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FORESEEING BUS ARRIVAL TIME IN VIEW OF TRAFFIC MODELING AND REAL-TIME DELAY

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ABSTRACT

To know the entry time of bus to a bus stop is the fundamental data each travel clients need to know. Sitting tight for quite a while at a bus stop debilitates the individuals to depend upon open transports. In this paper, we display a framework which can foresee the landing time of bus to a specific bus stop considering the ongoing parameters that influences the travel time of transport. With transport module, the ongoing parameters that influence travel time are persistently gathered and used to foresee the bus arrival time at different transport stops. A portable application is created to help the questioning clients in getting the arrival time of bus to a specific stop. As there will be postpone in travel time because of the vehicles on street, street movement is displayed utilizing M/G/1 lining hypothesis to ascertain the delay created by other vehicles going in the same street. Server predicts the arrival time on the real time basis by bus module and the data shown in the database of server. Server is coded such that it sends the anticipated arrival time of transport to the questioned users wireless at each bus stop it goes till it achieves the stop questioned by client. Arrival time got by clients helps the travel clients to arrange their schedule and reach the bus stop in time. Such an anticipating framework propels the non clients of open transport frameworks to utilize them and avoid the utilization of private vehicles in their normal life.

KEYWORDS: Bus landing time expectation, ongoing postponement, traffic modeling.

INTRODUCTION

Utilization of Public transport administrations and minimizing the utilization of private vehicles diminishes the general fuel utilization furthermore decreases traffic congestion. Individuals have a tendency to utilize private vehicles rather than open transport to spare the season of travel. Time of travel means the time one sits tight for a vehicle medium added with the time needed to go to a certain destination. As opposed to investing energy sitting tight for an open transport to come, individuals depend on their private vehicle to move starting with one spot then onto the next. In the event that each individual in a city utilizes private vehicles, it brings about car influx or traffic congestion. Traffic congestion is a term used to express a circumstance where there are a greater number of vehicles on a street than the quantity of vehicles that ought to be there with the expectation of complimentary stream of the vehicles out and about.

In circumstance of open transport framework, travelers typically need to know the exact time at which the bus achieves bus stop which is close-by to them. Nowadays a large portion of the transport working organizations gives the timetable of transports on their sites which are unreservedly accessible for the travelers. However, these give just restricted data, for example, working hours, time in terms, and so on which is not convenient upgraded. Despite the fact that they give valuable data they are a long way from adequate level of general society transport clients. Calendar of a transport may be postponed because of numerous capricious variables, for example, climate conditions, more number of travelers at the transport stop, breakdown of the transport, movement conditions. Precise entry time of the transport is essential to the transport operation control and the traveler data framework. This precise landing time is vital for the travel clients to react to the surprising deferral of a transport. By this the travel administrators can arrange their timetable and set aside a few minutes. They can likewise take some different method for transport on the off chance that the transport arrives past the point of no return. However the general nature of travel administration can be enhanced by giving such data to the travel clients.

In this framework travel clients are furnished with the landing time of a transport for a specific transport stop. This data is sent to the mobile phone of travel client who had asked for the framework to do as such. At whatever point a client needs to utilize people in general transport framework, he sends question to the predefined number of server from which he gets back the landing time of the transport as an answer. This framework comprises of three noteworthy parts querying client, bus module and the backend server.

(1) Querying client: One who inquiries the landing time of the bus utilizing a cellular telephone.
(2) Bus module: Using which the details of the parameters that cause the delay are accounted for.
(3) Backend server: Collecting the data reported by the transport module and mentally handling the data in order to foresee the transport landing time.GPS is not used to obtain the physical area inputs.

Such an arrival time predicting system has the advantage compared with other approaches. First, compared to conventional approaches (e.g., GPS supported ones) this is system is energy friendly. Second, sending continuous updated arrival time to the queried user makes the information more accurate. Outlining such a framework has a couple challenges:

(1) Modeling the activity, delay in the transport entry is likewise created by the vehicles in the street, so it is important to model the road traffic
(2) Bus route and arrangement and bus stop identification is additionally important. There will be numerous transports in an open transport framework so it is important to classify the routes of the transports taking into account bus stops the bus goes through.

In this arrival time predicting system road traffic is modeled using M/G/1 queuing model and the parameter that causes delay for the bus arrival are collected from bus module and is sent to server. Based on the accumulated information, both the historical knowledge of the road and the real time parameters we are able to predict the bus arrival time and send the arrival time of bus to a specified bus stop, queried by the user.

