Communication Module For Urban Vehicle Two-Way Connection Monitoring Device

Ahmad Kamil Bin Mohamad Yunus
Faculty Of Electrical Engineering UiTM Shah Alam
Electronic Engineering
Shah Alam ,Malaysia
akahmdkamil@gmail.com

***Abstract*— This project present a communication module for urban vehicle 2-way connection monitoring device for fleet monitoring system. The vehicle monitoring device which allows two-way connection via mobile communications internet or GSM between an owner and his vehicle. Available current solutions for vehicle monitoring and as well security rely on action of people close to the vehicle because there is no owner-to-vehicle interconnection when owners and vehicles are separated. Besides the owner also difficult to monitor their vehicle if they have more than one vehicle .The main objective of this project is to create a fleet monitoring device that allows interconnection between owner and vehicle . The main purpose is to allow the owner to keep track of the vehicle, by alerting the owner when certain conditions are detected which suitable for private usage or for transportation company. The project framework is divided into 3 modules: sensing, action and communication module. The sensing module will allow temperature, audio, acceleration and impact sensing. The action module will cover GPS, GSM, GPRS and camera triggering and interfacing, controlled by an algorithm programmed to suitable microcontroller platform. The communication module will ease two-way interconnection involving notification for location and images of the vehicle .Scope of this proposal will focus on only for communication module for 2-way connection monitoring device between users and vehicle for fleet monitoring system. When certain conditions are detected, the monitoring unit will be programmed to send out notifications to the fleet monitoring system. From that notification , the user able to monitor their vehicle and communicate using a device such as smartphone or computer .The owner now has access to monitor the vehicle at any time and at anywhere from their mobile device or computer.**

***Index Terms*— GSM, internet of things, global positioning system, global system for mobile, general packet radio service**

I. INTRODUCTION

This project put forward two-way connection monitoring device via mobile communications between an owner and his vehicle for fleet monitoring system.

Available current solutions for vehicle security mostly rely on action of people close to the vehicle because there is no interconnection between owners and vehicles when they are separated. The problem with the current solution for security is that once the owner leaves his vehicle, or the vehicle is away from the owner, there is no communication between these two.Besides the owner also difficult to monitor their vehicle if they have more than one vehicle.

Oftenly used in communication is SMS, while 3G connection over supported network such as WCDMA or HSPA is the latest trend on IoT based system. The Internet of Things (IoT) refers to ever-growing network of physical objects that feature an IP address for Internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems[7]. IoT has been widely used in nowadays system and therefore implementation of IoT is consistent to the current industry.

The project looks at fleet monitoring system and as well as for vehicle security such as stolen vehicles. Looking at hijacked vehicles, 150 vehicles were reportedly stolen per day in Malaysia by the The Star and Asia News Network[1]. Moreover, according to statistics reported by General Insurance Association of Malaysia (PIAM), 15,727 private cars were reported stolen to insurers in 2007 and 2008[2]. Total claims incurred by insurers for these vehicles amounted to RM673.4 million, which is reported by New Straits Times[2]. From these statistics and information, vehicle stolen is no longer an uncommon crime in Malaysia, leading to millions of Ringgit in losses .

In fact the other the issues is when the owner of the vehicle want to monitor more than one vehicle. Owner will face difficulty to keep track each of the vehicle they have and access the information about the vehicle .Most currently available fleet monitoring solutions are targeted towards managing large fleets, making them too expensive and/or difficult to operate for small fleet managers . Besides, fleet vehicles extend such surveillance to employees that traditionally had less supervision [3].

The objective of this project is to create a fleet monitoring device that allows interconnection between owner and vehicle for monitoring for one vehicle or more than one vehicle .The main purpose is to allow the owner to keep track of the vehicle by alerting the owner when certain conditions are detected for each vehicle that user want to monitor through their device. It will show alert message to the owner through mobile communication/internet connection or GSM for fleet monitoring system.

II. DESIGN METHODOLOGY

The overall architecture for fleet monitoring system as shown in Fig. 1 divided into the following scope of work:

(i)system design: covering architecture of microcontroller to sensing module and communication module.
(ii)sensing modules: covering temperature, range, sound, and impact sensing.
(iii)communication: covering protocols between application and module.

In this project focuses on communication module which is covering all the interfacing and protocol between application and microcontroller for fleet monitoring system which is user able to access through their phone or computer.

