DEVELOPMENT OF E-BECA MONITORING SYSTEM USING WEB-BASED APPLICATION

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DECLARATION

I declare that this thesis entitled "DEVELOPMENT OF E-BECA MONITORING SYSTEM USING WEB-BASED APPLICATION" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : --

Name : --

Date : --

APPROVAL

I hereby declare that I have checked this report entitled “Development of e-Beca Monitoring System Using Web-Based Application” and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Electrical Engineering with Honours

Signature : ....

Supervisor Name : ....

Date : ....

DEDICATIONS

To my beloved mother and father

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ABSTRACT

E-Beca is a solar powered electrical trishaw which is introduced to promote tourism in Malaysia due to its significant identity as a conventional transportation system especially in the state of Malacca. E-Beca is also an innovative product built by a research team from Universiti Teknikal Malaysia Melaka (UTeM) for the purpose of introducing education tourism system in UTeM. In order to assure the safety of user and asset which is the e-Beca, a web-based application monitoring system is proposed to track the real-time location of e-Beca. A smart phone with inbuilt sensors is selected as the tracking device for the project and several software like “XAMPP” and “Notepad ++” are used to develop the web-based application. Programming languages like HTML, CSS, JavaScript and PHP are used to develop the user interface and functionality of the web pages. Besides, an additional development for a mobile application control system is introduced to control the switching of LED and buzzer using Arduino UNO as the microcontroller by assuming LED is the power supply and buzzer is the alarm system of e-Beca. Total of ten experiments are conducted by collecting latitude and longitude coordinates and instantaneous time displayed on both the application and monitoring system in order to determine the performance and reliability of the system in terms of location tracking accuracy and data communication efficiency. Eventually, the e-Beca web-based monitoring system has been developed to provide all the required functionalities to administrator and user of the system. Based on the requirements needed for the monitoring system, administrator is able to track the real-time location of the smart phone which is represented as the target unit while the smart phone user is able to see their real-time location, time left for the ride, e-Beca advertising video as well as making phone call to the host system. Throughout a series of experiments, a mean distance error of 7.12 meter between the actual and displayed coordinate is obtained as a result of location tracking accuracy. Then, a mean time difference of 0.572 seconds is obtained as the time latency of displaying real-time locations for the e-Beca monitoring system. Lastly, the development of mobile application control system is proven to be reliable and stable by switching the LED and buzzer ON and OFF successfully for ten times using an open source mobile application.

ABSTRAK

E-Beca adalah beca elektrik berkuasa suria yang diperkenalkan untuk mempromosikan pelancongan di Malaysia disebabkan identitinya sebagai sistem pengangkutan konvensional di negeri Melaka. E-Beca juga merupakan produk inovatif yang dibina oleh pasukan penyelidikan dari Universiti Teknikal Malaysia Melaka (UTeM) bagi tujuan memperkenalkan sistem pelancongan pendidikan di UTeM. Untuk memastikan keselamatan pengguna dan aset iaitu e-Beca, sistem pemantauan berasaskan aplikasi laman web dicadangkan untuk mengesan lokasi masa nyata e-Beca. Telefon pintar dengan sensor terbina dipilih sebagai alat penjejakan untuk projek ini dan beberapa program komputer seperti "XAMPP" dan "Notepad ++" digunakan untuk membangunkan aplikasi web. Bahasa pengaturcaraan seperti HTML, CSS, JavaScript dan PHP digunakan untuk membangunkan fungsi laman web. Selain itu, pembangunan tambahan untuk sistem kawalan aplikasi mudah alih diperkenalkan untuk mengawal pembukaan LED dan buzzer menggunakan Arduino UNO sebagai mikrokontroler dengan menganggap LED adalah bekalan kuasa dan buzzer adalah sistem penggera e-Beca. Sebanyak 10 percubaan dijalankan dengan mengumpul koordinat latitud dan longitud dan masa serta merta yang dipaparkan pada kedua-dua aplikasi dan sistem pemantauan untuk menentukan prestasi dan kebolehpercayaan sistem dari segi ketepatan pengesanan lokasi dan kecekapan komunikasi data. Akhirnya, sistem pemantauan berasaskan web e-Beca telah dibangunkan dengan mengandungi fungsi-fungsi yang diperlukan untuk pentadbir dan pengguna sistem. Berdasarkan keperluan sistem pemantauan, pentadbir dapat mengesan lokasi masa nyata telefon pintar yang dikenali sebagai sasaran sementara pengguna telefon pintar dapat melihat lokasi masa nyata mereka, masa tinggal untuk menggunakan e-Beca, video pengiklanan e-Beca serta membuat panggilan telefon ke sistem kawalan. Selepas percubaan telah dijalankan, kesilapan jarak purata sebanyak 7.12 meter antara koordinat sebenar dengan koordinat yang dipaparkan telah diperolehi sebagai ketepatan pengesanan lokasi. Kemudian, perbezaan masa purata sebanyak 0.572 saat telah diperolehi sebagai tempoh latensi untuk memaparkan lokasi masa sebenar. Akhir sekali, pembangunan sistem kawalan aplikasi mudah alih terbukti dapat dipercayai dan stabil dengan berjaya membuka dan menutup LED dan buzzer sebanyak sepuluh kali dengan menggunakan aplikasi mudah alih sumber terbuka.

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LIST OF SYMBOLS AND ABBREVIATIONS

UTeM	-	Universiti Teknikal Malaysia Melaka
LED	-	Light Emitting Diode
TV	-	Television
UI	-	User Interface
SEMS	-	Smart E-bike Monitoring System
GPS	-	Global Positioning System
HTML	-	HyperText Markup Language
CSS	-	Cascading Style Sheets
PHP	-	PHP: Hypertext Preprocessor
E-Bikes	-	Electric Bicycles
AC	-	Alternating Current
DC	-	Direct Current
GNSS	-	Global Navigation Satellite System
API	-	Application Programming Interface
URL	-	Uniform Resource Locator
m	-	Meter
ms	-	Millisecond

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CHAPTER 1

INTRODUCTION

1.1 Overview

Few subtopics including project background, motivation, problem statement, objective and scope of the project are covered in Chapter 1 of this report. Introduction of project background and related work to e-Beca are discussed to show the importance and reasons in developing the monitoring system for e-Beca. Besides, limitations of the project are discussed in this chapter as well.

1.2 Project Background

E-Beca, also known as electrical trishaw, was introduced and launched by a research team from Universiti Teknikal Malaysia Melaka (UTeM) in year 2016. The organization chart of the research team for the development of e-Beca is shown in Figure 1.1 as below.

Figure 1.1: Organisation chart of e-Beca research team.

E-Beca is built and equipped with plenty of modern technologies such as implementing a green technology by using solar energy as the power source for the electrical trishaw. Green technology is the development and application of products, equipment and systems used to conserve the natural environment and resources, which minimize and reduces the negative impact of human activities [1]. The overall structure and components of e-Beca consist of a main control system with several control switches for the hardware system, a solar system which is used to drive the high power electric motor, a LED TV acts as digital advertising board, an electric fan for cooling purpose, LED lamps as decoration, light and firm framework made of steel and aluminium composite as well as the aluminium rims installed on the trishaw. Therefore, e-Beca has a great capability in promoting the aspect of tourism in Malacca as well as introducing the education tourism system in UTeM since a solar powered electrical trishaw can be known as an upgraded version of the conventional trishaw which plays an important role in representing one of the significant identity of Malacca. An example of the end product of e-Beca is shown as below in Figure 1.2.

Figure 1.2: E-Beca.

Besides, e-Beca is an innovative project launched by UTeM for the purpose of upgrading the conventional trishaw to an advanced electrical trishaw by integrating modern technologies with the contribution of a research team in UTeM. Apart from that, this project is also aimed to improve the lifestyles of conventional trishaw riders and to trigger tourism economic by attracting more tourists and offering more job opportunities for trishaw riders at the same time. The World Travel & Tourism Council states that Travel & Tourism is an important economic activity in most countries around the world. As well as its direct economic impact, the industry has significant indirect and induced impacts [2].

1.3 Motivation

The e-Beca research project is similar to the existing e-bikes system which has been rapidly becoming mainstream in European countries with developed cycling cultures, appealing to both existing and new cyclists [3]. Therefore, with the existing hardware developed for the e-Beca, it requires a development of the monitoring system which is also known as a software-based system to work as a platform to track and to communicate with the users or riders on e-Beca. Figure 1.3 below shows an example of simple user interface (UI) of the real-time location tracking system for the smart e-bike monitoring system (SEMS).

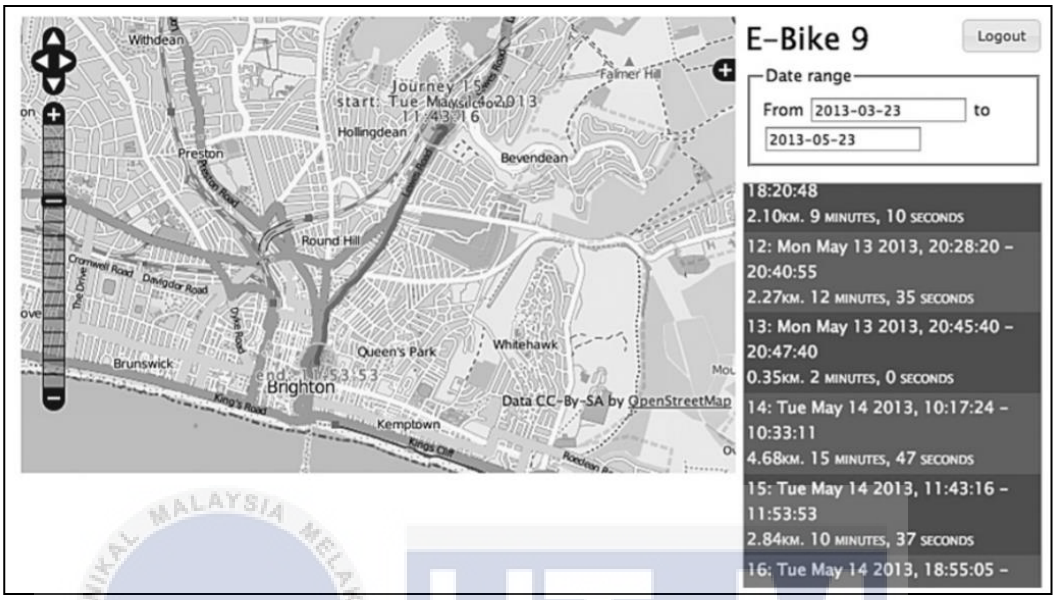

Figure 1.3: Online interface of SEMS [4].

Based on Figure 1.3 shown above, participants or users of e-bikes can view their own ride data via an online interface with secure login system. It is user friendly since the fundamental monitoring system is well developed and it has all the basic functions it needs for both administrator and user of the system.

In order to promote education tourism in UTeM by introducing the e-Beca system, a monitoring system is essential to be developed for e-Beca which is important to monitor and to secure the assets from being damaged or being used inappropriately by using a web-based platform where it can be utilised anywhere as long as there is internet connection for both administrator and user of the system.

1.4 Problem Statement

In order to provide a complete system for the existing e-Beca in UTeM, it is mandatory to develop a software-based monitoring system for e-Beca since there is no existing monitoring system being developed to track and to communicate with e-Beca yet.

Besides, e-Beca can be easily rode away from the dedicated route or path within the travelling area without a monitoring system for the e-Beca. A web-based application of monitoring system is used to limit the travelling area of users of e-Beca in order to ensure a safe and comfortable environment for the users.

Next, users of e-Beca might exceed the time given for each ride without an appropriate control system to indicate the limited time for each ride of the journey so that the resource management system of e-Beca can be provided.

1.5 Objective

1. To design an e-Beca monitoring system for location tracking purpose.

2. To develop a web-based monitoring system and application to track the real-time location of e-Beca.

3. To analyse the performance of e-Beca web-based monitoring system and application in terms of location accuracy and data communication efficiency.

1.6 Scope

1. The monitoring system is developed as a web-based application.

2. Only a laptop and an Android-based Samsung Galaxy S6 Edge Plus (with built-in Wi-Fi connectivity, GPS, clock, gyroscope, accelerometer, and magnetometer) are used to develop the system.

3. Software like XAMPP and Notepad ++ are used to develop the web-based application of e-Beca monitoring system.

4. Programming languages like HTML, CSS, PHP and JavaScript are utilised in the development of the system.

5. Several functions such as tracking location, calling function, restricting time of each ride and displaying video will be developed for the web-based application.

6. Experiment to track the real-time location of e-Beca will be carried out within the area in UTeM.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter discusses about the definitions and theoretical background of the main elements covered in this project such as electric bicycles, monitoring system and web-based application. Plenty of previous related studies done by other researchers are taken as references for the development of e-Beca monitoring system.

2.2 Electric Bicycles (E-Bikes)

The concept of constructing an e-Beca is similar to the concept of electric bicycles (also known as e-bikes) but different in overall structure. Therefore, references of the e-bikes development can be taken into consideration with respect to the development of e-Beca.

Nowadays, energy crisis is one of the major concerns due to fast depleting resources of petrol, diesel and natural gas. Thus, an alternating mode of transport like e-bike is needed to encounter the problem of increasing consumption of natural resources caused by fuel-based vehicles. E-bike is a bicycle which is driven with the help of battery that is coupled to electric motor. It works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter. The solar panels can be alternative source for this by adding it to the system [5]. E-bike system contains plenty advantages such as lower purchase and operating costs compared to conventional vehicles like cars, ability to travel with less physical effort compared to traditional bicycles, and zero emissions during operation. Thus, e-bike adoption has been accelerating widely and globally, with over 200 million being used in China alone [6]. Moreover, in year 2015, 28 percent of all bicycle sales in the Netherlands were e-bikes

[7]. Specifications of e-bikes used in different countries are shown in the following Table 2.1.

Table 2.1: Specifications of e-bikes in various countries [5].

Country	**Type of Bike**	**Speed Limit (km/h)**	**Motor output power (Watt)**
Australia	Pedal	25	250
Canada	Hand	32	500
China	Pedal/Hand	30	200
Norway	Pedal	25	250
Israel	Pedal	25	250
United Kingdom	Hand	27	250
Taiwan	Hand	25	200
United States of America	Hand	25	750
China	Pedal/Hand	30	500

On the other hand, another type of e-bike which is known as hybrid powered electric bicycle is introduced to improve the performance of an ordinary e-bike in terms of power consumption and environmental friendly. The hybrid powered electric bicycle is a system that involves three different ways of charging a battery such as solar power, Dynamo and 220V Ac wall charge. Such idea is to make the bicycle last longer and can be automatically recharge by renewable solar energy when the bicycle is not in use. The implementation of solar energy is that a high torque motor will be put on the bicycle which will be generated by the solar energy which is absorbed and stored by the portable solar panel. The power that had been absorbed by the panel can be used directly by the motor if the power matches the power requirement. Otherwise, the motor will use the power supplied from a battery. This system is believed to make the existing e-bikes to operate more efficiently [8]. A block diagram which illustrates the working principle of a hybrid powered e-bike is shown in Figure 2.1 as below.

