estimated time of arrival. The bus stops will be represented as nodes and the route will be in the form of chain of links. A particular route will be identified by its unique id.

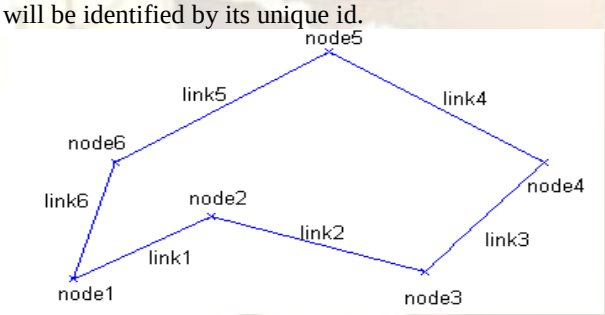

Fig.2 Route creation

II. ETA prediction:

Arrival time prediction forms the core of any RTPIS system. The algorithm can be very simple, involving only a bus schedule table, zone based or could be very complicated, involving Artificial Neural Networks , space-time correlation and time series modeling . Bus schedule table and past location data can be used to predict arrival time. The system provides a platform for executing any ETA algorithm, though we have implemented own simple one that adapts to changing traffic conditions. The algorithm works by recording the time it takes to traverse each link. Predictions are based on the present and past observations of a bus passing through each link. The past observations get lesser weight as time progresses; this reflects current traffic conditions better.

The predicted ETA at bus stops is bounded by an upper limit of one round trip time of the route, though the ETA can be predicted infinitely into the future by simply adding integral number of round trip times to the smallest ETA.

The ETA algorithm has two parts:
1. Link updater, which estimates the travel time for each link
2. ETA calculator, which calculates the ETA for every bus stop.

III. Link Updater

Link updater calculates the link travel times required by the ETA calculator. Whenever a bus position update is received from the vehicle unit, the link updater calculates the travel times for all links traversed by the bus from the previous known position. The link updater requires distance of each link. The distance between two positions having latitude, longitude values is calculated by the following formula.

dlon = lon2 - lon1
dlat = lat2 - lat1
a = (sin(dlat/2))^2 + cos(lat1) * cos(lat2) * (sin(dlon/2))^2
c = 2 * atan2(sqrt(a), sqrt(1-a))
d = R * c (where R is the radius of the Earth)

The weighted average of the previous value and the actual travel time obtained for the current bus is stored as the link travel time in the Link table. For an update rate of two per minute used in our trial runs, these weights give a good approximation of the average values, as well as track the recent trends. The link travel time is also common to all routes containing the link, so as to get the latest time estimate. This is the reason for sharing links between routes during route creation.
Link updater locates the bus position along the current route of the bus. The link updater then calculates the time required to reach the end of the current link and updates the estimated end time information in the Bus Position table. If the bus enters a new link, the entry time for the new link is stored in the Bus Position table against the bus and the travel time for all the crossed links is calculated. This time is also the exit time for the previous link. The time difference between the exit time and the previously recorded link entry time gives the link travel time for the crossed links. The travel times for links are a function of their lengths. Thus, when more than one link is traversed between updates, the individual link travel times are computed as *fractions* of the total travel time, with the fraction

for link *i* being the ratio of the length of the *i*th link to the sum of lengths of traversed links. This makes sure that among the traversed links, shorter links have smaller travel times and longer links have larger travel times. The computed link travel times are averaged with their previous values and the Link table is updated.

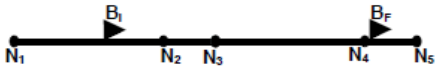

Fig.3 Link travel time calculation scenario

IV. ETA calculator

This program takes the current bus position, link travel times and estimated time to link-end to predict the ETA for all bus stops. ETA at a stop is the time taken for the nearest bus to reach the bus stop. It is calculated as the sum of travel times of the links, starting from the current bus position, up to the given bus stop.

IV. SERVER UTILITIES

I. RTPIS at bus stop

The real time arrival information of buses at bus stops will be provided in the form of rolling displays. It will help the passengers to make efficient use of time. When this information is disseminated to passengers, they can spend their time efficiently and reach the bus stop just before the bus arrives, or take alternate means of transport if the bus is delayed. This unit will periodically fetch the required ETA from the server via GPRS.

II. Smartphone Application:

In todays world, we want technology on our fingertips. We are creating a mobile application which will help the passengers to get bus arrivals at a particular stop. In this whole map of the city will be displayed and the passenger have to jst give source and destination point. It will fetch the ETA of the requested route and provide the real time information to passenger. This will make the public transport system competitive and passenger-friendly.

III. Tracking Buses:

The whole map of the system will be provided to the administrator. Through this web page, user can view the present position of all the buses on the route map. This is done by getting the position of all the buses of a route from the database and then plotting it on the route map.

V. Future scope and Conclusion

In this, propose paper an efficient way to improve the public transportation by providing the real time information and making public transport system competitive and passenger- friendly. With the advent of GPS and the ubiquitous cellular network, real time vehicle tracking for better transport management has become possible. These technologies can be applied to public transport systems, especially buses. As this system uses a combination of processing elements: PCs, Mobile Phones etc., there is a possibility of the overall system malfunction due to a particular type of attack, it is termed as Denial of Service (DoS) attack by malicious agents who might try to disrupt the function of the system. Similar methodology will be studied to make this Real Time Passenger Information System more robust.

The proposed system is also quite universal in nature and it is possible to extend the methodology for other type of fleet movement where security is of paramount importance. Here, the advantage lies in the fact that computationally costly encryption-decryption mechanism is avoided, thus making it suitable for a heterogeneous combination of processing elements, which are being used in our present system. Here, many processing elements e.g. Mobile phone etc. lacks the processing power and battery power, which is required for traditional encryption-decryption system.

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