A. System Design

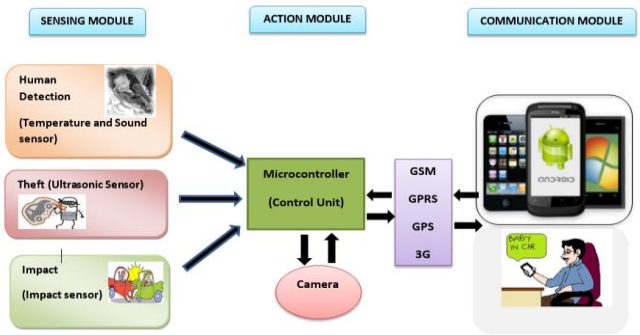


Fig. 1: System Architecture.

Fig. 1 shows the overall system architecture of the project. This fleet monitoring system was using two-way connection, either from vehicle to owner or from owner to vehicle. Moreover , user able to monitor and keep track if they have more than one vehicle by using fleet monitoring application install at their smartphone or using web browser.

For the connection from vehicle to owner, notification will be sent from microcontroller only if the sensing unit was given the input signal while the receiving signal to microcontroller will send notification to the owner via SMS. On the other connection ,owner to vehicle, microcontroller can perform two action modules which are tracking the vehicles using GPS or taking picture inside vehicle using camera. Both GPS and camera are categorized under action module for it's functionality as responses from the owner. The owner have access to request the coordinate of the vehicle or image on activity inside car from his/her Android application.

On the other hand, integration between Android application to microcontroller was using two approaches; (i)SMS protocol or (ii)database which using internet connection. When the owner request for registration, the microcontroller will receiving SMS protocol for registration. The owner will received authorization codes to register the microcontroller with the Android application. Upon completion of integration between Android application and microcontroller, the owner able to request the GPS coordinate of the car via SMS or image inside car from their Android application via MMS.

Secondly, by using database is the alternative approach to SMS protocol. The integration between microcontroller to Android application or webpage changes in term of registration and data transfer. To register microcontroller to Android application or webpage , less requirement is needed. It just need user detail such as username , password email , phone number and user vehicle plate number. When the owner requested for car's location, the database will upload the request up into database. Later, the microcontroller will check on its side with database to perform HTTP request to the server. On this HTTP request, the microcontroller will upload the coordinate of the car referring to its respective vehicle plate number. In term of sending picture, the same approach is used by using MMS or through internet to the database.

B. Communication module

In this part, the communication module for fleet monitoring used was either GSM or 3G internet. The 3G connection is used for the communication layer while cloud database server stores all the information or data based from action module.This system consistent to the IoT which represents things connecting with systems, people and other things[9]. Nowadays smart phone is one of the mobile device that widely used and its being the primary handled device for more than a billion people[4].Therefore it's easy for user to communicate by using application installed in smartphone.

This application will develop using Android system development kit because android has an open ecosystem and source code. Moreover 'Google Play' marketplace has over 700 thousand application and 25 billion downloads.[5]. Besides , a webpage also will be designed to communicate with database so user have option whether they can use android application or webpage for fleet monitoring system.

This android mobile application and webpage for fleet monitoring is namely SpotMeNow and was built specially to communicate with microcontroller module based on certain condition and situation. This application was built using Eclipse software and the languages used are Java and XML. The Java language is updated and customized for mobile environment due to limitations and new functionalities in hardware, such as touch screens, phone service, messaging, camera, size[6]. For the webpage is built using the PHP script. The communication module for fleet monitoring is divided into two part which is from vehicle to owner and from owner to vehicle

(i) Vehicle to Owner

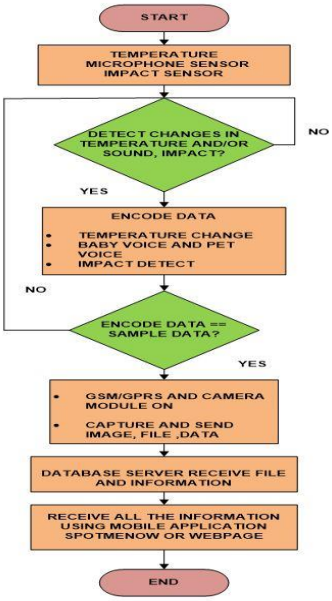


Fig. 2: The flow chart of communication module form vehicle to owner

The flowchart in Fig. 2 demonstrates the flowchart for the communication module from vehicle to owner for fleet monitoring system. Based from system design, when ever the sensing module detects the changes in certain condition, it will notify to the owner. Database send all the information received to the application that installed in a mobile phone to communicate with the vehicle's owner. When the users open the application and login into the SpotMeNow application which act as fleet monitoring system .The user able request real time image and also the location of the vehicle at anytime and anywhere.