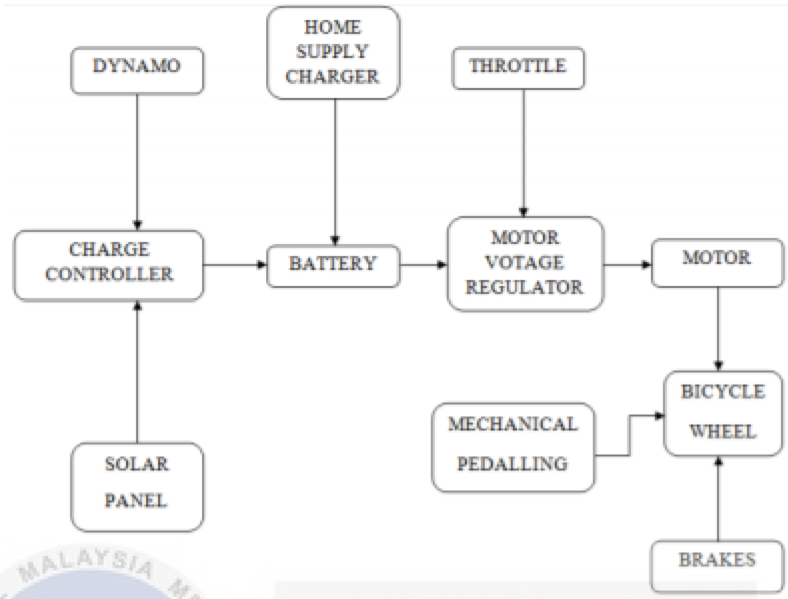

Figure 2.1: Block diagram of hybrid powered e-bike [8].

Since a hybrid powered e-bike uses solar panel as the component to absorb solar energy to generate power, it is similar to the e-Beca which is also using renewable solar energy to drive the motor on the trishaw. A comparison of various parameters between hybrid powered e-bike, e-bike and ordinary bicycle is shown in Table 2.2 below.

Table 2.2: Comparison between hybrid powered e-bike, e-bike and ordinary bicycle [8].

Parameter	Hybrid Powered E-bike	E-bike	Ordinary Bicycle
Max speed limit (km/h)	10-15	25-30	5-10
Drivers pedaling requirement	Optional	No	Yes
Initial unit cost in Rupees	8000	30000	4000
Weight in kg	25	50	15

Max travelling distance (fully charged) in km	25	70	-
Type of energy used	Electrical and muscle power	Electrical	Muscle power
Driving noise in dB	5-8	65-70	Noiseless
Charging time	• Conventional charger: 4 hours • Solar panel: 15 hours • Dynamo: 30 hours	8 hours (depend on charger)	Not applicable
Battery life time	2-3 years	1-2 years	-
Cost per km in Rupees	2	3.5	-

Due to certain constraints of conditions in order to produce an alternative electric vehicle with lower production cost, user and environmental friendly like e-bike and e-Beca, it is advisable and beneficial in using renewable solar energy as the power source to drive the motor.

2.3 Monitoring System

The term of a system can be described as a particular process of designing, testing, and implementing a new software application or program, including some internal customized system, internal development, the creation of database systems, or the acquisition of third-party developed software [9]. While monitoring can be defined as an act to observe and check the object over the period of time which means “the systematic and continuous assessment of the progress of a piece of work over time” [10]. Besides, the fundamental principle of a monitoring system is to allow users to capture data, process, and disseminate information in a systematic way, where monitoring system enables one to measure the trends of various indicators based on the collection of data in a field [11].

In this project of developing a monitoring system for e-Beca, the monitoring system is meant to represent a web-based platform to allow host or administrator of the project to monitor the target unit which is the e-Beca by tracking its real-time location and to provide a platform for the user to utilise the web page for custom features at the same time. With the arising trend of using e-bike, various related work and studies were done by many researches with different purposes including the monitoring system. Table 2.3 below shows a summary of previous e-bike field studies.

Table 2.3: Summary of previous e-bike field studies [12].

Reference	Purpose	Location	Participants	Duration	Data collected
Kiefer and Behrendt [4]	Usage	Brighton, UK	30 bikes/93 riders	10 months	GPS, assistance level, accelerometer
Fyhri and Fearnley [13]	Usage	Norway	66	2-4 weeks	Odometer
Paefgen and Michahelles [14]	Usage	Switzerland	17	4 months	GPS
MacArthur et al. [15]	Usage	Portland, OR, USA	30 bikes	1.5 years	Participant surveys
Dozza et al. [16]	Safety	Gothenburg, SE	3 bikes/12 riders	2 weeks	Video, GPS, braking force, lateral movement
Langford et al. [17]	Safety	Knoxville, TN, USA	12 bikes	2 years	GPS
Schleinitz et al. [18]	Speed	Germany	85	4 weeks	Video, speedometer
Fluchter and Wortmann [19]	IoT issues	Switzerland	32 bikes	4 months	GPS

Based on the related work shown in Table 2.3, several studies on e-bikes which require GPS (Global Positioning System) for data collection are significant to the development of monitoring system for e-Beca as it meets the main requirement of the desired functionality for the system which is to track the real-time location of e-Beca. One of the approaches used in the e-bike monitoring system done by a research team from Nanyang Technological University is by providing Android touchscreen computers for every machine. A custom navigation solution for the university campus, which encodes campus points of interest, pedestrian areas, high traffic areas and safety blackspots, has been written, called the eBike app. In addition to navigation capabilities, IEEE802.11 communications (wireless network communications) and a campus server allow each bicycle to periodically announce their locations, receive messages, and access location-aware services. These include social networking-based applications which enable riders to know where their friends are currently riding, participate in campus discovery tours, operate a distance-based charging scheme and so on [20]. The user interface of the application is shown in Figure 2.2 as below.

Figure 2.2: User interface of the Android eBike application [20].

A smart phone is used to record data samples from each sensor by controlling the sensing kit. However, for simplicity and to reduce costs, the phones do not transmit data in real time. Instead, the collected data are buffered on the phone and uploaded to a database server whenever the sensing kit comes within range of a known Wi-Fi network such as campus Wi-Fi. Each phone is associated with a unique ID so which bike the data are coming from can be known accordingly [12]. To further discuss about the monitoring systems used in various smart vehicle systems, several monitoring systems are compared and shown in Table 2.4.

Table 2.4: Comparison of smart vehicle monitoring systems.

Journal	Type of main devices used	Type of software design	Function
Smart e-bike monitoring system: real-time open source and open hardware GPS assistance and sensor data for electrically-assisted bicycles [4]	- Android phone (Samsung Galaxy Ace 2 S6500) - Open hardware interface board	Web page application	To monitor and display GPS location, rider control data and other custom sensor input in real time
Usage Patterns of Electric Bicycles: An Analysis of the WeBike Project [12]	- Custom-built sensing hardware - Android phone (Samsung Galaxy S3)	Cloud computing technique	To collect real e-bike usage data for statistical data analysis
Campus Mobility for the Future: The Electric Bicycle [20]	- Android touchscreen computer - GPS module	Android application	To monitor and display GPS location, analyse system effectiveness and identify particular usage challenges
Informatics and infotainment system for Smart E-Bike using Raspberry Pi [21]	- Raspberry PI 32-bit ARM controller - Speedometer (Reed switch sensor) - Neo 6M GPS module - MPU 6050 Accelerometer and gyro sensor - Wi-Fi module	Web page application	To collect and display data from vehicle sensors like speed, GPS information and motion tracking

IoT Based Smart Vehicle Monitoring System [22]	- Raspberry Pi - Accelerometer and gyroscope sensor - GSM/GPRS module - GPS module - Camera - Impact sensor	Web page application	To detect accidents with severity, remotely shutdown the vehicle and locate the vehicle position
An IoT Framework for Intelligent Vehicle Monitoring System [23]	- Arduino UNO computing module - Ethernet module (WIZnet-W5100) - RFID readers	Cloud computing technique	To collect and analyse sample data to view real-time plots of distance versus time graph and the actual velocity of the vehicles

Based on the comparison of several previous studies on the smart vehicle monitoring systems shown in Table 2.4, projects in [4], [12] and [20] used Android devices such as Android-based smart phone and computer instead of Raspberry Pi or Arduino microcontroller with various sensors in [21], [22] and [23] as the main monitoring and tracking device. This is due to the simplicity by the selection of smart phone which contains all the inbuilt sensors and modules such as GPS, Wi-Fi connectivity, clock, gyroscope, accelerometer, and magnetometer which are needed for data collection and data analysis of the monitoring system.

Besides, web application is the most common software design for monitoring system as in [4], [21] and [22] based on its ability and flexibility to collect and display various data for administrator and user of the system without considering any constraints in types of operating system of devices as compared to the Android application developed in [20] which is only accessible for Android devices. While the cloud computing technique used in [12] and [23] is meant to store data collected from sensors in the cloud server and to perform statistical analysis of the data to determine the performance of the system. However, the system did not provide an application to display the real-time location of the vehicle for user since it was aimed for the purpose of data analysis but not focused on the development of user application for the monitoring system.

2.4 Web-Based Application

Web-based applications are widely used and developed by programmers and users around the world. Web applications refer to applications accessed via Web browser over a network and developed using browser-supported languages (e.g., HTML, JavaScript) [24]. Web designers are required to understand and to capture the right requirements in order to develop usable web applications that meet users' needs. There are two types of system requirements such as functional requirements which specify what the system must do and user requirements which specify user performance and satisfaction with the system. To determine functional requirements, the developer identifies user, task, and environment characteristics [25]. An example of identifying important tasks contained in a system or an application is shown in Figure 2.3 as below.

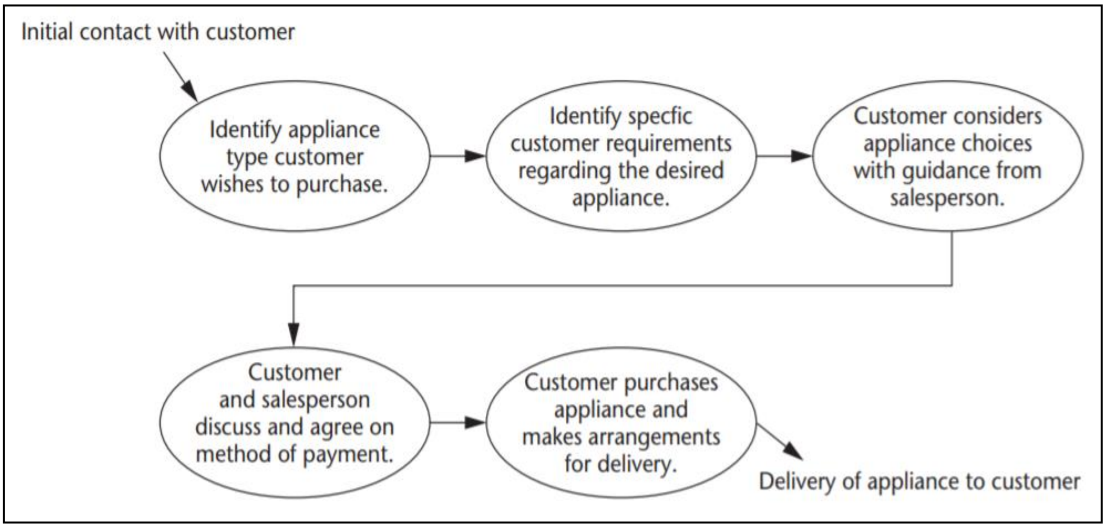

Figure 2.3: Task diagram for retail web application [25].

In the development of web-based application for e-Beca monitoring system, first step of the designing process is to identify all the required tasks that the system needs to do in order to provide appropriate authorisation to the administrator and the user of the system.

2.5 Programming language

A programming language is used to control the actions of a machine. Programming language is a properly drafted or constructed language because it is designed in such a way that it is able to communicate with a computer system through its instructions. Ever since the invention of computers, thousands of programming languages have been created, and more are being created every year [26]. Each programming language has its own grammar and syntax just like human languages. There are a lot of dialects of the same language, and each dialect requires its own translation system. There are few commonly used programming languages in the web such as HyperText Markup Language (HTML), JavaScript, Cascading Style Sheets

(CCS) and PHP: Hypertext Preprocessor (PHP). These languages are the basic elements needed to develop the web-based e-Beca monitoring system.

2.6 Global Positioning System (GPS)

Global Positioning System (GPS) technology is a satellite-based navigation system initiated by the US Department of Defense in 1978 which was originally designed for military purposes. Today, GPS has been widely used for applications like tracking package delivery, mobile commerce, emergency response, exploration, surveying, law enforcement, recreation, wildlife tracking, search and rescue, roadside assistance, stolen vehicle recovery, satellite data processing, and resource management. GPS consists of a network of 24 satellites in six different 12-hour orbital paths spaced (Figure 2.4) so that at least five are in view from every point on the globe [27].

Figure 2.4: Network of 24 satellites around the Earth [28].

GPS is a Global Navigation Satellite System (GNSS) where it is used for location or position determination, or so called as a geo positioning. A geo position in space and time can be calculated based on the transmission and reception of satellite signals between satellites and special receiver used in the system [28]. A technique known as triangulation or trilateration (Figure 2.5) is commonly used where the receiver can roughly determine its position by locking on to the signals of at least three satellites [27].

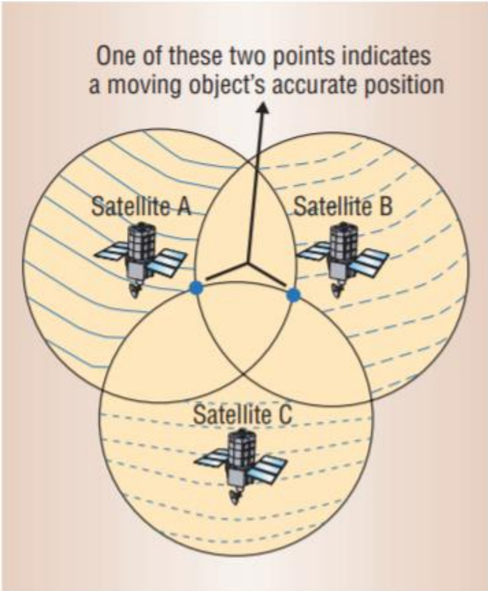

Figure 2.5: GPS trilateration technique [27].

Based on the trilateration technique shown in Figure 2.5 above, satellites A and B are each at the center of an imaginary sphere, the radius of which is equal to the distance to the receiver. Knowing the distance from satellite C lets the receiver narrow its position to one of two points on the circle that the intersection of these two spheres forms [27].

Today, smart phones are provided with the built in equipment for the navigation and tracking system. Therefore, there is a reduction in the size of the GPS receivers and also providing a more convenient and simpler tracking platform for the devices at the same time.

2.7 Summary

In conclusion with respect to the related studies discussed earlier, certain limitations and specifications on the components needed to develop the e-Beca monitoring system can be done by knowing the requirements of the project. Web application is selected as the platform for the monitoring system instead of developing mobile application because there are several constraints for mobile application such as type and version of operating system of the mobile phone are needed to be considered so that there are more target units can be used. While a web application can be developed and used by both administrator and user of the system by controlling or allowing specified authorisation by the system developer. Besides, mobile phone is selected as the core tracking device in this project due to its simplicity with several built-in features including Wi-Fi connectivity, GPS, clock, gyroscope, accelerometer, and magnetometer, which are needed for data collection in the monitoring system.

