PREFACE

This book chapter is produced by Internet of Things (IoT) Focus Group, Faculty of Electrical and Electronic Engineering. This book chapter is an introduction to a number of the topics in Internet of Things (IoT), which focusing on the tracking and monitoring systems. All topics described the design and system development related to IoT. The presented topics have been selected to give an idea to engineering students in order to design the IoT systems. This book chapter is generally suitable as complement to integrated design and final year project of engineering students.

Sharifah Saon
Abd Kadir Mahamad
Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia
2019

LIST OF CONTRIBUTORS

Abd Kadir Mahamad
Ansar Jamil
Ezri Mohd
Farhana Ahmad Poad
Fauziahanim Che Seman
Jiwa Abdullah
Lukman Hanif Muhammad Audah
Noorsaliza Abdullah
Nor Shahida Mohd Shah
Norshidah Katiran
Rozlan Alias
Sharifah Saon
Mohd Zulhafizie
Muhamad Nabil Asyraf Ghazali
Mohammad Nazri Rosli
Muhammad Iqmal A Ghani
Muzammil Mudzakir
Seh Bee Yan
Soon Jian Cheng
Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia (UTHM)

Jusrorizal Fadly Jusoh
Jabatan Teknologi Maklumat dan Komunikasi,
Politeknik Sultan Abdul Halim Muadzam Shah

Shingo Yamaguchi
Mohd Anuaruddin Ahmadon
Graduate School of Science and Technology for Innovation,
Yamaguchi University

e-Commerce Stock Inventory via ScanCart: The Android Barcode Scanner

Sharifah Saon[1*], Abd Kadir Mahamad[1], and Muzammil Mudzakir[1]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
sharifa@uthm.edu.my

1. Introduction

The usage of Android application was increased with the increment of smartphone per year, since user prefer internet to be one of the important infrastructure in their daily life. There are many applications for Android that has been released and some of them give great feedback in term of functionality and easy to used. Furthermore, it also very sustain in order to increase the productivity. Therefore, this is a great opportunity to create business based on mobile application. This project aims to develop an integrated Android barcode scanner with e-commerce system. This application allows user to scan a barcode and update quantity or create an order by using smartphone camera. Thus, the used of physical devices, were excessively reduced. Performances of developed Android application are evaluated based on survey by business and industrial partners.

Meanwhile, smartphone has become one of the most important electronic devices nowadays. With technology of internet has rapidly evolving, the functionality of the smartphone has become more convenience to the society due to lot of applications that may help people daily life such as surfing internet, messaging and also business management [1].

Online business is one of the electronic commerce (e commerce) that selling the goods or services. Several issues may cause delay in purchasing process, including separate or un-synchronising stocks quantities between online and retail, at the same time it's also cause the difficulty in monitor and update the sales. Therefore, motivation for this project is to develop interfacing application that support barcode scanner and may synchronize between physical stores (retail) and online for inventory purpose which can be monitored at any time, everywhere and real-time update.

This project involve several element which are E-commerce, Internet of Things (IoT) and also development of an application that compatible with Android operating system (OS) in order to connect the main website of database with barcode scanner of product to replace the existing barcode device [2].

2. Android Barcode Scanner for e-Commerce

Barcode is a machine readable representation of information in a visual format on a surface and it consist of printed parallel lines [3]. The development of barcode system was established a long time ago. It began with the design of the punch card system by Wallace Flint in 1890. However, the problems occur that the card reader equipment of the day was bulky and utterly unwieldy [4]. The first barcode system using glow under ultraviolet light was introduced by Bernard Silver in 1948 [5].

However, this system encountered problems which ranging from ink instability to printing costs. In 1970 Universal Product Code (UPC) has been widespread use of barcodes because it developed by the user community and continued by European Article Numbering System (EAN), and widely use today [6]. Meanwhile, in 2006, Wang and his colleges discovered 1D barcode reading using camera phones [3].

There are plenty types of barcode for 1D such as European Article Numbering (EAN-13) [7], International Standard Book Number (ISBN-Code) [8] and Universal Product Code (UPC) [6] . This work will be focusing on EAN-13 because it consists of numbers and support worldwide retail product marking. Figure 1 shows a typical EAN-13 Barcode.

Fig. 1 - EAN-13 Barcode [7]

In order to realised this idea, Android barcode scanner was integrated with other features of e-commerce system equipped with database and was connected via My Structure Query Language (MySQL). Open source e-commerce is a free of charge platform that can be installed in self-hosted. This type of e-commerce can be downloaded for free and user can easily access and redesign or modify the source code with help of community to understand the fundamental of the system. This system also provides wide variety of available extensions and it was a flexible system.

Meanwhile, data was logged into a database that arranged in table and structured. There are several others meaning of database, according to Silberchatz et. al. [9] the database is a set of data contains information on an entity, while Powell [10], described the database as an implementation or creation of physical data on a computer. However, Sumathi [11] interpret database as a collection of data that relate to and have a certain meaning which is stored properly and can be accessed in various ways and sequences.

There are three type of database tier; which are (1) First-Tier; developed for client that perform the task or services and it contain user interface and presentation services, (2) Second-Tier; a part for application server which contains the presentation code and the SQL statements for data access, while the (3) Third-Tier; data server that store the database. In general it can be concluded that all data stored either directly or indirectly depend on type of field. Thus, this work focusing on Multiple-Tier Architecture database which can provide the most benefits in terms of scalability, interoperability and flexibility.

3. A Framework of System Development

Figure 2 shows the project block diagram consist of barcode EAN-13 and Samsung Galaxy S4 mobile was used to scan the barcode. Internet connection was required in order to connect between Android application and server database via API. The website was designed using Opencart E-commerce, in order to set the product information and barcode EAN-13. Meanwhile, server database was used to store data information.

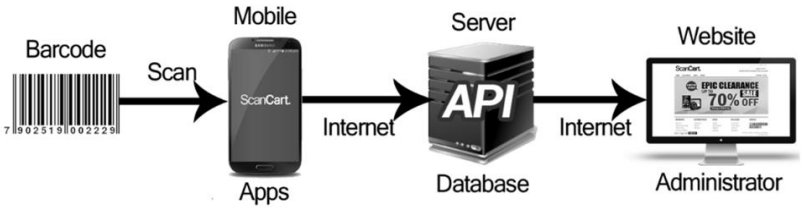


Fig. 2 - Project Block Diagram

In this work, Android barcode scanner application was designed using Android Studio, as shown in flowchart as in Figure 3. Once the application started, the start screen with ScanCart logo was popup. Thus, the login page with credentials field has been displayed on screen. All credentials are required, or else system will display wrong password, username or domain. Moreover this system work best with internet connection, otherwise the no internet connection information will be displayed.

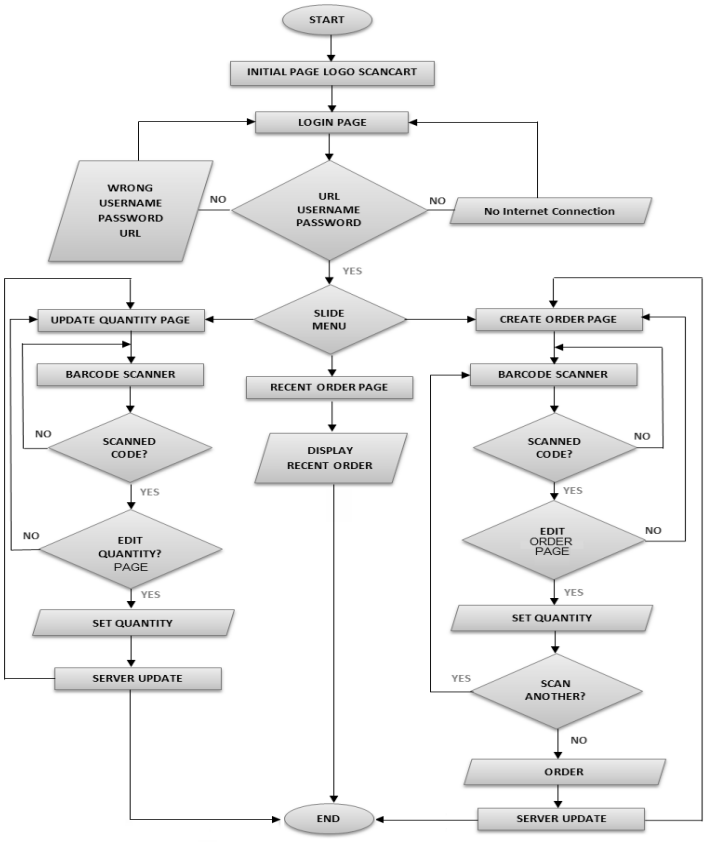


Fig. 3 - Flowchart of Android Barcode Scanner

4. Results and Discussion

ScanCart is a brand named for this application, comes with three features which are updating quantity, create order, and recent orders. Updating quantity is the main feature while create order and recent order are an additional features. Internet connection is required to ensure system can be operated, due to the data is stored in server database. User credentials can be create by the administrator of the website backend. Figure 4 shows the developed of initial start-up application, login page and main menu.

Fig. 4 - (a) Initial start-up application; (b) login page and; (c) main menu

Update quantity page is very crucial in order to show the current quantities and it also can be used to add or deduct the quantity from the database. By using the barcode scanner, EAN-13 Code format was scanned, and the information of barcode been stored in the database to retrieve and edit the quantity value. The step-by-step process flow is shown as in Figure 5, which are; (a) ScanCart application page, (b) Android barcode scanner application to scan the barcode, (c) key in the quantity of order, (d) by clicking the OK button, order are added to the chart, (e) chart view of order, and (f) order was successfully recorded.

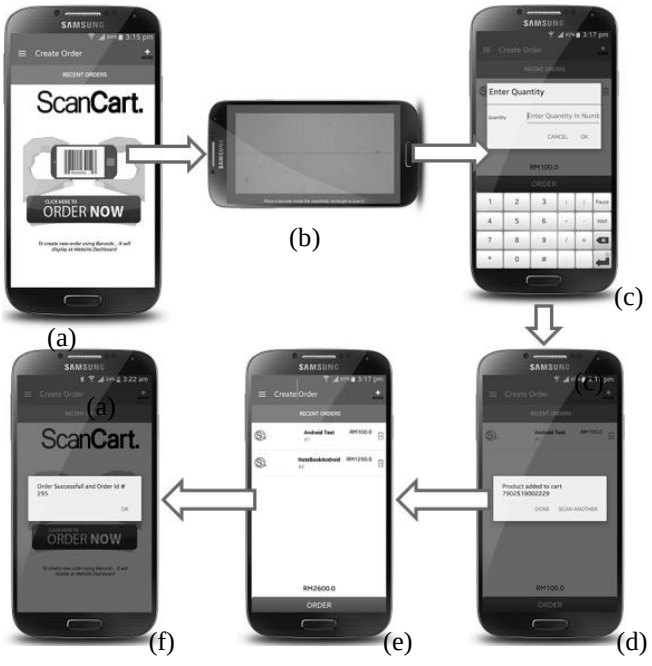


Fig. 5 - Step-by-Step of Order Process

The performance of Android application has been tested using Samsung S4 with Android Lollipop (5.0.1) OS, and Nexus 5 with Android Marshmallow (6.0.1) OS. All performance test was done by running the application operation for approximately three hours. The test are consist of battery consumption, RAM/ROM usage, data usage and connectivity between Android application and server. The result of this test showed that the performances of this application is in good condition with great battery consumption and minimal RAM and ROM usage. Table 1 summaries the performance comparison between this two devices.

Table 1 - Comparison Galaxy S4 and Nexus 5 for application performance

Samsung Galaxy S4				**Nexus 5**			
RAM	ROM	Battery	Data	RAM	ROM	Battery	Data
27.40 MB	13.77 MB	0.2 %	341 KB	31.99 MB	14.55 MB	0.3 %	60 KB

This system successful connected and communicated with website backend, website frontend and database. Frontend was designed using minimalist due to market demand for E-commerce. Figure 6 show the frontend page of website that consists of slideshow, wording and icons.

Fig. 6 - Frontend Website

While, Figure 7 shows the category section for product that has been selected as category 'Baru'. The minimalist website is the best as it helps customer to understand the concept of the webpage. The backend website is used purposely for administrator to manage the system. This backend consist of user administrator account, sales, statistics, track customer information, product information, customize the structure of the web and manage payment, as in Figure 8.

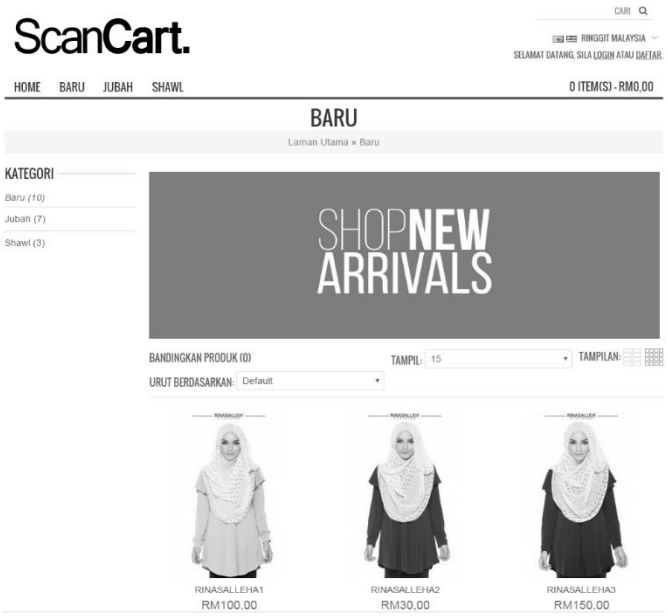


Fig. 7 - Category Section

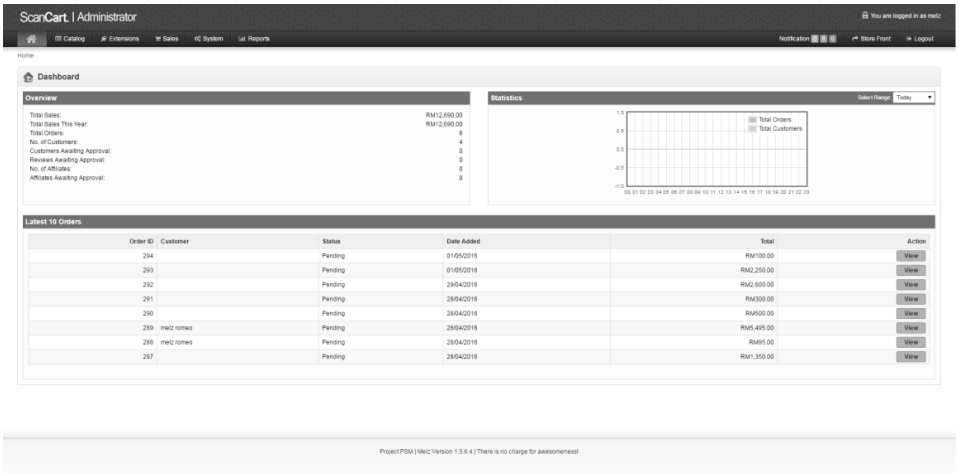


Fig. 8 - Backend Page

The database are visualized by using phpMyAdmin. This user interface display the table of database that has been created at website backend. Figure 9 shows the registered content for database table of product.

Another important factor in order to improve the quality of product or businesses, is the user and customer feedbacks. Therefore, three main points of feedback have been assessed which are design and user interface, system functionality and satisfaction. The respondent feedbacks are summaries as in Table 2. Based on the feedback analysis, the developed system is consider meet the user and customer requirement, with positive recommendation for features improvement.

	product_id	model	ean	quantity	price
Edit Copy Delete	70	Naerlofa2	9556135152165	15	95.0000
Edit Copy Delete	71	Naerlofa03	2356135152328	99	90.0000
Edit Copy Delete	58	RinasallehA1	7902519002229	150	100.0000
Edit Copy Delete	59	RINA3	8902519009784	27	150.0000
Edit Copy Delete	60	12345	1234567891023	22	111.0000
Edit Copy Delete	61	RINA2	5287039873026	29	30.0000
Edit Copy Delete	62	RinasallehA6	9876543210128	50	30.0000
Edit Copy Delete	67	BotolDesa	9556135185002	25	2.0000
Edit Copy Delete	69	Naelofar01	9556135132525	115	90.0000
Edit Copy Delete	53	1234	3702519002229	50	22.0000
Edit Copy Delete	54	ABCFGH	9550631080816	100	99.0000
Edit Copy Delete	55	45454	2902519002224	40	69.0000
Edit Copy Delete	56	232232	5944519002221	25	35.0000
Edit Copy Delete	57	12345	1902519002225	20	22.0000
Edit Copy Delete	52	ABC123	8302519002226	49	180.0000

Fig. 9 - Database Table view

Table 2 - User and Customer Feedback in Percentage (%)

Criteria	Good (5)	Above Average (4)	Average (3)	Below Average (2)	Poor (1)
Installation Process	17	50	33	0	0
User Friendly	41	35	24	0	0
Design Features	37	38	25	0	0
System Performance	55	36	9	0	0
System productivity	50	30	20	0	0

5. Conclusion

As a conclusion, this ScanCart, integrated Android barcode scanner with E-commerce system and database was successfully tested and verified by entrepreneurs, founder and industry; which are Rinasalleh boutique founder and their co-founder, BellamAmmara, Hijriahome and CloudHouze founder, Manager from Koperasi University Tun Hussein Onn Malaysia (UTHM) and Melaka ICT Holding Sdn. Bhd. (MICTH) with positive results in term of functionality, feedback, and integration.

Based on survey feedback and comment, we believed, this system are useful for Small-Medium Enterprise (SME) to enhance their productivity and update their stock inventory easily. Hopefully, this system is able to be upgrade and commercialize in future.

References

1. H. Pieterse and M.S. Olivier, “Android Botnets on the Rise: Trends and Characteristics”, Information Security for South Africa (ISSA), pp. 1-5, 2012.
2. Igor Pihir, Valentina Pihir and Stjepan Vida, “Improvement of Warehouse Operations through Implementation of Mobile Barcode Systems Aimed at Advancing Sales Process”, Information Technology Interfaces (ITI), pp. 433-438, 2011.
3. K.Wang, Y. Zou, and H. Wang, “1D bar code reading on camera phones”, International Journal of Image and Graphics, vol. 7, no. 3, pp. 529-550, 2007.
4. S. Tony, “Bar codes Sweep The world”, Invention & Technology Magazine, vol. 8, no. 4, 1993.
5. D. Sharma, V. Sharma, B. Shrivastava, R. Kumar and P. Sharma, “Regulatory Aspect Of Barcode Technology”, Asian Journal Of Pharmaceutical Sciences And Research, vol. 1, no. 4, Sep 2011.
6. W. Kent, “Understanding and Obtaining a Universal Product Code”, Center for Agribusiness and Economic Development, 2013.
7. Gowtham M N, Kanchana, “Generating EAN-13 Standard Barcodes”, International Journal of Science and Research, 2012.
8. Philip Bradley, “Book numbering: the importance of the ISBN”, The Indexer, vol. 18, April 1992.
9. Silberschatz-Korth-Sudarshan.,“Database System Concepts”, Fourth Edition, The McGraw-Hill Inc. 2001
10. Powell, Gavin., “Beginning Database Design”, Wiley Publishing, Inc, 2006
11. S. Sumathi, and S. Esakkirajan, “Fundamentals of Relational Database Management Systems”, Publisher: Springer-Verlag Berlin Heidelberg, 2007.

Barcode Document Tracking System

Soon Jian Cheng[1], Abd Kadir Mahamad[1*], Sharifah Saon[1], Mohd Anuaruddin Ahmadon[2] and Shingo Yamaguchi[2]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA

[2]Graduate School of Science and Technology for Innovation,
Yamaguchi University, JAPAN
kadir@uthm.edu.my

1. Introduction

In the era of bombastic technology, our world is occupied with electronic devices. Most of the manual system has been replaced by electronic systems. This can reduce the usage of time, cost and increase the efficiency of the system. Barcode technology is one of the automatic identification and data collection (AIDC) technology that introduce to reduce human error, and reduce time and labor by replacing manual method of data entry and data collection. Barcode technology is allowed to collect real time data with more accurate and faster. Barcode technology consist of the barcode and barcode reader. The combination of barcode technology with computer, database and some of the application software can increase the performance, efficiency and the productivity [1].

Documents are knows as the information carriers of a company. It is the important assets for a company. Therefore a good document management system is required implement in a company. By using the traditional method and physical standard way to manage, keep and transfer their document file may cause energy and time wasting, misplacing of file and sometime even loss of them. This is because the employee needs to move from one department to another department in order to find their file. This will influence the efficiency of the company. Electronic document management system is one of the popular document management system recently use in most organizer. It purposes is to store document, track document and reduce paper. According to Bo-Christer Björk (2002) [2] the electronic document management system is using a server connect to the database system that able to store the information of the document. The drawbacks of this type of system are hard to get the current status of document, information of the document need to type manually in the database and easily get type wrong information into the system. Therefore a document tracking system is needed to improve the registered, retrieved, preserved, and tracing the path of the document [3].

The traditional document management system is recorded the information into the logbook manually. This method tend to waste time and have the probability error occur when record the information. This method is not efficient and not suitable for a large company which has many documents. Therefore the barcode document tracking system is introduce to solve the problem occur by using the manual system. For every new coming document, barcode with the information of the document such as document ID, subject name, and date receive, is generated by admin and recorded into the database. While the document is passing to other department, admin of the department only need to using Android apps to scan the barcode and insert department name in the space “Department received” and click submit, thus data automatic inserted into database [4].

The main purpose of this project is to improve the document management and tracking system. For manual systems, it takes quite long time to record the information of the document and get the current status of document. Therefore, this project aims to improve the efficient of the document management system and the users can obtain document flow information by checking information through the website.

The target of this project is to implement a suitable document tracking system that can help every company and organization manage their document. This project also target to use minimal cost to produce a suitable and efficiency system. By considering the security issues, users are compulsory to register before granted to access to the database. There are two types of users for this system which are administrator (admin) and users. Besides, this system also targets the barcode reader able work well with the database.

2. System Development

This system is divided into two categories which are website application and android barcode scanner. Figure 1 shows the project development process flow.