(ii) Owner to Vehicle

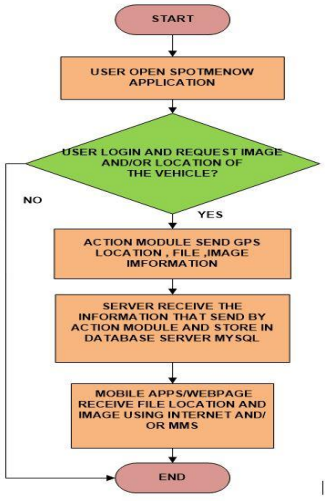


Fig. 3: The flow chart of communication module form owner to vehicle

Based on the flow chart in Fig. 3 show how the communication module from owner to vehicle for fleet monitoring system. First user can open the android application that installed in their mobile phone or open the webpage SpotMeNow. Then user will have to register before they can login into this fleet monitoring system.

After user login , user able to add their vehicle and request for the location and also images. The action module would take part to trigger the camera or GPS and then send all the information to the database server based on the user requeste. Then database server would store all the information and send back to mobile application using internet or SMS . User able to locate the coordinate of the vehicle which can open in google map and get the image of the vehicle .

III. RESULT AND DISCUSSION

A. Overall System

This project was built based on communication module for fleet monitoring with two-way connection monitoring device which is between single vehicle-to-owner and also between single owner and many vehicles. In two-way connection, this fleet monitoring system is flexible to any type of user whether for private usage or for transportation company for large vehicle monitoring .For the fleet monitoring system it includes the sensing module that helps in term of vehicle's security. The features of this application are monitoring vehicle from distance for the case of impact, presence of unknown person inside vehicle, and tracking the vehicle. notification will be send to the owner and user can request for the image inside vehicle or tracking their vehicle from SpotMeNow Android application or webpage.

B. Fleet Monitoring using SMS Connection

In fleet monitoring using SMS connection the application is design based on SMS protocol. It involves using standard communication protocol to exchange short messages between fixed lines or handheld device which is usually used in cell phones . Most of us are familiar with use of SMS in daily life but formally SMS can be defined as a wireless service which is globally accepted for transmission of alpha numeric data between two mobile subscribers [10] . The Short Message Service (SMS) works on low-end mobile phones and is available worldwide. Global SMS traffic is expected to reach 8.7 trillion messages by 2015, up from 5 trillion messages in 2010 [11].Using the SMS connection for fleet monitoring system the user able to request location or image through the Fleet monitoring system application which is call SpotMeNow .This application is android based operating system .The application install based on certain command that will communicate to the microcontroller module that installed in vehicle . The microcontroller module will respond based on certain command that only microcontroller can recognize.

SMSCommand From Android Application	ActionFrom Microcontroller
C!#@DI7415&%?R*-	Request registration code
C!#@DI4865&%?R*-	Request Image
C!#@DI6425&%?R*	Request Location GPS

Fig. 4: Table for SMS command to Microcontroller

From the table in Fig. 4 above, it shows how the Microcontroller installed in Vehicle will take action and response based on SMS command that are in the SpotMeNow application for fleet Monitoring system. All of the command is hard code in the coding for SpotMeNow android application using Java language.The microcontroller only start to communicate back if only they receive this command . Other than that , this microcontroller will do nothing or denied other SMS that it receive. All the detail and how the Fleet monitoring application using SMS connection will be based on flow chart in figure 6 below.

