GPS BASED SMARTPHONE APPLICATION: REAL TIME BUS TRACKING SYSTEM FOR EDUCATIONAL INSTITUTIONS

[1]TANZILA ISLAM, [2]MOHAMMAD RAIHAN RUHIN, [3]CHYON HAE KIM

[1]Department of Electrical Engineering and Computer Science, Iwate University, Morioka, Japan
[2]SKYCOM Corporation, Miyazaki, Japan
[3]Department of Electrical Engineering and Computer Science, Iwate University, Morioka, Japan
E-mail: [1]tanzilamohita@gmail.com, [2]raihanruhin@gmail.com, [3]tenkai@iwate-u.ac.jp

Abstract - GPS (Global Positioning System) based tracking system has many applications in today's world, including vehicle tracking, child tracking, any equipment tracking, etc. These services offer many advantages to the mobile users to retrieve the information about their current location and process that data to get more useful information. The development of a bus tracking system for android based smartphone with the aim of enabling educational institution students, faculties and staffs to locate their buses with ease and in a convenient manner. The system consists of two sides, server side and client side. The client side provides the facility to the user to track buses remotely through the mobile network or WIFI and the server side's main responsibility is to provide the exact location of the bus to the server . Any type of user can see the live location of their desire bus with only 5 seconds of update interval. This will reduce unnecessary hassle and waiting time for the users. It will provide multiple services to the user based on their category.

Keywords - Bus tracking, Global Positioning System (GPS), Smartphone application, Google Maps API, Android platform

I. INTRODUCTION

Every educational institution has their own transportation services for the students as well as the teachers and staffs. Typically, these buses travel along set routes, passing from house to house or from bus stop to bus stop, stopping to pick up or discharge students at designated times. Buses do not always arrive at the pre-designated stops on time, as a result of traffic conditions, weather etc. For this reason, students need to wait a long time. Longer waiting periods increase the probability of traffic accidents, as well the potential for interaction with unwelcome strangers, e.g., abduction. However, transportation information system is very poor nowadays. Bus user does not know the exact arrival time for a bus, but only know the scheduled arrival time. Bus transportation service does not have a proper system to track all buses location and the actual arrival time in every bus stop. These issues happen on the grounds that the present bus service system did not apply real time tracking technology to track the transport area. There is no online platform to update most recent bus traffic information to the bus users. To overcome this difficulty, real time bus tracking system has to develop and implement to aid tracking real time bus location. With real time bus tracking system in android platform, bus position data is connected real time and transmitted to a central server for processing and extracting transit information. Most of the vehicle tracking system is developed by using GPS/GSM technology [1]. In this bus tracking system, a bus location is one of the most important components. The location and time information anywhere on earth is provided by using GPS technology [2]. GPS technology able to receive the position of an object from space-based satellite navigation system through a GPS receiver.

In this paper, a smartphone based real time bus tracking system is proposed for an educational institution where three category users (Student, Teacher and Staff) can see the live location of buses. There is also another android application for drivers to update the corresponding location data. The developed bus tracking system will ready to provide bus users a real time system to check on updating bus traffic information, for examples bus schedule, real time bus location, bus arrival or departure time, etc. This system will able to reduce workload for the bus management team and provide an immediate platform to update most recent and accurate bustraffic information to bus users. The rest of the article is structured as follows. Related works are discussed in the second section. In the third section, requirement analysis is proposed. The system architecture is shown in section three. Section four presents user services and user interfaces in the proposed system. Conclusion and some future enhancements are given at the last section.

II. RELATED WORKS

GPS technology is used around the world in numerous fields, for example, vehicle position tracking systems, child tracking system [3], vehicle anti-theft tracking systems, fleet management systems, and intelligent transportation systems (ITS). Real-time vehicle tracking and management system [4] has been the focus of many researchers, and several studies have been done in this area. Verma and Bhatia [5] expressed in their investigation that GPS could be utilized as a part of numerous applications and it is possible to follow routes and locations driven a vehicle by methods for GPS. They build up an online system exhibiting vehicles' locations to the client. Guo et al. [6] coordinated the

Victoria Regional Transit System with suitable correspondence advancements to build up a corresponding smartphone application. In this smart bus system, clients can get to ongoing traveler data, for example, schedules, trip organizers, bus capacity estimates, bicycle rack accessibility and bus stop areas, by means of a Smartphone, on PCs and at bus stops.