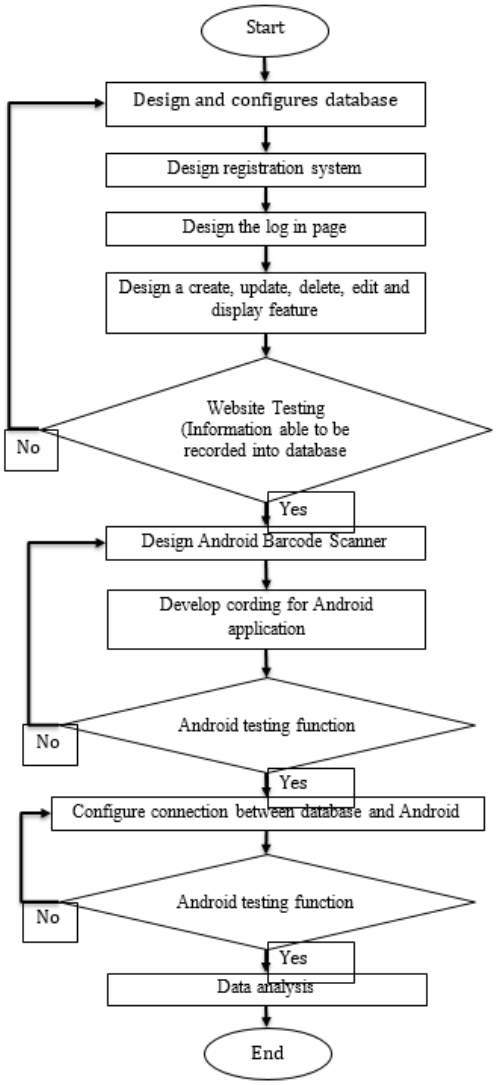


Fig. 1 - Project development process flow

2.1 Database Configuration

Database for this system is developed using MySQL, for storing the users and document information. Figure 2 shows the database configuration.

Database Tables				
Field	Type	Null	Extra	Links
Users				
Id	Int	No	Auto increment	
Username	Varchar	No		
Password	Varchar	No		
User_type	Varchar	No		
Tbl_users				
Id	Int	No	Auto increment	
Code	Varchar	No		
Subject	Varchar	No		
Date	Varchar	No		
Department	Varchar	No		
Barcode picture	Varchar	No		

Fig. 2 - Database Configuration

2.2 Website Design

Adobe Dreamweaver is used to design the website of document tracking system. 000Webhost is a free web hosting that allows uploading PHP code file and containing a MySQL database. There are some limitations and features for the free hosting. For examples, the size of the disc space is 1GB; size of the bandwidth is 10GB, 2 MySQL database allowed, 5 email forwarders, 2 website, website builder, free domain hosting, sleep 1 hour per day, FTP support, and web file managers. Next, this system is designed with multiple login system that divided into two categories which are normal users and admin users. There are different feature between the users and admin account. Table 1 shows the different between normal and admin users.

Table 1 - Different between users and admin

Function	Users	Admin
Login into system to view document status	Able	Able
Create new admin user	Unable	Able
Insert new document	Unable	Able
Edit document	Unable	Able
Delete document	Unable	Able

2.3 Design Barcode Scanner with MIT Apps Inventor

MIT Apps inventor is a platform that allowed the user to design and develop Android application for Android phone using web browser and either connected phone and emulator. This project work with the MIT app inventor for barcode scanner app development, in order to scan barcode of the document and insert data into the database. Next, users also able to search document information from database by scanning the barcode of document through this app. While the barcode button is pressed, camera is activated to scan the barcode. Then, the apps allow users to key in the data and store the data into the database. The App Inventor serves to store work and helps developer to keep track of project as shown in Figure 3.

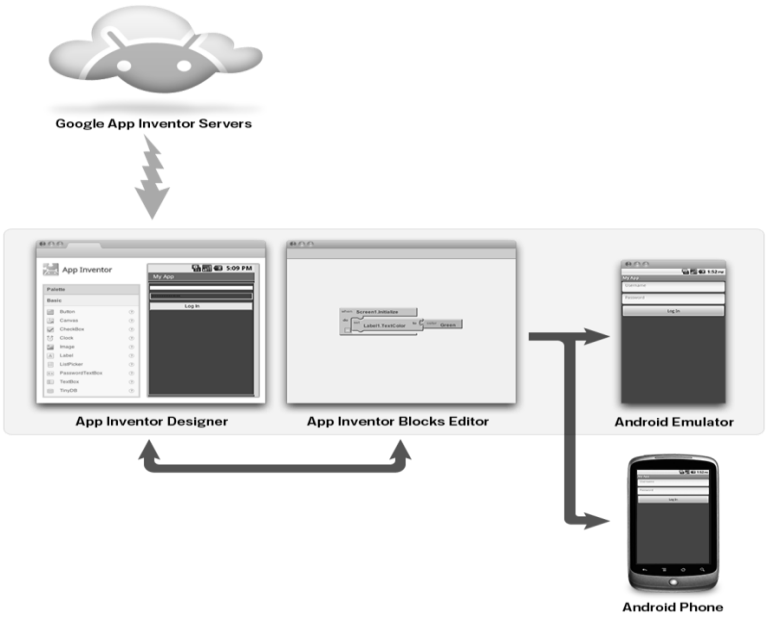


Fig. 3 - Process of MIT App Inventor

3. Results

There are two types of account which are admin and user with different function and features. The admin users able to insert new document information, edit and delete document information, and create new admin user while the normal users are only able to view the document information. Figure 4 and 5 shows the interaction diagram of login system and registration system flow.

The different between the users page and the admin page are, user page only allowed to view the document information in system while for admin page it is allowed to add new document, edit document, and delete document information. Figure 6 and Figure 7 show the user page and admin page.

Login System Flow

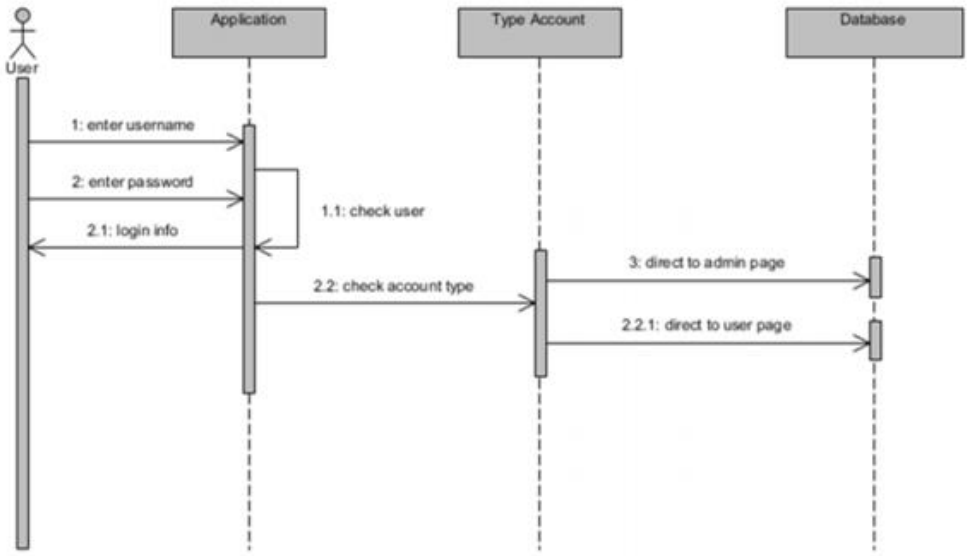


Fig. 4 - Login system flow

Register System Flow

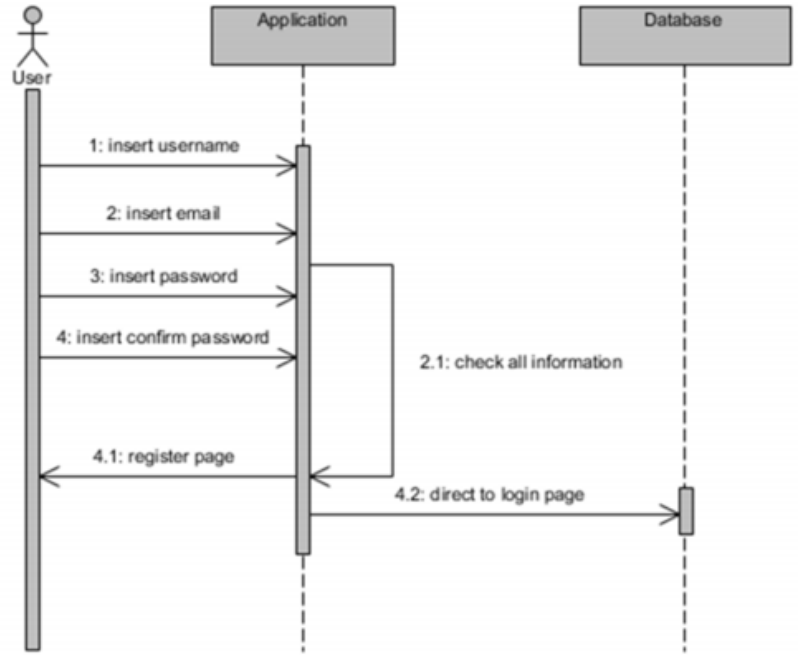


Fig. 5 - Registration system flows

Document list

ID	code	subject	date	department	barcode	Action
1	01/6-4/4/4J1(01)	PERTANDINGAN ZON SELATAN INNOVATE MALAYSIA DESIGN	11/9/2017	FKEE		
2	01/6-12/3/7J3(2)	Zero Draft Resmue	15 Mac 2018	FKEE		
3	01/6-12/3/7J4(1)	Ace Your Interview	4/19/2018	FKEE		
4	01/6-12/3/7J2(5)	Makan Malam Final Batch	5/4/2018	FKEE		
5	01/6-12/3/2J4(5)	Mock Interview	12/4/2018	FKEE		

Fig. 6 - Users page

Document list + Add New + add user

ID	code	subject	date	department	barcode	Action
1	01/6-4/4/4J1(01)	PERTANDINGAN ZON SELATAN INNOVATE MALAYSIA DESIGN	11/9/2017	FKEE		Edit Delete
2	01/6-12/3/7J3(2)	Zero Draft Resmue	15 Mac 2018	FKEE		Edit Delete
3	01/6-12/3/7J4(1)	Ace Your Interview	4/19/2018	FKEE		Edit Delete
4	01/6-12/3/7J2(5)	Makan Malam Final Batch	5/4/2018	FKEE		Edit Delete
5	01/6-12/3/2J4(5)	Mock Interview	12/4/2018	FKEE		Edit Delete

Fig. 7 - Admin page

Admin pages of document tracking system contains few features that are able to make system more efficient. The first feature is inserting new document information into the system. Admin are able to add the new document information by click on add new button on the top of insert page, as shown as in Figure 8. It will redirect to the index page once all the information inserted. Information that able to add into database are document ID, subject name, and date of document. Each involved department receives document and picture of barcode document. The maximum size of picture upload into database is 5MB while the maximum character is set to 50 characters.

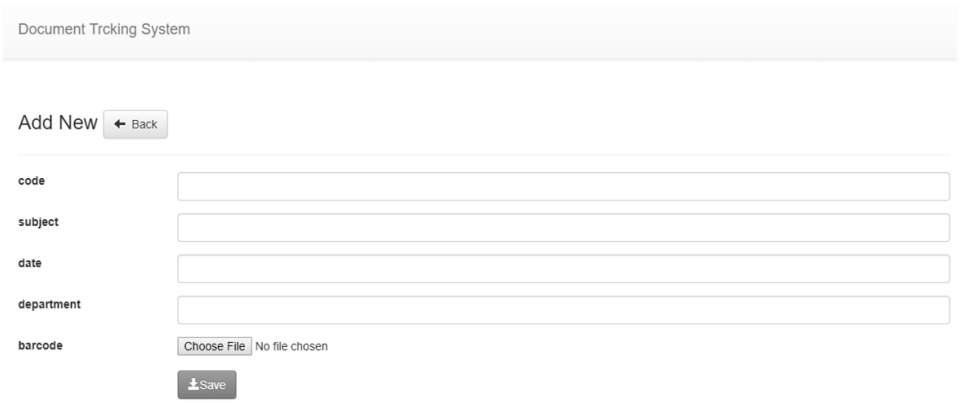


Fig. 8 - Add page system

Second feature is to create a new admin users by clicking the add users button, and admin user is directed to the admin registration for future action. The information of users are recorded into the database users table and the user type is mentioned as admin. While, edit button in the action column is allowing the users to update information of document. By clicking the edit button, admin is directed to the edit page and admin able to change and update information. Figure 9 shows the edit page of the system. Next the delete button is used to delete the unwanted document and log out button is return back to the login page.

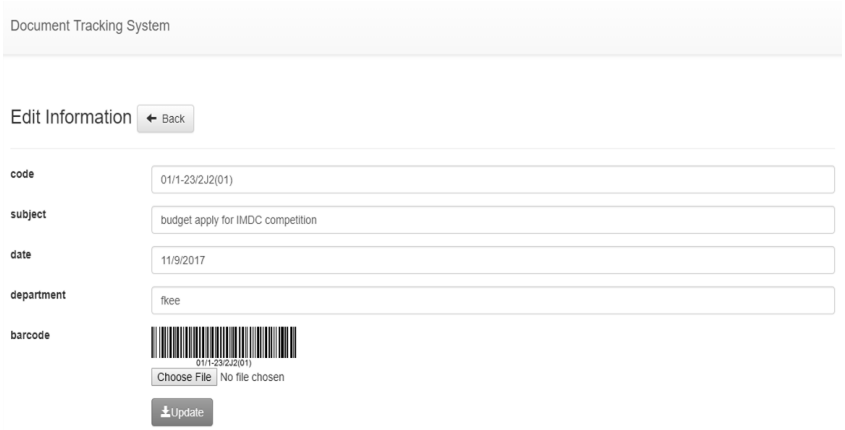


Fig. 9 - Edit page system

Comply with this system, mobile application is developed to ease the used of the system known as ScanTrack. ScanTrack is an Android app that design for the document tracking system. It is provided with three main features, which are barcode scanner, update current information of document and search or track the document information. The design of application icon is shown as in Figure 10. This icon appeared in the Android device once the apk file is installed. Figure 11 shows the initial start-up screen and login screen of this application. MIT App Inventor was used for designing this application [5].

The credentials of this application are register from the register page of this application. This system will compare the user's information with the database in the system. If the information is match then users are able access to this application, otherwise an error message will appear to alert the users. Internet connection is important in this page because it need to communicate with database. PHP file that connect between this application and system database is "lognew.php". There are two type of notification to alert the users. Table 2 shows the explanation of alert system.

Fig. 10 - Application icon

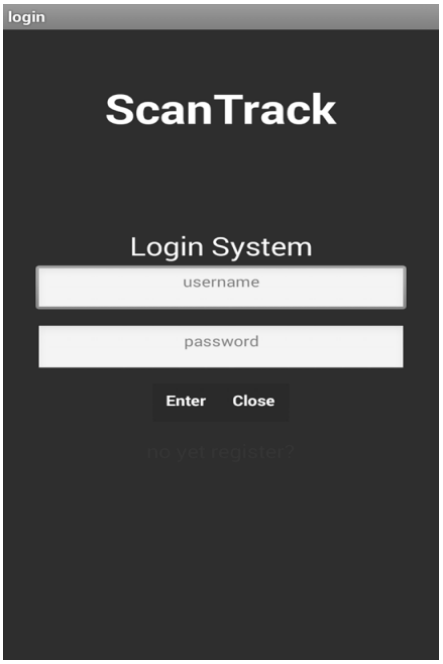


Fig. 11 - Initial start-up application and login system

Table 2 - Notification and explanation error of login page

Alert Notification	Explanation
Please fill	This alert when the username and password is empty
Wrong	This alert when the username or password is wrong

ScanTrack registration page used to register the user's information into database. Users who wish to access in this app need register by filling their information. The information required to register is their department name (use for username), email address, and password. All the information is recorded into the database users table. The PHP file that connects to this application with the system database is "registnew.php". Figure 12 shows the registration page of this application. There are four notifications in this system in order to alert users. The explanation of notification explained in Table 3.

Fig. 12 - Registration System

Table 3 - Notification and explain error of registration system

Notification	Explanation
Please fill in	Department name is empty
Please write email	Email is empty
Password dint match	Password do not match between two text box
Register success	Register success

Updating document information page used by users to update the information of document. This application is design for the admin of every department to inform the document tracking system when they received document by scanning the barcode of document and update to the system. This system include barcode scanner that able to scan the document barcode and insert the code into the code text box. Next, the department text box is auto fill with the username that the user use to login into system. The date received document text box is able to set by the date picker. When the date is pick it is write into the date text box. After all the information required is fill the button update is responsible update the information to the database. PHP file use to control this function to "submit.php". Search button is direct to the search page. There are four alert notification shows in Table 4 and Figure 13 shows the step updating document information page.

Table 4 - Notification and explain error of updating information page

Notification	Explanation
Please scan your code	Code text box is empty
Please write date	Date text box is empty
Please write department	Department text box is empty
Info success	Data is upload successfully into database

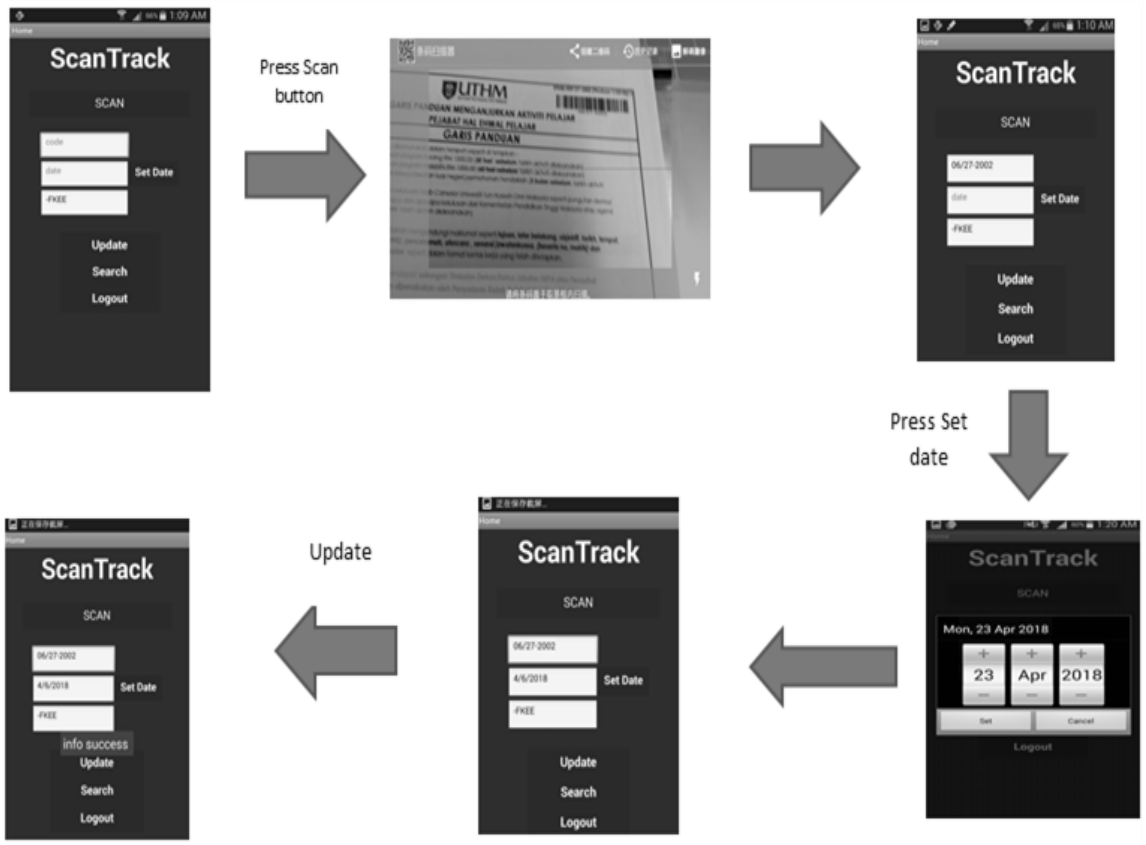


Fig. 13 - Step to update information

Searching page used by user to track the current location and condition of document. The feature design to this page is barcode scanner and the list view. Barcode scanner is use to scan the code of document required to search and insert into the empty textbox. When the search button is clicked all of the document information with the same code is listing in the list view form. Therefore, users able to know the latest location of document and track the whole life cycle movement of the file. The PHP code that use to fetch the information from database to this application is "json.php". The alert notification "no result" will prompt out when the code search is not record in database. Figure 14 shows the steps of searching document.

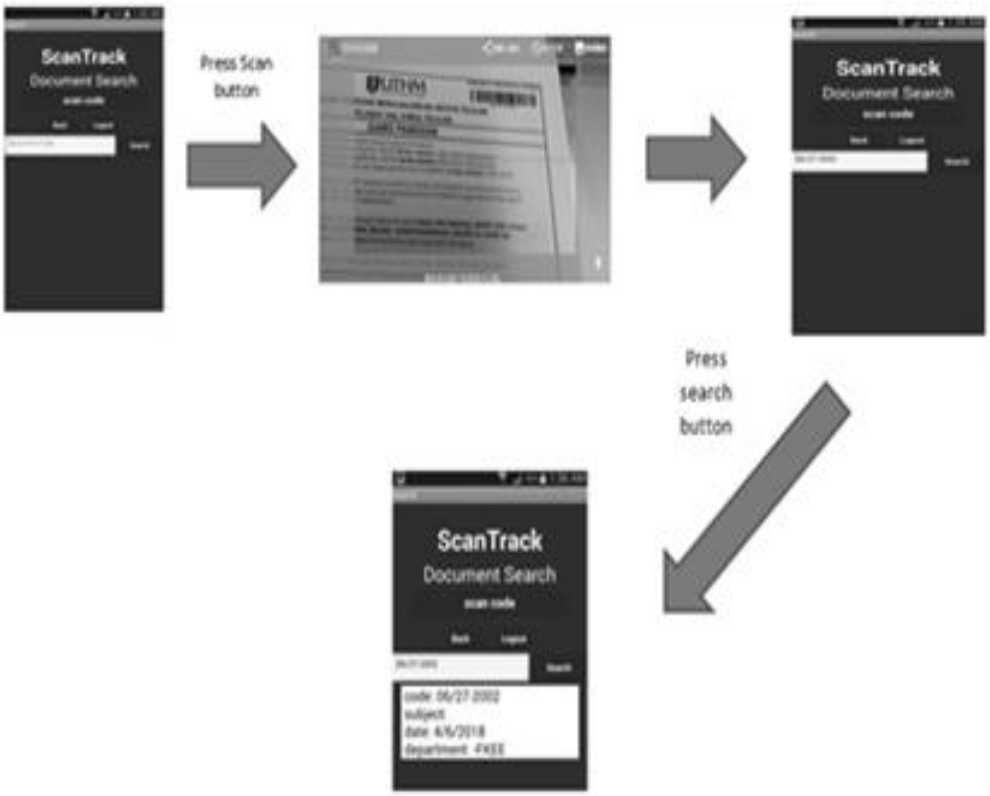


Fig. 14 - Steps of searching document

4. Conclusion

There are two important part include in Barcode Document Tracking System which are website system and Android app with a brand name ScanTrack. The website system is designed with multiple login system. This means that this system have different main pages for different users type. There are two users type in this system which is users and admin. The purpose of this system is considered with the security issues. This is because; they have different right between the admin and users. Admin able to do everything on the system such as manage database, add new document into system database, edit document information, and delete document information whereas for the user type account they can only login into system for viewing purpose only. This feature is to prevent other users to change document Information from system. This feature able to protect the confidential and security of document information that only allows admin to manage information of document in the system.