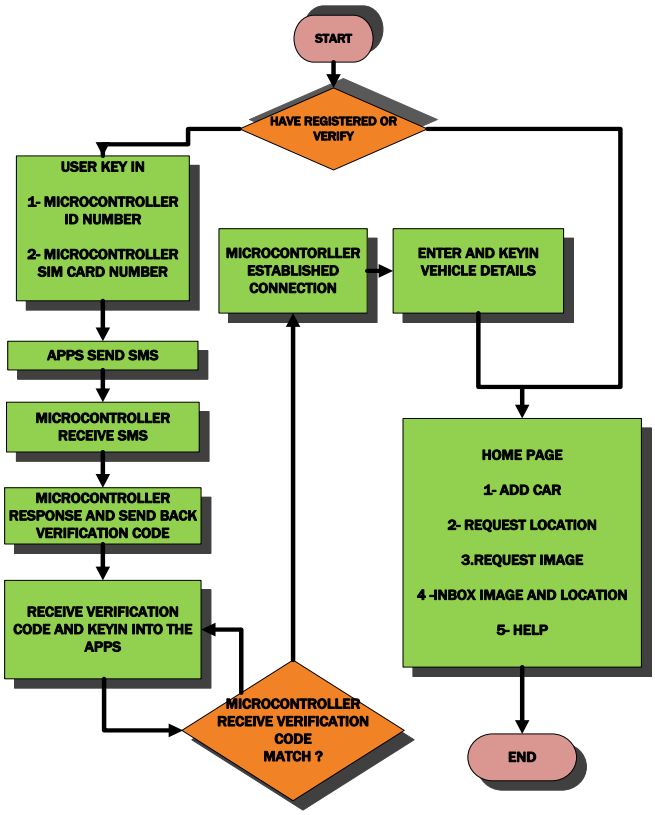


Fig. 5: Flow chart SpotMeNow Apps For Fleet Monitoring System

From the flow chart in Fig. 5 it shows how the SpotMeNow application for Fleet Monitoring application will work .First user have to download the application and installed in their smartphone which create for android user .User have to registered first before they can use and communicate with microcontroller and sensing module installed in the vehicle. Then for registration purpose user have to key in the microcontroller ID number and microcontroller sim card number to receive any SMS command from the application . The layout and user interface in the apps is as shown in Fig. 6 for registration and verification.

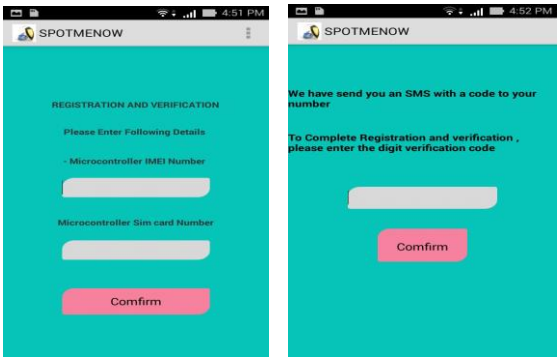


Fig. 6:The layout and user interface page for Registration and Verification

This application will send all the information that key in by the user and send it as SMS to microcontroller . Microcontroller will response based in certain command that have describe in Fig. 5. After that microcontroller will processed and send SMS verification code to user phone. User have to key in the verification code that was receive to establish connection between the apps and the microcontroller module as shown in Fig. 6 . If the code is match then user able to enter the vehicle details that user want to be monitor as shown in Fig. 7 below.

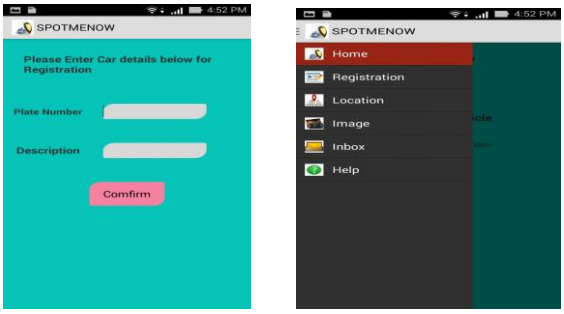


Fig. 7:The layout and user interface at page Insert Vehicle detail at home page

User able to request location and image by using this application at the home page which is as shown in Fig. 7. Besides user also able to add other car if user want to monitor other vehicle as long as the vehicle is equipped and installed with the microcontroller module. User can receive the location at the location and open it on google map . For the image user will receive as MMS image required a data retrieve the image .

C. Fleet Monitoring using Internet Connection

In fleet monitoring using Internet connection the communication module for fleet monitoring will use 3G connection . Fleet monitoring will be using database and therefore 3G connection is secured in between microcontroller and database, also in between Android application and microcontroller [10].The implementation of Fleet Monitoring system is over HTTP [12], is based on the Hyper Text Transfer Protocol (HTTP), and is most appropriate for desktop or laptop computers on the Internet. This fleet monitoring system have extended and retrieval system based on HTTP, so that it does not rely only on the Internet but can utilize the cellular telephony network which is by using 3G connection in the microcontroller module installed in the vehicle for monitoring purpose . Beside by using internet connection for fleet monitoring it require ip-connection between the application to the database to receive, retrieve and send the request and information.

The communication module for fleet monitoring application and database are connected by using internet for the transfer of information and data from action module . The communication module for fleet monitoring which is based on android application is called SpotMeNow. Generally the SpotMeNow application for fleet monitoring will communicate between the microcontroller and database based on Fig. 8 below.