Lau [7] proposed simple bus tracking system in UCSI University, Kuala Lumpur, Malaysia. The tracking system provides location of a bus for the students within a fixed route. The students are given a status of the bus after specified time interval utilizing LED board and a Smartphone application. KuanYew Tan and KokSheik Wong [8] introduced a low-cost campus bus tracker for University of Malaya campus using WiFi and GPS information, where three modes of data communication methods are considered. A website is constructed to display the current location of the bus, while an Android application is developed for the bus driver to send his current location data at a regular interval. In this system, no android application had been proposed for the users.

In Bangladesh, there is no bus tracking system for educational institution bus services as well as public bus services.

Real-time bus tracking systems are beneficial to the students who attend school/ colleges/ universities with large campuses. With the bus tracking system, they can spend more time studying, sleeping, or relaxing instead of sitting for a delayed bus. Spending less time waiting for a bus enhances the comfortable and effective time management of the students also. Additionally, the bus tracking system enhances children's safety when it is prepared in school buses.

III. REQUIREMENT ANALYSIS

The application is designed for drivers and users. Both must have a smartphone that supports GPS and internet minimum. At this Stage, the requirement analysis had been perceived the problem of bus services at Jahangirnagar University, Bangladesh. Most of the students faced difficulties about the bus timing. They need to wait a long time for buses. This type of difficulties is not only for the students, but also for the staffs and teachers. The problem can be resolved by developing a real time bus location tracking system. Such proposed system will be helpful for any kind of educational institutions. In a later phase for implementation purposes, the system will be developed using Android Studio [9], Android SDK tools, Android 6.0 emulator system image and Android 6.0 Platform. The reason behind choosing Android platform to target more users. Statistics show that the market share for the Android OS is 87.7% [10] . The programming language used to develop the application is PHP for its web-based software and Java for android based application development. The database management system is MySQL. GPS and Google Maps are used for displaying current locations of buses on the maps, together with the related route information.

IV. SYSTEM ARCHITECTURE

The requirement specifications are examined in this phase and the system architecture is prepared. The system architecture helps in specifying the application types, system requirements (e.g. GPS, Internet, etc.) and helps in defining the overall system architecture. The components and architecture of the proposed system consist of the following as shown in Fig. 1.

(i) There are two types of tracking application. One is for the user and another is for the driver.
(ii) The Internet is a must for updating and retrieving location details. Restful API services used to connect the server.
(iii) The driver will send the location so that user can get the live location. For sending location, the driver must enable the GPS in his phone.

Fig. 1 Architecture of smartphone based real time bus tracking system

A. Global Positioning System (GPS)

Global Positioning System (GPS) is a worldwide radio navigation system shaped from the constellation of 24 satellites and their ground stations. The Global Positioning System is essentially controlled by the U.S Department of Defense (DOD). The system was at first made and intended for the U.S. military use. But nowadays, it is accessible for non-military personnel, with no sort of charge or restrictions. Global Positioning System tracking is a technique for working out precisely the situation of GPS sensor holder in view of a basic scientific rule called trilateration or triangulation. Trilateration falls into two classes: 2-D Trilateration and 3-D Trilateration. It requires having no less than four satellites transmitting coded signals from known positions. Three satellites are required to provide the three distance measurements, and the fourth to remove the receiver clock error. A GPS tracking system can work in various ways, i.e. Active and passive tracking. In

Passive tracking, the position is normally stored in internal memory or on a memory card along the ride, while in the active tracking, also refers to a real time tracker; data is to be transmitted to a central database via modem within the GPS unit [11].

B. Google Map API

The latitude and longitude (lat, long) coordinate values have to be obtained to locate any bus location. These values are obtained from the GPS receiver in each bus. Google serves it via a simple REST (Representational State Transfer) API enhanced with JavaScript and AJAX technologies. The system utilizes map API in open source JAVA framework with the standard libraries. A sample http query to request a map is given below.

```
http://maps.googleapis.com/maps/api/geocode/json?
```

After the question mark, query parameters and their constraints are appended. Parameters' numbers and their values change depending on what users need from map services. The parameter lists are separated by the ampersand (&) symbol. An example query for a specific map is given below.

```
http://maps.googleapis.com/maps/api/geocode/json?latlng='
.trim($latitude).','.trim($longitude).'&sensor=false
```

The driver provides latitude and longitude, which later extend to locate name by calling the google geolocation API through server script. This one is in fact called reverse geolocation API which takes two double type coordinates and matches with their corresponding human readable names which is already pre-defined in the server. If the corresponding location name is not found, it returns null.