CHAPTER 3

METHODOLOGY

3.1 Overview

In this chapter, procedures and methods used to achieve the main objective stated in Chapter 1 which is to develop an e-Beca monitoring system will be discussed. Software development in web page application and experimental setup are presented in this chapter as well.

3.2 Gantt Chart

The overall progress flow of the project is listed in Gantt chart as shown in Appendix A and Appendix B for proper schedule purpose.

3.3 System Architecture

The entire flow of the e-Beca web-based monitoring system is shown in flow charts in Figure 3.1 and Figure 3.2.

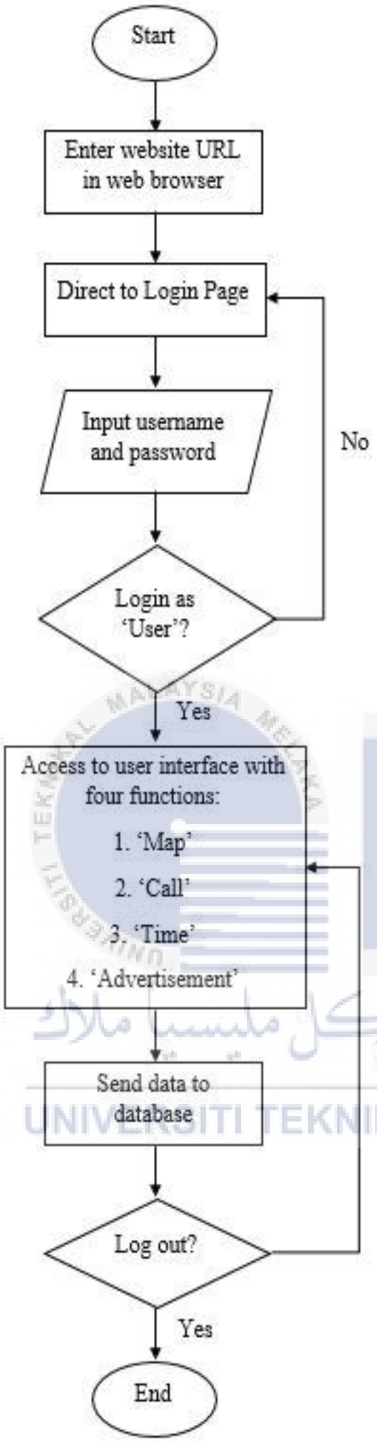

Figure 3.1: Flow chart of user application.

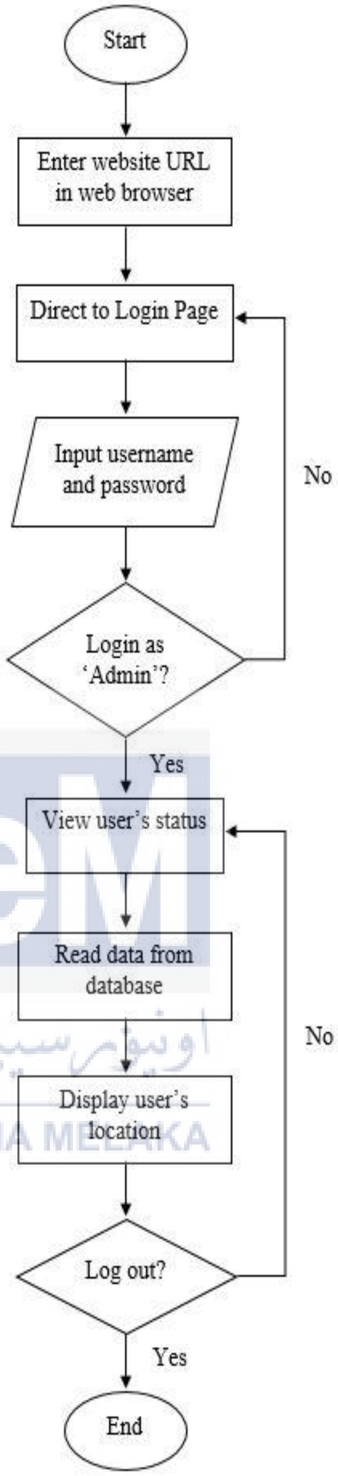

Figure 3.2: Flow chart of admin application.

Based on the flow charts shown in Figure 3.1 and Figure 3.2, user of the e-Beca system is required to enter the username and password on the 'login page' through web browser. Two types of users which are 'admin' and 'user' will be verified in order to proceed to the next function of the web application. In Figure 3.1, once the user logged in as 'user' where 'user' will be represented by the smart phone which is installed on the e-Beca as the target unit, the web application will direct to the web page which can access to the user interface of the application with four main functions such as displaying real-time location of e-Beca with 'Map' function, making phone call to host system with 'Call' function, displaying time for each ride with 'Time' function and displaying e-Beca advertising video with 'Advertisement' function. Significant data such as coordinates of location will be sent to database server using internet or available Wi-Fi connection in UTeM in order to improve the efficiency of data collection for real-time location. Then, 'user' can decide to continue using the web application or to quit the application by logging out.

While in Figure 3.2, once the user logged in as 'admin' where 'admin' represents the authorised party which is able to access and to monitor all the data stored in database server which are collected from the target unit, the web application will direct to the authorised web page with administration function to view data collected from e-Beca such as real-time location. This can be done by retrieving the data stored in database server and display the e-Beca real-time location on a mapping API such as Google Maps API. The 'admin' function of the application acts as the host system for the e-Beca monitoring system where the monitoring function for e-Beca can be done anywhere and anytime by logging in the web application using web browser with the correct username and password for administration.

Each and every task in the web application is needed to be well organised in order to create the required web file or web page with suitable coding to perform the specific functionality of every web page. A simple illustration of the overall monitoring system is shown in Figure 3.3 as below.

Figure 3.3: Illustration of e-Beca monitoring system.

3.4 Software Development

As been discussed earlier, the e-Beca monitoring system is developed as a web-based application. Thus, a HTML web application is developed using programming languages like HTML, CSS, PHP and JavaScript which will receive data from database server and will display the information in a simple user interface on the smart phone connected to the web server. GPS information is directly fed to a Google maps API which will locate the e-Beca. SQL database will contain all the various information details. Apache Server will be serving the database connectivity and PHP scripting will be needed for the database connection [29]. The overall procedures and methods used for the web page development will be further discussed in the following subtopic.

3.4.1 Web Page Development

Several steps are needed to be done in order to develop a complete web page application with various web files with respect to different functionalities. These steps can be listed as:

Step 1: Coding for front-end and back-end web development.

Step 2: Testing web page using local host server.

Step 3: Testing web page using web host server.

3.4.1.1 Coding for Front-End and Back-End Web Development

A software called 'Notepad++' (Figure 3.4) is used to code the overall coding for the web application. 'Notepad++' is a free source code editor which supports several programming languages running under the Microsoft Windows environment.

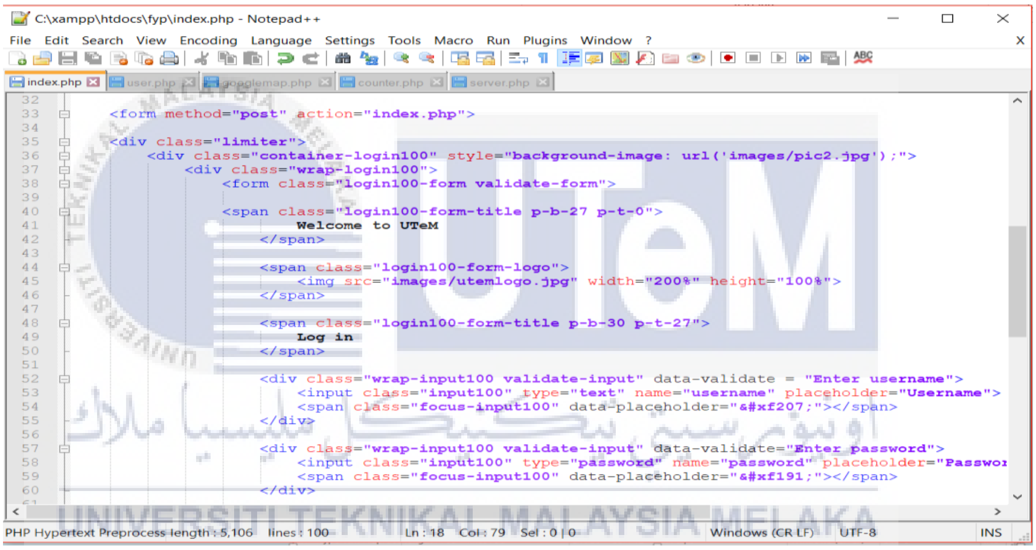

Figure 3.4: Coding with Notepad++.

On top of that, there are two types of web developments which can be represented as front-end and back-end developments. Front-end application is referred as "client-side" of the application which interfaces directly with users including the layout, user interface and styling of the web page which can be seen directly by users. Front-end application is commonly developed by programming languages like HTML and CSS. While the back-end application is referred as "server-side" of the application which serves indirectly in support of the front-end services and able to communicate with the required resource. It is used to perform connections with other web page, resource or database where the processes will be running behind the application and they are not meant to be seen. Programming languages like PHP and JavaScript are mainly used for back-end web development.

3.4.1.2 Testing Web Page using Local Host Server

After developing the source code for a web page, it is needed to be tested in web browser to see if the output of the web page meets the desired requirements. Therefore, a local host server is needed as a platform to test the web page instead of releasing the web page to web host server. Local host server is only accessible to the custom device of web developer which contains all the required web files stored in local system but not to users other than the custom device. A software called 'XAMPP' is used for creating the local host server. 'XAMPP' is a free and open-source cross-platform web server solution stack package. It is used to set up a local host server and local database server for testing purposes of the web files developed in the local system. Figure 3.5 below shows the user interface of the 'XAMPP' software.

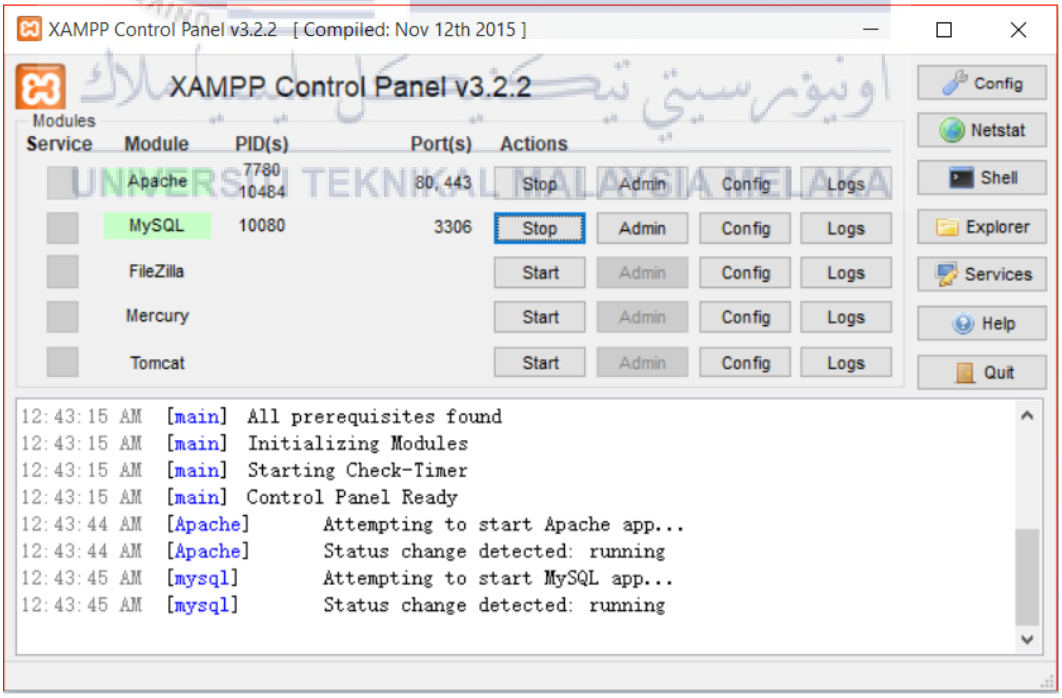

Figure 3.5: User interface of XAMPP control panel.

As can be seen in Figure 3.5, local host server and local database server can be set up by initialising the 'Apache' and 'MySQL' modules. 'Apache' is a free and open-source cross-platform web server creation system while ‘MySQL’ is an open-source relational database management system. Therefore, testing of web pages or web files can be done by setting up the local host server which is able to provide connections between web files and database server where specific functionality of web files can be shown according to the source code developed.

3.4.1.3 Testing Web Page using Web Host Server

When the overall web application is done, the final stage of the procedure for web page development is to release the application to the web server. Before releasing the web application, a custom Uniform Resource Locator (URL) is required to be registered using web host server as a custom domain for the web application developed. By having a website domain, it is able to store the project web files in the web hosting system as well as creating a web database server instead of using the local host and database server. Then, the web application can be released to other users by connecting to the custom URL through web browser. In this project, a free website domain is created in ‘000webhost’ due to the fact that no charges is needed for the overall web development where ‘000webhost’ is an open-source free web hosting and free website builder. The user interface of ‘000webhost’ is shown in Figure 3.6 as below.

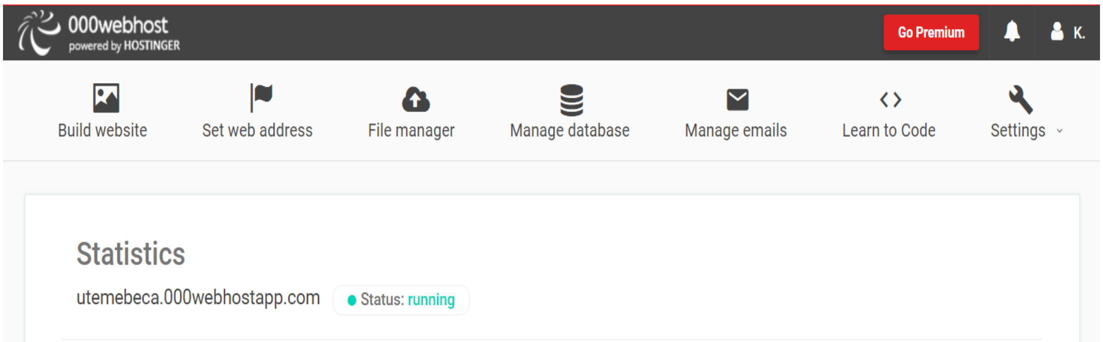

Figure 3.6: User interface of ‘000webhost’ website.

A custom URL with *utemebeca.000webhostapp.com* has been created for the e-Beca web application as shown in Figure 3.6. Therefore, users can access to the e-

Beca web application once the application is done by using the URL created through web browser.

