Real-Time Public Transport Arrival Information System

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Abstract **–The most prominent problem faced by passengers using public transport in Pakistan is uncertainty of its arrival on time. This creates a lot of anxiety in the commuters using public transport. To solve this problem in many countries like Japan, USA, Russia, etc. arrival information systems have been implemented. Our system is also designed to solve this problem and its primary objective for implementation will be on Rawalpindi Metro service, but in secondary phase it can also be implemented on local transport and Pakistan railway services across the country. The system will consist of three parts which are the transport module and the ground server and Smartphone. The transport module will send the location data to ground server. The ground server will utilize the location data to predict the ETA (estimated arrival time) and send it to commuter's smart phone. This system will help to improve the commuter's experience of local transport and also help to improve the congestion problem in big cities in Pakistan.**

Index Terms **– Real time information, ETA (estimated time of arrival), Prediction Algorithm, Public transport, GPS, GSM**

I. INTRODUCTION

Congestion is undoubtedly a problem in big cities of Pakistan including Karachi, Lahore, Gujranwala etc. and it is increasing day by day as the use of personnel transport is far much greater than the use of public transport. The use of public transport can minimize the problem of congestion and it is also much more efficient which is good for the economy, but to attract the commuters towards use of public transport we need to make the public transport more reliable and satisfactory. One of the main reasons for people avoiding the public transport is the uncertainty that the buses will arrive on time while waiting on bus stop and they might be waiting in vain as the bus might not come at all. This is due to the poor traffic conditions as during rush hours most of the routes are congested due to which the traffic movement is real slow or it get stuck thoroughly. The condition of public transport is not satisfactory in Pakistan but the experience can be greatly enhanced by taking certain measures one of which is to implement Real-Time Public Transport Arrival Information System.

Studies has shown that by implementing such system above 48% of the Local bus transport users become much more satisfied and 44% become somewhat more satisfied which is a great achievement [1].

Our system will focus on providing real time information to commuters using public transport so they can know for certain that the bus they are waiting for will come in how much time and they are not waiting unnecessarily on bus stop. Our system will utilize the location information of vehicle collected using a GPS and predict the ETA of the vehicle. It will do so by using prediction algorithms and account for delays which will be encountered by the vehicle. In the following sections we will give a brief description of our system and its working

II. SYSTEM DESCRIPTION

Our system will mainly consist of three parts.

I. Transport module
II. Ground server
III. Smart phone

The transport module will consists of a GSM, GPS and Arduino board while the ground server will consist of a Computer with internet.

The basic architecture of both modules is shown in Fig 1 and Fig 2.

Figure 1.Transport module

Figure 2.Ground Server

The GSM network is chosen due to its extensive coverage so we will not have to develop our own communication protocol. The use of off the shelf equipment will also help us bring down the price of module as it is very expensive to

develop a new wireless communication system. The Arduino board is chosen due to extensive availability and low price.

The whole system will be developed considering to keep the

cost lowest to maximize its profit and utilization.
The functionality of the whole system is described in Fig 3.

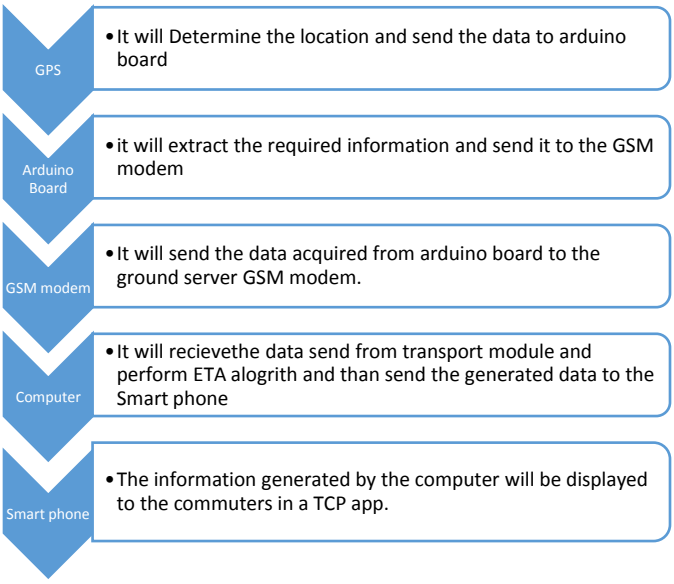


Figure 3.Functions

The estimation algorithm will be implemented on the computer in C# language.