RELATED WORKS

Numerous researchers, specialists have set forward numerous thoughts, hypotheses and frameworks with a specific end goal to predict the precise arrival time of bus. Intelligent transport systems (ITSs) are picking up acknowledgment everywhere throughout the world. Examination has been going on everywhere throughout the world for adding to an ITS which can predict the arrival time. Numerous frameworks and models are being produced. A framework is additionally grown in which they have introduced a bus arrival time expectation framework in light of participatory detecting utilizing cell tower sequence matching [1]. In this framework they have utilized the cell phones of travel clients to approximate the bus travel routes and to foresee bus arrival time at the bus stops.

Artificial neural network (ANN) model for anticipating bus arrival times was proposed [2]. ANN models oblige broad testing and preparing so as to locate the right system structure and focus the best parameter values. Arrival time is anticipated taking into account the information gathered by the GPS gadget mounted on the transport so as to get the constant area of the transport [3].

P2P overlay system was utilized as a part of a arrival time forecast system [4]. Here they have proposed a strategy for consolidating a P2P overlay system and WSN to build up a transport landing time forecast framework. In this a single WSN system was framed which comprises of a bus and a bus stop. So as to anticipate transport entry time and transmit constant transport data, P2P overlay system was shaped by joining all bus stations and bus terminals.

A real time passenger information system (RTPIS) [5] was created in which they have utilized GPS beacons to get GPS information of transport area and delineate it in the surmised geographic positions on the route map. Principle motivation behind this framework were to show the entry time of bus at bus stops, web based interface for control room to monitor buses in real time and mobile application for end users.

Another Arrival time forecast model was proposed in which they have anticipated the exact arrival time of bus utilizing Kalman channel model [6]. With a specific end goal to anticipate the arrival time of transport to a specific bus stop, they have utilized the movement data from informal organizations redesigned by individuals who have seen occasions and upgraded their online networking appropriately. They have confirmed the outcomes with a corresponding SUMO simulation.

SYSTEM OVERVIEW

We have to develop an arriving time foreseeing system which predicts the time for which the individuals at the bus stops needs to wait. The construction modeling of the framework is indicated in figure 1.This gives a record of the major parts of the system design and how each of the components in the system works.

The system mainly consists of three major components

- Querying user
- Bus module
- Backend server

3.1 Querying user

Querying user is the person who needs to get some data. In this framework Querying user is the person who needs to know the exact arrival time of the bus for a specific bus stop. The questioning client utilizes his phone to send the query request to the server by a message through GSM system.

3.1.1 Bus Module

Bus arrival time relies on upon numerous components, for example, climate conditions [7], number of travelers, movement clogging and so forth coming about, delay in the predefined schedule of the bus which results in problem for the people holding up at the bus stops. For a bus arriving time foreseeing framework it is important to know the ongoing area of bus. Not just the area of transport aides in foreseeing time, also need aggregate number of passengers additionally helps in anticipating the delay time of the bus. It is necessary to know the total passengers to figure the delay time which must be sent to the server from the bus.

The bus module contributes the data gathered inside of the module to the backend server as demonstrated in Figure 1 (left side).

Bus module consists of two components

1. RFID reader
2. Ticket machine

3.1.2 Server

Server is a software application that acknowledges the request from the customers and reacts to the request likewise. A backend server is the unit in a framework which will be out of client interface yet handles the client information. A large portion of the calculation complexity is moved to the Backend server where the data from all the modules in the framework will be stored.