3.5 Hardware Development

As an additional development for the monitoring system, a few devices like Arduino UNO, HC-06 Bluetooth module and 1 channel 5V relay module shield are introduced to further improve the functionality of the system. The purpose of using these devices is to develop a remote system to control the e-Beca by switching the power on and off and to trigger the alarm system with the use of a mobile application. The overall concept of the control system is shown by a block diagram in Figure 3.7.

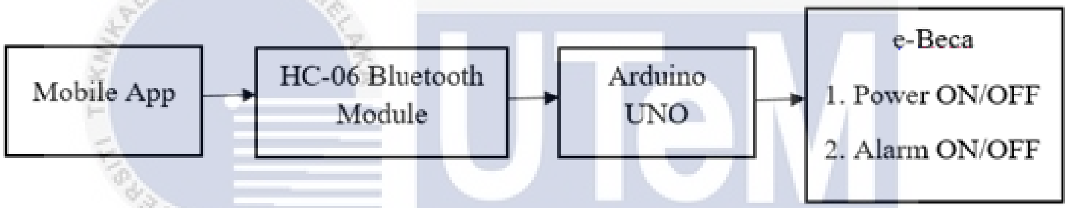

Figure 3.7: Block diagram of e-Beca control system.

Therefore, a simple circuit system has been set up as in Figure 3.8 to represent the early stage development of the desired system where the LED indicates the power supply of e-Beca and the buzzer indicates the alarm system on e-Beca. The pin connections between the components are listed in Table 3.1.

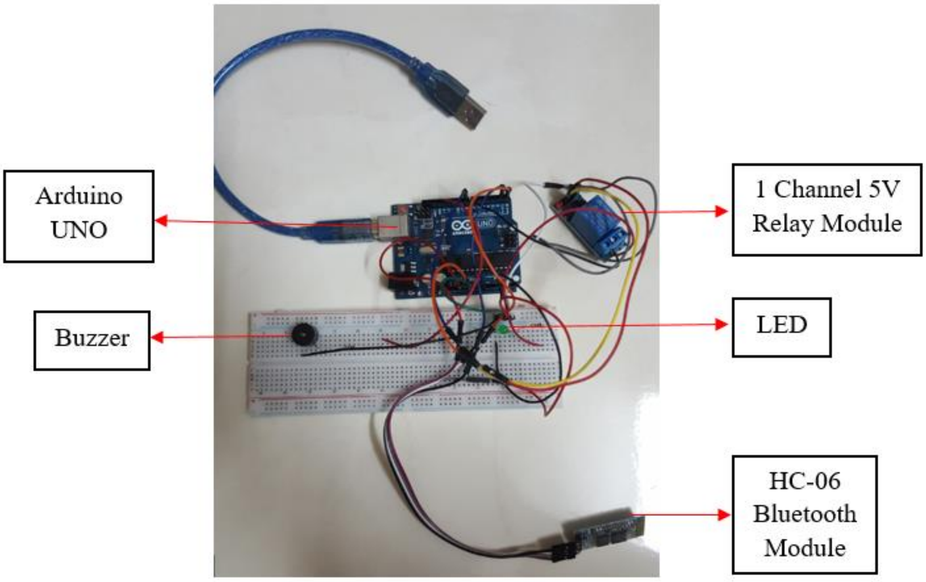

Figure 3.8: Circuit connection of e-Beca early stage control system.

Table 3.1: Pin connections between components.

Arduino UNO Pins and Components	**Module Pins**
	HC-06 Bluetooth Module
RX (Pin 0)	TX
TX (Pin 1)	RX
3.3V	VCC
GND	GND
	1 Channel 5V Relay Module
5V	VCC
GND	GND
Pin 8	IN (Signal)
LED (+ve side)	NO
Pin 7	COM
LED (-ve side) to GND	
Buzzer (+ve side) to Pin 13	
Buzzer (-ve side) to GND	

As HC-06 works on serial communication, an open source Android app called "Bluetooth Terminal" is downloaded from Google Play Store where it is designed to send serial data to the Arduino Bluetooth module when an input character is given on the app as it works just like the Arduino Serial Monitor. The Arduino Bluetooth module at the other end receives the data and sends it to the Arduino through the TX (transmit) pin of the Bluetooth module which is connected to RX (receive) pin of Arduino. The code uploaded to the Arduino checks the received data and compares it. If the received data is 'a', the buzzer will turn ON and then turns OFF when the received data is 'b'. If the received data is 'c', the relay will be triggered to turn ON the LED and then turns it OFF when the received data is 'd'. A reliability test has been conducted by switching the LED and buzzer ON and OFF for ten times to observe the stability of the system.

3.6 Experimental Setup

A series of experiments are conducted to test the performance of the web application in terms of accuracy of real-time location tracking and efficiency of data communication. Several procedures taken to perform the experimental setup are explained in the following subtopics of this section.

3.6.1 Setting up Travelling Route in UteM

Before conducting any experiments for the system, a dedicated travelling route is needed to be set up in order to determine the performance of the e-Beca monitoring system. Thus, after several considerations on various locations within the areas in UTeM, Dewan Canselor is selected as the best location for conducting the performance analysis of e-Beca web application and monitoring system as Dewan Canselor provides a sufficient round shape travelling route as shown in Figure 3.9 which is suitable to determine the performance of location tracking of the monitoring system.

Figure 3.9: Satellite view of Dewan Canselor, UTeM.

Besides, Dewan Canselor is chosen as the experimental location for e-Beca web application and monitoring system analysis because the surrounding road is safe to use due to the fact that no people will be using the road on usual days.

3.6.2 Setting up Reference Coordinates on Travelling Route

In order to test the accuracy of the e-Beca location tracking functionality, comparison between actual coordinates on the travelling route and displayed coordinates on the application is essential for the accuracy analysis of the e-Beca web application. Since the overall travelling route at Dewan Canselor is wide and huge, nine points or coordinates have been selected as the reference coordinates along the travelling route with sufficient gap distance separation. These coordinates are represented by latitude and longitude decimal values and they are used to compare with the latitude and longitude coordinates displayed on the e-Beca web application to determine the accuracy of the real-time location tracking functionality. All of the nine selected locations and coordinates are shown in Figure 3.10, Figure 3.11, Figure 3.12, Figure 3.13, Figure 3.14, Figure 3.15, Figure 3.16, Figure 3.17 and Figure 3.18 respectively.

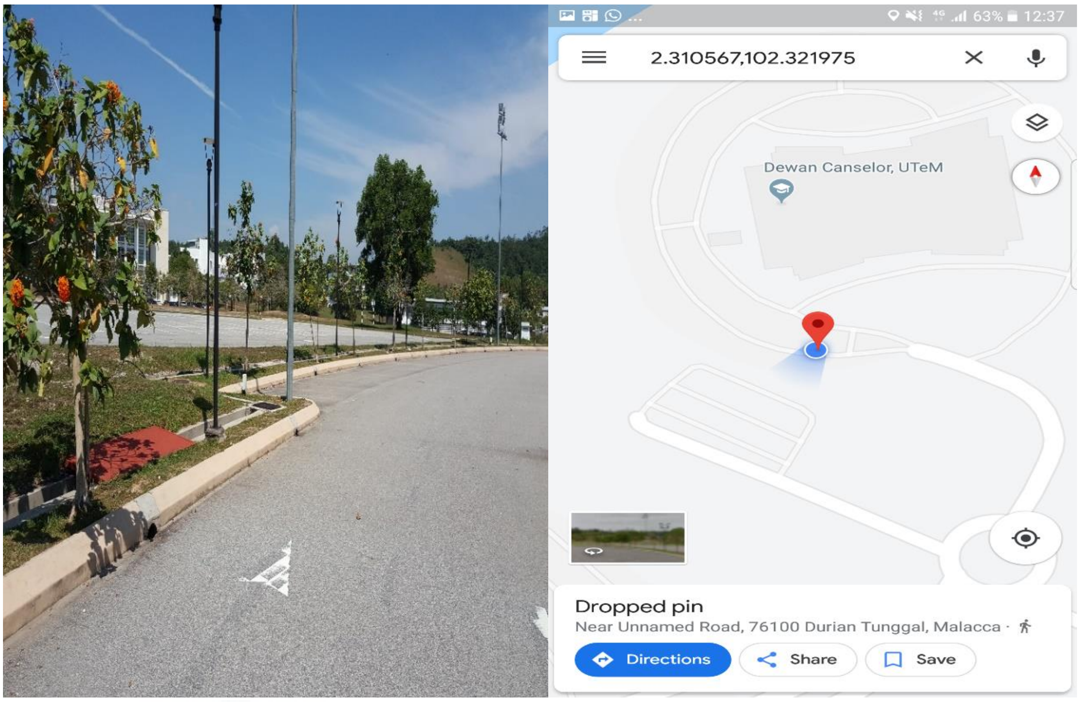

Figure 3.10: Location and coordinate of Point 1.

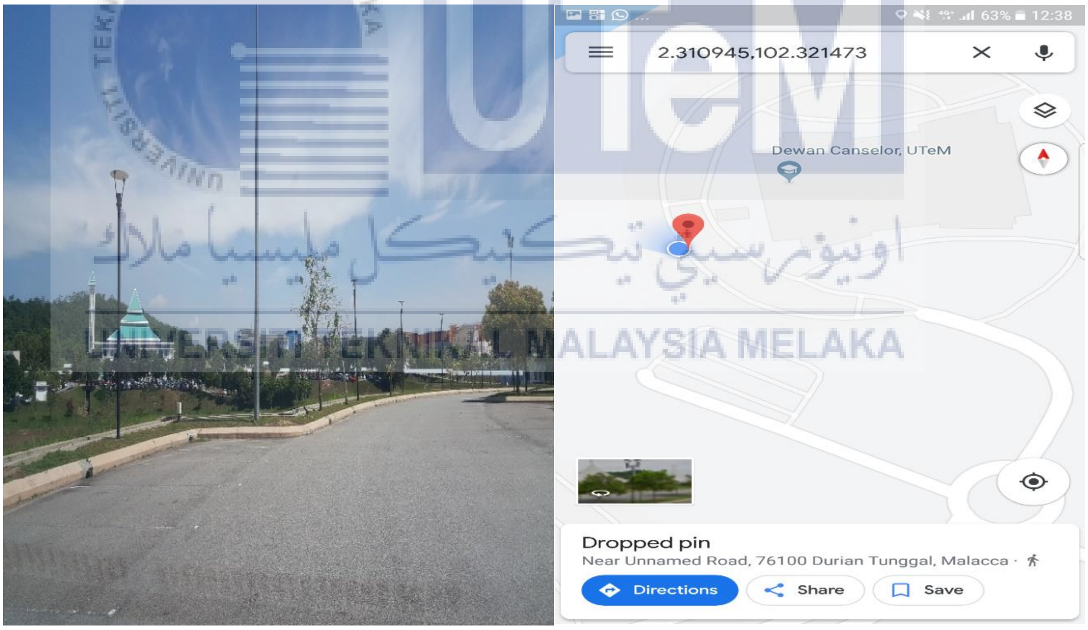

Figure 3.11: Location and coordinate of Point 2.

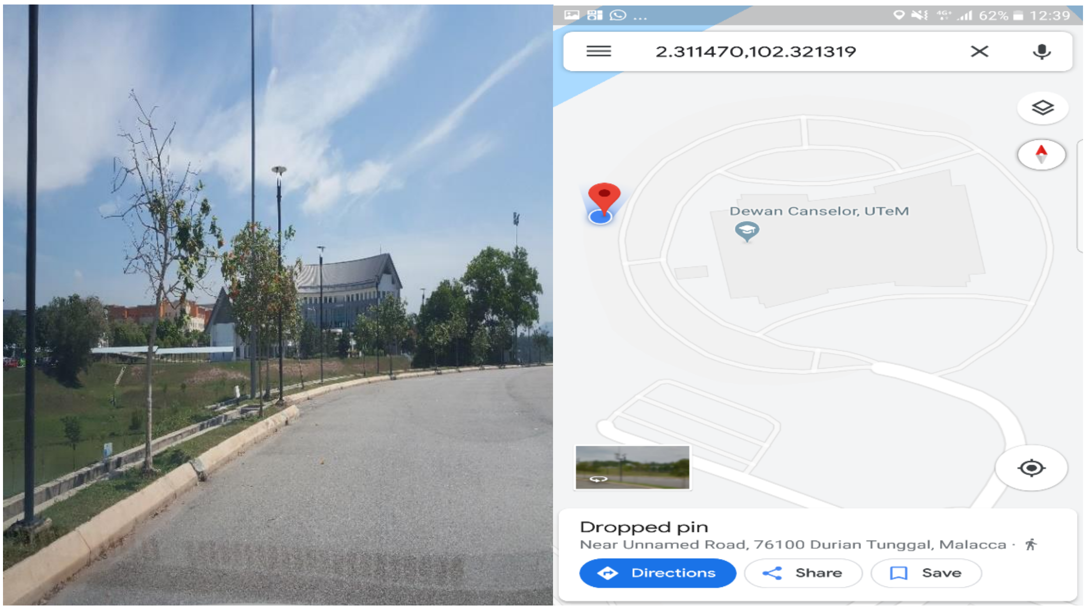

Figure 3.12 Location and coordinate of Point 3.

Figure 3.13: Location and coordinate of Point 4.

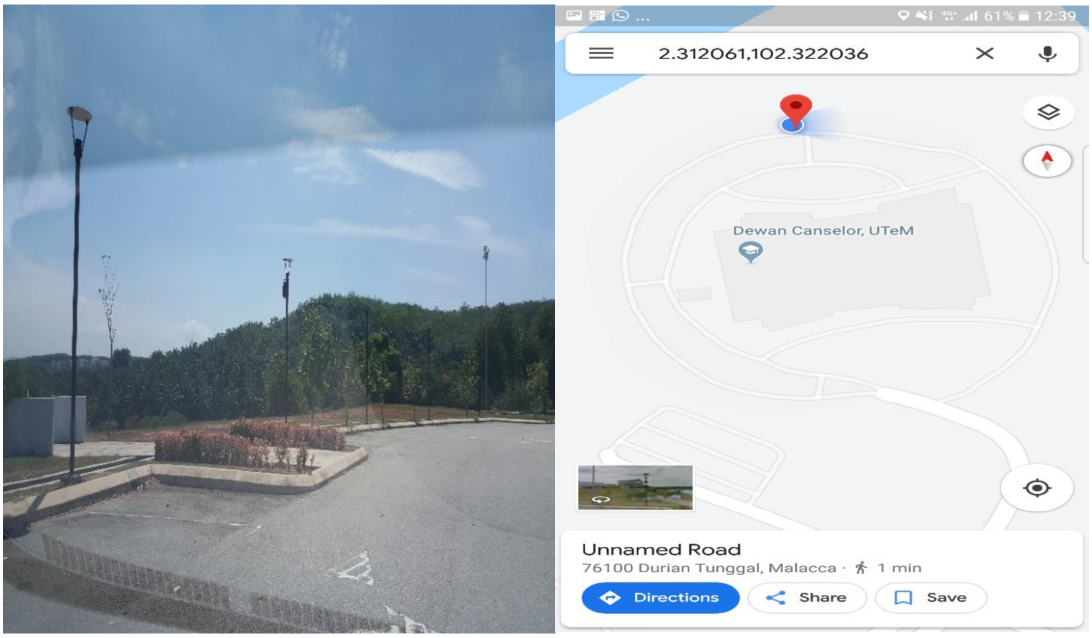

Figure 3.14: Location and coordinate of Point 5.