ScanTrack is an Android apps design for every department admin. Each department admin will receive an apk file to let them installed in their Android device. The function of this app is for every department to scan the barcode and update to the system to inform system that this file is already received by this department. This function able reduces time consuming for record the document information into log book. Besides, it able prevents and reduce human error mistake. This app improves the communication between the sender department and receiver department.

Sender department are easily to know the condition of document after they send to other department when the receiver company scan the barcode and update information into the system. Beside, this app also opens for students apply to track their document. This app has a searching feature by using barcode scanner. Searching page contain barcode scanner feature to scan the document code they want to search. After that, all information relates the code use for search is display on Android device. Hence, objective "to develop system that allow user track the whole life cycle of movement of the file" is successful achieve because users able to view the flow of document from this app.

This system also focuses on the safety and security issues. Users who wish to access into the system and Android app need to register their information first on the registration system. All the information of users is record into the database and manages by admin. For admin account it can only create by the previously admin users only. This is to prevent other user access to the system without authorisation and protect the information of document being exposing to the world. Next, password access to the system database only provides to database admin.

References

1. G. Singh, and M. Sharma, "Barcode technology and its application in libraries and Information centers," International Journal of Next Generation Library and Technologies, Vol. 1, No. 1, pp. 1-8.
2. Bo-Christer Björk. "The Impact of Electronic Document Management on Construction Information Management," Swedish School of Economics and Business Administration. 2002
3. R. Demong, L.F. Abu Hassan, T.B.H. Tuan Besar, and Z. Zulkifli, "Electronic Document Tracking System (EDTS): A Prototype," In the Lecture Notes in Computer Science book series, Springer-Verlag Berlin Heidelberg, Vol. 5617, pp. 375–383, 2009.
4. N. Wartenberg and S. Snyder, "Introduction to Bar Codes for the Automated Laboratory," Journal of Laboratory Automation, Vol. 8, No. 5, pp. 51-58, 2003
5. J. Benedict, L. Bernardo, and D.anica Pacana, "A Barcode Scanner Application Framework Using Android Phones for an Enhanced Shopping Experience," International Journal of Applied Engineering Research, Vol. 11, No. 23, pp. 11250-11258, 2016

An Early Warning Elephant Intrusion Integrated with IoT

Mohd Zulhafizie[1] and Fauziahanim Che Seman[1*]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
fauziahs@uthm.edu.my

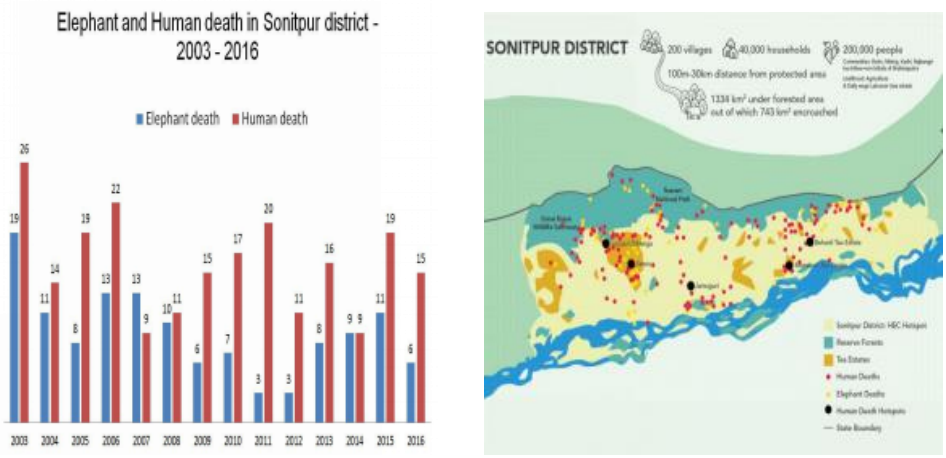
1. Introduction

Human–animal conflict (HEC) is one of the main issue in the forest border areas where herds of wild elephants straying into human habitation. Another issues is that the elephant start to raid the villager's plantation. The main idea of this project is to design a prototype of an early warning detection and prevention system that prevent elephant intrusion at the same time alerts the villagers. The system also be able to integrate with Internet of Things (IoT). In this proposed system, a Passive Infrared (PIR) sensor or motion detection sensor being used to capture the movement of the elephant. The prevention mechanism is conducted by Arduino Uno R3 ATMega328P as microcontroller and later communicate with the other microcontroller via nRf2401 modules. The system is connected with cloud database using Favoriot platform. The platform communicate with Arduino Uno ATMega328P via NodeMCU ESP8266 Wi-Fi to obtain the Wi-Fi signal for uploading the data of intrusion events. The average of uploading time for the data for Favoriot platform is within 10 seconds until 15 seconds. The systems able to alerts the local villagers and triggers prevention mechanism at the same time when the elephant intrusion event occurs. The data intrusions is uploaded to Favoriot platform on regular bases and specifically extract the data making into real time analysis.

2. Recent Incidents of Elephant Intrusion Worldwide

According to paper [1] there are only 50 countries in the world that can be considered as natural habitats for wild elephants. From that, only 13 of these countries are in Asia while rest are from the African continent. As for today, only a total of 51,000 to 66,000 elephants are living in Asia, and of these elephants only 35,000 to 50,000 are living in their natural habitats [2].

In the worldwide, the North-East India shows the highest human-elephant conflict (HEC). The particular area that hot in elephant intrusion is Sonitpur District in Assam province. The statistics in Figure 1 (a) shows the elephant and human death in Sonitpur District during (2003–2016) with the highest human loss is 26 people and elephant loss is 19. Figure 1 show the map of Sonitpur District with the region of hotspot of HEC conflict occurs. This conflict most occur at night and usually September to February coinciding with the cropping cycle when elephants are often attracted to the fresh paddy.



(a) (b)

Fig. 1 - (a) Elephant and human deaths in; (b) the map of Sonitpur District Sonipur District [3]

As in Figure 1, the bar chart tends to fluctuate from year to year which mean the conflict still not have a right solution. In the following year, the number of victims from this conflict may increase. Therefore, early detection of elephants can prevent surprise encounters and give people more time to choose the best response to prevent escalation into conflict.

3. Development of the Elephant Intrusion System

The key success of the system is based on sensorial parts and the networks. M. S. Nakandala et al. [2] proposed an early warning system which can act as a virtual barrier covering elephant corridors or villages which consists of PIC microcontroller, Infra-red (IR) sensors, Passive Infra-red (PIR) sensors and wireless communication module. The basic detection is explained which when the both IR and PIR sensor triggered simultaneously then warning signal is send. For the sending the warning, the system using a GSM modem as this necessary and important to alert all the people in the village. In this study, the main sensor is Passive Infrared (PIR) sensor and the system using the wireless network which related to this project. Ms. Gayathri. R et al. [4] presented an automated system for identification of elephant where the system consists of three consecutive layers and by using piezoelectric vibrating sensor, the sensor is sensed the vibration created when obstacles or elephants enter as shown in Figure 2.

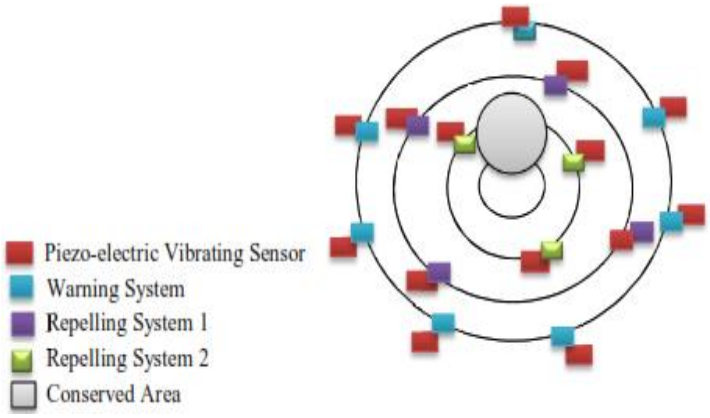


Fig. 2 - Sensor deployment [4]

Inspired by this work, here the proposed system will be using the same modus operation which consists of consecutive of layers. This layers acts as the virtual barriers covering the border of the plantations. E. Kanniga et al. [5] presented an enhanced target detection and classification performance by fusion of seismic and PIR sensor signals. This system presents a fusion of seismic and PIR sensor which shows the PIR sensor can give more credibility in detection system. Therefore, this give more reasons to select the PIR sensor as main sensor in this project.

The previous works focus on the network system and the sensorial approach while provide the alternatives for the elephant intrusion detection system. From there, it was decided to use PIR sensor and multilayer sensor as virtual barriers in this project. Fig. 3 shows the architecture of proposed system. This project is developed with wireless network system which the data information may be uploaded into Internet of Things (IoT) platform and the platform is able to alert the local villagers by sending the notification. From the data uploaded, the IoT platform can bring the analysis results as reference in the future.

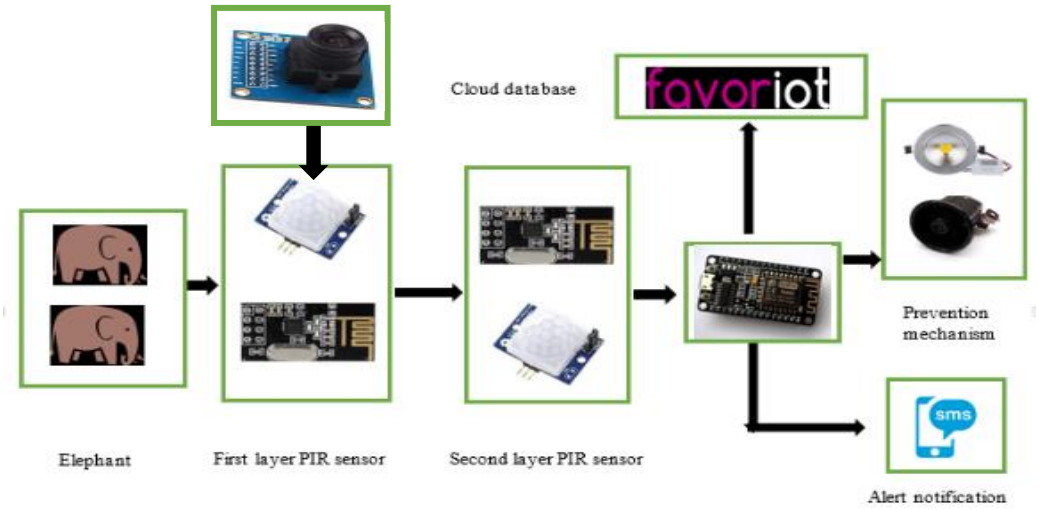


Fig. 3 - Illustration of overall flow of the system

4. Realisation of the Prototype

The prototype have two parts which is first layer and second layer detection sensor. Figure 4 shows the setup of the prototype. The first layer of detection sensor is connected with the second layer via nRF24L01 modules that communicate using radio frequency (RF). The Internet of Things (IoT) which Favoriot platform is communicated with the prototype using NodeMCU ESP8266 Wifi board. To monitor the connection between the first and second layer, the prototype is connected to the computer. The prototype has been testing in the outdoor location at Lorong Baitul Manisah in Parit Bengkok's area. The prototype is installed at the parking's pillar to act as the tree because it more convenient to see the prototype working properly. Figure 5 shows the first and second layer of the detection system are installed at the pillars. While, Figure 6 shows the both layer of the detection system.

Fig. 4 - The setup of the prototype

(a) (b)

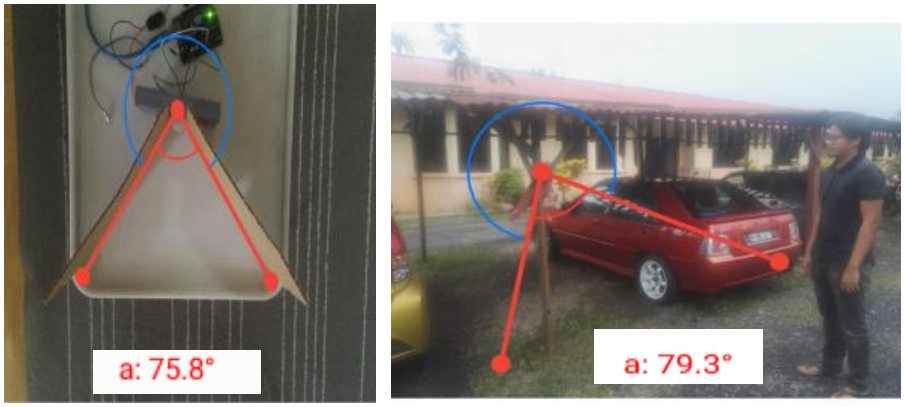
Fig. 5 - (a) First layer of detection system; (b) second layer of detection system

Fig. 6 - Both of layer in detection system

The system is conducted by using a person to walk beside the first layer until the second layer to see the working prototype. This is to indicate when the elephant passing by the system. The camera module is ready to capture any images of the passing intruders. When the first layer detect the motion, the message is sending to the second layer for ready and light up the first defense mechanism which is spotlight or lamp. For the intrusion happened, the elephant need to pass the second layer as the motion sensor ready. As the person walk through, the second layer detect the motion and this trigger the second defense mechanism which is an alarm. In the same time, the alert warning is sending to the villagers and data of intrusion is uploaded to the Favoriot platform via NodeMCU ESP8266 wifi board. The alert sending to the villagers using email. From the platform, data analysis are recorded and discussed.

5. Performance of the System

The angle of beam from the PIR sensor is analyzed. From the datasheet, angle from the top view for the sensor is 90° degrees. The indoor and outdoor testing for the actual angle is done by using mobile application which is Angulus. Figure 7 shows the indoor angle is 75.8° degrees while the outdoor angle is 79.3° degrees. From the both testing, the side range of sensor is less than the expecting angle of beam from the sensor which is 90° degrees. The sensitivity of the PIR sensor to detect an object movement which may represent an elephants is analyzed. It also absorved that the workability distance for the system is up to 5 meter. This distance can be increased if the sensitivity of the sensor is adjusted.



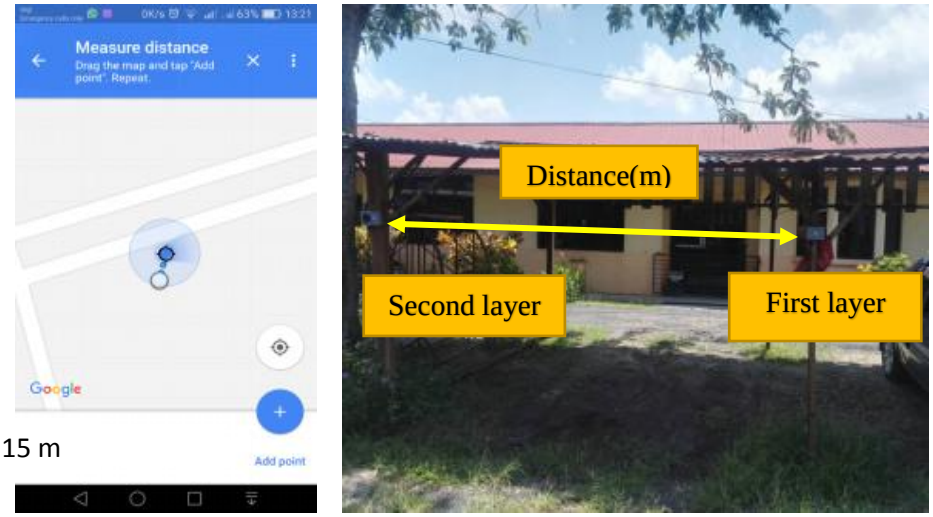
(a) (b)

Fig. 7 - (a) Indoor testing; (b) outdoor testing

The ability of the PIR sensor to detect a movement across the sensor is analysed. The speed is measured by time taken of average walking at constant distance. From here we may observe the slowest and the farthest movement the PIR sensor can detect. The average speed of the elephant walking is 0.8 m/s while average of human walking is 1.4 m/s. The testing shows the PIR sensor can detect a movement as slow as 0.33 m/s. The sensitivity of the PIR sensor can be adjusted using the potentiometer. An increased sensitivity can be beneficial for when using a PIR for long range detection, which up to 6 meters or more. While, the decreased sensitivity is good for a short range, as the half of the maximum range or up to 4 meters. This can be dependent on how the data taken and measured.

Based on the project application, the sensor sensivity is more suitable to be on the lower side because the speed of elephants in moderate speed. Therefore, the detection of elephant should be closer to the sensor as for the short range detection. If using the long range detection, it may indicate a false alarm.

The distance between the first layer and second layer is tested. This is to ensure the elephant intrusion to the plantation and avoid false alarm whereas only first layer detect motion but not the second layer. The alert be triggered after the both layer of sensor is detected the motion. This testing is done using line of sight (LOS) and obstructed sight between the first and second layer. The obstructed sight indicated the trees and by using application Maps, the distance can be measured and recorded. The starting point is located at 1.88453914, 103.0795110, Parit Bengkok as shown in Figure 8. It is shown that that the distance between the first and second layer of sensor can be achieved up to 18 m with line of sight (LOS) while obstructed sight is 15 m.

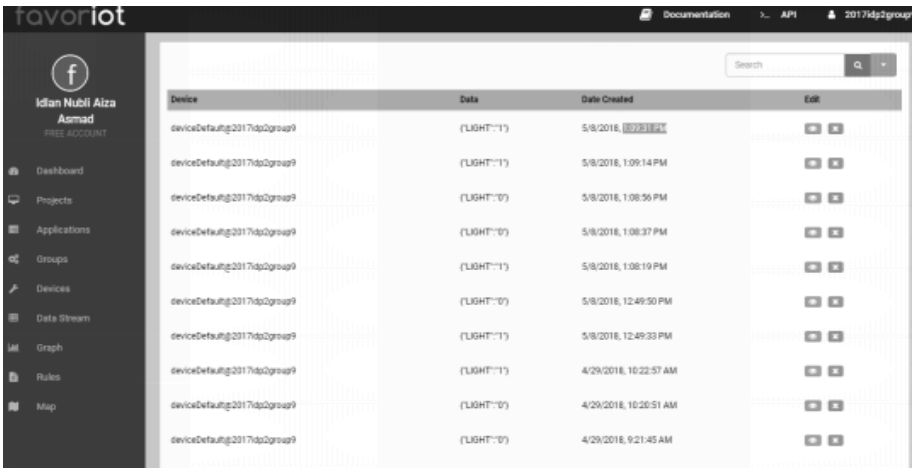


(a) (b)

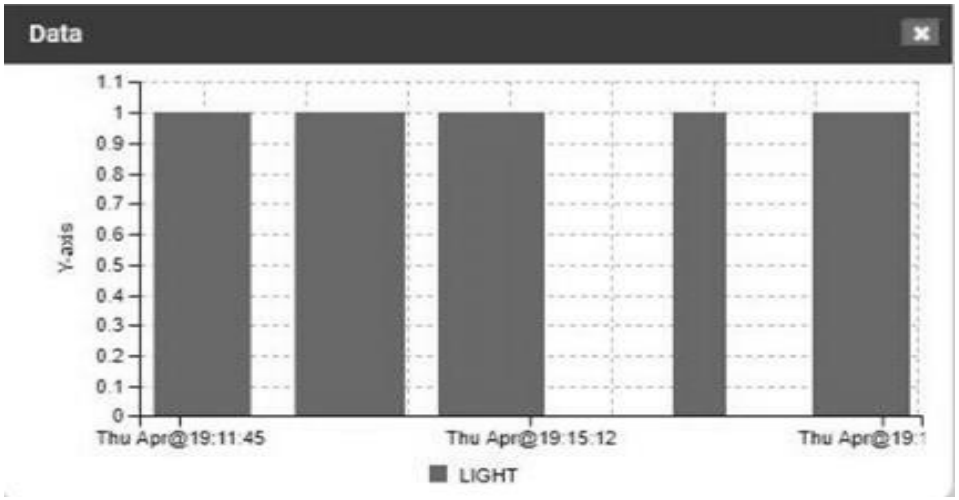
Fig. 8 - (a) Distance in Maps, and; (b) distance between the first layer and second layer

The captured images is taken by OV7670 camera module. The camera is able to capture and save the images into SD card. The restriction that occur is the camera module cannot able to send the images to the cloud platform which is Favoriot platform.

The data uploaded into Favoriot platform is taken and analyzed. For every motion detected and alert sending, the data is uploaded and analyzed into bar graph. This graph is detailed the data stream into the time of intrusion happened and the date which called real time data. The data from the graph can be analyzed into how the frequent of intrusion and hot areas where the intrusion occurs. Figure 9 shows data stream uploaded and bar graph in the Favoriot platform. From the Table 1, the date and time is recorded for the future analysis. It is observed that the time uploading to Favoriot platform may delay between 10-15 seconds. This time different does not affected the time for react to the intrusion.



(a)



(b)

Fig. 9 - (a) Data stream in Favoriot platform and; (b) bar graph in Favoriot platform

Table 1 - Recorded result of uploading time for Favoriot platform

No. of motion detect	Date	Time
1.	8/5/2018	1:09:31 pm
2.	8/5/2018	1:08:37 pm
3.	8/5/2018	12:49:50 pm
4.	29/4/2018	10:22:57 pm
5.	29/4/2018	10:20:51 pm
6.	29/4/2018	9:21:45 pm

6. Conclusion

From the results, it shows that an early warning elephant intrusion system integrated with internet of things (IoT) is successfully done. The system able to detect and react by using defense mechanism. Moreover, it is able to alert the villagers and keep the data of intrusion into Favoriot platform. The conclusion and recommendation of this project are discussed in detail for next chapter.

References

1. B. M. A. O. Perera, "The Human-Elephant Conflict: A Review of Current Status and Mitigation Methods," Gajah: Journal of the Iucn/Ssc Asian Elephant Specialist Group, vol. 30, pp. 41-52, 2009.
2. M. S. Nakandala, S. S. Namasivayam, D. P. Chandima “Detecting Wild Elephants via Wsn for Early Warning System” March 2015.
3. (N.D.). Retrieved from https://www.Wildlabs.Net/Hwc-Tech-Challenge-Elephant-Case.
4. Ms. Gayathri. R Dr. K. Sheela Sobana Rani, Ms. R. Lavanya, “An Automatic Repelling System to Reduce Human Elephants Conflicts using Sensors”, vol 5.V, May 2017.
5. E. Kanniga, K. Selva Rama Rathnam Ashish Kumar Yadav, “Wireless Based Target Detection and Object Identification using Seismic and Pir Sensors” Idosi Publications, 2014.