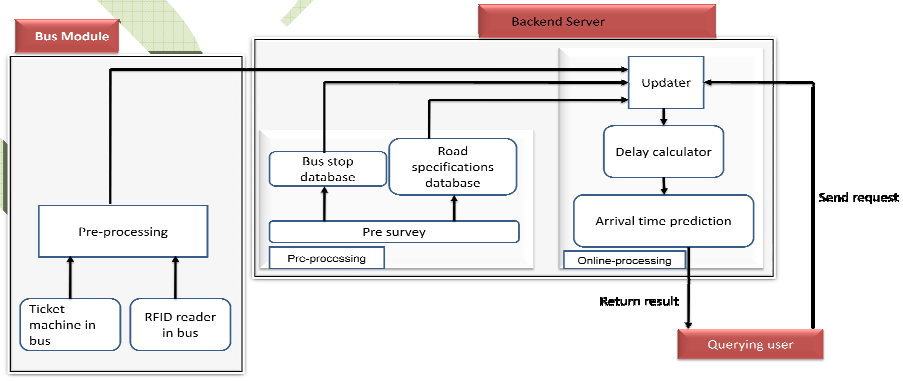

Fig. 1: System architecture

It is necessary to build up a server in which the querying user gets the information when the client sends the question to the server. The database of the server incorporates the road information and the bus stop points of interest and the online processing part have the updater, delay time anticipating and the arrival time indicator in it. The GSM module of the server gathers the question from the client and the information from the bus module and sends to the updater for the arrival time anticipating.

TRAFFIC MODELLING

Traffic congestion of transport framework is a phenomenon of increased interruption in traffic development on a street. It is watched at the point when number of vehicles methodologies or exceeds the limit of street. Traffic congestion relies on upon the arrival rate of vehicles, service rate on the road, dispersing between the vehicles, deviations from the street and numerous more perspectives add to congestion. Traffic congestion is one of the primary reasons that influences the commute time of vehicles. So the modeling of the traffic is essential to figure the time needed by the vehicles to reach from one point then onto the next point.
Simulation will be done based on real situations utilizing the traffic simulator, simulation in urban mobility (SUMO) which is capable of simulating real world road traffic utilizing digital maps and traffic models [8]. M/G/1 lining hypothesis model is one of the approaches that are utilized for traffic modeling and it has been utilized as a part of numerous framework outlines and references [9] [10] [11].

4.1 M/G/1 Queuing System

In M/G/1 queuing system, a discipline within them mathematical theory of probability, an M/G/1 queue is a queue model where arrivals are Markovian (modulated by a Poisson process), service times have a General distribution and there is a single server. The model name is written in Kendall's notation, and is an extension of the M/M/1 queue, where service times must be distributed. A queue represented by a M/G/1 queue is a stochastic process whose state space is the set {0,1,2,3...}, where the value corresponds to the number of customers in the queue, including any being served. Transitions from state i to i + 1 represent the arrival of a new customer: the times between such arrivals have an exponential distribution with parameter λ. Transitions from state i to i − 1 represent a customer who has been served, finishing being served and departing: the length of time required for serving an individual customer has a general distribution function. The lengths of times between arrivals and of service periods are random variables which are assumed to be statistically independent.
M/G/1 queuing system refers to a system which has negative exponential arrivals and service times and a single server. It is a better approximation for a large number of queuing systems. Since a single road is considered, this queuing theory suits the consideration. For instance, a single link fed by a single transmit queue qualifies as a single server and can be modeled as an M/M/1 queuing system. Here:

M = Arrival or Departure distribution which is a Poisson process.

1 = Number of server (number of roads).

4.1.1 Queue discipline

Discipline of a queuing system means the rule that server uses to choose the next customer from queue when server completes the service of current customer. Queue discipline used here is “first in- first out” abbreviated as FIFO. This discipline serves one customer at a time.

ARRIVAL TIME PREDICTION

In this section, arrival time is anticipated based on discussed topic in section 3 and different parameters that cause delay of the bus. The database, that is the information, for example, distance between the bus stops, Poisson arrival rate of each of the streets including the streets that converges, service rate of street (i.e street at which the arrival time is to be anticipated), average difference per individual in getting in and out of bus, average rate of vehicles is gathered. This information is essential for backend server to figure the arrival time. Parameters that impact the calculation of arrival time of bus are number of individuals, commute time, traffic congestion.

5.1 Number of people

Traveler is one of the essential segments of a public transport framework. In this segment we calculate the delay time in view of number of travelers who get in and out of the bus. When tickets are issued, the ticket issuing machine updates the include of individuals who get at a specific bus stop and get down at the forthcoming stops. Taking into account this data the delay time is computed deterministically. The time delay brought on by the travelers.

$$D_N = N \times d \qquad 2$$

Where, N = Number of people
d = Average delay per individual

This delay time is added to commute time to expand the accuracy of anticipation and this delay time (D_N) and individuals updated to the server from stop to stop as the individual get in and out at every stop.

5.2 Commute time

Commute time alludes to the time taken for a man to move from one place then onto the next. At whatever point a vehicle moves from one spot to another, it needs to move with some speed. This speed of the vehicle won't be same all through the distance, sometimes it moves with more speed and some of the time in less speed (in view of the street conditions and other different factors). So the normal velocity of vehicle should be considered to foresee the commute time of bus.