Figure 3.15: Location and coordinate of Point 6.

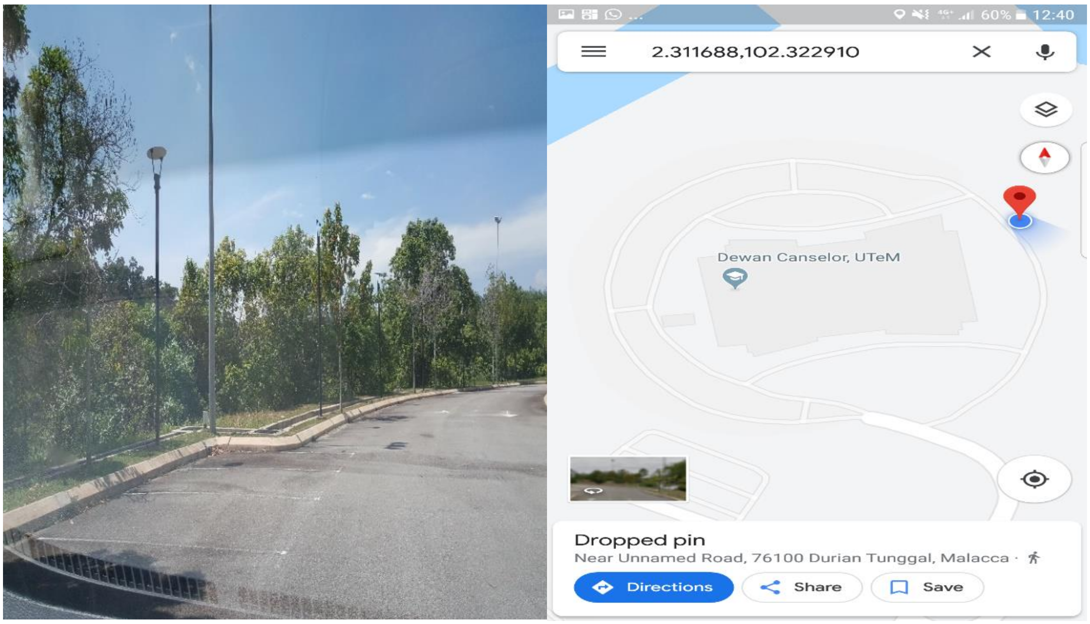

Figure 3.16: Location and coordinate of Point 7.

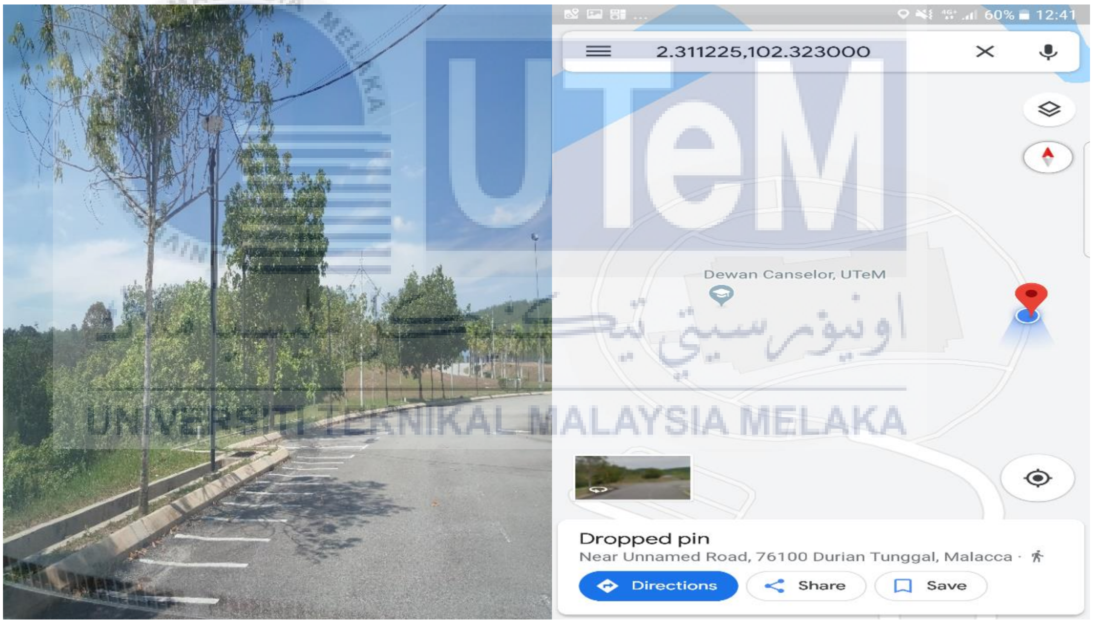

Figure 3.17: Location and coordinate of Point 8.

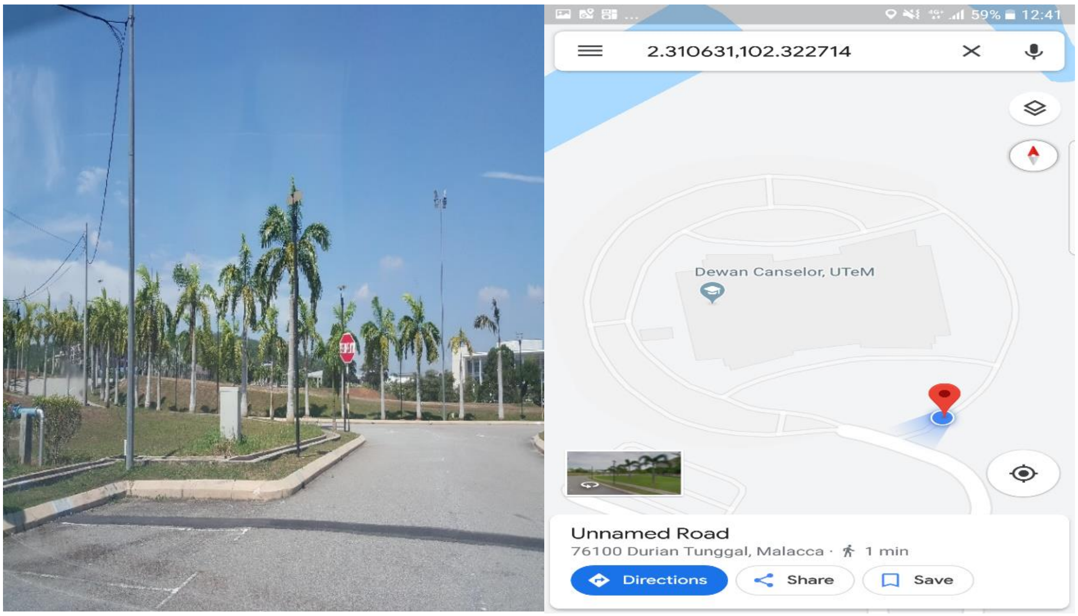

Figure 3.18: Location and coordinate of Point 9.

3.6.3 System Reliability Test

By referring to the coordinates shown earlier, an experiment was conducted for ten times by using the same route to collect all the nine coordinates shown by the e-Beca web application at the same locations. A correlation test is performed by comparing both the actual and displayed coordinates in order to analyse the accuracy of real-time location tracking. Besides, the instantaneous time displayed on both application and monitoring system are collected to analyse the latency of data communication between both systems. The efficiency of data communication is important to ensure the objective of developing a real-time location tracking system.

3.7 Summary

To conclude this chapter, several procedures and methods used to develop the e-Beca web-based monitoring system are shown in details together with appropriate explanations and figures. Results and discussion of the e-Beca web application will be presented in the next chapter.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Overview

This chapter presents the results and discussions of the development of e-Beca monitoring system using web-based application. The layout or user interface of the system and the performance analysis of the system are shown in this chapter.

4.2 User Interface of e-Beca Web Application and Monitoring System

The e-Beca web application is developed to provide all the required functionalities according to type of user such as administrator and ordinary user of the system respectively. The overall e-Beca web-based monitoring system is shown in the following subtopics.

4.2.1 Login Page

The user interface of 'login' page is shown in Figure 4.1 as below.

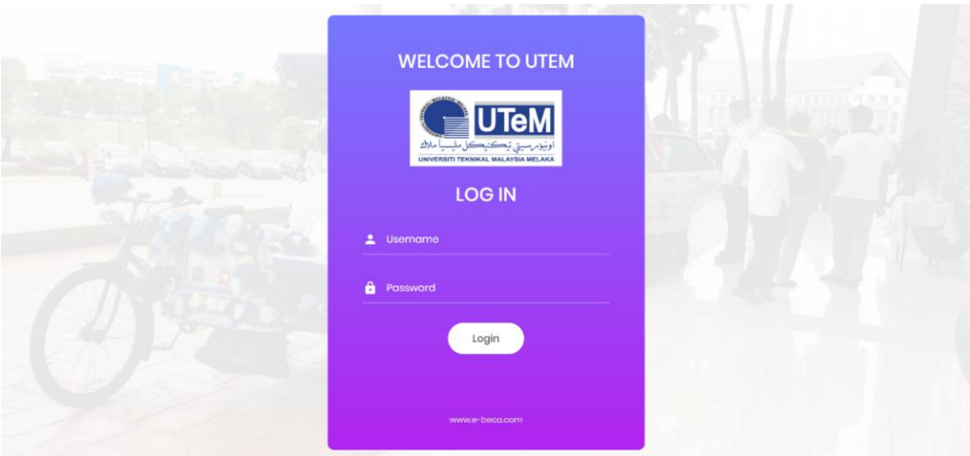

Figure 4.1: UI for 'Login' page.

In this section, user is required to log in to the system in either ‘admin’ or ‘user’ mode as discussed earlier in Chapter 3.

4.2.2 User Page

Once the user logged in as ‘user’ with the preset username and password, the user of e-Beca is able to utilise all the functions developed for the ‘user’ application of the monitoring system such as to see their real-time location when they are travelling in UTeM by e-Beca, to communicate with the host system or operator by dialing to the phone number being preset under a symbol of phone shown in the application, to see the remaining time of their ride and also to watch the e-Beca advertising video on the same web page. All of these specific functionalities are displayed on the screen of the smart phone as shown in Figure 4.2.

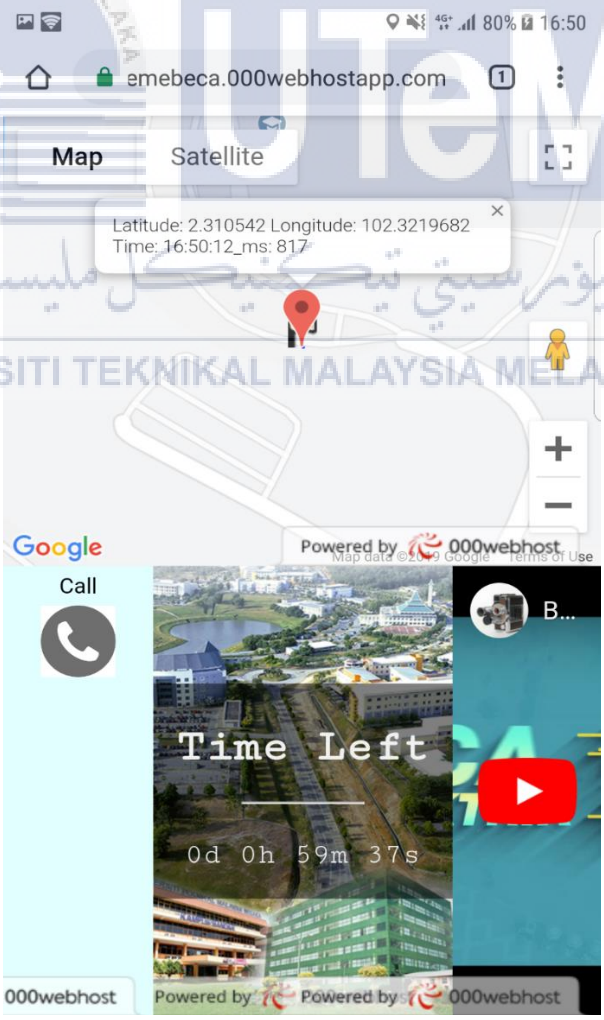

Figure 4.2: UI for ‘User’ Page.

4.2.3 Admin Page

Once the user logged in to the system as ‘admin’, authorisation to view users’ data will be granted to monitor various data collected and stored in the database server such as to display the real-time location of the selected e-Beca. The user interface of the ‘admin’ page and the real-time location tracking system are shown in Figure 4.3 and Figure 4.4 respectively.

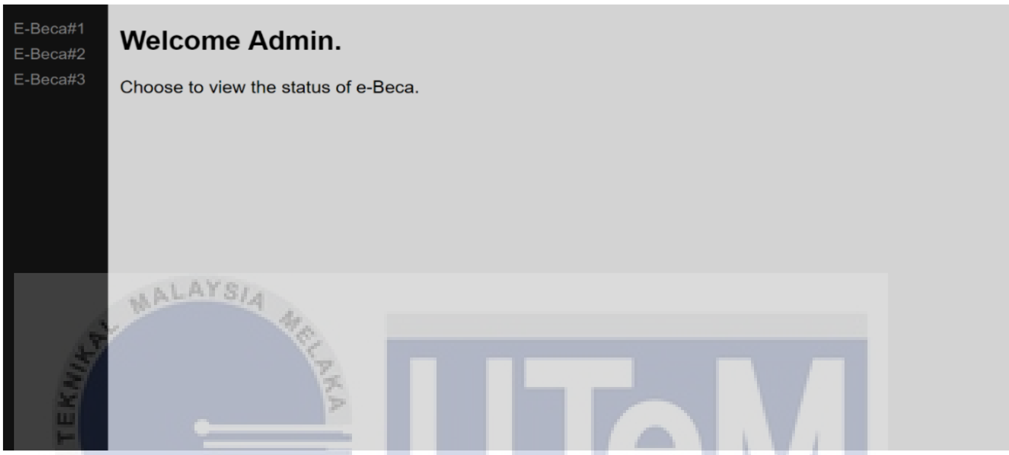

Figure 4.3: UI for ‘Admin’ page.

Figure 4.4: UI for e-Beca real-time location tracking system.

4.3 Results of System Reliability Test

In order to obtain ten sets of the nine selected coordinates on the dedicated route at Dewan Canselor as discussed in Chapter 3, the instantaneous coordinate and time displayed on both the web application and monitoring system are collected as shown in Figure 4.5, Figure 4.6, Figure 4.7, Figure 4.8, Figure 4.9, Figure 4.10, Figure 4.11, Figure 4.12 and Figure 4.13 respectively.