III. Transport Module

In this section we will briefly explain the working of transport module. As discussed before it will consists of three components and they will be integrated together in a single device which will be installed on the locomotives. The GPS will determine the location and send its data to the Arduino board which will extract the necessary location data including the latitude, longitude of the vehicle. The data will be processed and then send to the ground server after every twenty seconds using the GSM.

A. GPS module

GPS which is also known as global positioning system is a device which can determine the location anywhere on earth. The accuracy depends on the device. The device we will be using in our case is Skylab SKM53 as shown in Fig 4.[2]

Figure 4.GPS module

It is a device with high sensitivity, low form factor and really fast fixing time.
It generates data in the format shown below.
$GPGLL,3723.2475,N,12158.3416,W,161229.487,A,A*41
Many type of data is generated by the module but we will require only Latitude and Longitude information. The data is send using Serial protocol to Arduino board at 9600 baud rate[2].

B. Arduino board

The board we will be using is Arduino Mega 2560 as shown if Fig 5.[3]

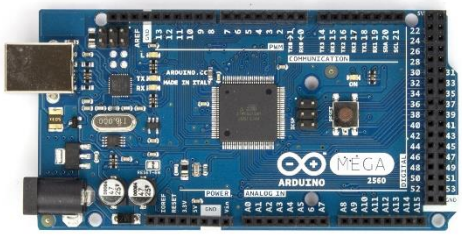


Figure 5.Arduino Board

It is a microcontroller board and it is based on the ATmega2560. It has 54 digital input/output, 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button[3].
The GPS and GSM modem will be connected to this board. It will receive the data from GPS module and extract Latitude and Longitude information. It will then convert the data into format like 33.580411#73.069413 in which first part is the Latitude and second after # is the Longitude. The # is added for ease of separation between the Latitude and Longitude at server end. It will then send the data to GSM modem which will transmit it the ground server over TCP protocol.

C. GSM modem

The GSM modem we are using is SIMCOM SIM900D GSM module Fig 6.[4]

Figure 6.GSM modem

This receive the data from Arduino board and send it over GSM network to server using TCP protocol. The data will be send using At commands as shown in the following Table 1[5].

Table 1.AT Commands

Sr #	Command
1	AT+CGATT?
2	AT+CIPSHUT
3	AT+CIPMUX=0
4	AT+CSTT=\"ufone.pinternet\",\"\",\"\"
5	AT+CIICR
6	AT+CIFSR
7	AT+CIPSPRT=0
8	AT+CIPSTART=\"tcp\",\"8.8.8.8\",\"8000\"
9	AT+CIPSEND
10	AT+CIPCLOSE

Through utilizing these commands the data will be send to the server over GSM network using TCP protocol.

IV. GROUND SERVER

The most important module of our system is the ground server which will perform the most important task which is the implementation of the algorithm to predict the arrival time. This is implemented in the C# program in Computer. We can further enhance the system by use of web and smart phone platform which will be integrated to our system in later stages.

A. *Computer*

The computer which will be connected to the internet will receive the data and the server implemented in C# program will access this data. The computer utilized in this case can be any personnel computer as this job will not be too much demanding for a computer. Than the program will extract the Location data, separate it into Latitude and Longitude and implement the ETA algorithm. It will also store the data for future usage in Settings Data base. Than the results which will be generated will be send to Smart phones via TCP protocol over internet to be displayed on required bus stop.

B. *Smart phone*

The commuter's Smart phone which is also connected to the internet will receive the ETA information over TCP protocol and display the information using any available TCP communication application. The ETA information can also be displayed on LCD or LED installed on bus stops configured to receive the information over TCP protocol and display it.

The display utilized can be either LED or it can be an LCD display as shown in Fig 7[6] and Fig 8[6].