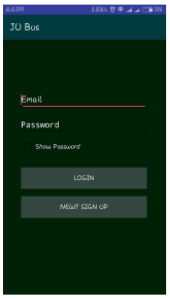
V. USER SERVICES AND INTERFACES

The proposed system named JU Bus Tracker is an Android based application where users can see the live location of university buses. There is also another android application for drivers to update the corresponding location data. Google provides an IDE called Android Studio have been used as the preferred development environment for creating Android applications. The policy of this tracking system is to facilitate the university students as well as the staffs and faculties. This system uses computer technology, which is much faster, secure and provide confidence and authenticity for any user.

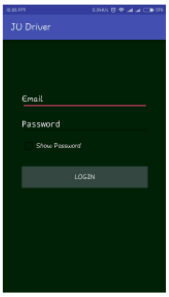
In this tracker system, there are two categories: users' category and bus category. User categories are in three types. These are student, staff and teacher. Student can get live location of student bus services. Staff can get live location of staff buses. The teacher can get live location of teacher buses. User can open an account free of cost. They can open an account by using e-mail address. In a bus category, there are four types of buses. These are student bus, staff bus, teacher bus and a community bus. Staff and teacher both can use community buses.

There are some features in this tracker system. These are:

Login : There is a Login form at the beginning of both the user and driver application. In the Login form, there are two fields. One is for Email; another is for a password. If anyone is already registered, only he/she can login to this application. In Fig. 2, there is no signup button for the driver as they are pre-registered and credentials are just handed over manually. When the user gives his email and password, it will be checked from the database, whether this user exists or not. If the given ID and password is correct, only then user can go next. Here, PHP API used for connecting to MySQL database.



a. User



b. Driver

Fig. 2 Login form of smartphone based real time bus tracking system

Registration : The user must fill up every field in this Registration form. The user cannot use the same email address twice for opening an account. In this form, there is a Name field, Email field, Date of Birth field, Gender field, Batch field, Department field, Password field and Re-type Password field. If registration is complete, there will show a message, "Successfully Registered" after clicking signup button. After successful registration, the user automatically redirects to the Login activity. Now he/she can login his/her account by using email ID and password. At the beginning of registration section, there is a spinner/ drop down menu for selecting account type. There are three types of Account Categories. These are Students, Teachers and Staffs. User must select one of them. Student option is selected by default. If the user is a Student, he/she must select "Student", same goes for teacher and staff. When the user is a teacher or staff, the date of birth, gender and batch field gets hidden. These 3 fields are applicable only when the user is a student.

There is an input validation in application. If the user gives any wrong information, an alert will be shown.

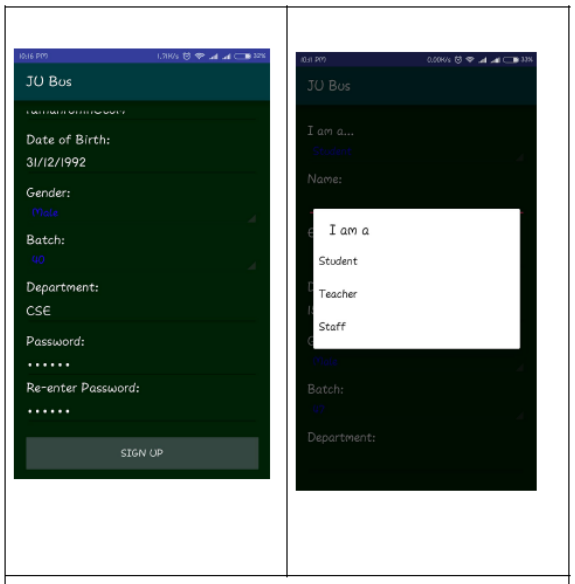
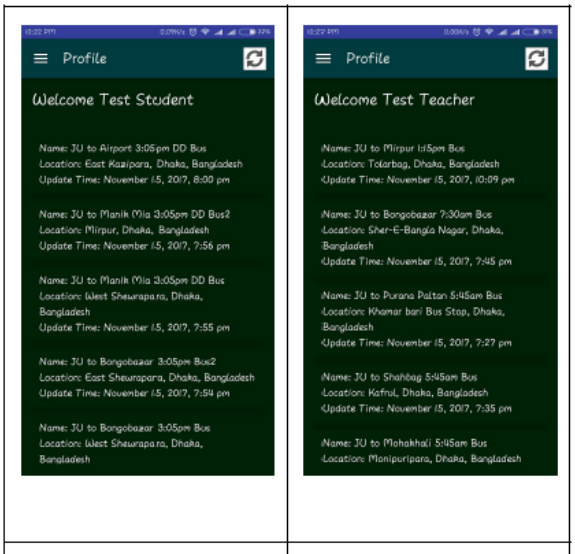