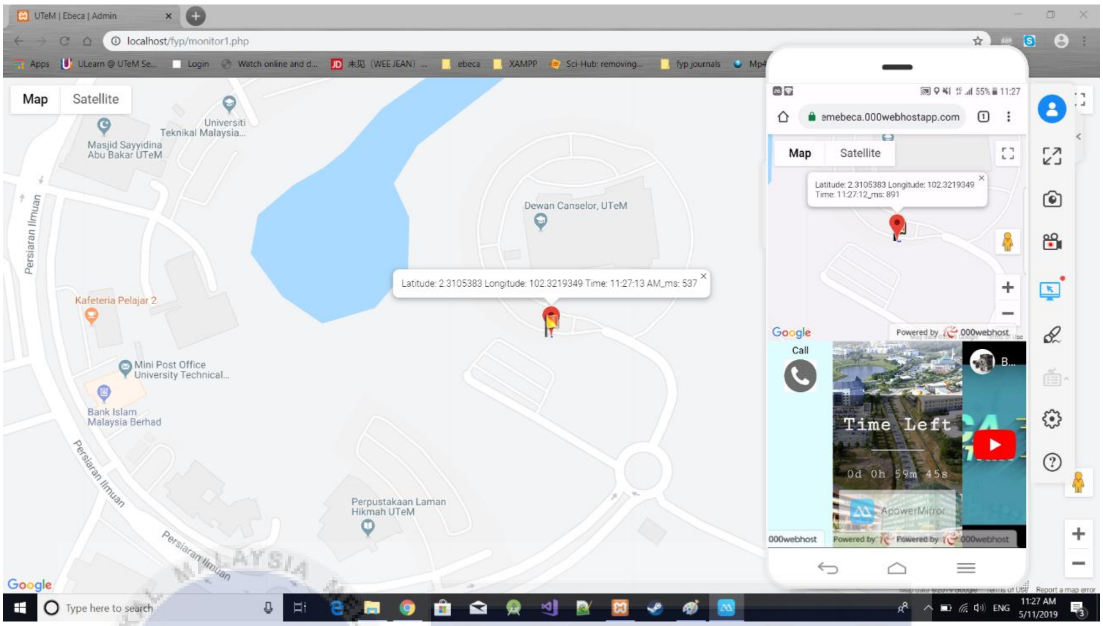

Figure 4.5: Instantaneous coordinate and time of Point 1.

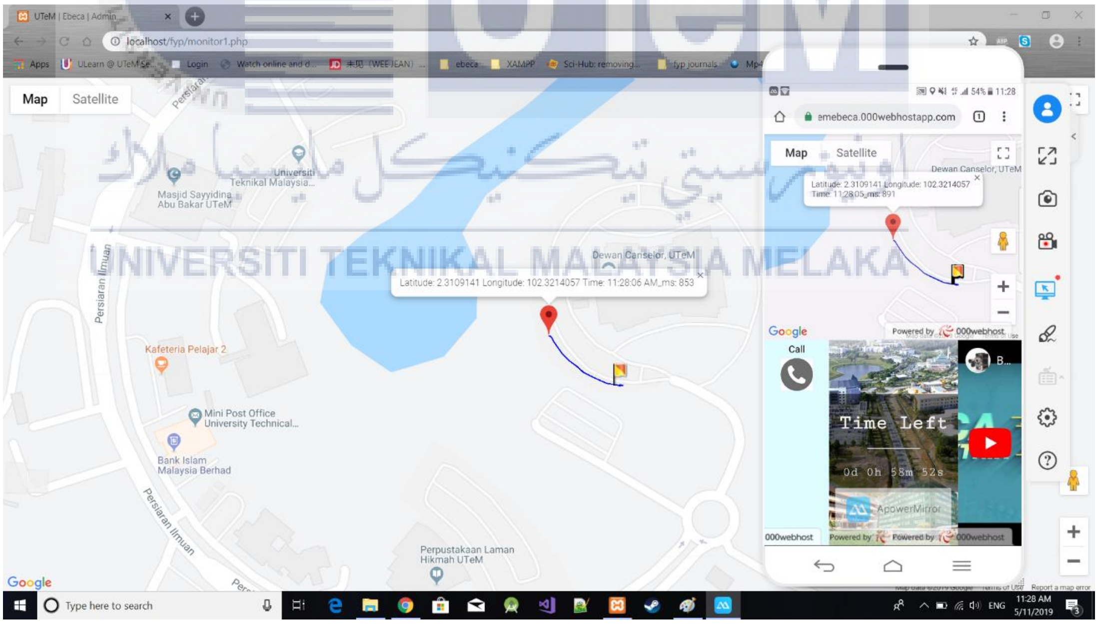

Figure 4.6: Instantaneous coordinate and time of Point 2.

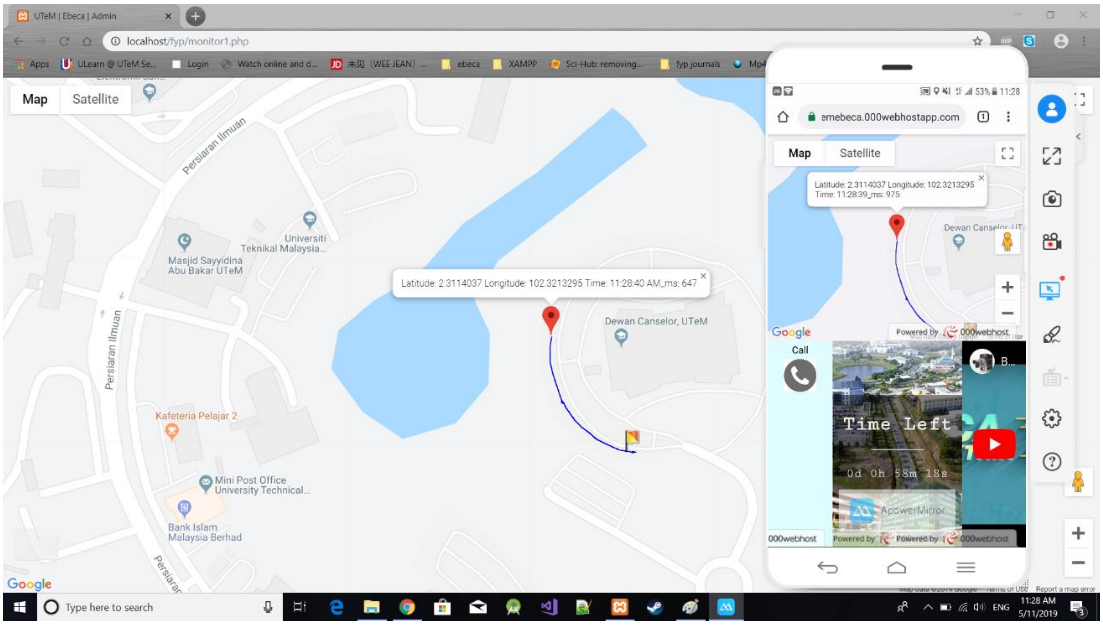

Figure 4.7: Instantaneous coordinate and time of Point 3.

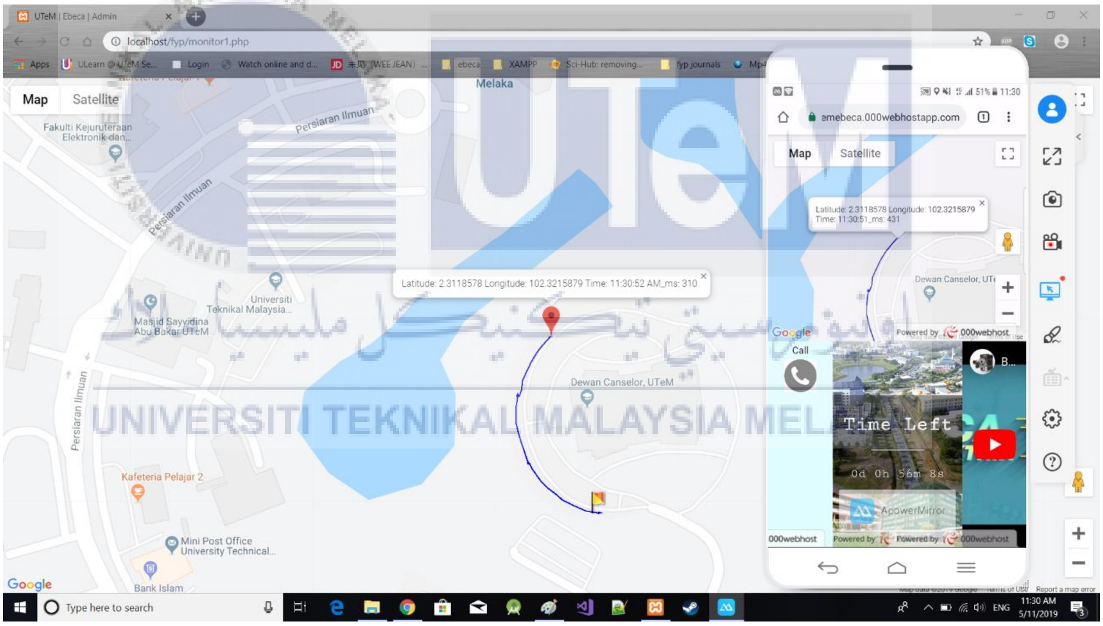

Figure 4.8: Instantaneous coordinate and time of Point 4.

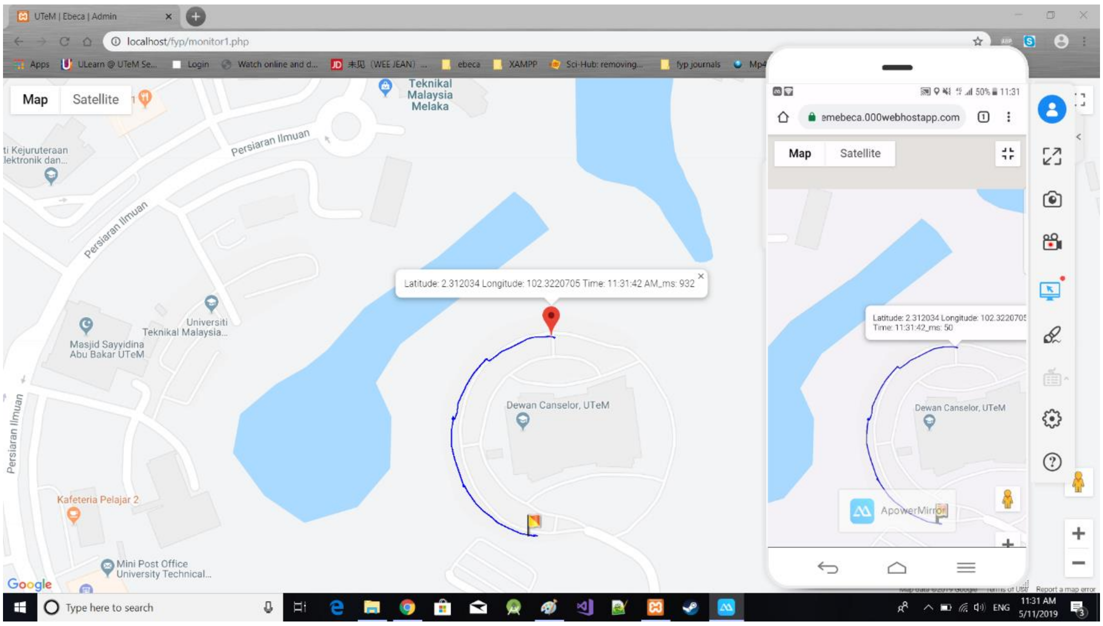

Figure 4.9: Instantaneous coordinate and time of Point 5.

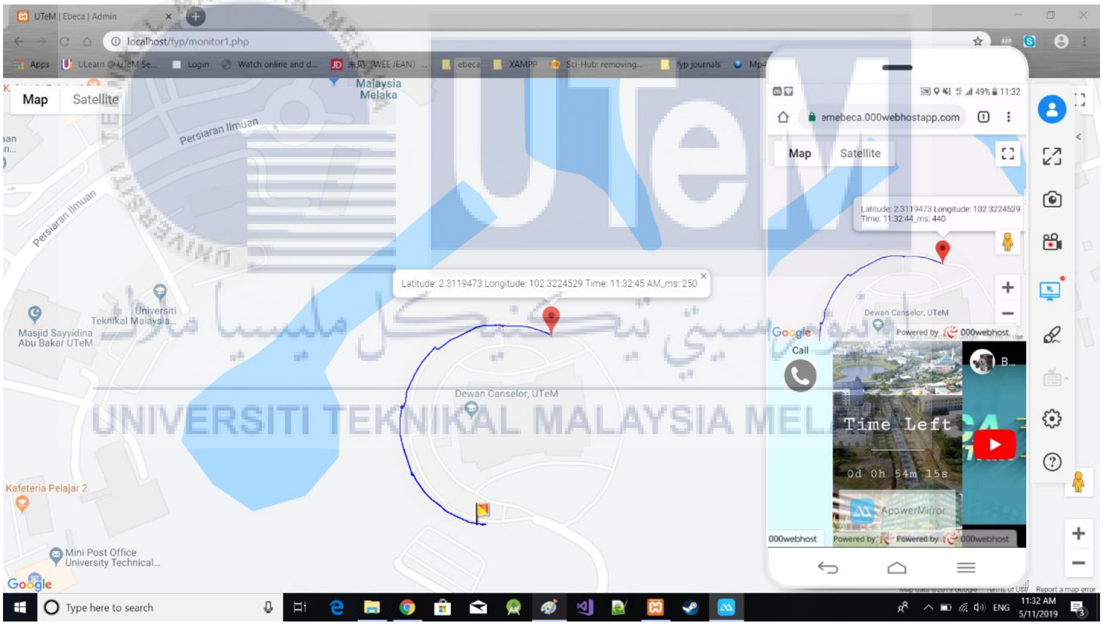

Figure 4.10: Instantaneous coordinate and time of Point 6.

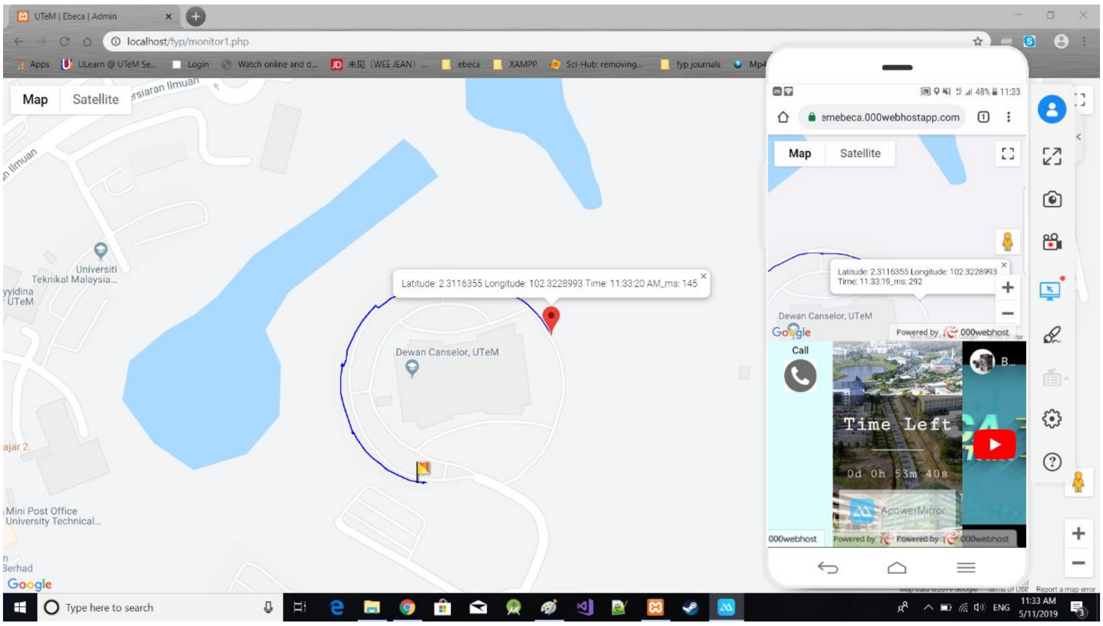

Figure 4.11: Instantaneous coordinate and time of Point 7.