Flood Detection and Mitigition System Using SMS Notifications

Muhamad Nabil Asyraf Ghazali[1], Ansar Jamil[1*], Jiwa Abdullah[1], Lukman Hanif Muhammad Audah[1] and Rozlan Alias[1]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
ansar@uthm.edu.my

1. Introduction

The main causes of flood are hydrological condition, metrological condition, geographical condition, planning problem and environmental status due to human activity etc. [1]. Hydrological condition arises due to the discharge of heavy rain fall and the enormous water. The hydrological condition is directly and indirectly associated with the metrological condition such as heavy rainfall, cyclone and storm. The geographical condition is also a major factor for flooding condition, for example, altitude of the place. Lower is the altitude of a place; the water flows from the neighbouring higher altitude. The planning problem such as poor drainage, high siltation in river, breaching of the embankments, spilling of floodwaters over them, contribute to flooding situation. The environmental status due to human activity is a significant cause for flooding situation, for example, deforestation, different type of pollution and more buildings construction etc. [1]. Floods can have devastating consequences and can have effects on the economy, environment, and people. During floods (especially flash floods), roads, bridges, farms, houses and automobiles are destroyed. The environment also suffers when floods occurred [2].

Today many flood detection systems in rural area in Malaysia used the conventional way to predict the disaster; where the resident itself keeps watching water raises event near the river side. This action is too risky because the area near the river become dangerous for their safety, which can caused current water level data cannot be collected causing a delay in notifying all resident [3]. The existing flood detecting system just monitor water level for the main rivers but not providing an efficient alert system especially to the resident near the river.

2. Related Work

Jaymala Patil and Anuja Kulkarni [4] came with an idea to enhance safety of track over bridges against any unforeseen flash floods and breaches. The project used LPC 2148 Microcontroller as the controller, when it rise in water level will be sensed by the electromechanical float sensor and sends the signal provided to the Central Processing Unit (CPU). The project also included with GSM modem which turn to send Short Message Service (SMS) notification.

Danny Hughes and Phil Greenwood from Computing Department, Infolab21, Lancaster University [5] developed an intelligent and adaptable grid-based flood monitoring and warning system. In their project, they used Gridstix platform in order to describes a wireless sensor network (WSN) for flood warning which is not only capable of integrating with remote fixed-network grids for computationally-intensive flood modelling purposes, but it also capable of performing on-site flood modelling by organising itself as a ‘local grid’.

Nivethithaa.P and Karthiga S.R [6] from Krishnamy College of Engineering & Technology, Cuddalore, India comes out with the role of satellite Zigbee technology in flood monitoring and communication system. Zigbee is the latest wireless weather monitoring technique. The vital role of the designed satellite Zigbee technology in flood monitoring and communication sytem is based on mobile apps. The mobile apps is used to communicate with the people during flood times and is to continuously monitor, detect and report the environmental status to a control unit using water level sensor, satellite Zigbee and the readings are displayed in it.

Anthone et al. [7] has described about an alternative network as a substitute to the usual communication links which are unavailable during major disaster. They proposed an alternative network for maintaining communications capabilities during major natural disasters and other emergency situations by a system that utilizes Short Message Service (SMS) of length up to 7bits over Wireless Mesh Sensor Networks (WMSNs). This technique is relatively simple and inexpensive. Other related works on flood detection and mitigation system are described in Table 1.

Table 1 - Existing flood detection and monitoring system

Project	Description	Pros and Cons
Early Flood Detection System [8]	Power supply AC to DC (transformer) Electrode 8051 series microcontroller GSM module	Need AC power supply to turn on
Citizen Flood Detection Network [9]	Small battery (lithium 3.6v) Ultrasonic rangefinder Ciseco SRF shield deploys under bridge or overhang above water	Small batteries Includes temperature sensor
Automatic Flood Detection and Warning Device, a Prototype [10]	6 x 1.5 V battery Overhang above water	Does not emit smoke, burning smell or spark while being used Does not overheat The components of the device do not blow up or short circuit.
The ALERT121A [11]	Integrated battery bracket that can accommodate up to 24 hour of rechargeable battery Style stand pipe installations	Configurable as an alert transmitter and repeater Sealed, circular sensor connectors on lid of canister Modular mounting of components for easier field servicing and expansion.
Telemetry System [12]	AC power supply Telemetry system Integrated data logging system tipping bucket rain gauge Radar water level sensor Live data Bridge or overhead structure for securely mounting the radar sensor	Data updated 24 hour per day Real time data accessed Radar sensors maintenance free To ensure the sensor provide accurate data by visually checking the sensor and measurement beam using a portable distance sensor or nearby staff gauge.
Fujitsu Flood Detection [13]	Thermoelectric converter that transforms energy from fluctuations of the manhole cover's heat into electricity Thermoelectric converter Drainage pipes	Transmit water level info to the cloud every 5mins Extends the time between battery replacement to five years from 10 months
Smart Flood Warning System [14]	Bank of siren Scale pole Near the river	There were markings on the scale, but no indication as to which water level was the signal for precaution to be taken

Flood Protection Systems [15]	Long life battery Moisture Sensors are placed or installed in potential leak, overflow, or flood-risk locations throughout the home–this may be directly on the floor, in a cabinet beneath a sink or water heater, in the basement, or beside a bathtub. Once water is detected, the sensor sets off the alarm—likely a loud, audible sound and/or blinking light	Early detection of moisture, water leaks and flooding, which often go undetected for long periods. Protection against mold, which can be a serious health risk. Protection for elderly and children from falls caused by water leaks and overflows.
Flood Sensing Network by Arduino and WSN [16]	Powered by solar panel Arduino Uno R3 Xbee Near The River	Battery always rechargeable Only siren as alert warning Inexpensive Solar panel thus benefits villagers, because of a limited access to electricity.

3. System Design

This system consists of ultrasonic sensor (HC-SR04) as the water level detection. The Arduino UNO is selected as the system microcontroller and connected to the GSM modem. Both of the Arduino UNO and GSM modem supplied by a battery. The system intended are to provide information of the current water level status in the selected area and give an alert notification to the user if the water level rises that would cause a flood. This system is user friendly and be attained anywhere as long as mobile communication coverage is available. Figure 1 shows the block diagram of the system.

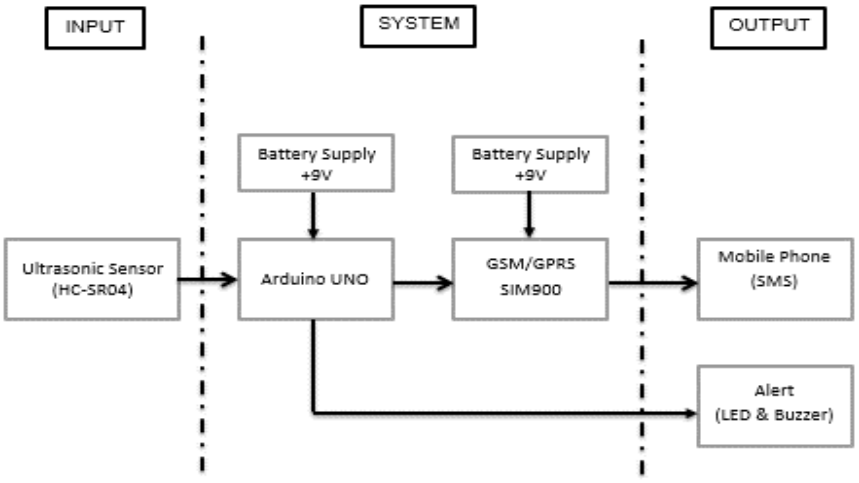


Fig. 1 - Block diagram of the system with GSM/GPRS module

Figure 2 shows deployment of the system to detect current water level of a river, drain, or etc. Table 2 indicate the parameters that being used.

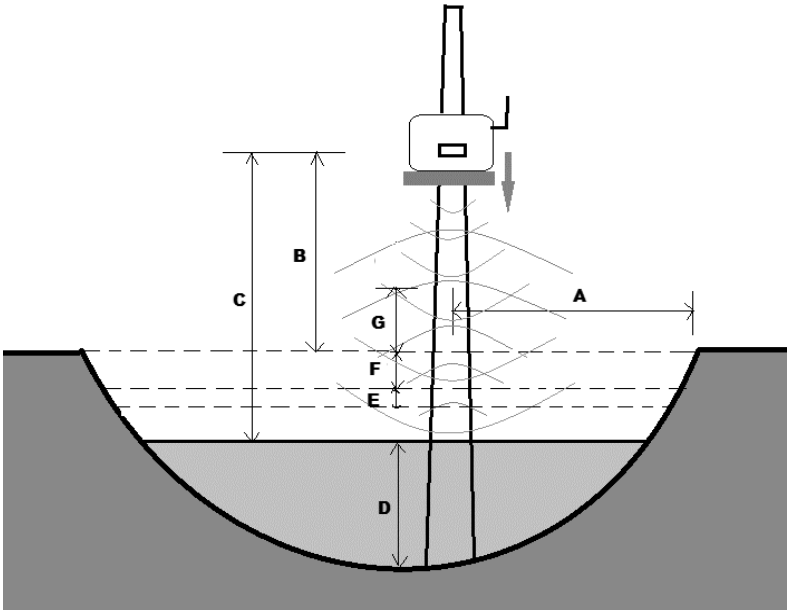


Fig. 2 - Visualization of device implementation

Table 2 - Parameters for water level calculation

Parameter	Description	Notes
A, B	Distance from cliff (1 meter)	-
C_{deploy}	Distance of sensor to water surface during deployment	-
$C_{current}$	Current distance of sensor to water surface	
D_{deploy}	Level of water during deployment	-
E	STANDBY level (Green Indicator/	40 cm below the bank
F	EVACUATE level (Yellow Indicator)	20 cm below the bank
G	Danger Level (Red Indicator)	Above 20 cm from from the bank

In order to deploy the system, a procedure should be followed as the following:

1. Measure the current water depth (D_{deploy}) using a benchmark stick.
2. The device must be placed 1 meter upper and 1 meter apart from the water bank (refer A and B).
3. When placing the device, make sure that the ultrasonic sensor of the device is facing the surface of the water.
4. Set the depth of water (D_{deploy}) and current reading of ultrasonic sensor (C_{deploy}) during deployment manually in the source code and program the device.
5. The ultrasonic sensor will detect the rising of water level. The current water level ($D_{current}$) is calculated using the equation (1).

$$D_{current} = D_{deploy} + (C_{deploy} - C_{current}) \quad (1)$$

6. The current water level reading ($D_{current}$) is send to the user using SMS.
7. Alert notifications are sent to the user when the water level reaches STANDBY, EVACUATE and DANGER level.

4. Experimental Works

4.1 Indoor Experiment

Figure 3 shows the indoor measurement setup that consist of a measuring stick, a big container, a laptop and a table. The important parameters about the indoor experiment setup is shown in Table 3. The purpose of these experiments are to study about the accuracy of the system, the effect of wave and floating materials on the water level reading of the system.

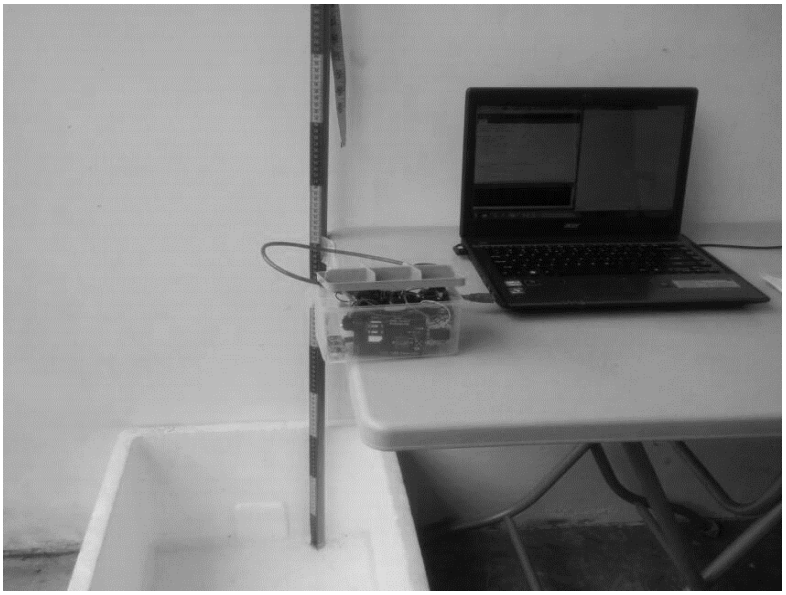


Fig. 3 - Tools that have been set up before doing the experiment

Table 3 - Parameters for indoor experiment setup

Parameter	Values
Distance between sensor and water surface (C)	68 cm
Current Depth (D)	2 cm
Box Container Depth	29 cm

4.2 Actual Implementation

The purpose of these experiment is to study the actual performance of the system. Two experiments have been conducted in selected areas within UTHM. Figure 4 and Figure 5, shows the actual experiments were conducted at two different locations in UTHM campus: drain between block E14 & E15 and drain in front of Diploma Study center (PPD). In this experiment, the system collects level of the water for three times each day. Each time, ultrasonic sensor collects data for three times every 10 minutes Average water level is calculated based on these readings. The water level status is send along with the sensor reading via SMS notification, as shown in Figure 6.

Fig. 4 - Actual experiment setup at the drain between block E14 & E15

Fig. 5 - Actual experiment setup at the drain in front of Diploma Study center (PPD)

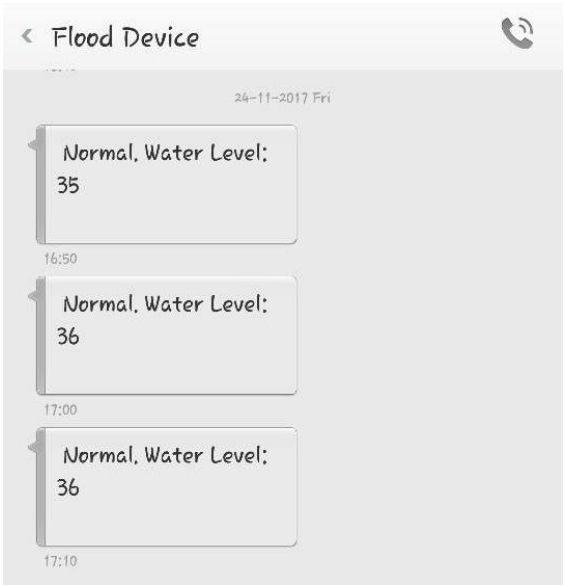


Fig. 6 - Water level readings sent via SMS

5. Data Analysis for Indoor Experimental

5.1 Accuracy of the Water Level Reading

The purpose of this experiment is to determine the accuracy of the water level reading collected by the system. As comparison, the actual water level is measured using measuring stick. Initially, the water container is filled with water until it reach to the level equal to 2cm. The system collects about 14 readings of water level. Then, each sensor reading is sent to a laptop using serial communication. Then, t water level is increased for each 2 cm. The same step is repeated for each increase of the water level. Figure 7 shows the water level reading from the system compared to the actual measurement. Based on the result, the water level reading from the same is almost consistent with the actual measurement and the highest standard error deviation is ±0.33.

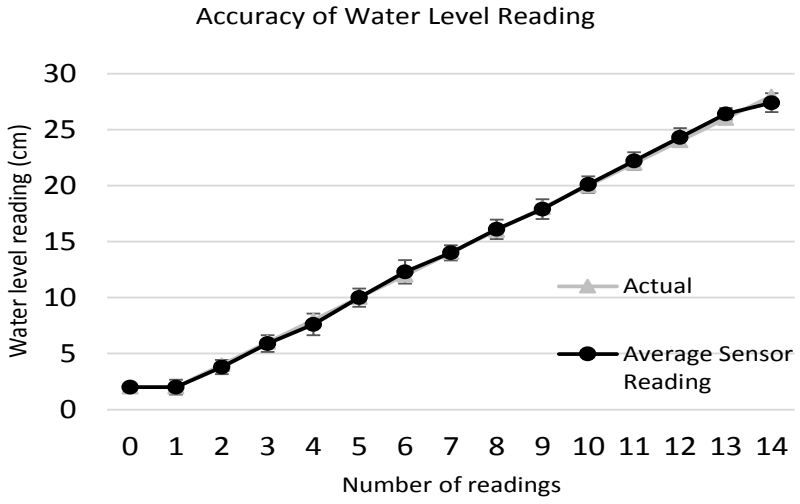


Fig. 7 - Graph of water level reading through measuring stick against serial monitor

5.2 Effect of Wave on the Water Level Reading

This experiment is conducted to understand the effect of wave of the water level reading. Three different levels of water are tested: 9cm, 17cm and 25 cm. In this experiment, wave is generated in this experiment by shaking the water using an empty bottle. Small part of the bottle is sunk into the water. The bottle is rotated for about 20 times per minute to create wave. The water level reading is taken for a duration of 150 seconds. The time interval for each reading is 5 seconds. The experiment is repeated for 5 times. Figure 8 shows the plotted graph of water level reading over time for each water level.

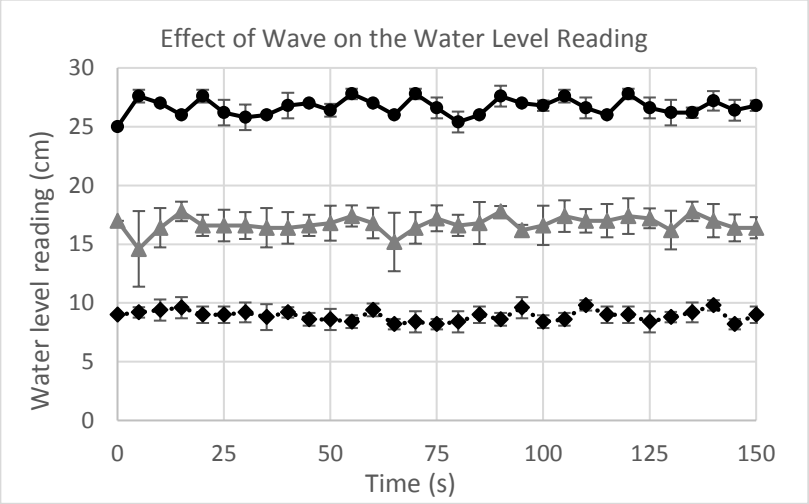


Fig. 8 - Graph effect of slow wave on standby water level reading

Based on Figure 8, the result shows that wave has a significant effect on the water level reading. The water level data is fluctuated. It is because wave on the surface of the water may increase or reduce the water level reading. The result also shows that, the higher the water level, effect of wave of the water level become more significant.

5.3 Effect of Floating Materials on the Water Level Reading

This purpose of the experiment is to determine effect of floating materials on the water level reading of the system. Four floating materials are used: bottle, polystyrene, biscuit container and tree bark as shown in Table 4. The level of water is fixed at value of 23 cm.

Table 4 - Floating materials

Materials	**Plastic bottle**	**Polystyrene**	**Biscuits Container**	**Tree Bark**
Thickness	9 cm	6 cm	14 cm	5 cm
Picture				

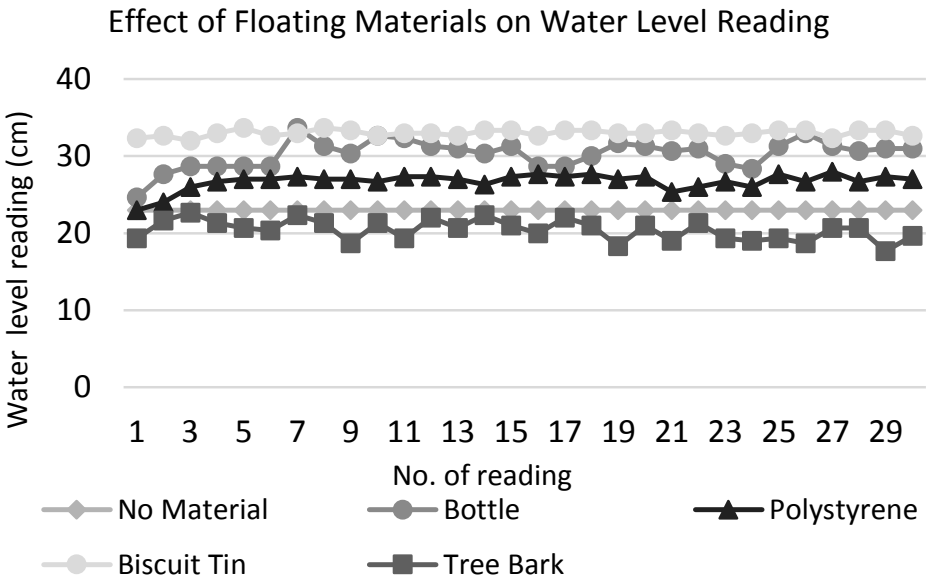


Fig. 9 - Graph of the effect of floating materials on water level reading

Figure 9 shows water level readings over time for all the floating materials. Overall, the results shows that the water level reading of the system affected by the floating materials. It is found that the floating materials make the water level readings becomes inaccurate. This is because, the floating materials exist between the ultrasound sensor and the surface of water. This will caused the emitted signal of the ultrasound sensor is reflected by the floating materials and not the surface of the water that gives an accurate reading. The error in water level reading depends on the thickness of the floating materials. The higher the thickness of the floating material, the larger the error of the water level readings. In addition of that, if the floating materials have uneven or bumpy surface, can caused an error in the reading because of the signal is not reflected back to the ultrasound sensor. As an example, water level reading for tree bark is in error because the reading is below the actual water level.

6. Data Analysis of Actual Implementation in UTHM

6.1 Experiment Result for Drain between Block E4 & E15, UTHM

Figure 10 shows water level reading for drain between block E4 & E15, UTHM. The experiment was conducted for 8 days from 23/2/2017 until 30/11/207. Based on the Figure 10, the highest water level was recorded on 29/11/2017 in the afternoon, which is equal to 41.67cm due to heavy rain. The lowest water level was on 25/11/2017, which the water level reading equal to 23.63cm height.