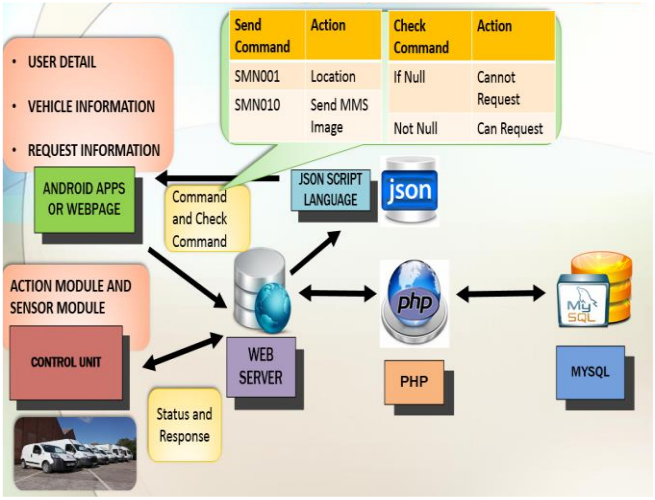


Fig. 8: Block diagram interconnection from microcontroller to database and from Android application SpotMeNow to database for Fleet Monitoring

From the Fig. 8 android and microcontroller will be connected to the webserver and database MySQL using PHP script . The PHP script will be write based on specific function that will be done . From the android to database command and check command PHP script was created for request function to the database and then to microcontroller. Each command performed different request . For example SMN001 perform location request and SMN010 perform send image .All the command will push to database and microcontroller will responds based on request and doing the action.

For android application it need JSON to translate the PHP script to response in the android application. For microcontroller to database it need status and response PHP script . It will check the request function at the database to know the status and then it will response based on the request .

The most important part is that all the PHP script will function accordingly to the created database. PHP will do all of the talking for the transferring data in and out of the database. For instance, a new user account can be created in this application using some input fields such as username, password, or even backup security question for the password.When the user fills out this information submitted it from the available button, the information will be passed to the PHP web service.

Then the web service will connect to the MySQL Database, and find the "Users" table and insert a new row into the MySQL database with all the information that was sent from earlier created account. After web service submits the query, PHP script will tell whether query was successful or vice versa by echoing some JSON data.

After JSON response was created, it will tell the Android application to interpret the JSON response, which is called as parsing. In this project there are several tables created in the database. Each table will store all the data that inserted from the SpotMeNow mobile application. For this project, 5 tables were created inside the database call as Spotme. Fig. 9 below shows the details of the table created.

	Table	Action
☐	cars	Browse Structure
☐	commandresponse	Browse Structure
☐	configs	Browse Structure
☐	product	Browse Structure
☐	usercar	Browse Structure
☐	users	Browse Structure
	6 tables	Sum

Fig. 9: List of table in Spotme database

Each table has different information that can be stored. One of the examples is the function of users to store data of all the details when a new user wants to register before login into the application. The users are required to fill all the form in the application including username, password, emails and phone number..

All the details for the new users account will be stored inside Spotme database under table user .Once registration success, only then they can login to enter the SpotMeNow application. Fig. 10 below shows the table structured in user table.

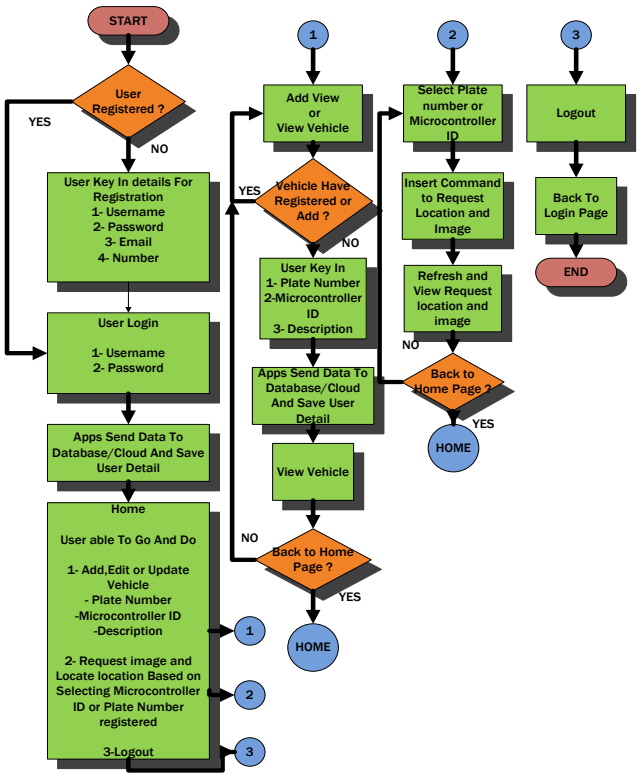


Fig. 10:Flow Chart of Fleet monitoring in SpotMeNow Apps and Webpage

From Fig. 10 above, it shows how the Fleet monitoring worked using internet connection will worked. First users have to open the SpotMeNow application that was installed in mobile phone or can open it on SpotMeNow webpage. For first time user, registration is required.After user have successfully done with registration, the user able to login through the application. Each user has its own username, password, email and phone number that will save and update in Spotme database. Then for the login process user need to login based on his username and password that have created when they registered. After done the login process, users have the access to the car menus to add their vehicle without limit. For adding more than one vehicle inside the SpotMeNow application, the user can add the vehicle plat number, microcontroller id and description of the vehicle .