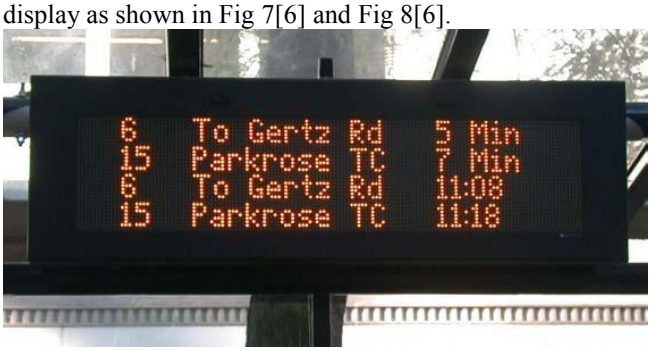


Figure 7. LED display

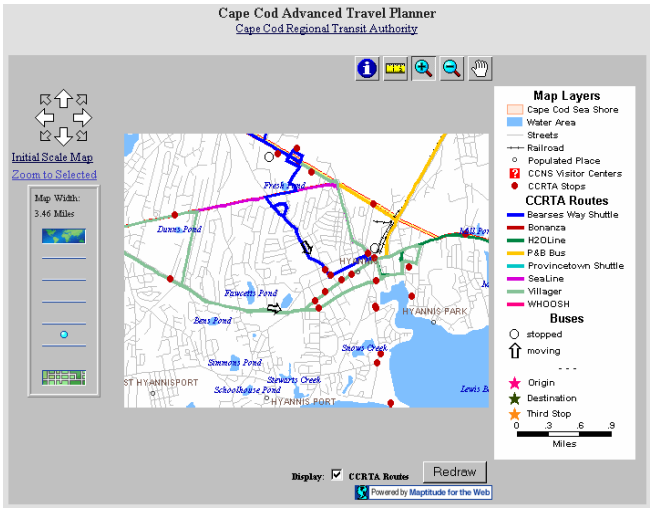


Figure 8.LCD display

V. ALGORITHM

This the part where all the work will be done. The algorithm we will be utilizing will work on the following logic.

First it will receive the location data and speed of the vehicle which will be stored on the computer. Than this data will be used to identify the location of the vehicle and then the remaining distance will be measured utilizing this data. The location will be directly send to be displayed. The route will be divided in 100 meters segment and the time for each segmented will be recorded in storage. From the data we stored for each segment we will predict the dwell time for each segment. Now for how we will estimate the time we will first find the remaining distance of vehicle for stop through which we will know the segment in which it is currently travelling. Depending on the speed of the vehicle we will estimate the time required without the delays to reach the stop using the formula T=S/D where T is the time S is the speed and D is the remaining distance.

The distance is found by using formula.

$$L = \arccos\begin{pmatrix}\sin(yo)\sin(ye)\cos(yo)\cos(ye)\\ \cos(xo-xe)\end{pmatrix} * Re \quad (1)$$

In this formula the L is the distance while Re is the radius of the earth and the (Xo,Yo), (Xe,Ye) represents the coordinates of the points.[7]

Than the delays will be added to this time. Now for which delays to be consider we will use statistics. We will be storing delays for each segment with the time of the day and the average speed of the vehicle. Now for delays to be considered we will first look at the time of the day as it will affect the traffic on the road greatly. Than we will consider the speed of the vehicle and reference the data which is in 20% of margin to that speed. Than we will take the average of the delays and it will be added to the calculated time. This way we will estimate the ETA for the vehicle.
This is a simple algorithm and it is not very comprehensive as for delays it greatly rely on the statistics and past data which cannot be fully reliable. So we can also utilize the algorithms developed by many others as discussed below.
Now consider the prediction based on path developed at Beijing University. The bus position is determined from the GPS data and the data is utilized to form data tables and dwell times are noted as shown in Figure 9[7].