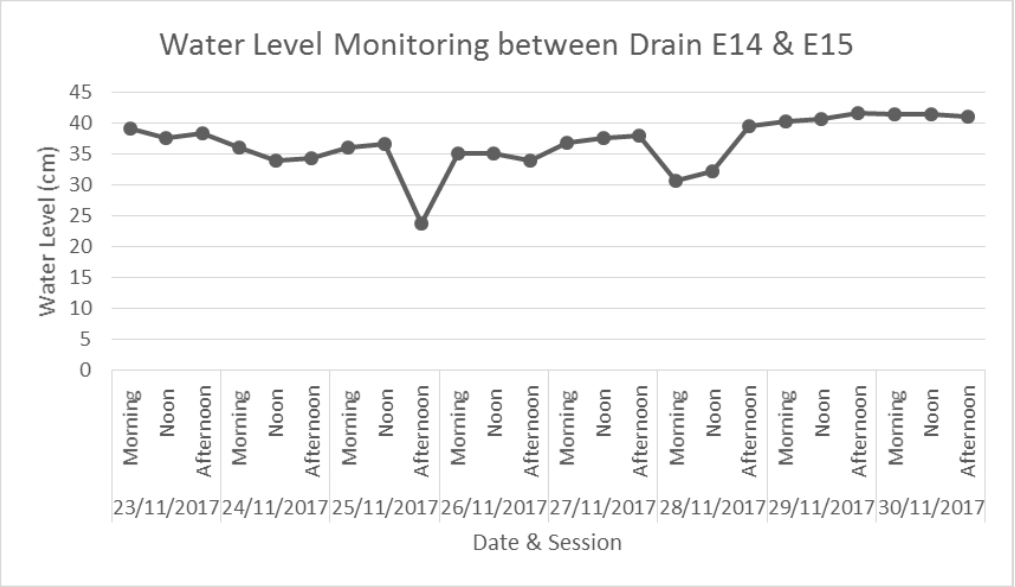


Fig. 10 - Graph of water level reading at the drain E14 & E15

6.2 Experiment Result for the Drain in front of PPD, UTHM

Figure 11 shows the water level reading for the drain in front of PPD. The experiment was conducted for seven days from 29/11/2019 until 5/12/2017. It is found that the water level decreased throughout the week due to no rain. The highest water level was recorded in the afternoon on 29/11/2017, which is equal to 43.67cm. The lowest water level reading was recorded in the afternoon on 5/12/17 with the reading value equal to 34cm.

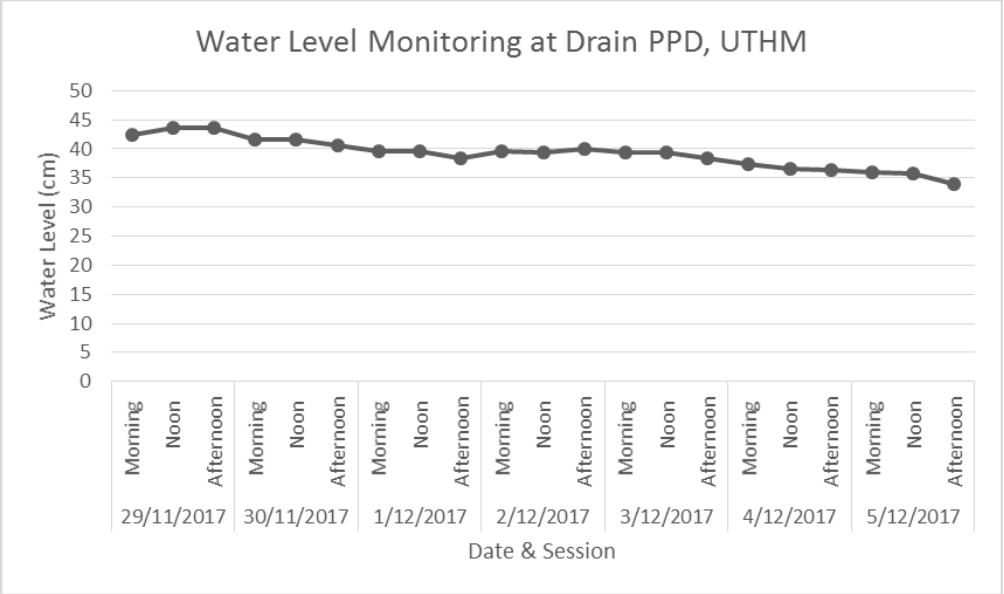


Fig. 11 - The graph of water level reading at the drain in front of PPD

7. Conclusion

As a conclusion, the flood detection and mitigation system has been developed to monitor water level of river, drain, stretch or canal, and provide an early warning of flood. The system is built using Arduino Uno microcontroller. Ultrasound sensor (HC-SR04) is connected to Arduino to detect current water level. GSM/GPRS SIM900 modem is included in the design in order to allow water level reading and notification message to be delivered via SMS. In order to determine the performance of the system, few experimental works had been conducted. These experimental work includes to determine the accuracy of water level reading, the effect wave and floating materials on the water level reading. The actual experimental are conducted in UTHM area. As a recommendation, the system should be improved to provide more accurate water level readings in the condition of wave and floating material.

References

1. I. Priyadarshinee, "A Model for Flood Prediction and Prevention using Wireless Sensor Network," *International Conference on Emergent Trends in Computing and Communication* (ETCC 2015), pp. 22–30, 2015.
2. K. Prasanti, C. J. Lakshmi, and C. S. Savalam, "A prototype controlling of barrage gates using arduino under flood conditions," pp. 579–583, 2016.
3. A. Engineering, B. Vidya, K. Poonam, G. Priyanka, D. Gaurav, and P. A. S. Chandgude, "Water Level Monitoring System In Real Time Mode Using WSN," *Int. J. Emerg. Technol. Adv. Eng.*, vol. 6, no. 9, pp. 212–214, 2016.
4. Patil, Jaymala, and Anuja Kulkarni. "Wireless Sensor Network Using Flood Monitoring." *International Journal of Computer Science and Mobile Computing, IJCSMC* 2.11 (2013): 297-302.
5. Hughes, Danny, et al. "Gridstix: Supporting flood prediction using embedded hardware and next generation grid middleware." *World of Wireless, Mobile and Multimedia Networks, 2006. WoWMoM 2006. International Symposium on a. IEEE*, 2006.
6. Nivethitha, P., S. R. Karthiga, and C. Reikha. "The Role of Satellite Zigbee Technology in Flood Monitoring and Communication System." 2017.
7. Anthone Andrade, Mynor Vinicio, and Satoru Oishi. "A Wireless Mesh Sensor Network Framework For River Flood Detection And Emergency Communications In Case Of Disaster." 2014.
8. Permut, Alan R., Albert A. Permut, and Ronald M. Permut. "Early flood warning system." U.S. Patent No. 4,153,881. 8 May 1979.
9. "Flood Network by PhotoScape" [Online]. Available: http://www.postscapes.com/citizen-flood-detection-network/ [Accessed: 24-Feb-2017]
10. "Automatic Flood Detection and Warning Device a Prototype: [Online]. Available:https://www.slideshare.net/shainamavreenvillaroza/automatic-flood-detection-and-warning-device-a-prototype [Accessed: 24-Feb-2017]
11. "Alert Flood Warning System" [Online]. Available: https://www.campbellsci.com.au/alert121a [Accessed: 25-Feb-2017]
12. "Flood Warning System" [Online]. Available:http://www.fondriest.com/environmentalmeasurements/environmental-monitoring-applications/flood-warning-systems/ [Accessed: 25-Feb-2017]
13. "Fujitsu Flood Detection Device" [Online]. Available: http://www.fujitsu.com/global/about/resources/news/pressreleases/2016/0815-01.html [Accessed: 25-Feb-2017]
14. "Smart Flood Warning" [Online]. Available: https://www.campbellsci.com.au/news-17-q4-smart-flood-warning [Accessed: 25-Feb-2017]
15. "Flood Protection System" [Online]. Available: https://www.safety.com/p/flood-protection-systems/ [Accessed: 25-Feb-2017]
16. Vunabandi, Vianney, et al. "Flood Sensing Framework by Arduino and Wireless Sensor Network in Rural-Rwanda." *Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD)*, 2015 16th IEEE/ACIS International Conference on. IEEE, 2015.

Smart Home Automation System using Internet of Thing (IoT)

Noorsaliza Abdullah[1*], Norshidah Katiran[1] and Ezri Mohd[1]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
nsaliza@uthm.edu.my

1. Introduction

The Internet of Things (IoT) is sometimes referred to as the internet of objects that describe by Dave Evans, is to change or will change everything including ourselves. The internet had apparently been one of the most essential and influential creations in all human history as it had done many simultaneous innovations in education, communications, businesses, sciences and humanity itself [1]. Lopez Research of Cisco added that IoT describes a system where the object in the physical world, and sensors within or attached these objects are connected to the Internet via wireless and wired Internet connections [2]. The IoT, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver of anything or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network [3]. These statements prove the fact that IoT is a term used for connection of worldly devices over the web that improves communication between human-to-machine and machine-to-machine relations.

Nowadays, society is fixated by the idea that they can control their house, cars, and electrical appliances, automatically via their computers and mobile devices, and this simplifies things of not doing those tasks themselves as everything is regulated automatically to the fixed algorithm provided by what society needs over the network. IoT has been developed extensively that there are now no walls between the interactions anymore that are limited to machine-to-machine only. It saves costs, time and providing no additional charge for a significant amount of cabling through walls or underground as everything is connected to the cloud-based system. Experts from Cisco IBSG have predicted that there will be around 50 billion connected devices to the internet in the year 2020 [1] as technology continues to grow.

To show this theory relatable, this project: Smart Home with Wireless Integrated Weather Monitoring System is an example, and it will provide the most straightforward term of how IoT works. Smart Home has been developed for quite some time as it allows for comfortability, entertainment and security to the users and the focus of this is to integrate ease of communication between the house and the humans living inside it, with interactions or none at all. This weather monitoring system is set to ensure full automation on home comfortability. This project will control the lights based on the lighting inside the house automatically; fans will be turned on automatically while there will be a water sprinkler on the roof to shower the hot roof panels from the sun rays to cool down the temperature of the house. All the devices can also be controlled manually if the user wants it. Lastly, this system also provides the essential monitoring for temperature, humidity, lux intensity, and weather.

Comfortability in houses is number one priority as it is where society goes to rest and spend their time with families. Usually, people will create those prospects by turning on the fan, dimming the lights but what if all the devices can be automated by a system while monitoring the surroundings variables? Smart Houses is a system that will prioritize the minimization of human interactions in the process, and this creates importance over anything now as technology grows transparently. Secondly, a lot of big projects nowadays used tons of cables and wasted a tremendous amount of money to overcome obstacles underground or through buildings. Here is where IoT could simplify the problem and saves cost if applied. Although there are a lot of IoT projects that are still being developed, most of them are not implemented mostly due to the little knowledge of technology reliability. There are several solutions, via connecting the controllers and sensors over the Wi-Fi, where the controller can activate the relays with the data given through the network. There are a lot of controllers and microcontrollers released throughout the years, and this gave developers to create possibilities that seem impossible decades ago; to create an inter-connection seamlessly between the devices, sensors and the control panels. Controllers such as Arduino with the Wi-Fi shields, Raspberry Pi type B with its integrated Wi-Fi module, Micro Intel Boards, and other microcontroller development kits. This project will use Arduino Uno with an Ethernet Shield as the controller to connect all the devices needed for the monitoring system and to control the hardware, lighting and the water sprinkler with it just to show a few applications. The Arduino Uno will be integrated with Android and an IoT Platform for monitoring and manual control through the network. The data received can transfer and stored between them through the cloud-based system on the web. This project will test the possibilities of accuracy and the reliability of data transferring time on a real-time basis to accommodate the faulty delay that will present with each data.

2. System Design

The Arduino board will be connected to Android, for that specific method with existing programming platforms available by the open source developers like Thinger.io™ and Windows 10 IoT Core™. Furthermore, the monitoring system must be able to monitor the temperature, humidity, and lighting and also able to make a quick prediction on weather from the given variables while collecting data. For this, the Data Bucket from Thinger.io™ will be used for the cloud data storage; archiving the data received by the Arduino from the sensors.

2.1 Hardware Implementation

Microcontroller

Arduino Uno is used as a microcontroller for this system. Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which six can be used as PWM outputs), six analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Arduino Uno R3 uses Atmega328 as a processor which is smaller than any other processor.

The Arduino Ethernet Shield connects your Arduino to the internet with RJ45 cable. It has an operating voltage of 5V which is supplied by the Arduino board. A W550 Ethernet Controller with an internal 32K buffer which is a good and optimal controller. The W5500 provides a network (IP) stack capable of both TCP and UDP. It supports up to eight simultaneous socket connections. It can hold the connection speed up to 10/100 Mb and the Ethernet Shield establish a connection with the Arduino with the SPI port.

Sensors

Sensors that are used in this project are light intensity sensor, humidity sensor, and temperature sensor. Photo Resistor LDR sensor is a light-controlled variable resistor. As the light intensity increases, the resistance in the sensor decreases as this sensor exhibits photoconductivity as it is made from high resistance semiconductor. The DHT11 is a low-cost digital humidity sensor. It uses a capacitive humidity to measure the surrounding air and put out digital signal on the data pin as this sensor does not need any ADC connected. It is relatively simple to use but requires careful timing to grab data. The sensor can get new accurate data every 2-second time delay. This sensor also used low power, about 3V-5V.

2.2 Software Implementation

In this phase, the entire system and software are designed. The data structure design is all defined at this stage. A software development model is created. Analysis and design are very crucial in the whole development cycle. Any glitch in the design phase could be costly to solve in the later stage of the software development. Much care is taken during this stage. The logical system of the product is developed at this stage.

Figure 1 shows the overall home monitoring system. Arduino is used for collecting data from sensors and send it to the server in real time. The user can extract data from the server using home monitoring mobile application.

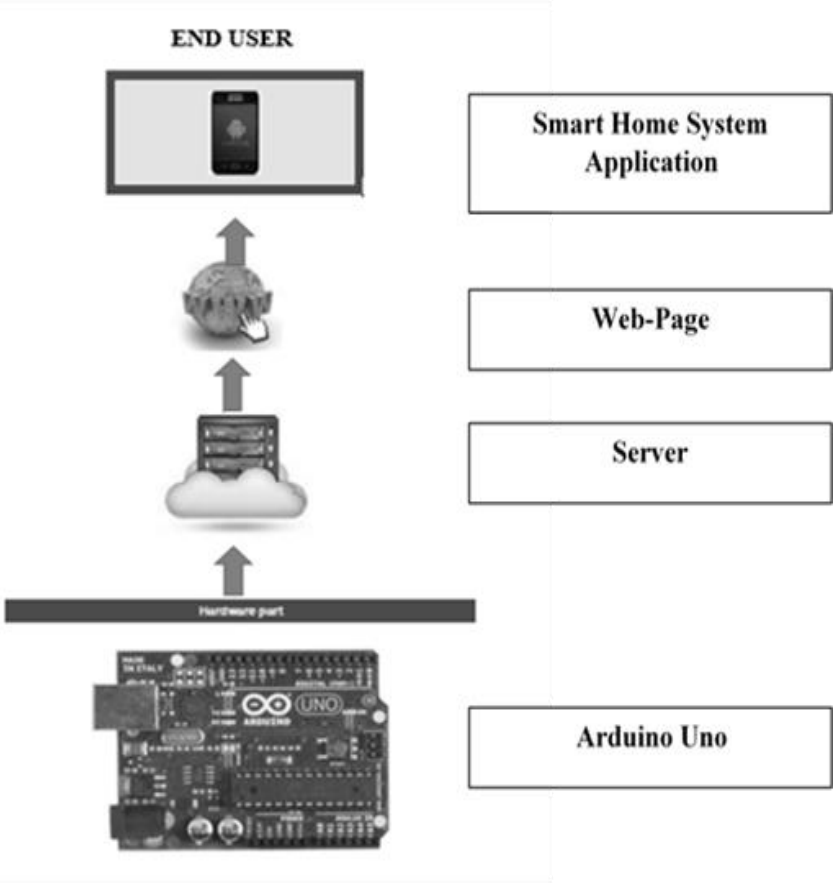


Fig. 1 - Overall monitoring system

3. Results

This section discusses the results of the entire system. This system is divided into two modules, one module is used to sense all sensor data by different interfacing sensor to the Arduino Uno board, and another module is used to send the data on the web. The web page is created where all sensor data is displayed with the control button. The control button is used to control the devices from a web page. The interfacing of all sensor to Arduino board is shown in Figure 2. WiFi module used to connect the Arduino Uno board and IoT platform. The data collected to from sensors were transferred to the cloud through WiFi module and display the data on the platform dashboard.

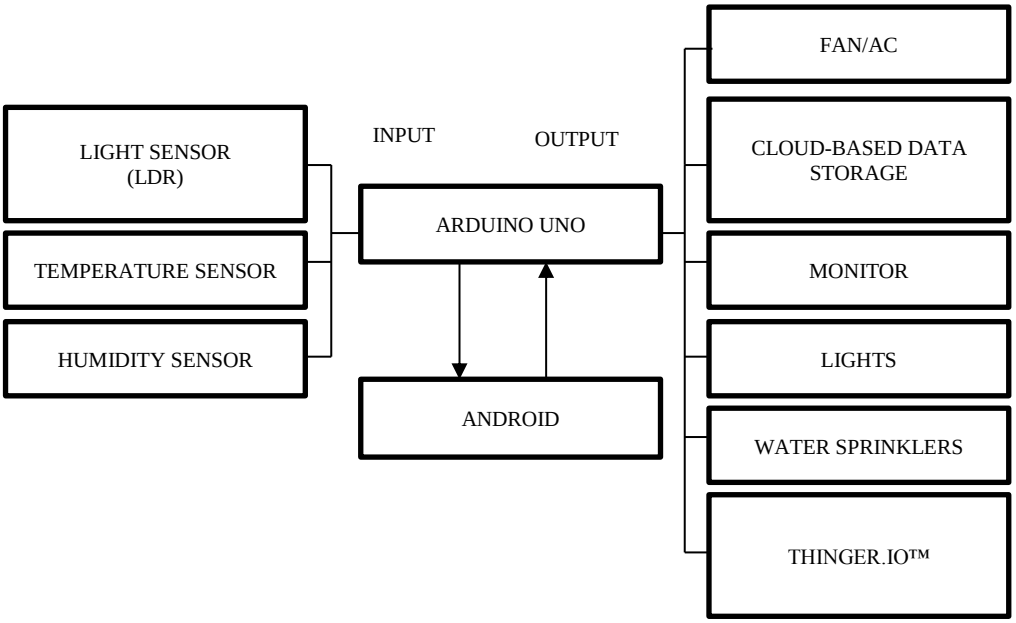


Fig. 2 - Block Diagram for Smart Home Monitoring System

Figure 3 shows temperature and humidity sensor reading display on LCD. As the temperature is the only solid parameter and the most appropriate to determine whether it is 'Sunny' or 'Raining' outside, the algorithm that will be used is to compare between them depending on the temperature read by the Arduino.

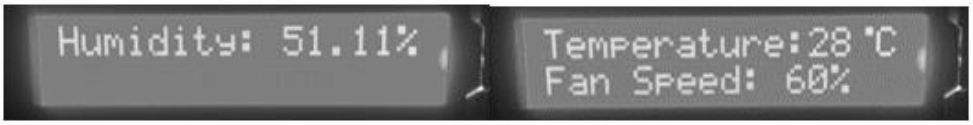


Fig. 3 - Temperature and humidity reading on LCD

A simple code as shown in Figure 4 was used, 'if' and 'else' to determine the weather. The next part is to integrate the Arduino board with the IoT Platform. Thinger.io™ is used to store the data collected from microcontroller. Figure 5 shows the dashboard of Thinger.io™ which contains the temperature and humidity data. Figure 6 shows the Pseudo code used for lighting brightness. The data is sent to Thinger.io™ for monitoring.

```
thing["dht11"] >> [](pson& out){              //sending data out to Thinger.io™ as
                                              //'dht11'
    out["humidity"] = DHT.humidity;           //sending humidity value
    out["celsius"] = DHT.temperature;         //sending temperature value
    out["CON"] = if (temp <= 27) {
              ("Raining"); }                  //sending text 'raining'
       else if (temp == 28) {
              ("Cloudy"); }                   //sending text 'cloudy'
       else {
              ("Sunny"); }                    //sending text 'sunny'
  };
```

Fig. 4 - Pseudo code to determine humidity

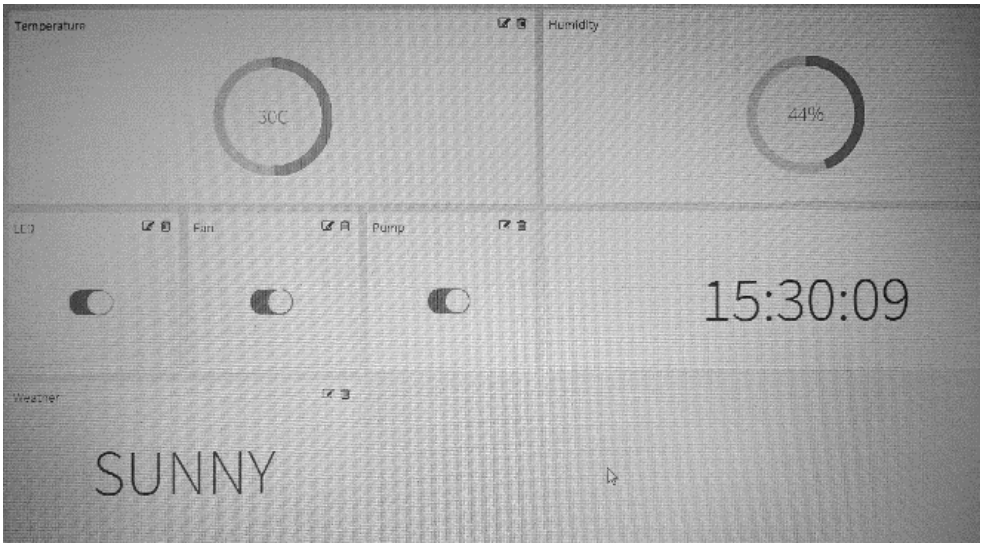


Fig. 5 - Data from Thinger.io™ dashboard

The value of Lux:

```
Lux=(2500/((analogRead*0.0048828125)-500))/10          //step is defined by 5/1024
```

Fig. 6 - Pseudo code for LED

The LEDs need to be dimmed when the light intensity is high; this means it needs to create a pull-down condition on the LDR to reverse the effect rather than have it light up when the lux intensity is high. The dimming result is shown in Figure 7.

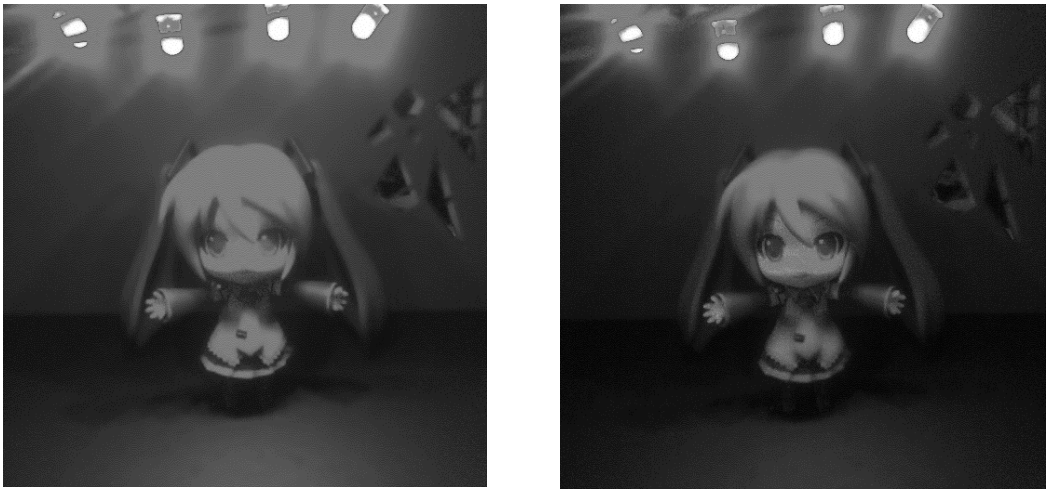


Fig. 7 - Dimming effect

Fan speed depends on the temperature, if the temperature is less than 26º fan will automatically off. And the speed is increased gradually as the temperature rose as tabulated in Table 1.

