UTM Computing Proceedings
Innovation in Computing Technology and Applications
Volume: 2| Year: 2017 |ISBN: 978-967-0194-95-0

Location-based Service Crowdsourcing For Efficient and Effective Public Bus Services

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Abstract. Public transport plays a vital role in a developing country where people from all around the world pay a visit to the country and public transport would be their priority concern. In Malaysia, Passenger Information System (PIS) has been set up for citizens such as displaying the time of arrival of respective buses but those numbers are not accurate. Crowdsourcing has become a popular approach on capitalizing on the potential of the information generated by large and open crowds of people external to the organization. OurBus is a location-based crowdsourcing Android application to improve the efficiency and effectiveness of public bus services. It applies the crowdsourcing method to gain information from the users and displays it to others for better user experience and for better admin management.

Keywords: public bus; crowdsourcing; location-based; Android mobile App

1 Introduction

Public transport plays a vital role in a developing country where people from all around the world pay a visit to the country and public transport would be their priority concern. An affordable and effective network of public transport system is essential for a developing country. Public transport is often the only means of transport for most of the working citizen via social perspective. Without a spatial network of public transport, they would only search for work opportunities which are walking distance from their homes, so a good network of public transport improves their livelihood opportunities. It also gives them greater access to education, health care and recreation. For senior citizens, people with disabilities and children, public transport is also their main means of mobility.

The term location-based services (LBS) is a concept that denotes applications integrating geographic location (i.e., spatial coordinates) with the general notion of services. [1] Crowdsourcing has become a popular approach on capitalizing on the potential of the information generated by large and open crowds of people external to the organization. Crowdsourcing is defined by Merriam-Webster as the process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers. [2] Location-based Crowdsourcing for Efficient and Effective Public Bus Services Mobile App is an Android application that apply the crowdsourcing method to gain information from the users and display it to others for better experience of the user.

The objectives of this project are i. to study and identify the problems of current unreliable public bus services. ii. to design a crowdsourcing system and to implement the proposed system and iii.to test the developed system in UTM for system performance and end-result.

2 Problem Background

Up till the present moment, some cities in Malaysia integrated multiple technologies, such as metro rail, light rail, Bus Rapid Transit and basic bus services. A common ticket or fare card serves all the systems, making it

easy for passengers to transfer from one mode to the other. Passenger information systems (PIS) allows users to know when the next service is due and to understand the routes easily, and high frequency of service

reduces the hassle of a long wait for the next bus or train. PIS was set up for citizens to display the time of arrival of respective buses but those numbers are not accurate, it is only an assumptions from the bus company without taking the severe traffic condition into account.

3 Methodology

For this project, Rational Unified Process (RUP) has been chosen to be the development model. Each phase of RUP methodology will be discussed later in this chapter. And it will provide a clearer insight to the list of activities covered in each phase. Lastly, there is a brief justification for the hardware and software choices.

3.1 Inception Phase

Inception is a phase where a business case for the software system is developed and project scopes are determined. At this phase, the public bus services are being determined and interpreted thoroughly. As this project is part of the Digital Lifestyle Project, involvement on inception phase from other partner might be taken into consideration. There are going to be three iterations in this phase. During the first iterations, the objectives, scopes and problem backgrounds of the projects are to be determined. For the next iteration, the output from previous iteration will be reviewed along with the production of literature review of the existing systems available on the market. In the last iteration, an assessment of the literature review would be done.

3.2 Elaboration Phase

In elaboration phase, the focus is on the establishment of product vision and architecture. First and foremost, the problem domain will be interpreted to elicit both functional and non-functional requirements for the project. For this project, Model-View-Controller architecture will be applied to the system as it is component-based which support modifiability. Model will be the data stored in the Firebase, controllers will be declared to access those model and views are the User Interface where the data are displayed.

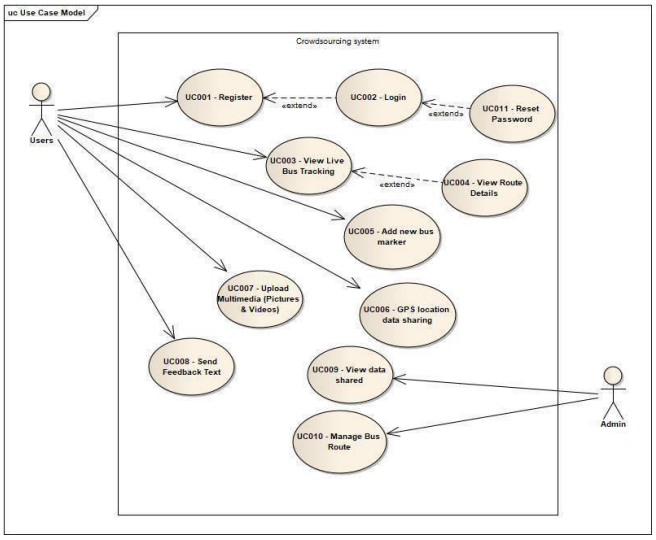

Figure 1. Use Case Diagram

Same as the previous one, this phase is similarly broken down into three iterations. For the first iterations, the existing system on the current market will be studied and analysed to elicit the requirements for the project. Alongside with it, the actors for the system are to be singled out. Later in iteration two, the major use cases will be identified and converted into a use case diagram with the help of Enterprise Architecture.