Fig. 3 Registration form of smartphone based real time bus tracking system

There is a validation of input text. It will give an error message when get the value of EditText is null. Then the user has to take care about validation. Here validation is used for an Email, Password and Re-type Password. An Email must be unique. There is a digit limit for Password. The Password must be minimum six digits. Re-type password must be matched with the Password field. If it does not match, there will be an error message "Password did not match." The Password can be any type of letters, digits or special characters. If all the information is validated, only then the user can create an account.



a. Student b. Teacher

Fig. 4 Location Tracker of smartphone based real time bus tracking system

Location track : This is the main page for a user to see the live location of buses. Student category user will see only the buses assigned to students, same goes for Teacher and Staff user. Another category bus is community bus, which is kept common in both Teacher and Staff category users. The bus lists are kept in the list view with the most updated first approach. Each bus info consists of 3 portions, Bus Name, Location and Update time. Bus Name includes starting place, destination place and leaving time. Location shows the live human readable GPS location which is updated every 5 seconds. The last part is Updated Time, which shows the last update time of the particular bus up to minutes.

Location update : Fig. 5 shows the Location Update activity in driver application. This is the only activity in the driver application after login. When a driver logs in successfully, he will show the activity to start sending location updates of buses. Basically, the driver sends the latitude and longitude of the corresponding bus, which is found directly from device GPS. If the GPS is not enabled, there will be warning message to enable the GPS. Similar warning for Internet too. Driver app requires Internet connectivity to send the location update to the server.

Schedule : There is a filter option for the bus schedule which separates the full schedule list into 4 types. Dhaka to JU, JU to Dhaka, Dhaka to JU during holiday and JU to Dhaka during holidays. Upon selection of any option, schedule data is pulled from the server and shown as a list. A single list item does contain Starting location, Destination location, Leaving time and other info like AC or Double Decker bus. At the beginning of this activity, Dhaka to JU option is selected by default.

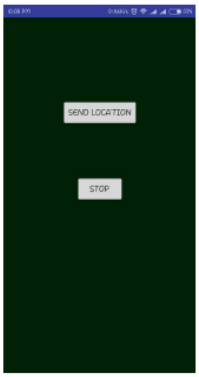


Fig. 5 Location Update of smartphone based real time bus tracking system

Fig. 6 Feedback activity of smartphone based real time bus tracking system

Feedback : Fig. 6 shows a feedback activity for each user. The entire user can submit any query, suggestion, bug report or any other info through this

application. When the user presses the email button, android system will open his default email provider (e.g. gmail) with "To" and "Subject" field are already has been filled up. User needs to type in Body section only and send the mail. Email will be checked frequently.

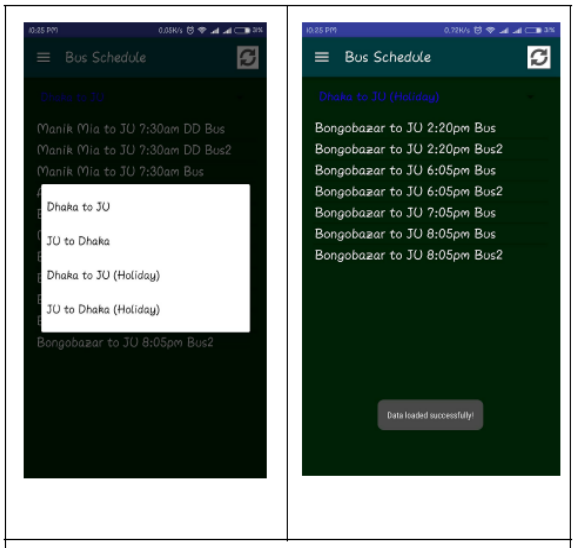


Fig. 7 Bus Schedule activity of smartphone based real time bus tracking system

Logout : Once the user is login to the application, his credentials are saved even he close the application so that the next time user is automatically kept logged in. This was made possible by "Shared Preference" android feature. But if the user wants to be completely logged out from the application and remove any saved data, he needs to press logout option (Fig. 9) in the drawer menu (Fig. 8). A confirmation prompt will be shown with "Yes" and "No" option. "No" option keeps the user in the app and "Yes" option closes the app.