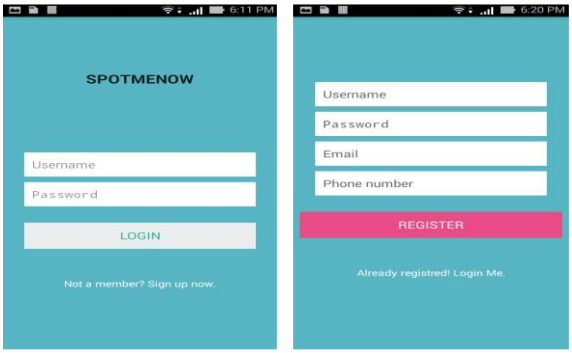
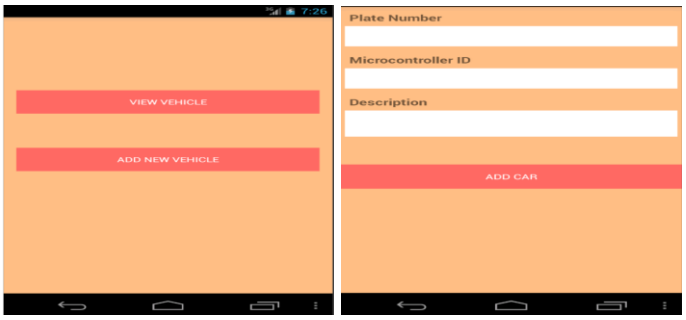


Fig. 11: Screenshot for login registration

All the user detail such as username, password, email and phone that were registered in the SpotMeNow application will be updated and stored in Spotme database. Only users that have information saved inside database have the access to the login page of the application. Each user will have its own user's id namely as uid. This uid is used as reference in database to add, delete vehicle in this application .All this concept for registration and login activity will apply the same method for building the webpage for fleet monitoring system

Besides that, user can edit, update and delete the vehicle's information such as plate number, microcontroller id or description of the car. All the information that user have edit will updated in Spotme database under cars table. This concept also will be applied same concept for the webpage and android apps for fleet monitoring system as in Fig. 12 below.



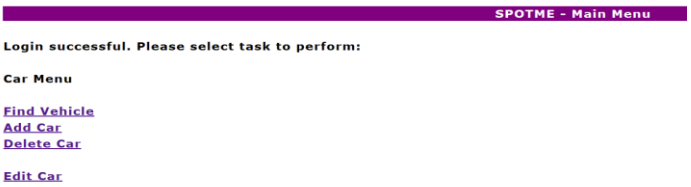


Fig. 12: Screenshot activity in login page for android app and webpage

All the functionality in webpage for fleet monitoring will be same as in SpotMeNow Android application . User able to add as many vehicle they want that want to be monitor whether through android application or web page . This fleet monitoring system can request the location and image for each vehicle that they want to track.

#	Name	Type	Collation	Attributes	Null	Default	Extra
1	cid	int(255)			No	None	AUTO_INCREMENT
2	plate	varchar(20)	latin1_swedish_ci		No	None	
3	longitude	double			No	None	
4	latitude	double			No	None	
5	mcid	varchar(10)	latin1_swedish_ci		No	None	
6	description	varchar(1000)	latin1_swedish_ci		No	None	
7	link	varchar(100)	latin1_swedish_ci		No	None	
8	speed	double			No	None	

Fig. 13: Cars table structure in Spotme database

From the Fig. 13 above it shows the structure of cars table. All the details such as plate number, mcid, or the description that user have filled in Android application or in webpage will be updated in this cars table in Spotme database. For longitude, latitude and speed of the car it will be updated by microcontroller when the user request from the application. The microcontroller will update all the information and differentiate which user by referring to cid which stand for car id and uid. The users are now able to view the information in SpotMeNow application from mobile phone or through webpage in the computer . When users register it will automatically create uid for user. Each user have different uid,

This function is to differentiate between users that login in this application. From uid the database able to know how the number of car that user have added by referring to cid. This cid is created in user cars table structure so that one user able to add more than one vehicle. This cid and then will refer back in cars table in spotme database. Then each cid have different information and details that the user want to add

In fact user able to see the list view of the vehicle that has been added in the SpotMeNow application or webpage to be monitor based on plate number that has been added. They can select which vehicle they want to monitor based on plate number . In fact, they can choose which vehicle to display and request based on plate number that they have added in the Fleet monitoring application at the android apps or webpage .