Table 1 - Fan speed

Temperature (˚C)	**Fan Speed**	**Remarks**
Less than 26	OFF	Pump Off
26	20%	-
27	40%	-
28	60%	-
29	80%	-
30	100%	-
More or equal to 31	100%	Pump On

4. Conclusions

The smart home monitoring system is successfully developed using IoT. This is called as smart home which can access from the remote location. Smart home monitoring system plays an important role. This system based on to monitoring & controls all the parameters with the use of different sensors. All sensors are selected depending upon the characteristics and specification required for the system to give an accurate result. This parameter sends to the user through the web browser. The system contains different sensors like humidity sensor, temperature, LDR sensor integrated to Arduino Uno is used to send the data on web page. The all sensor value is updated after every 5 seconds.

References

1. D. Evans, *The Internet of Things: How the Next Evolution of the Internet is Changing Everything*, 1st ed. Cisco Internet Business Solutions Group (IBSG), 2011, p. 11.
2. M. Rouse, "What is Internet of Things (IoT)? - Definition from WhatIs.com", *IoT Agenda*, 2016. [Online]. Available: http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT. [Accessed: 24- Nov- 2016].
3. S. Indart and P. Wuttidittachotti, "Smart Farm Monitoring Using Raspberry Pi and Arduino," *IEEE 2015 International Conference*, p. 5, 2015.
4. M. Abdul Jamil and M. Ahmad, "A Pilot Study: Development of Home Automation System via Raspberry Pi," *201 2nd International Conference on Biomedical Engineering*, p. 4, 2015.
5. M. Ibrahim, "Internet of Things based Smart Environmental Monitoring using the Raspberry-Pi Computer," *2015 IEEE Conference*, p. 6, 2015.
6. J. B. Lopez and H. M. Villaruz, "Low-Cost Weather Monitoring System with Online Logging and Data Visualization," *8th IEEE International Conference Humanoid, Nanotechnology*, p. 6, 2015.
7. M. Asay, a. Myers, b. Proffitt, o. Thomas and D. Curry, "Xively Connect Things In The Internet Of Things - ReadWrite," *ReadWrite*, 2016. [Online]. Available: http://readwrite.com/2013/05/14/xively-actually-connects-things-in-the-internet-of-things/. [Accessed: 28- Nov- 2016].
8. B. Benchoff, "Raspberry Pi and Windows 10 IoT Core: A Huge Letdown", *Hackaday*, 2016. [Online]. Available: http://hackaday.com/2015/08/13/raspberry-pi-and-windows-10-iot-core-a-huge-letdown/. [Accessed: 29- Nov- 2016]

Integrated Outdoor and Indoor Tracking Through GPS, LTE and Wi-Fi Solution

Seh Bee Yan[1], and Fauziahanim Che Seman[1*]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
fauziahs@uthm.edu.my

1. Introduction

Nowadays, the outdoor tracking system that utilizes the GPS signal become a common technology. A GPS Navigator System is a must have gadget to a driver as it helps to navigate driver to any places easily. On the other side, an indoor location is becoming more important to help us navigate especially in a wide building with multi floors spaces. Here, the main challenges is the fact that inside a buildings a GPS signal is not that strong to operate [1]. However, this limitation may be overcome if Wi-fi signal which is commonly available in a closed area and supported by cellular signals can perform similar operation as GPS signal. Cellular signals or to be specific is the Long-Term Evolution (LTE) signal and WI-FI signal can be analyzed to perform estimation for indoor tracking [2]. This chapter explains about the proposed outdoor and indoor tracking system to estimation location of stationary and mobile objects in the open terrain as well as inside a building by utilizing GPS signal, cellular signal and WiFi signal. The accuracy of the system is found within 5 m and 2 m range for outdoor and indoor environment respectively. The estimation of the location is uploaded to cloud based platform, ThingSpeak. In this proposed system, we are utilizing the Motorola board known as M-WiCom platform, act as the key component and able to upload the estimated location in a cloud platform, ThingSpeak. The workability of the system is evaluated by conducting few experiments in UTHM campus area.

2. Development of Outdoor and Indoor Tracking System

This section presents the architecture of proposed system as shown in Figure 1. The M-WiCoM platform consist of Beaglebone Black Module to communicate with two parts, the first part is associate to outdoor tracking and the second part is mean for indoor tracking. For outdoor part, the Beaglebone Black Module have been connected to the Qualcomm LTE-GPS chipset (Sierra Wireless module) with SIM Card slot. For indoor part, The M-WiCom has communicated with the Arduino ESP8266 NodeMCU Lua WIFI Controller Board V3 (with FC Certification) module via the UART pins. To monitor the output of the proposed system in real time, the board is connected to a laptop as shown in Figure 2.

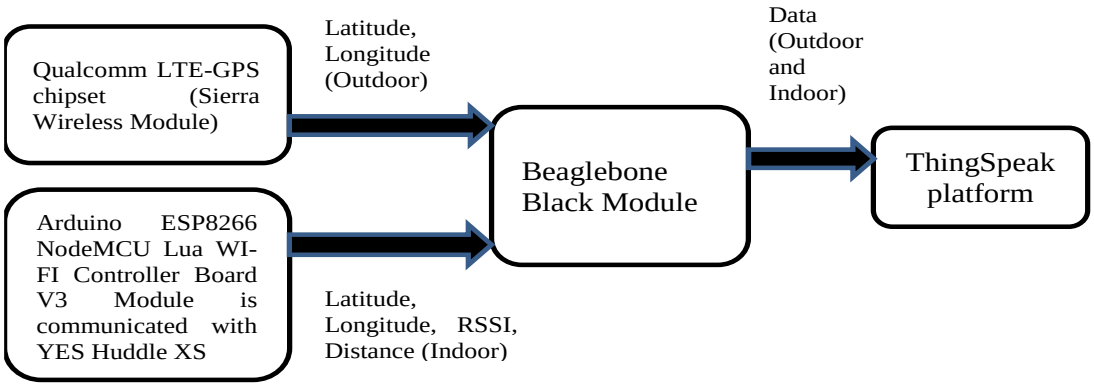


Fig. 1 - System block diagram

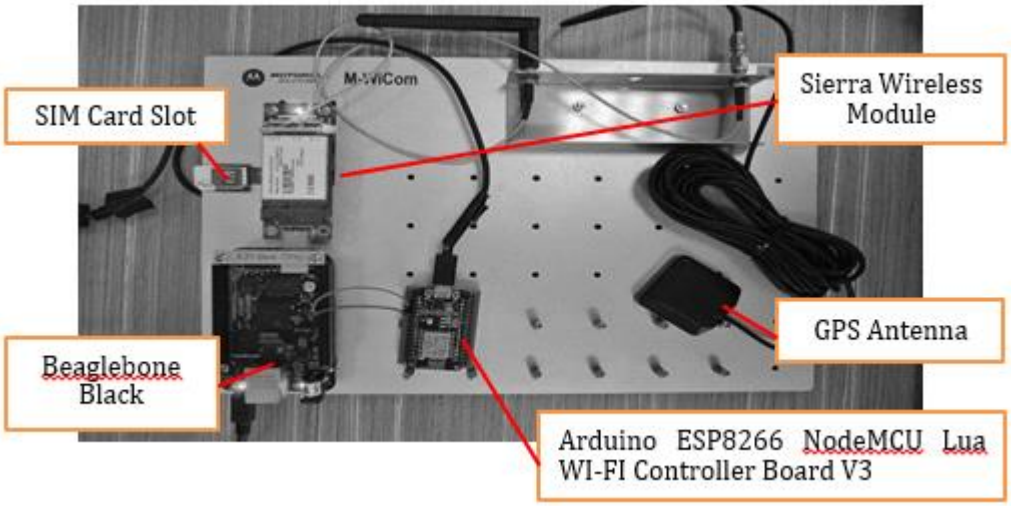


Fig. 2 - Development of board

3. Operation in Outdoor Tracking

The GPS receiver identify the prototype location and sending the data to BeagleBone Black module. Then, raw GPS data uploaded to cloud platform, ThingSpeak through LTE connection in real time basis. The outdoor latitude and outdoor longitude of the prototype is displayed at the ThingSpeak Platform. The experiment is carried out by taking measurements at three fix checkpoints around UTHM's area; 1) Checkpoint 1: Faculty of Electronic and Electric Engineering, Block Q; 2) Checkpoint 2: Faculty of Civil and Environmental Engineering (FKAAS); Checkpoint 3: Faculty of Technical and Vocational Education (FPTV). The location of all three checkpoints along the route is marked in red dotted in Figure 3 (a). The reading taken from stopwatch for the time serial monitor (Linux Software) and uploading time for ThingSpeak Platform are recorded to demonstrate system functionality and accuracy.

The prototype is placed on the dashboard in a car during the testing as shows in Figure 3 (b). The real time data on latitude and longitude in collected as soon as the car started to move. The stopwatch is started to calculate the processing time taken by the prototype to upload the GPS data into to ThingSpeak Platform.

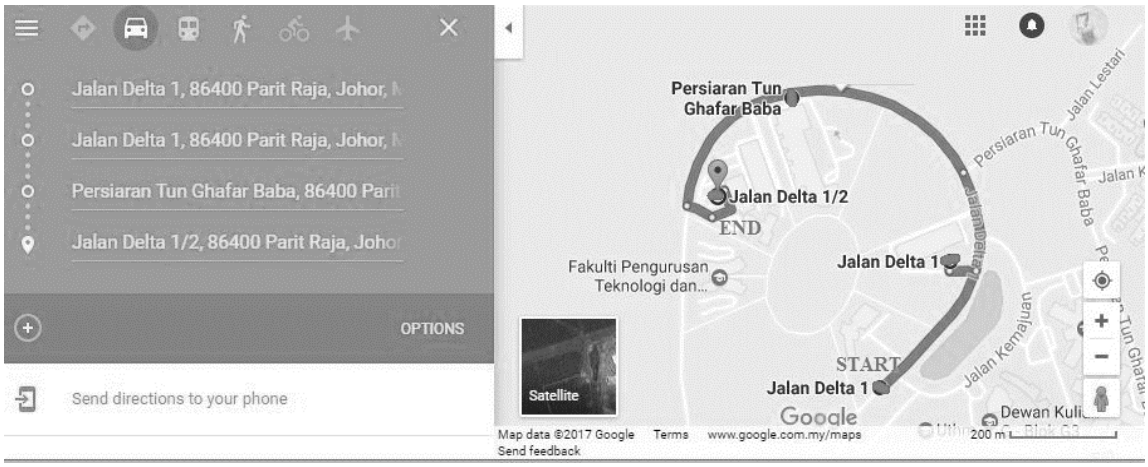


Fig. 3 - (a) Site testing areas for outdoor

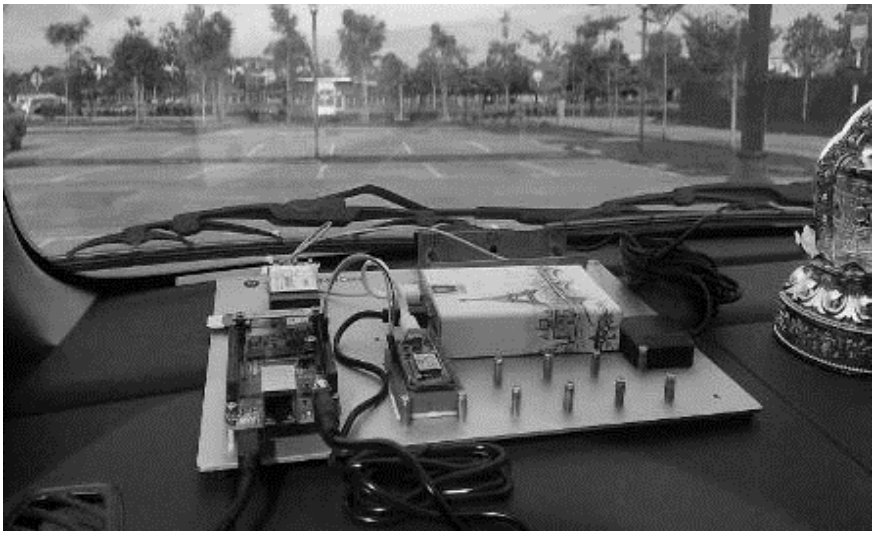
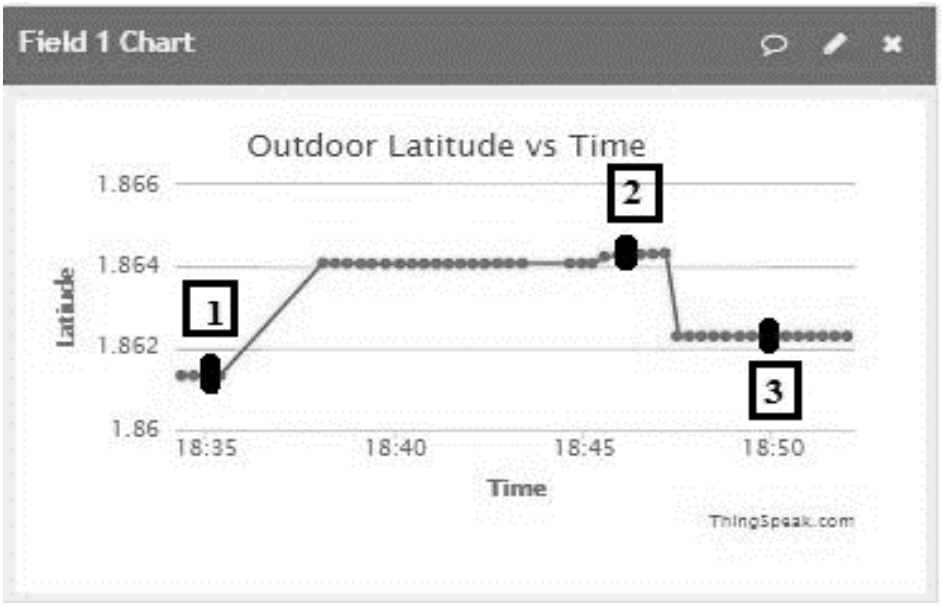
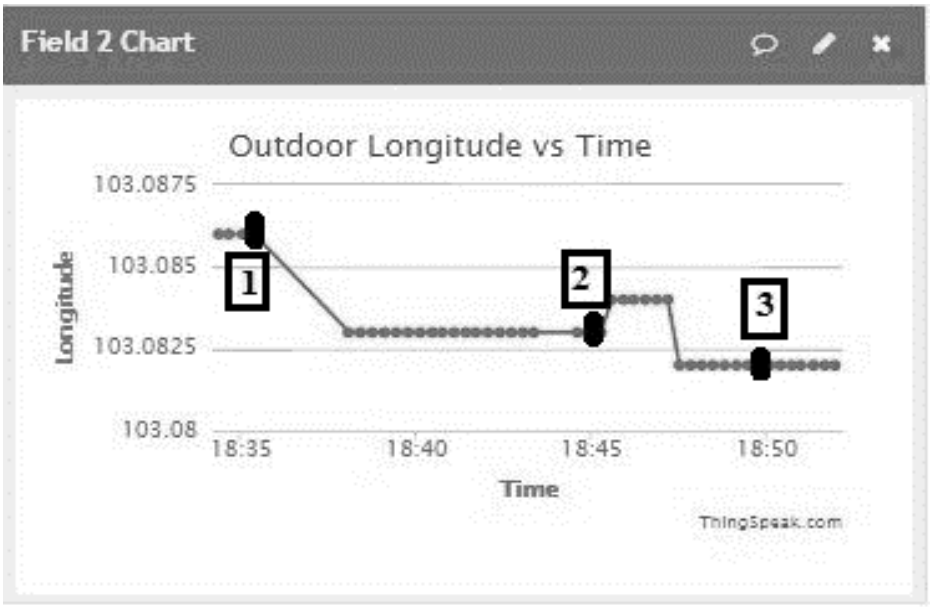


Fig. 3 - (b) Prototype placed on bus dashboard

Figure 4 show the current latitude and longitude as the car move from Checkpoint 1 to Checkpoint 2 and Checkpoint 3. The black dotted point are representing to position of each checkpoint.



(a)



(b)

Fig. 4 - (a) Outdoor latitude (Field 1 Chart); (b) outdoor longitude (Field 2 Chart)

These collected data is compared with the actual latitude and longitude as tabulated in Table 1. It is shown that the difference distance between the actual location and location gathered by the developed prototype is less than 5 m. It is observed that the developed prototype requires 30 seconds to display the GPS data in time serial monitor displays. This is mainly depending on the sensitivity of the GPS receiver and the speed of the LTE connection. In some cases, the signal of GPS receiver maybe blocked by the trees and other building therefore it takes times to react. The average time taken to uploading the data into ThingSpeak Platform is lower than 20 seconds.

Table 1 - Comparison between the latitude and longitude of the real location and the latitude and longitude of ThingSpeak Platform

Checkpoint	ThingSpeak Platform		Actual location (latitude, longitude)	Difference Distance, km
	Latitude	***Longitude***		
1	1.86147	103.0860	1.861502,103.085973	0.004655
2	1.86421	103.08328	1.864219,103.083287	0.001268
3	1.8626	103.082	1.862608,103.081979	0.002498

4. Operation in Indoor Tracking

Arduino IDE and Python code is mainly utilized for indoor tracking system. Arduino ESP8266 NodeMCU Lua WI-FI Controller Board V3 module is connected with Yes Huddle XS and supported by Google Map Geolocation API to detect the indoor latitude and longitude. In initial setup, the average signal propagation exponent, n need to be calibrated by referring to the equation (1) [3]:

$$\text{RSSI} = -(10n\log 10\ d + A) \qquad (1)$$

Where n is the signal propagation constant or exponent, d is the distance from sender and A is received signal strength at 1 meter distance. In intial experiments, the RSSI for each distance is measured to calculate the average n. The prototype is tested in the G3 classroom and Level 3 of Tunku Tun Aminah Library, UTHM as shown in the Figure 5. The average n is recorded for this two locations before taking the results of the estimated distance between Yes Huddle XS and prototype. At the same time Beaglebone Black reads the data from the Arduino IDE and send the data to ThingSpeak via Python code.

(a) (b)

Fig. 5 - (a) G3 classroom UTHM; (b) level 3 of Tunku Tun Aminah Library, UTHM

The prototype is tested to gather estimated distance between the Yes Huddle XS and prototype. The data is measured at position 2 m, 3 m, 4 m and 5 m. The latitude and longitude for G3 classroom and Level 3 of Tunku Tun Aminah Library, UTHM and RSSI is recorded for every sample distance. The reading is taken for five times at each distance to get the accurate data. If it found that the average latitude for the G3 classroom is between 1.858690 until 1.858725 whereas the average longitude is between 103.086800 until 103.086806. Besides, the average latitude of Level 3 of Tunku Tun Aminah Library, UTHM is within 1.857300 to 1.857330, whereas the longitude is within 103.081890 until 103.081905.

Table 2 depicts the comparison between the actual location and average location gathered by prototype for all distance. It is shown that accuracy of the average indoor location is within 2 m. For the G3 Classroom, the average *n* is obtained as 1.63, 2.02, 2.36 and 1.76 whereas the average *n* in Level 3 of Tunku Tun Aminah Library, are 1.57, 1.68, 1.89 and 1.55. Table 3 and Table 4 depict the estimated distance and actual distance calculated according to the different values of average *n*.

Table 2 - Difference distance between real location and average location

Actual distance, m	**G3 classroom**			**Level 3 Tunku Tun Aminah Library**		
	Real location	***Average location***	***|Real - Average|***	***Real location***	***Average location***	***|Real - Average|***
2	1.8587009, 103.0868090	1.858694, 103.086806	0.0008366	1.8573040, 103.0819050	1.857304, 103.081898	0.0007780
3	1.8587100, 103.0868100	1.858710, 103.086804	0.0006668	1.8573140, 103.0819060	1.857310, 103.081918	0.001406
4	1.8587200, 103.0868100	1.858720, 103.086806	0.0004445	1.8573239, 103.0819065	1.857324, 103.081922	0.001723
5	1.8587279, 103.0868100	1.858724, 103.086804	0.0007954	1.8573310, 103.0819065	1.857326, 103.081904	0.0006215

Table 3 - Record results of G3 Classroom UTHM (estimate distance)

Actual Distance, m	Estimated Distance, m					Average Distance, m
	1st (average n= 1.63)	***2nd (average n= 2.02)***	***3rd (average n= 2.36)***	***4th (average n= 2.02)***	***5th (average n= 1.76)***	
2	1.76	1.96	1.96	1.98	2.19	1.92
3	2.71	3.06	3.16	3.12	2.84	3.01
4	3.47	3.83	3.83	3.92	3.69	3.76
5	5.05	4.93	4.75	4.93	4.8	4.92

Table 4 - Record results of the Level 3 of Tunku Tun Aminah Library, UTHM (estimate distance)

Actual Distance, m	Estimated Distance, m					Average Distance, m
	1st (average n= 1.57)	***2nd (average n= 1.68)***	***3rd (average n=1.68)***	***4th (average n= 1.89)***	***5th (average n= 1.55)***	
2	1.87	1.99	1.99	2.08	2.10	1.98
3	3.00	3.00	3.00	2.99	2.83	3.00
4	4.11	3.94	3.94	3.82	3.81	3.95
5	5.63	5.19	5.19	4.87	5.13	5.22

From the results, the average *n* for the library is below 2 whereas the average *n* for the G3 classroom is in the range of 1.6 to 2.4. These values are expected because in indoor environment, the signal propagation exponent, *n* is within 1.6 to 1.8. It is observed that the average *n* for the library is much lower than the G3 classroom, so does the RSSI. Note that the environment influences the RSSI value and the average *n* which may be due to signal propagation such as reflection, diffraction and scattering in none or line of sight path. The size area of the G3 classroom is also smaller than the area of the library UTHM and the propagation due to partition may influence the RSSI results. For indoor, the processing time taken to display the indoor data in Linux Software is depending on the speed of the internet connection which is within 30 seconds. Time taken to upload the gathered data to ThingSpeak Platform is within 25 seconds.