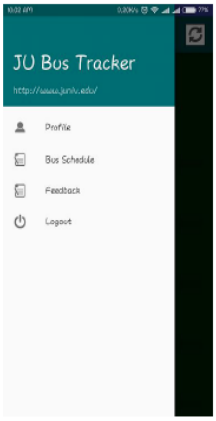


Fig. 8 Drawer Menu of smartphone based real time bus tracking system

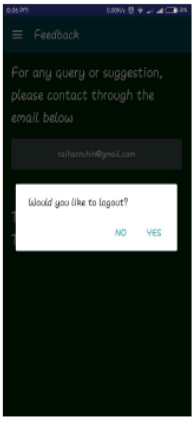


Fig. 9 Logout feature of smartphone based real time bus tracking system

CONCLUSION AND FUTURE ENHANCEMENTS

Waiting for the bus is hectic and even many of us are unaware of the bus timing. From the bus management side, it is very difficult to provide an accurate schedule for a bus user due to some uncertainties may happen on the road such as traffic jam or bus break down. When a bus is delayed, bus management side should inform bus users immediately. However, they do not have a platform to inform bus users in real time about the latest bus traffic status. In order to reduce the difficulties, realtime bus tracking system is needed in educational institutions. Real time bus tracking system provided a real time platform for bus users to check on bus traffic status in anytime and anywhere. It also provided a platform for bus service provider to monitor bus status and update latest information to the user. Real time data synchronization was one of the major challenges of this application. App crashes due to several reasons were another challenging issue, especially, due to internet disconnection of users. After conquering all the obstacles, the applications are finally live and tested. One of the major limitations of the user application that is missing map view like Uber.

In future, the app view will be added in the upcoming update. There are many other enhancements for the proposed system; one of the important enhancements would be integrated on Messenger or Whatsapp like third party application with the back-end system to reduce driver application completely for more convenience. Another important enhancement would be creating an artificial intelligence program to automatically study and analysis bus route data to provide most optimum estimate arrival time. By applying artificial intelligence program, the system will become more valuable because of the accuracy of estimation of arrival time.

REFERENCES

[1] S. Tarapiah, S. Atalla, R. AbuHania, "Smart On-Board Transportation Management System Using GPS/GSM/GPRS Technologies to Reduce Traffic Violation in Developing Countries," International Journal of Digital Information and Wireless Communications (IJDIWC), pp. 96-105, 2013.

[2] Muruganandham, "Real Time Web based Vehicle Tracking using GPS," World Academy of Science, Engineering and Technology, 2010.

[3] Al-Mazloum, E. Omer, M. F. A. Abdullah, "GPS and SMS-Based Child Tracking System Using Smart Phone," International Journal of Electrical Computer Electronics and Communication Engineering, vol. 7, no. 2, 2013.

[4] I.M. Almomani, N.Y. Alkhalil, E.M. Ahmad, R.M. Jodeh "Ubiquitous GPS Vehicle Tracking and Management System," IEEE Jordan Conference on Applied Electrical Engineering and Computing Techniques, pp. 1-8, 2011.

[5] P. Verma, J.S. Bhatia, "Design and Development of GPS-GSM based Tracking System with Google Map based Monitoring," International Journal of Computer Science, Engineering and Applications (IJCSEA), vol. 3, no. 3, pp. 33-40, 2013.

[6] X. Guo, E. Huang, B. Hung, "Design a Smart Bus System," Canada, 2012.

[7] E. C.-W. Lau, "Simple Bus Tracking System," Journal of Advanced Computer Science and Technology Research, vol. 3, no. 1, 2013.

[8] K. Tan, K. Wong, “Low-cost campus bus tracker using WiFi access points," in IEEE International Conference on Consumer Electronics-Taiwan (ICCE-TW) , Taiwan, 2016.

[9] "Android Developers," Google, [Online]. Available: https://developer.android.com/studio/. [Accessed 2018].

[10] "Statista," Statista GmbH, [Online]. Available: https://www.statista.com/statistics/266136/global-market-share-held-by-smartphone-operating-systems/.[Accessed 2018].

[11] T. Pratt, Charles W. Bostian, Jeremy E. Allnutt, Satellite communications, Wiley, 2003.

★★★