By knowing the distance went by the vehicle and the time devoured by it to travel that distance, it is possible to compute the average speed of the vehicle as takes after: .

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

The average speed for vehicles on that particular street will be fixed. [4].

To compute commute time of the bus, current area of bus is to be known. Once the area of bus is known, distance from the bus and destination bus stop can be calculated(taking into account the study results which are done to calculate the distance between bus stops). To know the area of bus and to foresee the time, the update time of bus at one of the bus stop in the route it travels is considered.

In the event that questioning client is at Q and the last or late upgrade was from stop X, Assume that the bus has passed bus stop Q at time T, inquiry has been gotten at time T1. Then it s given by-

$$time(t) = \frac{\text{Distance between stop Q and X}}{\text{Average speed}}$$

$$Commute\ time\ (D_C) = t - (T - T_1)$$

5.3 Delay due to traffic

Delay time due to traffic is figured in view of the hypothesis examined previously. From mathematical equation 1, average waiting time of a vehicle in a queue is

$$W = \frac{1}{\mu - \lambda}$$

M/G/1 queuing theory can be applied to the road traffic [11] in order to find the delay due to more number of vehicles in the queue of the main road. W in M/G/1 queuing theory refers to the waiting time of bus in queue which is the delay due to traffic.
Delay due to traffic (D_T) is given

$$D_T = \frac{1}{\mu - \sum_{i=0}^{n} \lambda_i} \qquad 3$$

Where, n = number of intersections.

5.4 Arrival time

Arrival time of bus to the bus stop queried by user is delayed due to traffic and the number of travelers as calculated in the previous sections. Total delay time of a bus to reach the bus stop requested by the querying user will be the sum of D_N, D_C and D_T.

$$\text{Total delay time} = D_N + D_C + D_T$$

$$\text{Arriving time of bus} = \text{Queried time} + \text{total delay time}$$

This arriving time is sent to queried user by a message through GSM network. Since the arriving time is sent from stop to stop to queried user based on the changes in number of people and also the Poisson rates, prediction time sent to the querying user will be more accurate.

SYSTEM WORKING

Arrival time anticipating framework for a bus is designed utilizing,

1. Cell phone.
2. Bus module-RFID reader, Ticket machine, GSM gadget, microcontroller.
3. Server- Microcontroller, laptops, GSM device.

Questioning client sends the inquiry request to server by a message through GSM system. Server has a GSM module in it, which can get information sent by questioning client and the bus module. Information got by the GSM module of server is read by a microcontroller. This microcontroller is associated with the laptop utilizing a USB to UART link. Laptop shows the information got by microcontroller. Microcontroller is coded in such a way that every message received by the GSM module of server is read and updated.

RFID reader reads the tag (bus stop) details and ticket machine gets the count of individual at every bus stop. RFID reader, ticket machine and bus GSM module of the bus are controlled by a microcontroller of the bus module. Whenever a bus reaches the bus stop, real time information from the RFID reader and ticket machine is read by the microcontroller of bus module which is then processed. Microprocessor prompts the GSM device of bus module to send processed data to GSM module of the server.

Once the parameters necessary for calculating delay is received by the GSM module of server, microcontroller within the server reads these data and displays them in the laptop. Updater unit of server updates these data within it and passes the data to delay calculator which calculates the delay. Arrival time for the queried bus stop is calculated based on this delay calculated. The microcontroller connected to server is then prompted to allow the GSM device of the server to send the predicted arrival time to queried user by a text message through GSM network.

6.1 Mobile Application

Mobile phone to be used will be Android smart phone which is installed with a mobile application coded using java language and developed under Android platform by using Eclipse tool. Purpose of using this application is to send querying request to server in a format that could be understood by server and the other thing is that by using a specified format of request, unwanted messages which are sent to servers by other people can be filtered out. The communication link between cell phone and server is through GSM network.

6.2 Bus module

Bus module consists of the RFID reader, ticket machine, pre-processing unit and a GSM device.

6.2.1RFID reader and tag

RFID readers are generally used to detect the objects which have RFID tag in it. Here each of the bus stops is assigned with a unique RFID tag. Whenever a bus approaches any bus stop, RFID reader is supposed to detect the bus stop (tag). For this purpose RFID reader is embedded into the bus module so that it can detect the details of bus stop it passes by.