5. Conclusion

Here, the development of integrated outdoor and indoor tracking system is presented. The system able to track the location of stationary and mobile objects both in the open terrain and inside a building. The tracking mechanism is build by manipulating signal strength from GPS, LTE and WI-FI signals. For outdoor tracking system, the Motorola Solutions WiCom platform is deployed while for indoor tracking system, Arduino ESP8266 NodeMCU Lua WI-FI Controller Board V3 Module and YES Huddle XS is exploited. The localization in indoor and outdoor environment is uploaded into ThingSpeak Platform through LTE connection. The accuracy of the outdoor tracking and indoor tracking is below 5 m and 2 m respectively. The accuracy of the developed system may be improved by using trilateration method where the average *n* can be calculated by using combination of three or more routers. The operation also may be extended to cater indoor tracking in multi-level indoor environment.

References

1. Neilson, S. "Mobile Network Geolocation: Obtaining the Cell IDs and the Signal Strength of Surrounding Towers from a GSM Modem and Triangulating Device Location." 2013. [Online]. Available: http://www.neilson.co.za
2. Lin, D.B., Juang, R.T. and Lin, H.P. "Mobile location estimation and tracking for GSM systems" 15th IEEE International Symposium in Personal, Indoor and Mobile Radio Communications, vol.4. pp. 2835-2839. 2014.
3. Lau, E.E.L and Chung, W.Y. "Enhanced RSSI-based Real-time User Location Tracking System for Indoor and Outdoor Environments." in International Conference on Convergence Information Technology 2007, pp. 1213-1218, 2007

IoT Based Security System for a One Bed Hospital Room

Mohammad Nazri Rosli[1], Lukman Audah[1*] and Nor Shahida Mohd Shah[1]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
hanif@uthm.edu.my

1. Introduction

The use of hospital facilities, whether in private or government hospitals is increasing and most of it involve serious cases until some of the patients need to be detained in the hospital for further examinations and continued monitoring from the doctor. Therefore, hospital rooms are often full with patients and visitors [1]. This may cause lack of attention and awareness from the authorities. So, the authorities should seek some alternatives in order to overcome this problem by creating or using devices that could be used by patients or caregivers.

Based on previous related studies, there are some other advanced technology security systems being applied in hospital security system. One of the examples is the nurse call button system as shown in Figure 1. It works with an ontology that specifies for each risk factor a probability, which indicates the similarities of the patient and the risk factor that is classified [2].

The patient can go anywhere he wants in the hospital areas as long as the wireless call button is with them. This button will send a signal that triggers a message which will be received by the nearby sensors. There are many available sensors all over the place so there will be no error. Even if one of the sensors is not functioning, there are other nearby sensors which can receive the signal from the push button. This signal will be sent through the switch to the back-end server [3] [4].

In order to achieve system efficiency, information about the profiles of the patients and staff members should be linked together. Ontologies are used to construct the information and link it together in the system. The Monitoring Component always monitors the ontology to pick up trends and patterns in the way the priorities are assigned by the caregivers.

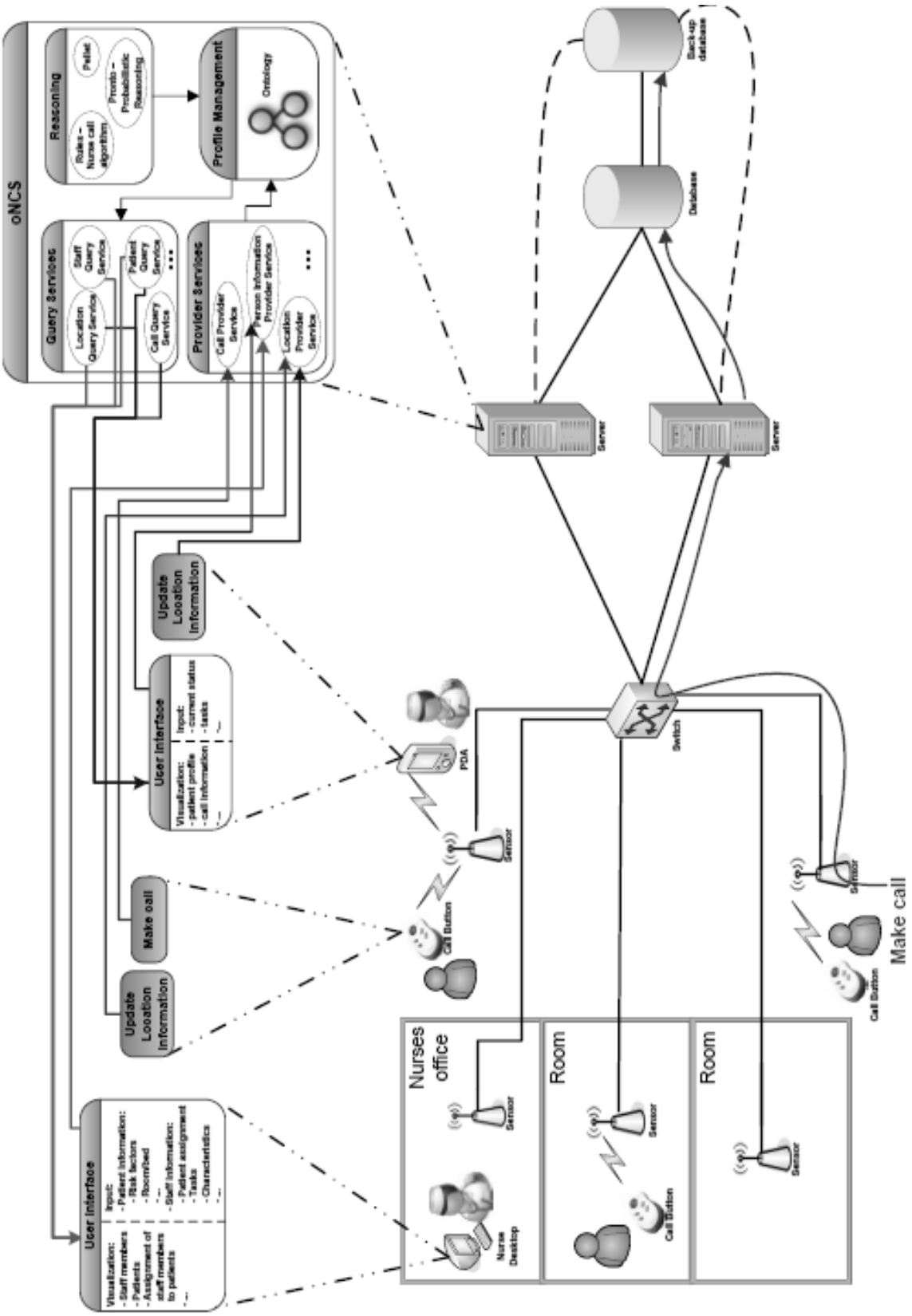


Fig. 1 - General concept of nurse call system [2]

This component stores the information and data in the Persistence Layer. This data can be inspected by the experts by using the Configuration Module. When enough data and information has been collected, the Learning Pipeline can be initiated by the Configuration Module. The Configuration Module is being notified of which data should be collected for the Learning Pipeline, either by the Monitoring Component or by the domain experts and administrator. The latter allows the initiation of the Learning Pipeline with external data provided by the stake holders. As shown in Figure 2, the Configuration Module configures the Pipeline Manager to use the Data Collection Component, Input Convertor and Integration Component that suit this type of evidence. It also passes the correct parameters to the Pipeline Manager, which are needed to retrieve the data from the Persistence Layer using the Data Collection Component [5].

The Learning Pipeline is implemented by using the Pipes-and- Filters architectural design pattern [6]. A pipeline consists of a set of filters, implementing small processing steps, which are connected by pipes. All the filters implement the same interface. Such filters can easily be rearranged, omitted or added. In this way, an extensible and flexible architecture is achieved.

For the security notification system, one of the projects that has been done is a project that implements a door lock system as shown in Figure 3 which communicates through internet platform (IoT). As the process stage, the microcontroller will process all the data sent through it. Equipped with Wi-Fi dongle, the way of communication can be made wirelessly. From the output side there are LCD and magnetic door lock. Besides that, it is also provided with mailing and tweeting accommodations [6].

Basically, all of these systems still utilizing LAN connection or offline mode which the data can only be received with the utilizer who has connection with the server. Nurse call buttons which are located or annexed at the wall or in the toilet still do not give full security quantification and accommodations [7].

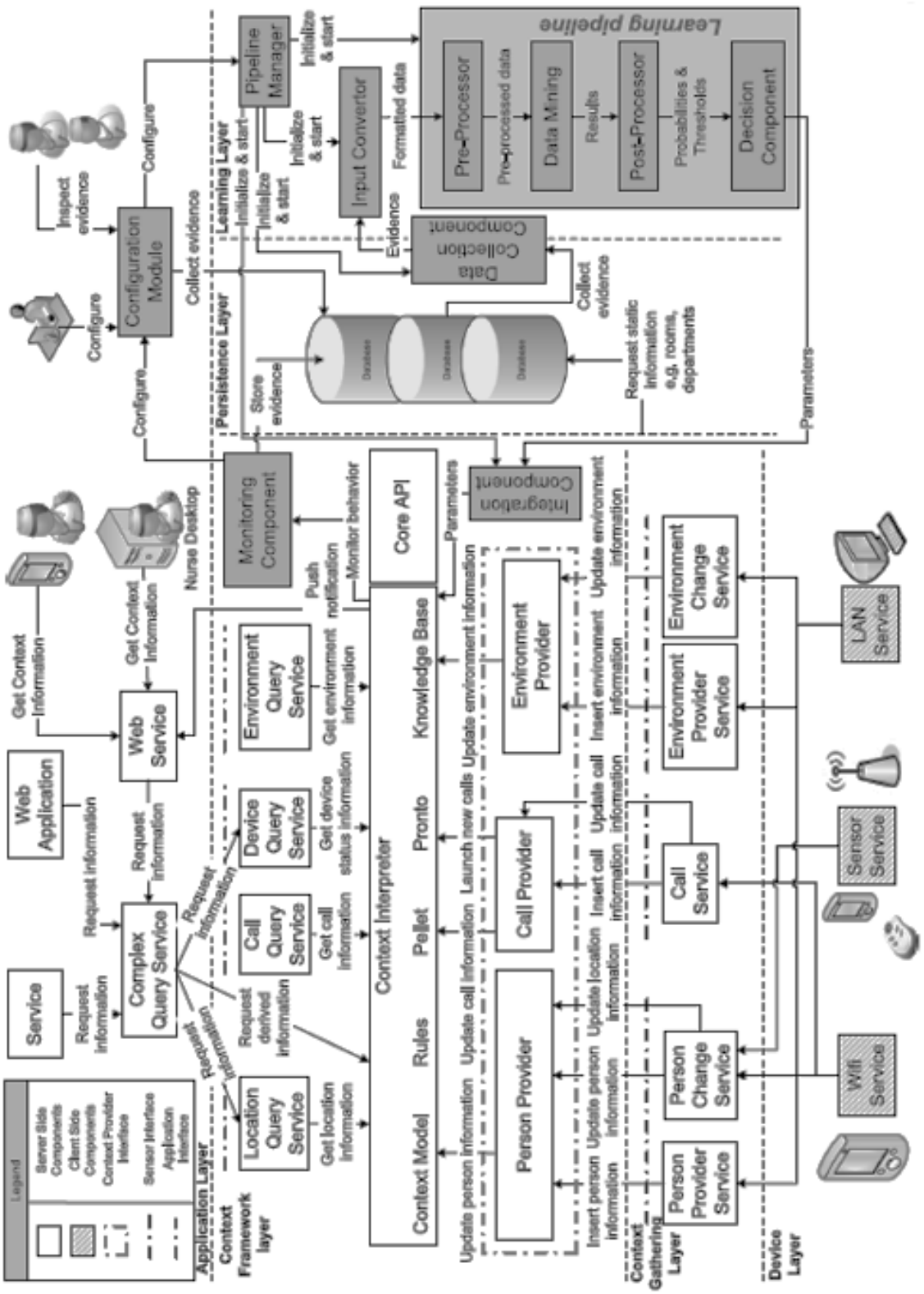


Fig. 2 - A self-learning component [2]

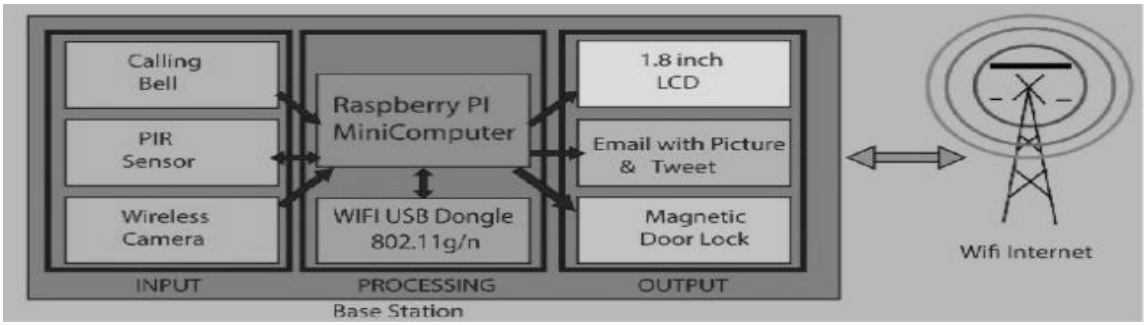


Fig. 3 - Security notification system block diagram [6]

2. Methodology

For the project methodology, this system was firstly built by designing the system. The idea came out when the Internet of things (IoT) was first became famous in Malaysia. Integration of IoT in the hospital security system will benefit many people. In order to make the system successful, hardware and software needed to be required. In software development, the selection of application used and web service application chosen were important in order to make sure that the system was a success. In the hardware part, the right combination of sensor, microcontroller and output software/hardware made the system easier to be developed as shown in Figure 4. At last, both software and hardware were combined and in the end, the analysis was made.

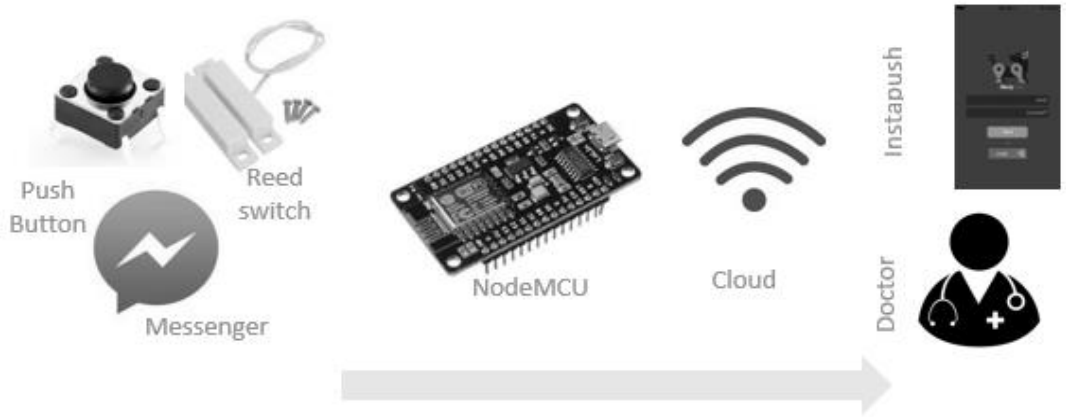


Fig. 4 - Project system architecture

2.1 Application Services

The application services service is an important medium to connect users to the website created by them. For this project http://instapush.im/ was used as an application for this project. The Instapush, is an application that can provide push-notification services between the controller and user through internet connection. This application was suitable to be used in this project because it provided many types of language of API services that were used to connect the controller with the server. Figure 5 shows the instapush web application website.

The ‘push message’ had to be programmed as the message that was going to be sent to the user. It was then linked to the tracker status so that it would appear in the push notification message correctly. For an example, if the tracker was programmed as ‘status’ then the push massage would have been notified to link the trackers as ‘{status}’. In order to connect the web application with the controller program, it could only be done inside the controller program.

Another web service application was a RETE IoT platform which was used as the medium to connect the CHATFuel application with Facebook messenger. RETE IoT was used as the main server to connect the microcontroller API with the chatfuel application. Figure 6 shows the chatfuelJSON API application.

From Figure 6, there are some function blocks referring the situation needed by the user. For this system, illustrated in the Figure 6, each block was built for both emergency protocol and no emergency protocol which will be linked with the hardware using JSON API console. Using RETE IoT application, the blocks of both situations were stated in two conditions, either ON or OFF.

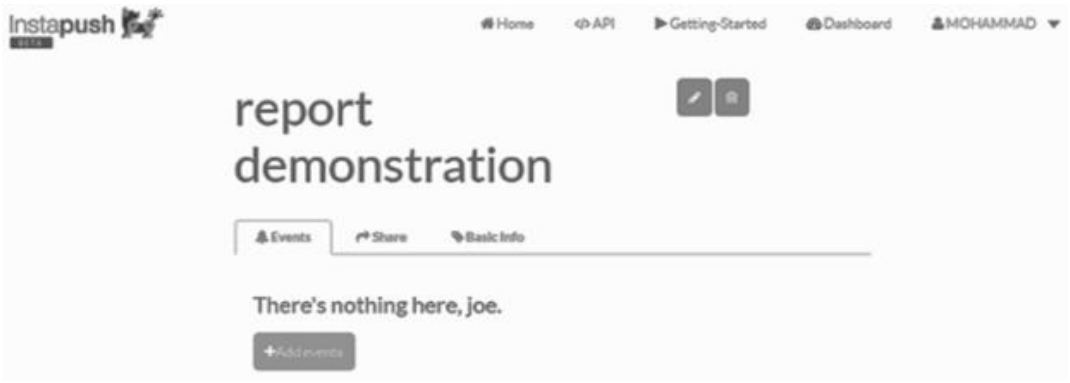


Fig. 5 - Instapush web application

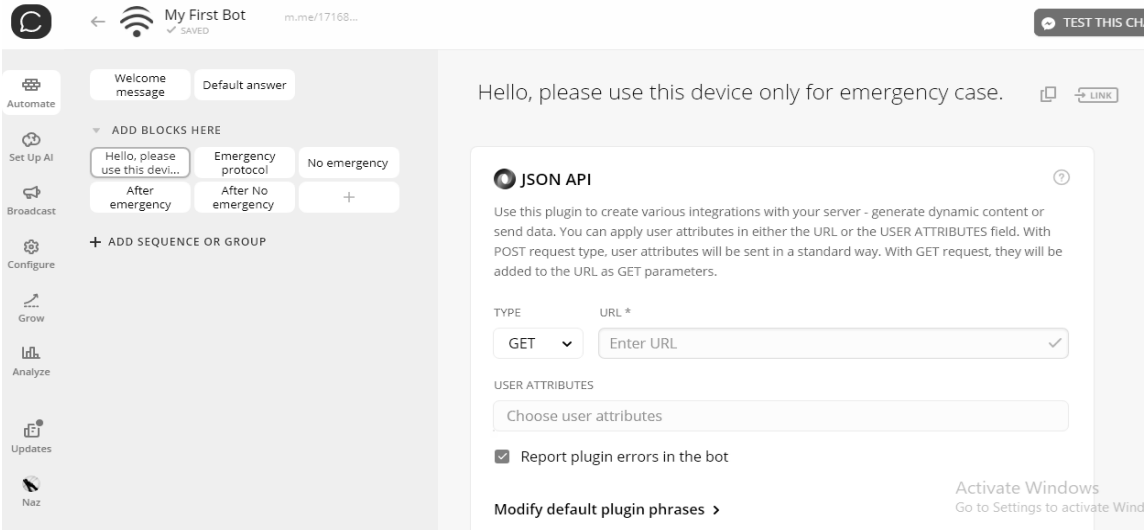


Fig. 6 - ChatfuelJSON API application

2.2 Microcontroller

The NodeMCU is a combination of Arduino UNO and ESP8266 that provided access to the GPIO (General Purpose Input/Output) subsystem. In this project, the connection between the microcontroller and the application had to be made through the program. Arduino IDE provided a programming tool through Arduino IDE application as shown in Figure 7. All the project programs were coded and compiled before being uploaded to the microcontroller.

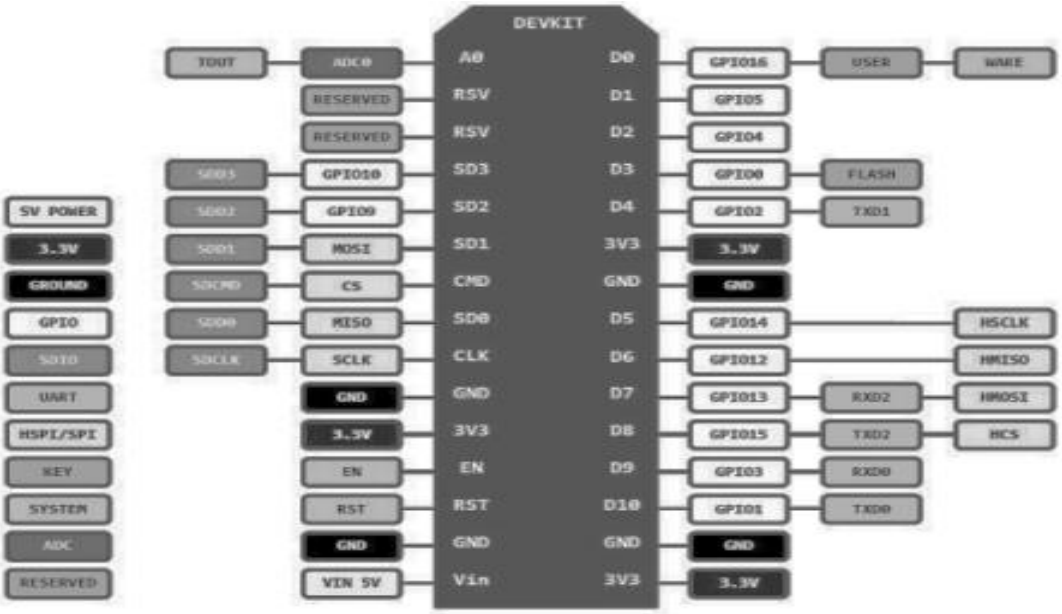


Fig. 7 - NodeMCU description

For this project, the pins used were the Vin and GND buttons, which were used for the voltage supply to turn on the microcontroller. Pin D5, GND and 3V3 were used to connect the microcontroller to the sensor. For pull-up connection, the 3V3 had to be connected to the input pin so it could control the microcontroller, either to be switched ON or OFF. Digital 5 pin was chosen as the sensor pin because the pin was located near to the ground and voltage pin, so it was easy to make a pull up connection.