3.3 Construction Phase

The main objective of construction phase is to construct the planned and designed system into an executable and working system. Primarily, the idea is to execute the plan by developing the

components defined earlier and other significant features of the system in details. This has to be done by making sure that all the resources are utilised optimally, thus avoiding any redundant works.

3.4 Transition Phase

In this phase, the project team has to validate and make sure that all the needs of stakeholders are satisfied before delivering the complete system. The system will be put to test and adapt continuously based on user feedback until a high quality complete system is produced. The system will be tested in UTM using the bus routes available and the tests will be run on UTM students where they act as the public users.

4 System Overview

OurBus is an Android native app that enable users to share their information to the system so that that information can be used for improving the Passenger Information System(PIS). OurBus import the map of UTM into the application and there will be marker on where the bus is currently positioned according to the information shared by the users.

4.1 System Backend

Firebase is chose to be apply on this application. It provides reliable real-time database where data can be displayed to the users immediately if there are any changes to the information. The information received by the users will be processed to come out with a more reliable and accurate information. Users' geo-data information will also be filtered first at client side before they are sent to the system

4.2 Information shared

There are several ways for a user to share their information.

i. Fine GPS location
ii. Picture / Videos
iii. Text

4.3 Data processing

Data processing is a must in this aspect as every location received by the system will be minorly varied to one another. And the coordinate received will be different as one would be sitting in front row of the bus and the other one might be sitting at the back row of the bus. But they are still on the same bus sharing the same bus location and only a point should be chose to be displayed on the map.

Thus, the data will be processed to find the average of total sum coordinate.

$$\text{Average coordinate} = \frac{\sum \text{users' coordinate}}{\text{Number of users (n)}}$$

4.4 Data filtering

Data filtering is very important in this crowdsourcing backend as lots of fake data or noise data might occur throughout the whole crowdsourcing process. So, for the GPS location sharing, the filtering process is done locally at client's phone where a square perimeter of 10m (meter) is set up around the bus.

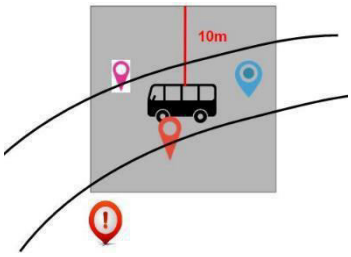

Figure 2. Perimeter set for filtering

A perimeter of 10m would be result in 0.0001 in coordinate for both longitude and latitude. Therefore, the perimeter is set by adding 0.0001 to the average latitude and longitude of the specific bus. A checking is done before the users are able to share the location. This method is implemented to avoid fake location sharing.

5 System Implementation

OurBus will be connected to Firebase where users have to create an account and start sharing. Users can only start to share after successful login authentication. This is due to the rule of Firebase where users can only read and write after authentication and this is the way to get the users' ID key.

5.1 Firebase structure

All Firebase Realtime Database data is stored as JSON objects. Unlike a SQL database, there are no tables or records. When you add data to the JSON tree, it becomes a node in the existing JSON structure with an associated key. [3]

The two main tree branch are: Bus and Users which contain bus information and users information. In the Bus branch, user input data are separated from the system data where system data contain data that have been processed.

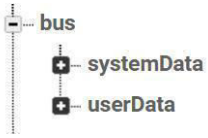

Figure 3. JSON tree structure

Inside the systemData, the average of each bus location is stored according to their busID and busRoute. There are currently 4 routes that been put into test which is 101, 102, 103 and 104. Each route may contain one or more bus running at the same time, so the busID is the bus plate number. As shown as below is the structure of systemData.

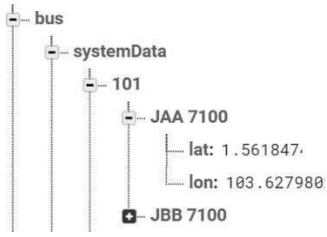

Figure 4. Structure of Bus's SystemData

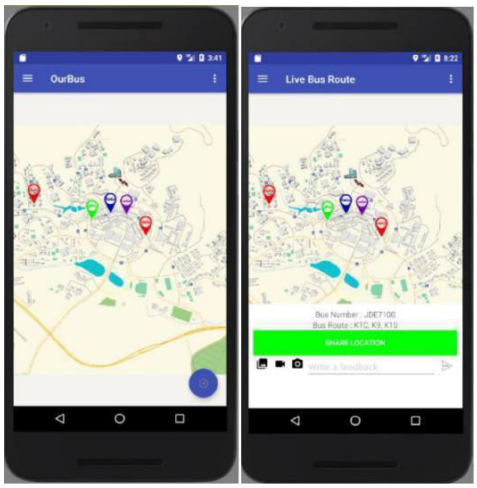

Figure 5. User Interface of OurBus

6 Conclusion

This project has been successfully developed where all the functional and non-functional requirements are met. The objectives of this project have also successfully achieved. A recommendation for future work, OurBus currently only cover the map of University of Technology Malaysia and their buses information. It can be further extended to every city and co-operate with Prasarana under Digital Lifestyle Project which involve Prasarana and UTM.

Acknowledgements. This project is conducted under Digital Lifestyle Project by Assoc. Prof. Dr. Toni Anwar. Deepest gratitude and thankfulness to all the people involved.

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