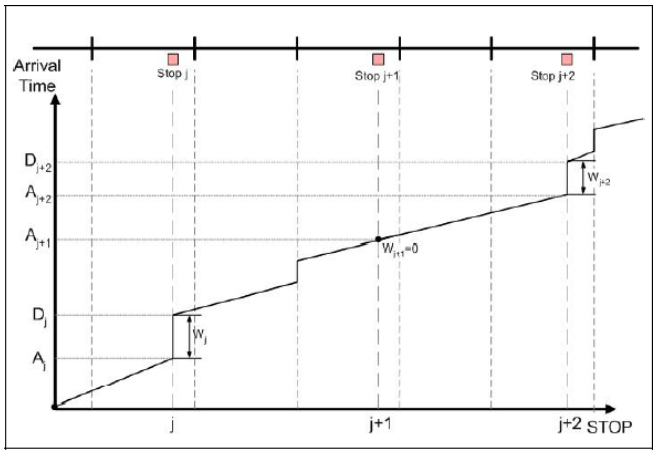


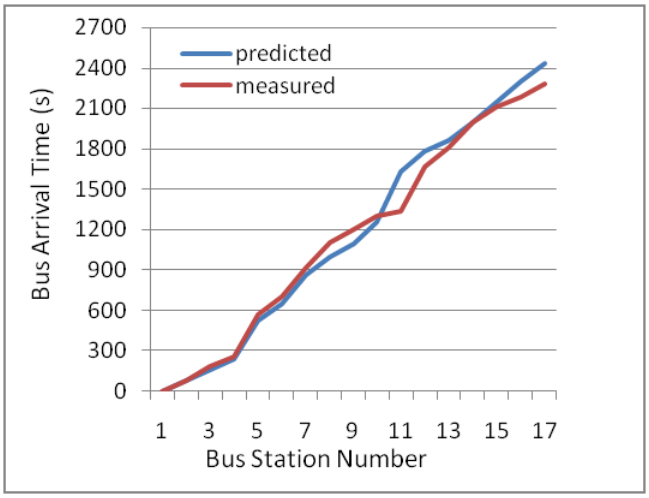
Figure 9. Bus data

The dwell time is predicted by using statistic tools and the ETA is predicted.
The Mean Absolute Percentage Error (MAPE) is used as a measure of estimation accuracy and is calculated using

$$MAPE = \left(\frac{1}{N}\sum_{k=1}^{N}\frac{|t(k)-t_m(k)|}{t_m(k)}\right)*100 \quad (2)$$

Where tm (k) is the arrival time of the test buses measured from the field N is the test times. [7]
When the bus was far away from the stop the above method was implemented and the estimated arrival time and the measured arrival time of one bus for the 17 bus stops were compared and the results are shown in Fig 10.

It can be seen from the graph that the margin of error was



obtained to be maximum at 13% which is a good result.[7]

Figure 10. Results

Using these types of algorithms we will be able to predict the arrival time with minimum error.

VI. WEBSITE

The number of online internet users is increasing day by day and now almost all the countries in the world have access to the internet. Internet is a great source of sharing information and we can utilize it to broaden our system. We can display the ETA data on a website. The website will be updated on every 1 minute interval and will show the relevant information to users so the commuters can know the Bus arrival time before hand at home instead of waiting at bus stops. [8]
This system is already implemented in many countries. A website for this purpose showing information in Fig 11[1].

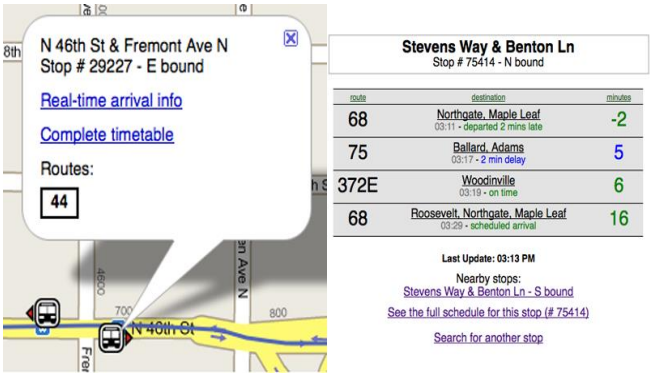


Figure 11.Website

One of the main advantages of utilizing website is that the internet protocols are universal so they can be accessed from any location and on any type of internet enabled device which includes smartphones, computers, tablets etc.

CONCLUSION

In this paper we have propose a very simple but useful ETA system which can be implemented on local transport at low cost and with great benefits. From this we can conclude that by implementing our system we will help to save time of end users from needless wait at bus stops. It will improve the experience of local transport system. It will help to attract more customers towards public transport. It will make public transport more reliable. If the public transport is improved and the numbers of commuters using it increases it will help to solve the congestion problem in big cities and it will also help save fuel which is imported in Pakistan and is a great burden on our national economy.

VII. REFERENCES

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