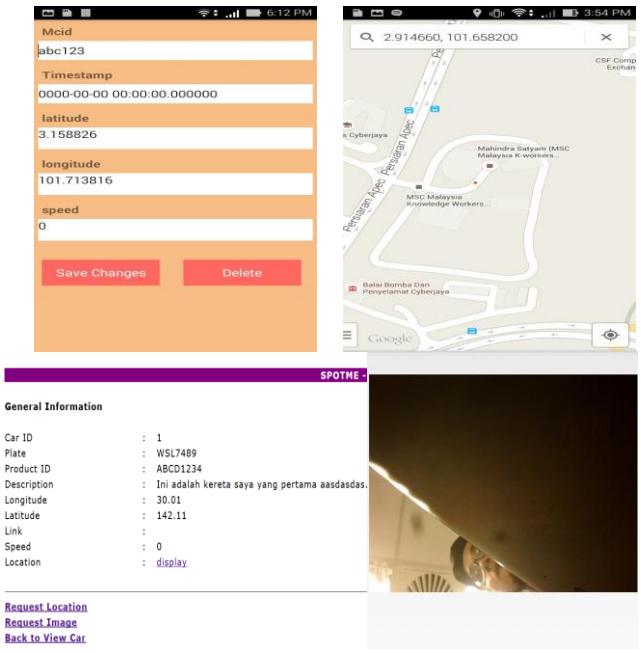


Fig. 14: The screenshot information that receive using fleet monitoring sytem in apps and webpage

Based on Fig. 14 , it show the information that user will receive once they request image and location of the vehicle by using SpotMeNow application or webpage. All this information is install in the database MySQL and user able to view and access at anytime and anywhere through their smartphone or computer.

D. Comparison SMS connection with Internet Connection

	SMS connection	**Internet connection**
Communication Channel	GSM network	3G connection
Internet Protocol usage	Not required	Required
Data Usage	Only use for receiving image	Always use
Transfer of information	Directly to SMS/MMS inbox	Required database and retrieve from database
Credit Usage	Required for sending and recieve	Only use data plan based on telco
Vehicle information and detail	Not store and have to verify back	All user data store in database . Don't have to registerback

Fig. 15: Comparison between SMS and Internet Connection for Fleet monitoring

Based on Fig. 15 above it shows the comparison between SMS connection and Internet connection for fleet monitoring system . For SMS connection it only required GSM network but for internet connection it needs 3G connection for faster transfer and request information of the vehicle. Besides SMS connection doesn't need internet protocol but for fleet monitoring using internet it needs Transmission Control Protocol – Internet Protocol (TCP-IP) to send and receive information from database

Using the SMS connection for fleet monitoring it needs data usage only if one retrieve image that send from microcontroller but for internet connection always need data to transfer and receive vehicle information . The transfer of vehicle information using SMS connection it will directly to SMS/MMS inbox but for internet connection all data will be store at database and have to retrieve the vehicle information in the database. For the credit usage SMS connection required when sending and receiving SMS from microcontroller . For internet connection it only need internet data plan for receiving and request information form the database . The vehicle information and detail by using SMS connection does not be stored which it means user have to register back their microcontroller id for verification if want to monitor the vehicle .

Compare to using internet connection all data user will be stored in database so each user have different type of data and information . Besides user that have registered just only have to login if they have logout form the Fleet monitoring system.

E. Cache size in SpotMeNow application

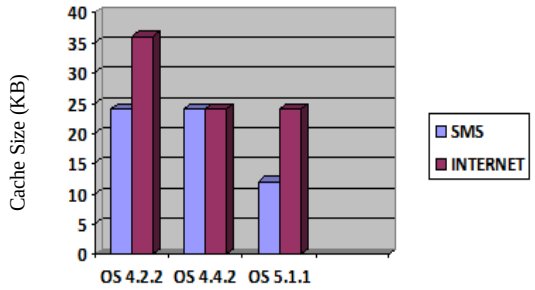


Fig. 16:Cache size for SpotMeNow Application based on operating system and connection

Based on Fig. 16 above it shows the cache size for SpotMeNow android application based on operating system and connection whether using SMS or internet. Cache in general is a type of temporary and quick access data used by apps. Any temporary information created or used by an app is part of cache. From the bar chart above ,operating system that is use will effect the cache size .Besides the functionality and type of connection use also have effect to cache size .