This reader collects the information of bus stop and passes to the pre-processing unit. Pre-processing unit converts the collected data to the format that could be understood by server. The information of the bus stop will be collected automatically by RFID reader without manual interpretation. The functionality of RFID reader, GSM device is controlled by the microcontroller of the bus module.

5.2.2 Ticket machine

As soon as the passengers get into bus at each bus stop, tickets are issued to the passengers through a ticket vending machine. This ticket vending machine within bus module stores the count of people who got into bus at that particular stop and who will get out of bus in the coming bus stops.

6.3 Backend server

Backend server will be used in Microsoft visual studio running on a Lenovo G500 laptop which has 2GB inbuilt RAM and INTEL CORE i3 processor. Dot net language has been used for coding server. Functionality of the GSM device of server and bus module, handling of incoming queries to server and incoming data from the bus module is efficiently done by a Renesas 64 pin IC, whose brief operation is explained as follows.

Backend server has database which is obtained by the survey off road and bus stops, updater, delay calculator and arrival time predictor. Survey data includes data such as bus stop IDs, Poisson arrival rate and Poisson service rate of the individual roads, total number of intersections of the roads to main road. Information received from bus module is updated in server .Once the querying user sends query request to server by specifying the bus stop, server fetches the data which was already stored in server and calculates the delay time .This delay time is used to calculate arrival time of bus to the bus stop specified by the querying user and sends this time to the user using GSM device of server.

ASSUMPTIONS AND CONSIDERATION

- Server gets updated as soon as the bus reaches any bus stop (including people count).
- Bus travels in a fixed route. There are no diverging deviations from the main route. Some other roads with different Poisson arrival and service rates will join the main route.
- Single lane road is considered which means that vehicles cannot overtake other vehicle in a queue and one vehicle is serviced at a time. Figure 2 shows the queue system along with the service station.
  - Interval for calculating Poisson arrival rate (λ) and service rate (μ) is “1 minute” [10].
- Sum of Poisson arrival rates will be less than the service rate of the main road.Bus travels in a pre-defined average speed all through the distance.

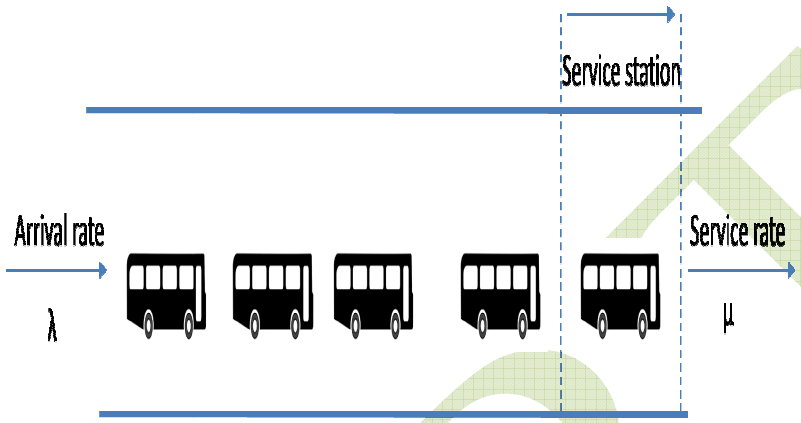

Fig. 2: Queue system along with the service station

RESULTS AND CONCLUSION

Server responds to the queried user by text messages. GSM module of server sends the arrival time of bus to the queried user's cell phone. Along with sending the arrival time it also sends the updated arrival time at every bus stop it reaches. This increases the accuracy of prediction.

Arrival time predicting system has been designed which considers real time parameters that causes delay such as number of people and also results of traffic modeling. This system updates the arrival time of bus to queried user based on his query. It sends the updated arrival time to user whenever bus reaches the bus stops of predefined route until bus reaches the stop queried by user.

This system uses the location update of bus only when it reaches the bus stops of predefined route in order to predict the arrival time. But for higher accuracy of arrival time prediction it is necessary to track the bus (location of bus) continuously all along the route travelled by bus. Continuous tracking of bus helps to predict précised arrival time of bus.

Road transport services can use this system for implementing in real time so that, updated arrival time received by users helps the transit users to plan their schedule and reach the bus stop in time. Such a predicting system also motivates the non users of public transport systems to use them and reduce the use of private vehicles in their day to day life.

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