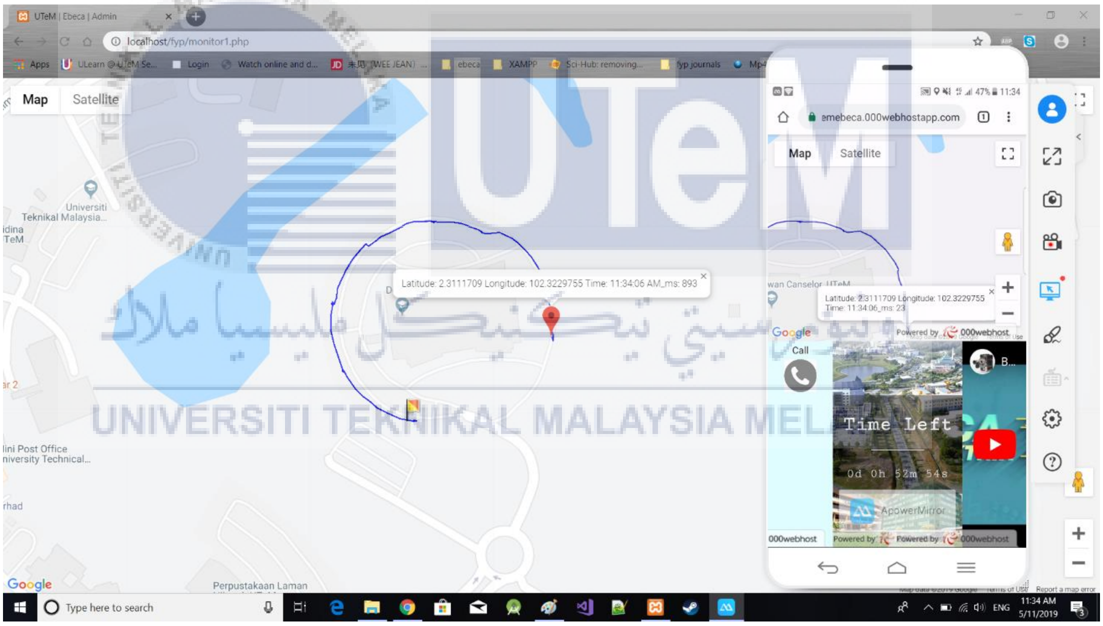

Figure 4.12: Instantaneous coordinate and time of Point 8.

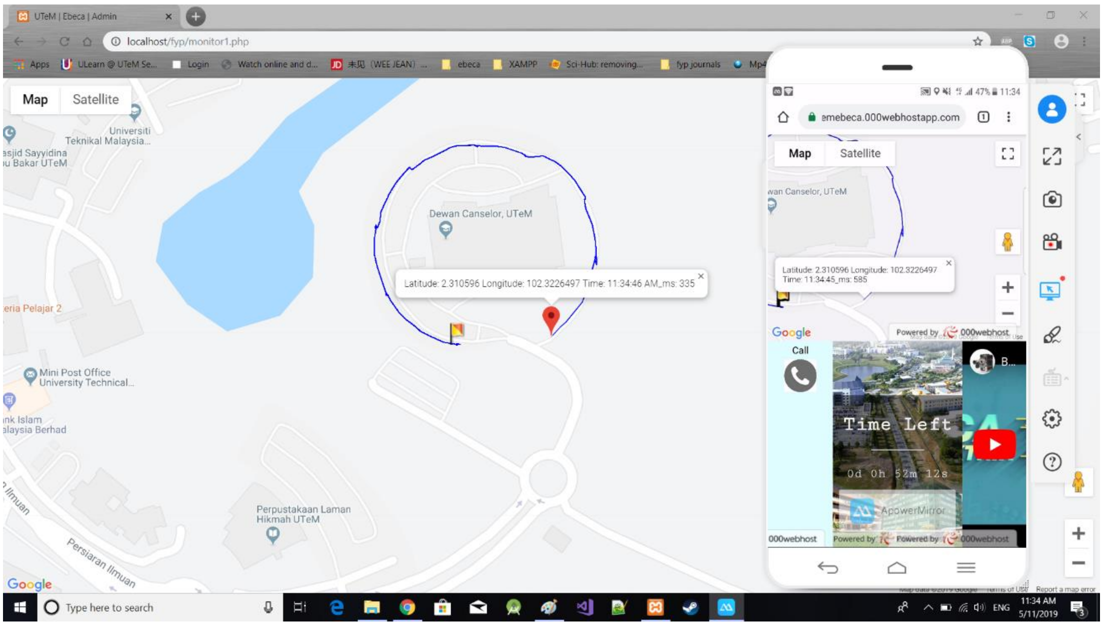

Figure 4.13: Instantaneous coordinate and time of Point 9.

After collecting all the coordinates and time shown in the system, all data are tabulated in a list of tables as shown in Table 4.1, Table 4.2, Table 4.3, Table 4.4, Table 4.5, Table 4.6, Table 4.7, Table 4.8, Table 4.9, Table 4.10 and Table 4.11.

Table 4.1: Actual coordinates of nine selected points.

Points	Actual Coordinates	
	Latitude	**Longitude**
1	2.310567	102.321975
2	2.310945	102.321473
3	2.311470	102.321319
4	2.311909	102.321561
5	2.312061	102.322036
6	2.312000	102.322456
7	2.311688	102.322910
8	2.311225	102.323000
9	2.310631	102.322714

Table 4.2: Instantaneous coordinates and time displayed for Experiment 1.

Points	e-Beca Web App			Monitoring System		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**

1	2.3106070	102.3220055	16:39:02:152	2.3106070	102.3220055	16:39:01:658
2	2.3109139	102.3214463	16:39:50:148	2.3109139	102.3214463	16:39:49:988
3	2.3114175	102.3213552	16:40:28:223	2.3114175	102.3213552	16:40:28:082
4	2.3119114	102.3216337	16:41:04:317	2.3119114	102.3216337	16:41:03:933
5	2.3121133	102.3220906	16:41:39:245	2.3121133	102.3220906	16:41:39:173
6	2.3120347	102.3224255	16:42:19:255	2.3120347	102.3224255	16:42:19:195
7	2.3118342	102.3228842	16:43:09:535	2.3118342	102.3228842	16:43:09:455
8	2.3112498	102.3230403	16:43:58:976	2.3112498	102.3230403	16:43:58:994
9	2.3106009	102.3226685	16:44:52:500	2.3106009	102.3226685	16:44:52:456

Table 4.3: Instantaneous coordinates and time displayed for Experiment 2.

Points	e-Beca Web App			Monitoring System		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3106016	102.3219549	16:46:01:167	2.3106016	102.3219549	16:46:00:673
2	2.3109172	102.3214538	16:46:40:174	2.3109172	102.3214538	16:46:39:772
3	2.3114481	102.3213243	16:47:16:147	2.3114481	102.3213243	16:47:15:746
4	2.3119166	102.3215839	16:49:13:891	2.3119166	102.3215839	16:49:13:563
5	2.3121072	102.3220875	16:49:56:476	2.3121072	102.3220875	16:49:56:157
6	2.3120152	102.3225130	16:50:55:098	2.3120152	102.3225130	16:50:55:079
7	2.3117592	102.3229917	16:52:03:198	2.3117592	102.3229917	16:52:02:919
8	2.3112405	102.3230307	16:52:50:671	2.3112405	102.3230307	16:52:50:640
9	2.3106111	102.3226847	16:53:41:592	2.3106111	102.3226847	16:53:41:341

Table 4.4: Instantaneous coordinates and time displayed for Experiment 3.

Points	e-Beca Web App			Monitoring System		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3105383	102.3219349	11:27:12:891	2.3105383	102.3219349	11:27:13:537
2	2.3109141	102.3214057	11:28:05:891	2.3109141	102.3214057	11:28:06:853
3	2.3114037	102.3213295	11:28:39:975	2.3114037	102.3213295	11:28:40:647
4	2.3118578	102.3215879	11:30:51:431	2.3118578	102.3215879	11:30:52:310
5	2.3120340	102.3220705	11:31:42:050	2.3120340	102.3220705	11:31:42:932
6	2.3119473	102.3224529	11:32:44:440	2.3119473	102.3224529	11:32:45:250
7	2.3116355	102.3228993	11:33:19:292	2.3116355	102.3228993	11:33:20:145
8	2.3111709	102.3229755	11:34:06:023	2.3111709	102.3229755	11:34:06:893
9	2.3105960	102.3226497	11:34:45:585	2.3105960	102.3226497	11:34:46:335

Table 4.5: Instantaneous coordinates and time displayed for Experiment 4.

Points	e-Beca Web App			Monitoring System		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3105118	102.3219614	11:35:43:902	2.3105118	102.3219614	11:35:44:776
2	2.3108609	102.3213986	11:36:17:890	2.3108609	102.3213986	11:36:18:498
3	2.3113720	102.3212767	11:36:45:916	2.3113720	102.3212767	11:36:46:688
4	2.3118620	102.3215302	11:37:16:020	2.3118620	102.3215302	11:37:16:550
5	2.3120335	102.3220664	11:37:48:023	2.3120335	102.3220664	11:37:48:820
6	2.3119582	102.3224852	11:38:23:987	2.3119582	102.3224852	11:38:23:794
7	2.3116200	102.3229618	11:39:12:528	2.3116200	102.3229618	11:39:13:724

8	2.3111929	102.3230171	11:39:42:448	2.3111929	102.3230171	11:39:43:136
9	2.3105363	102.3225858	11:40:25:728	2.3105363	102.3225858	11:40:26:665

Table 4.6: Instantaneous coordinates and time displayed for Experiment 5.

Points	**e-Beca Web App**			**Monitoring System**		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3104567	102.3220689	11:41:34:945	2.3104567	102.3220689	11:41:35:591
2	2.3109123	102.3214439	11:42:01:912	2.3109123	102.3214439	11:42:02:515
3	2.3114202	102.3213594	11:42:32:927	2.3114202	102.3213594	11:42:33:578
4	2.3118985	102.3216071	11:43:02:049	2.3118985	102.3216071	11:43:02:572
5	2.3120848	102.3220721	11:43:34:011	2.3120848	102.3220721	11:43:35:049
6	2.3119816	102.3225229	11:44:10:994	2.3119816	102.3225229	11:44:12:527
7	2.3116359	102.3230491	11:44:39:222	2.3116359	102.3230491	11:44:40:071
8	2.3111551	102.3231408	11:45:15:780	2.3111551	102.3231408	11:45:16:389
9	2.3105361	102.3227500	11:45:55:069	2.3105361	102.3227500	11:45:55:966

Table 4.7: Instantaneous coordinates and time displayed for Experiment 6.

Points	**e-Beca Web App**			**Monitoring System**		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3105699	102.3219765	16:54:47:139	2.3105699	102.3219765	16:54:46:803
2	2.3106786	102.3214814	16:55:26:145	2.3106786	102.3214814	16:55:26:345
3	2.3113972	102.3214108	16:56:05:166	2.3113972	102.3214108	16:56:05:033

4	2.3119022	102.3216438	16:56:41:225	2.3119022	102.3216438	16:56:40:883
5	2.3120871	102.3220489	16:57:15:202	2.3120871	102.3220489	16:57:14:835
6	2.3120069	102.3224526	16:57:49:416	2.3120069	102.3224526	16:57:49:099
7	2.3116985	102.3229687	16:58:32:790	2.3116985	102.3229687	16:58:32:442
8	2.3112211	102.3230703	16:59:07:817	2.3112211	102.3230703	16:59:07:549
9	2.3105984	102.3227026	17:00:17:989	2.3105984	102.3227026	17:00:17:944

Table 4.8: Instantaneous coordinates and time displayed for Experiment 7.

Points	**e-Beca Web App**			**Monitoring System**		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3105448	102.3220060	11:59:25:897	2.3105448	102.3220060	11:59:26:594
2	2.3109271	102.3214730	11:59:51:909	2.3109271	102.3214730	11:59:52:384
3	2.3114033	102.3213656	12:00:12:942	2.3114033	102.3213656	12:00:13:676
4	2.3118927	102.3215906	12:00:35:897	2.3118927	102.3215906	12:00:36:416
5	2.3120986	102.3220465	12:00:57:934	2.3120986	102.3220465	12:00:58:508
6	2.3120200	102.3224831	12:01:26:939	2.3120200	102.3224831	12:01:27:657
7	2.3116840	102.3229908	12:02:15:497	2.3116840	102.3229908	12:02:16:082
8	2.3112167	102.3230671	12:02:41:127	2.3112167	102.3230671	12:02:41:952
9	2.3105911	102.3227412	12:03:12:945	2.3105911	102.3227412	12:03:13:635

Table 4.9: Instantaneous coordinates and time displayed for Experiment 8.

Points	**e-Beca Web App**	**Monitoring System**

	Latitude	Longitude	Time	Latitude	Longitude	Time
1	2.3105716	102.3219588	12:04:10:890	2.3105716	102.3219588	12:04:11:392
2	2.3109492	102.3214692	12:04:34:907	2.3109492	102.3214692	12:04:35:414
3	2.3114370	102.3213743	12:04:58:890	2.3114370	102.3213743	12:04:59:435
4	2.3118913	102.3215857	12:05:21:885	2.3118913	102.3215857	12:05:22:486
5	2.3120897	102.3220256	12:05:50:105	2.3120897	102.3220256	12:05:50:666
6	2.3120323	102.3224672	12:06:15:953	2.3120323	102.3224672	12:06:16:605
7	2.3117743	102.3229458	12:06:39:117	2.3117743	102.3229458	12:06:40:026
8	2.3112340	102.3231058	12:07:04:327	2.3112340	102.3231058	12:07:04:963
9	2.3106052	102.3228097	12:07:38:412	2.3106052	102.3228097	12:07:39:241

Table 4.10: Instantaneous coordinates and time displayed for Experiment 9.