The older operating system which is android 4.2.2 have largest cache size compare to android OS 4.4.2 and OS 5.1.1 when the apps is using Internet connection for receive and request database for fleet monitoring system. For android OS 4.2.2 and OS 4.4.2 there have no different in size of cache but the latest OS 5.1.1 have lowest cache value by using SMS connection for fleet monitoring system.

Cache should not cause problems, but occasionally it can become corrupted and cause an app to misbehave. It's not dangerous to clear it, but by doing so, you force the app to recreate any information it had previously stored in cache, which can slow down the app until the information is recreated.

IV. Conclusion, Recommendation and Benefits

SpotMeNow is android based application and webpage for fleet monitoring system able to communicate using GSM ,GPRS and 3G connection for the activity of sending notification between module and Android application. It also use database to store all the user information that have registere by using internet connection. This fleet monitoring aim to the transportation company or private vehicle for monitoring purpose. These transportation can be taxis, buses, lorries and others[8].Besides it also suitable for private user that have more than one car to be monitor.

In future, to maximize the usage of SpotMeNow application for fleet monitoring it able to locate the real time location of the vehicle moving at each second .Besides it also can monitor the speed , the estimate time arrive for the vehicle and also identifying improper driving habits.

The implementation for fleet monitoring system using android application and webpage is a cost-effective solution that able the fleet managers to always know the location and performance of each their vehicles at anytime and anywhere.

Acknowledgement

A special gratitude is given to our final year project supervisor, Dr Wan Fazlida Hanim, whose contribution in stimulating suggestions and encouragement along the period of this project. Million appreciation also dedicate to Dr Wan for helping us in term of funding for all the materials supported on this project. Last but not least, not forgetten to our co-supervisor, Dr Ihsan Yassin for equipped us with knowledge and guidance alongside this project period.

References

[1] Lily (2013, July 11) Alarming Car Theft Statistics![Online].Available:http://www.automology.com/2013/11/alarming-car-theft-statistics.html

[2] New Straits Times. (2009, May 2). Car Thefts: RM673.4m claims incurred[Online].Available:http://www.piam.org.my/index.php/news/113-insurance-news/2009/285-car-thefts-rm673-4m-claims-incurred

[3] James R.Hagerty (June 1,2011). 'Big Brother'Keeps an Eye On Heavy –Equipment Fleet review [Online]. Available http://www.wsj.com/articles/SB10001424052748703509104576329881589249 57

[4] Serrano, N. Hernantes, J. ; Gallardo, G. "Mobile Web Apps" Software, IEEE , vol .30 , Issu), pp.22-27

[5] R.Triggs, "Apple App Store vs Google Play: year-end trend statistics,"21December2012.[Online]. Available:http://www.androidauthority.com/apple-appstore-vs-google-play-distimo-141851/.

[6] Seyitriza Tigrek. "Teaching Smartphone and Microcontroller System Using "Android Java"." Doctor of Philosophy, University of Colorado, United States, 2012.

[7] Pedro Hernandez (May 21, 2014). Internet of Things Shows Promise and Peril.[Online]. Available: http://www.smallbusinesscomputing.com/News/Security/internet-of-things-shows-promise-and-peril.html

[8] Joe Moran (Apr 2, 2015). Small Businees Guide To Fleet Monitoring [Online].Available: http://www.smallbusinesscomputing.com/buyersguide/small-business-guide-to-fleet-management.html

[9] Bill Zujewski (Jan 22,2014). IoT vs. M2M...There's a Difference[Online]. Availablle:http://blog.axeda.com/archived-Axeda-blog-/tabid/90718/bid/104683/IoT-vs-M2M-There-s-a-Difference.aspx

[10] I. E. Consortium, T he Basics of Telecommunications (2002). International Engineering Consortium.

[11] Tsirulnik G (2011) Global SMS traffic to reach 8.7 trillion by 2015: study. In: Mobile commerce daily, 3 February 2011. http://www.mobilecommercedaily.com/2011/02/03/global-smstraffic-to-reach-8-7-trillion-by-2015. Accessed 25 Sept 2012

[12] Michel Lombera I, Chuang YT,Melliar-Smith PM, Moser LE (2011) Trustworthy distribution and retrieval of information over HTTP and the Internet. In: 3rd international conference on the evolving Internet, Luxembourg City, Luxembourg, pp 7–13