Points	e-Beca Web App			Monitoring System		
	Latitude	**Longitude**	**Time**	**Latitude**	**Longitude**	**Time**
1	2.3105529	102.3219871	12:09:14:899	2.3105529	102.3219871	12:09:15:391
2	2.3109510	102.3214007	12:09:39:895	2.3109510	102.3214007	12:09:40:373
3	2.3114237	102.3213199	12:10:49:922	2.3114237	102.3213199	12:10:50:486
4	2.3119104	102.3215794	12:11:25:996	2.3119104	102.3215794	12:11:26:511
5	2.3120887	102.3220162	12:11:48:234	2.3120887	102.3220162	12:11:49:099
6	2.3120341	102.3224129	12:12:09:361	2.3120341	102.3224129	12:12:09:899
7	2.3116884	102.3229680	12:13:29:390	2.3116884	102.3229680	12:13:30:322
8	2.3112182	102.3230612	12:13:54:993	2.3112182	102.3230612	12:13:55:559
9	2.3105998	102.3227258	12:14:29:417	2.3105998	102.3227258	12:14:30:141

Table 4.11: Instantaneous coordinates and time displayed for Experiment 10.

Points	e-Beca Web App			Monitoring System		
	Latitude	Longitude	Time	Latitude	Longitude	Time
1	2.3105614	102.3219832	12:15:31:215	2.3105614	102.3219832	12:15:31:648
2	2.3108956	102.3214897	12:16:37:877	2.3108956	102.3214897	12:16:38:473
3	2.3113454	102.3214309	12:17:00:951	2.3113454	102.3214309	12:17:01:728
4	2.3118656	102.3216334	12:17:26:055	2.3118656	102.3216334	12:17:27:061
5	2.3120793	102.3220401	12:17:46:968	2.3120793	102.3220401	12:17:48:166
6	2.3120271	102.3224478	12:18:16:038	2.3120271	102.3224478	12:18:16:650
7	2.3118070	102.3229134	12:18:47:278	2.3118070	102.3229134	12:18:48:037
8	2.3112738	102.3231160	12:19:22:927	2.3112738	102.3231160	12:19:23:564
9	2.3105796	102.3227857	12:19:57:804	2.3105796	102.3227857	12:19:58:476

4.3.1 Accuracy Analysis of Location Tracking System

A simple correlation test is done to observe the movement and changes of all the coordinates obtained throughout the experiments. It is done by plotting a scatter with smooth lines graph to observe the pattern of all routes taken by each experiment where a longitude against latitude graph is used to represent the moving path of the experiment as shown in Figure 4.14.

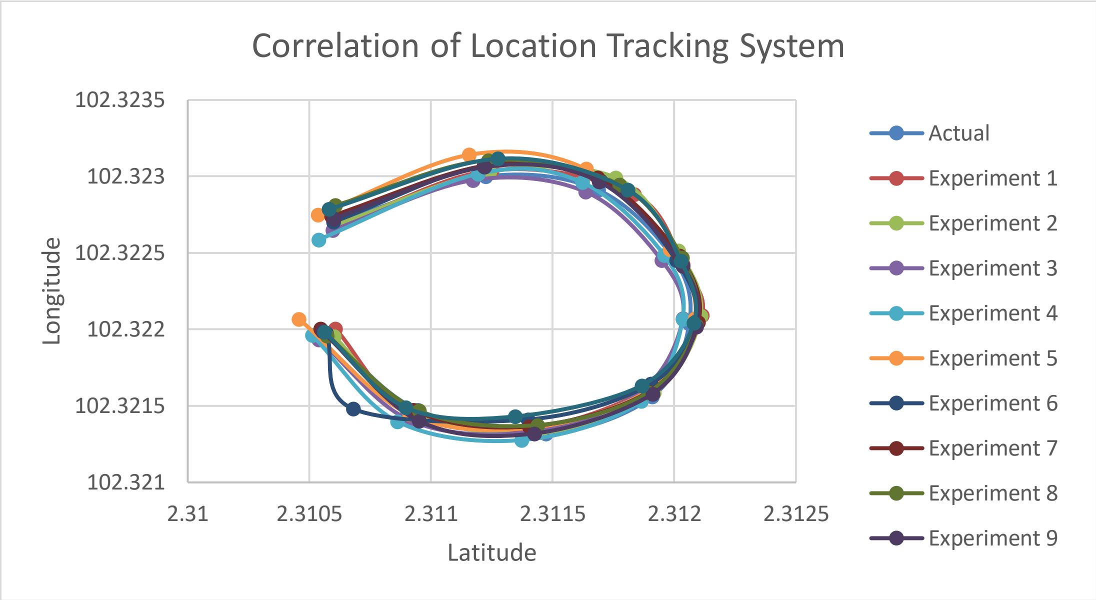

Figure 4.14: Correlation of location tracking system.

4.3.1.1 Distance Error Analysis

In order to obtain the difference in distance between the actual coordinate and the coordinate obtained using e-Beca web application, a free source online distance calculator is used to ease the conversion of two coordinates to distance in meter. The overall distance error is tabulated as shown in Table 4.12.

Table 4.12: Distance error between actual and displayed coordinates.

Experiments	Distance Error from Actual Coordinates (m)									Average Distance Error for Each Experiment (m)
	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	
1	5.59	4.56	7.09	8.08	8.40	5.14	16.51	5.26	6.06	7.41
2	4.45	3.76	2.51	2.68	7.69	6.55	12.04	3.82	3.94	5.27
3	5.48	8.23	7.46	6.43	4.87	5.87	5.96	6.60	8.14	6.56
4	6.32	12.48	11.87	6.25	4.56	5.67	9.50	4.04	17.71	8.71
5	16.10	4.87	7.13	5.25	4.81	7.71	16.50	17.47	11.28	10.12
6	0.36	29.64	13.02	9.23	3.24	0.86	6.63	7.82	3.84	8.29
7	4.24	1.99	9.05	3.76	4.34	3.74	8.99	7.51	5.37	5.44
8	1.87	0.63	7.16	3.38	3.39	3.80	10.39	11.80	11.01	5.94
9	2.07	8.06	5.15	2.05	3.79	6.11	6.44	6.84	3.71	4.91
10	1.10	5.80	18.62	9.38	2.09	3.15	13.24	13.98	9.80	8.57
Average Distance Error for Each Point (m)	4.76	8.00	8.91	5.65	4.72	4.86	10.62	8.51	8.09	**Mean Distance Error (m) =** 7.12

As can be seen from Table 4.12, the distance error is inconsistent for every point throughout all of the experiments done. Therefore, an average distance error is calculated for each point and each experiment for the purpose of distance error analysis.

Based on the average distance error calculated for each point, a highest distance error of 10.62 meter is obtained at point 7 as compared to other points. In fact, there are many things which can degrade the GPS positioning accuracy, some common causes include satellite signal blockage due to buildings and trees, indoor and underground use and also signals reflected by buildings and walls. Taking the significant distance error obtained at point 7, it could be caused by the geographical factor that the location is close to large amount of tall trees right behind the chosen experimental location which is Dewan Canselor, UTeM. Therefore, the accuracy of location tracking is affected where there is a significant signal blockage due to trees at point 7. While the low distance error of 4.76 meter and 4.72 meter at point 1 and point 5 respectively are obtained due to the open and clear areas with less blockage at the locations. Besides, the consistency of the data collection at the selected points could affect the average distance error for each experiment as well.

The overall mean distance error between the actual and displayed coordinates of the web application is obtained by averaging all the distances calculated from point 1 to point 9 throughout all of the ten experiments. Eventually, a mean distance error of 7.12 meter is obtained to represent the accuracy of the location tracking system developed for this project.

4.3.2 Efficiency Analysis of Data Communication

To conduct the efficiency test for data communication of the system, the instantaneous time displayed on both the application and monitoring system are collected to calculate the time difference or time latency of the system. The overall time differences between both application and monitoring system are tabulated as shown in Table 4.13.

Table 4.13: Time difference between application and monitoring system.

Experiments	Time Difference between Application and Monitoring System (ms)								
	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**
1	494	160	141	384	72	60	80	18	44
2	494	402	401	328	319	19	279	31	251
3	646	962	672	879	882	810	853	870	750
4	874	608	772	530	797	193	1196	688	937
5	646	603	651	523	1038	1533	849	609	897
6	336	200	133	342	367	317	348	268	45
7	697	475	734	519	574	718	585	825	690
8	502	507	545	601	561	652	909	636	829
9	492	478	564	515	865	538	932	566	724
10	433	596	777	1006	1198	612	759	637	672
Mean Time Difference (ms)	572								

All the time differences obtained in Table 4.13 are calculated in millisecond, where the longest time latency obtained is 1533 milliseconds or equivalent to 1.533 seconds. While the shortest time latency of the system is 18 milliseconds or 0.018 seconds which is incredibly fast. The fluctuation of the time differences are mainly caused by the stability of internet connection of the devices used where the coverage and the speed provided by the internet connection through either Wi-Fi or personal telecommunication services are significant in providing an efficient data communication system.

The overall efficiency of the data communication of the e-Beca monitoring system can be obtained by averaging all the time differences in order to get the mean time difference which is 572 milliseconds or 0.572 seconds. This can be understood by a condition where the moment when the location displayed on the web application and the moment when location displayed on the monitoring system is delayed by an average latency of 0.572 seconds, which is pretty close to real-time application.

4.4 Results of Mobile App Control System

As an early stage development for the e-Beca control system using mobile application, the connection between mobile application and electronic components worked perfectly as they were intended to be by controlling the LED and buzzer through the mobile application. Since the sound of buzzer cannot be presented in figure, the results for controlling LED are shown in Figure 4.15 and Figure 4.16 as below. The results of reliability test for the control system is shown in Table 4.14.

Figure 4.15: Turning LED ON using mobile app.

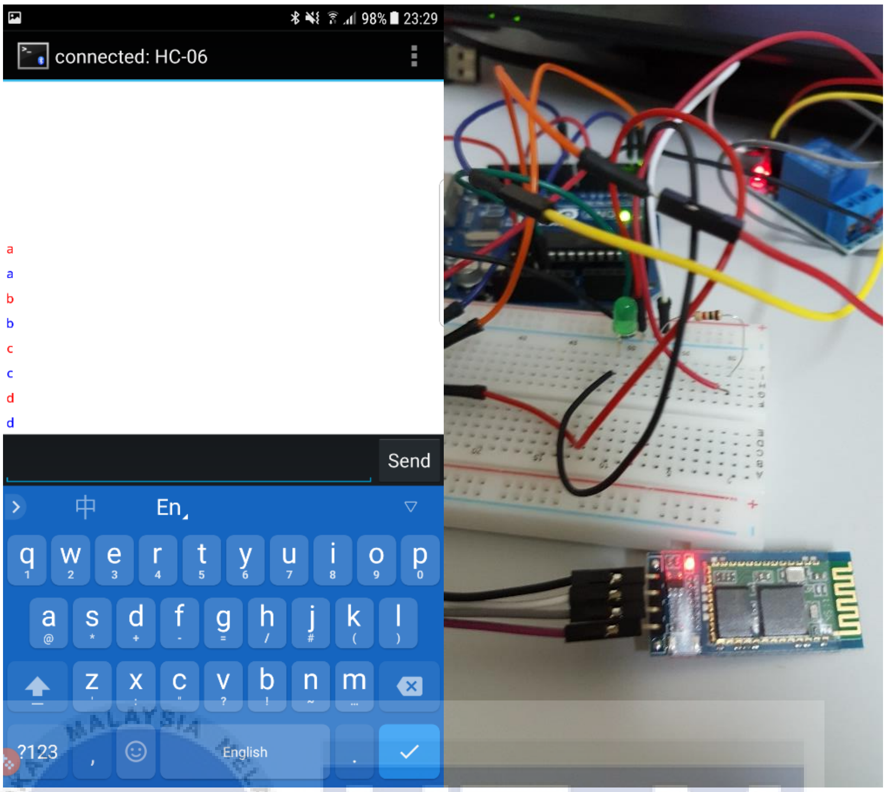

Figure 4.16: Turning LED OFF using mobile app.

Table 4.14: Reliability test for mobile app control system.

Experiments	**LED**		**Buzzer**	
	Success	**Fail**	**Success**	**Fail**
1	/		/	
2	/		/	
3	/		/	
4	/		/	
5	/		/	
6	/		/	
7	/		/	
8	/		/	
9	/		/	
10	/		/	

Based on the results obtained from the reliability test for the mobile application control system, it is clearly to be seen that the system is stable and reliable due to zero failure throughout the ten experiments of switching the LED and buzzer ON and OFF by using the "Bluetooth Terminal" mobile application. As an early stage development of the control system, it is convinced that the circuit connection used in this experiment could be applied to the actual e-Beca operating system in order to control the power supply and alarm system of e-Beca.

4.5 Summary

The overall results of e-Beca web-based monitoring system are shown and explained in details by displaying user interface and functionalities of various web pages developed in this project. Results obtained for performance analysis in terms of accuracy and efficiency tests of the system are discussed by providing appropriate tables and figures. Results of mobile application control system are shown in details as well. Conclusion and future work for the project will be presented in the next chapter.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

To conclude the overall achievements of the project, the main objective is achieved by developing a functional e-Beca web-based application and monitoring system with a real-time location tracking ability. Various functionalities such as displaying real-time location of the device, phone calling function to the host system, displaying time left for each ride, and displaying e-Beca advertising video are provided in the web application to the user. For the monitoring system, the host or the administrator of the system is able to track the location of the smart phone installed on the e-Beca for location monitoring purpose. A total of ten experiments are conducted by collecting latitude and longitude coordinates and instantaneous time displayed on both the application and monitoring system for the purpose of location accuracy and data communication efficiency tests. As a result for accuracy analysis of location tracking, a mean distance error of 7.12 meter between the actual and displayed coordinate is obtained. Besides, a mean time difference of 0.572 seconds is obtained as the time latency of displaying real-time locations for the e-Beca monitoring system. Last but not least, the early stage development of mobile application control system is reliable and stable throughout a series of tests by switching the LED and buzzer ON and OFF successfully using an open source mobile application, where LED represents the power supply and buzzer represents the alarm system of e-Beca.

5.2 Future Works

For further improvement of the e-Beca monitoring system, a complete control or remote feature is recommended to be developed for the system. The remote feature could be controlling the power switching and movement of e-Beca by using the monitoring system which is far from the target unit. This is convinced to be able to further enhance the functionality of the e-Beca monitoring system as it will be more than just to serve as the location tracking purpose. Besides, further improvement and development of the web application can be done by inserting more features and functionalities such as to retrieve the real-time data for voltage and current drawn by the e-Beca which is important to improve the performance of the e-Beca operating system as well. Lastly, the e-Beca monitoring system should be further developed as functional as possible since there are a lot of features and possible functionalities could be added to enhance the system.

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APPENDICES

APPENDIX A GANTT CHART FOR FINAL YEAR PROJECT 1

Project Activities of Final Year Project 1	**Week**														
	Sept			**Oct**					**Nov**				**Dec**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Title selection															
First meeting with supervisor															
Selection of hardware and software															
Research of related studies and journals															
Software development for e-Beca web page application															
Preliminary results for e-Beca web page application															
FYP 1 Presentation															
Submission of FYP 1 final report															

APPENDIX B GANTT CHART FOR FINAL YEAR PROJECT 2

Project Activities of Final Year Project 2	Week															
	Feb			Mac				Apr				May				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Completion of e-Beca web page application	■	■	■	■	■	■										
Experimental testing for e-Beca web page application						■	■	■	■	■	■	■				
Data analysis and discussion									■	■	■	■	■			
FYP 2 Presentation														■		
Submission of FYP 2 final report															■	■