The controller had to make a HTTP request, which used ESP 8266 as the user agent. The host for this application had already fixed which was the 'api.instapush.im'. If the application accepted this request, it would have read the instapush app-id (ID) and also the instapush secret (password). For this project program, it only triggered notification once at a time. This means that the controller only triggered the output once after it had been switch on. This project was programmed in this way so that it could reset the connection each time after it triggered the output for better connection and real-time data execution.

3. Results and Discussion

The push notification was sent when the sensor was triggered. However, there was some time delay before the application received the push notification. Basically, the delay was determined by the internet network speed. The faster the internet connection, the less the delay would be. Figure 8 shows the push notification circuit. It is small enough to be a portable prototype and can be used by the patient. Figure 9 shows the nurse call system prototype which consists of one input and two outputs. The outputs were the light emitting diode (LED) and also the buzzer. Both of these outputs were enough to trigger the doctor in charged.

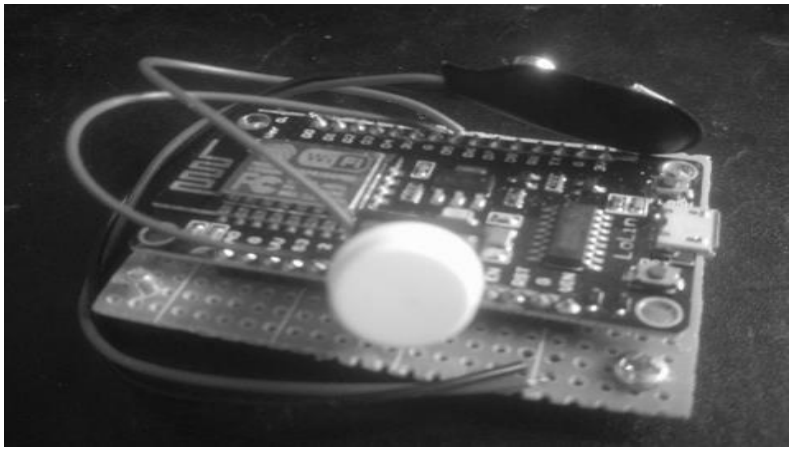


Fig. 8 - Push notification prototype

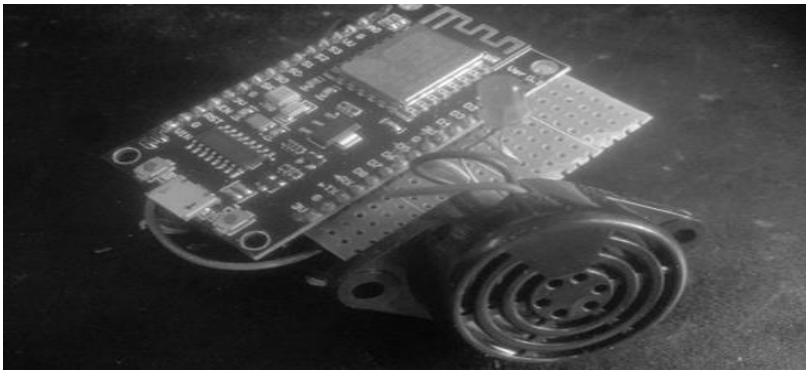


Fig. 9 - Nurse Call system prototype

The web service application could be accessed through the website and also a smartphone. Figure 10 shows the instapush output from the website application.

In instapush web application, the notification output was sent for both of the applications; the website and also the smart phone application. The difference between both outputs was that the push notification from the smart phone was way faster and in real time notification. Meanwhile, in the web-service application, the page needed to be reloaded or refreshed in order to receive the notification.

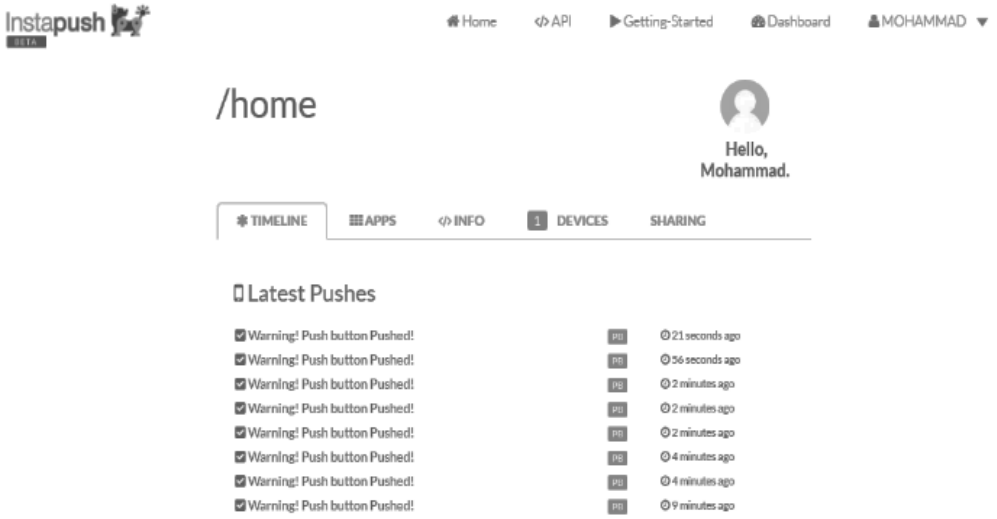


Fig. 10 - Instapush website output notification

Instapush application provided real time push notification. Using NodeMCU as the microcontroller, the sensors which were the reed switch and push button that switched the prototype on and off. For security door system, when the door closed, the pull-up connection on the NodeMCU switched off the microcontroller. When the door opened, the microcontroller was switched on, connecting it to the Wi-Fi. Then the system was connected to the instapush server before the push notification signal was sent to the GUI application. After the push notification had been sent, the system closed the connection with the server but the microcontroller was still connected to the Wi-Fi. It took some time for the microcontroller to connect to the server. So, the sensor should not be pushed many times as it would reset the connection. It also delayed the connection between the microcontroller, the Wi-Fi and the Instapush server.

The same process happened with the push button system. The difference is, when the push button was pressed, the pull-up connection switched off the Microcontroller until the push button was released. As the push button was released, it reset the connection of the microcontroller to the server and resent the signal to the server for push notification through Wi-Fi medium of communication.

Different process happened to the nurse-call-system. The nurse call system used Facebook messenger to send a signal to the microcontroller, light up the LED and switch the buzzer on. The process happened as mentioned in previous chapter. It was used to notify the doctor that he was needed in the ward. The prototype was portable and could be carried anywhere as long as it had its registered Wi-Fi connection. The voltage entering the circuit was 3.04V and enough to supply the output of the circuit as illustrated in Figure 11.

In order to make sure that the circuit was stable and safe to be used, the analysis of the circuit power supply was using oscilloscope. In order to operate this system, a maximum of 5V of DC power supply was used. This type of power supply made it safer to be used and the mass of the power supply was low so it was more suitable to be used as a portable device.

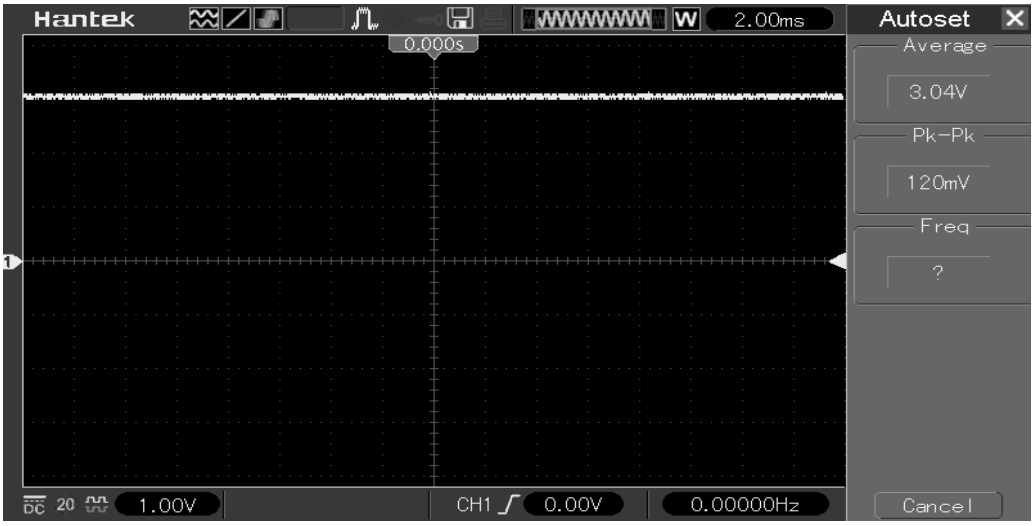


Fig. 11 - Operating voltage for nurse call system

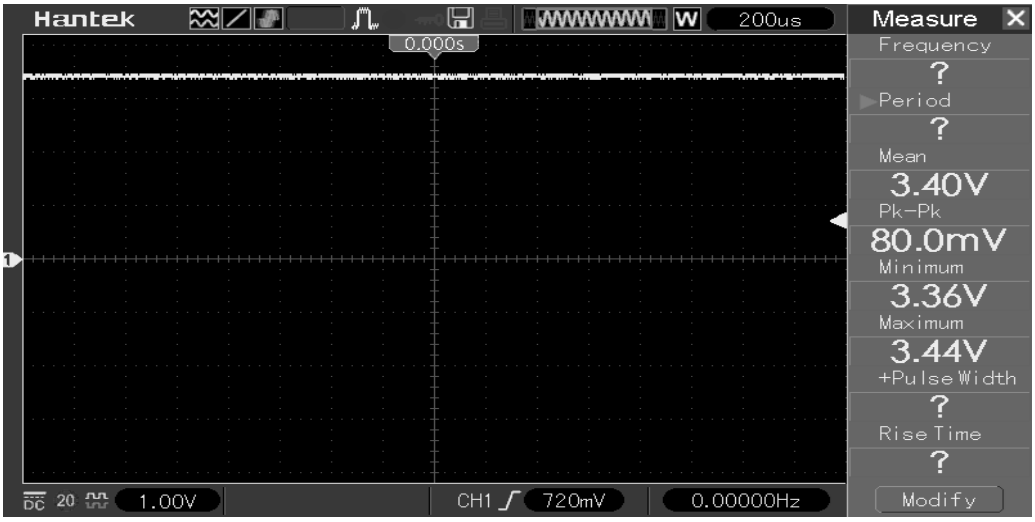


Fig. 12 - Voltage supply for the push notification system circuit

Figure 12 shows the voltage flow from the microcontroller which was operated in 3.4V and was enough to send a signal to cloud. Meanwhile, Figure 11 shows the nurse call system voltage supply of 3.04V. When the signal was sent from the Facebook messenger, it triggered a signal to the microcontroller. The microcontroller then provided 3.04V into the outputs which were the LED and buzzer. The system did not stop until the cancel button was triggered from the transmitter. It was continuously looping and it could only be stopped when the user called for the stop button.

Basically, the range of connection depended on the Wi-Fi router. In this situation, the router of D-Link DSL-2750EADSL2+ 4 Port Wireless N 300M Router Modem (2 x 5dBi Antenna) was used. The results of the connection test are as shown in Table 1.

For the sensor sensitivity, Reed switches are a mechanical device with magnetic moving parts. It consists of two ferromagnetic wires separated by a small gap. In the presence of a magnetic field that is parallel to those wires, they will touch each other, making electrical contact. In other words, the magnetic axis of the magnet should be parallel to the long axis of the reed switch. The range of sensitivity depends on the tolerance of the magnetic field between those sensors. In this project, the range of sensitivity is shown in Table 2.

In this project, the limitation of the project was the Wi-Fi connection. From the analysis above, it shows that the distance of the project and the Wi-Fi router affected the prototype process. Wi-Fi router distance had to be higher depending on the work range of the hospital ward. Secondly, the security of the internet-of-thing (IoT) still remains as the limitation in every IoT project. The security system is easily breached. In future study, the security of the system needs to be enhanced because it is connected to the safety of the patient itself.

Table 1 - Table of the connection versus the distance

Distance (m)	Connection
30	Yes
60	Yes
90	Yes
120	Yes
150	Yes
180	Yes
210	Yes
240	Yes
270	Yes
300	No
330	No
360	No

Table 2 - Graph of reed switch sensitivity

Distance (m)	States
0.2	Off
0.4	Off
0.6	Off
0.8	Off
1.0	Off
1.2	Off
1.4	Off
1.6	On
1.8	On

Thirdly, the data storage (cloud storage) was not too specific in this project. It means that the data storage in terms of the period of the transducer used and the number of user are important in order to enhance the security itself. In case of emergency, the data plays as the most important role to every investigation. Single bedrooms are privacy rooms created for special patients. There is no other visual monitoring except for the caretaker and in-charged hospital staff. So the data is important in any case of emergency.

Then, the project sensor had its own limitation. The sensor could not be used in short period of time as it took time to connect with the server. In pull up connection, the sensor toggled the states of the microcontroller. When the microcontroller was switched on, it took some time to be connected to the Wi-Fi and sent signal to the cloud. For nurse-call-systems, it did not take much time to respond because it was already connected to the server as it did not apply pull up connection.

Last but not least the limitation of this project was the portable power supply. In this project, 9V DC battery was used for one system. The power voltage was enough to operate the system well. However, the endurance of the power supply was not the same as it was reduced especially when it involved Wi-Fi connection which consumed more power than the offline connection. Power supply needed to be monitored periodically before being used in order to get a fully functional system.

4. Conclusion

In conclusion, in order to fulfil the proposed objective of the project, two sensors were used which were the reed switch sensor for the door security system and also the push button for the nurse call button. Both of these sensors were used as the inputs for the microcontroller which was the NodeMCU. The other system was the nurse-call-system which used Facebook messenger as the medium to communicate with the microcontroller.

The microcontroller was programmed to connect the hardware to the cloud. The application services used were instapush, Chatfuel and ReteIoT. Instapush is an application that can send a push-notification to the user using internet connection. There were several steps to link the microcontroller with the instapush. Meanwhile the ReteIoT was the medium to link the microcontroller with the Chatfuel bot chat system. The medium to transfer the signal was the Wi-Fi module, ESP8266. ESP8266 was connected to the Wi-Fi and sent signal to the server before the application sent a push notification to the caregivers and also the hospital authorities.

For push button system, it was developed to be portable, wireless and also waterproof as it was attached to the patient. Besides that, the door security system was developed to trigger the user if the door had been opened either by the hospital authorities or strangers. The nurse call system was used to notify the doctor in charged if there were any cases of emergency. Other than that, this device would generate better security for the patients especially for patients who are staying in single room wards.

References

1. Symantec World Headquarters, White paper: Best Practices Series for Healthcare. “Security and Privacy for Healthcare Providers”, Dec, 2009.
2. DemkeOngenae, Maxim Claeys, WannesKeckhove, Thomas Dupont, Piet Verhoeve, Filip De Turck: “A Self-Learning Nurse Call System”, Computers in Biology and Medicine, 2014, pp. 110-123.
3. Gruber T: “A translation approach to portable ontology specifications KNOWLACQUIS” 1993, pp. 199-220.
4. L. Bass, P. Clements, R. Kazman: “Software Architecture in Practice”, 2nd edition, Addison-Wesley Professional, 2003.

Development of Anti-Theft Monitoring System in IoT Environment

Farhana Ahmad Poad[1*], Jusrorizal Fadly Jusoh[2] and Muhammad Iqmal A Ghani[1]

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA

[2]Jabatan Teknologi Maklumat dan Komunikasi,
Politeknik Sultan Abdul Halim Muadzam Shah
farhana@uthm.edu.my

1. Introduction

RFID is a technique of transmitting and receiving data wirelessly through electromagnetic transmission between two mobile devices, called an interrogator or an RFID reader and a transponder or an RFID tag. A standard RFID system consists of three major components: tags, reader, and middleware software acting as an interface between user and RFID system. Generally, RFID technology uses radio waves to transmit data from the reader to the tag, in return, reader will receives the modulated returned echoes from the tag via the reader. The tag modulates the electromagnetic waves and send the data back to the reader. RFID tags are classified into two broad categories: passive and active. Passive tag, operating without a battery, reflect the RF signal transmitted to them from reader and add information by modulating the reflected signal. In contrast to active tag, it contains a radio transceiver powered by an embedded battery. Due to the onboard radio, active tags have a longer working range than passive tag.

WSN on the other hand provide limitless potentials for the RFID with the capabilities to work in multi-hops environment that possibly extends the operation of RFID in a larger area. Consequently, by incorporating the RFID and WSN technologies on a single platform, the disadvantages of each technology can be overcome and the advantages can be combined and utilised in some important applications. Since, the proposed work is focused on developing an anti-theft monitoring system, therefore a literature study on previous development conducted by other researchers are gathered and summarised in Table 1.

Table 1 - Review of previous work

Author	Technology	Mobile	Mesh Network	M2M	Sensor	Real Time	Long Range	Integrated Platform	Latency
Animal Situation Tracking Service Using RFID, GPS, and Sensors [1]	Active RFID, GPS and Sensor	Yes	No	Yes	Yes (Temperature)	Yes	No	Yes	Not Stated
Bicycle management systems in anti-theft, certification, and race by using RFID [2]	Passive UHF RFID, GPS and GSM	Yes	No	Yes	No	Yes	No	Yes	Not Stated
Design and implementation of RFID-based anti-theft system [3]	433 MHz Active RFID and Motion Sensor	Yes	No	Yes	Yes (Motion)	Yes	Yes	Yes	Not Stated
Motion sensitive RFID in wireless sensor network platform [4]	2.4 GHz Active RFID and WSN	Yes	Yes	Yes	Yes (Motion)	Yes	Yes	Yes	> 1s
Vehicle anti-theft tracking system based on Internet of things [5]	Passive RFID, GSM and Android Mobile Phone	Yes	No	Yes	No	Yes	No	Yes	Not Stated
Design and implementation of anti-theft module for ATM machine [6]	Rapsbery Pi, Fingerprint module and Embedded Web Server, CCTV	No	No	Yes	No	Yes	No	Yes	Not Stated
Improving motorcycle anti-theft system with the use of Bluetooth Low Energy 4.0 [7]	Bluetooth Low Energy (BLE) 4.0, Passive RFID	Yes	No	Yes	No	Yes	No	Yes	Not Stated
An RFID Based Smartphone Proximity Absence Alert System [8]	Low Power Passive RFID, Samsung Galaxy Note 2 Mobile Phone	Yes	No	Yes	Yes (Accelerometer)	Yes	No	No	Not Stated
Anti-theft and tracking mechanism for vehicles using GSM and GPS [9]	GSM and GPS	Yes	No	Yes	No	Yes	No	Yes	Not Stated
Proposed System	2.4 GHz Active RFID and WSN	Yes	Yes	Yes	Yes (Vibration)	Yes	Yes	Yes	<1s

From the review, it can be seen that most of the systems are not using active RFID and WSN as their main technology and unable to work in wireless mesh network environment with short range communication between transmitter and receiver. In addition, the latency between transmission and reception is not a major concern in their work which will reduce their overall system performance. Therefore, an anti-theft monitoring system that combining 2.4 GHz active RFID, WSN and vibration sensor is proposed to real timely monitor the movement of an equipment placed inside laboratory. The system provides a unified mesh networking between tag and reader which able to perform transmission and reception in long range communication (unlimited range with hopping technique) with improved algorithm that provides low latency less then 1s. The proposed system consist of embedded active RFID tag with motion sensor and a modified active RFID reader communicating in WSN environment as shown in Figure 1. It is capable to monitor objects in indoor and outdoor environment with machine-to-machine (M2M) capabilities. It merges 2 great technologies which are RFID and WSN on a single platform that are controlled by a single processing unit.

The main contribution is on the system design, development, implementation and testing of the proposed RFID system to evaluate the system effectiveness. Table 1 shows a brief description of previous inventions done by other inventors related to the anti-theft application. It is shown that the proposed RFID system is better than other patented systems since it is designed with an ability to track and monitor the movement of object in indoor and outdoor environment on the same platform.

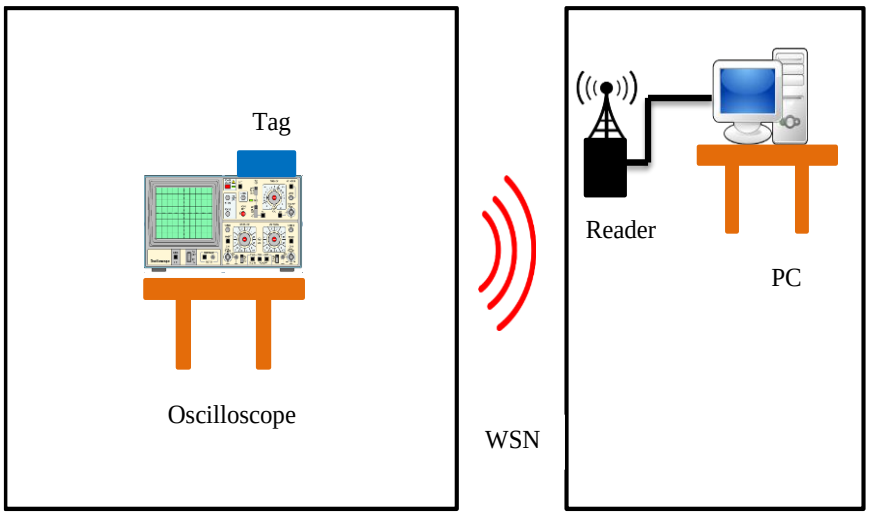


Fig. 1 - Overview of the anti-theft monitoring system

2. System Development

The proposed active RFID system for anti-theft application combines both active RFID, ZigBee and sensor technologies to provide identification, extend the capabilities of existing RFID system and sense the environment that complied with ISO 18000, Part 4 (2.45 GHz) standard. The RFID system components use a unified wireless mesh-networking infrastructure to trace and monitor object in indoor and outdoor environments which can reduce difficulties of implementation and provide reliable identification reporting. The system comprises of three categories which are hardware, software and network development which will be explained in the later subtopic.

3. Hardware Architecture

The proposed system hardware architecture comprises of 2 parts which are tag and reader. Basically, the proposed system works by detecting the movement of equipment using motion sensor. Once the movement is detected by the sensor, it will trigger the embedded active RFID tag from sleep state mode to wakeup mode. The embedded tag will process the information given by motion sensor before sending the information along with unique identification number to the reader via WSN platform. The information will be converted into meaningful information before display on the Graphical User Interface (GUI) and save into data logger system. The embedded active RFID tag will turn into sleep mode once the communication between tag and reader is completed and only wakeup if receiving interrupt from the motion sensor to conserve the energy. Figure 2 shows the embedded active RFID tag with vibration sensor utilizing Arduino Uno platform that is powered by 12 V battery. In this work, the tag will be attached to the equipment to be monitored in the laboratory.

As for tag, the active RFID reader circuit as shown in Figure 3 consists of a RF transceiver connected to USB serial communication. The reader is connected to the monitoring station to display data during transmission and reception process.

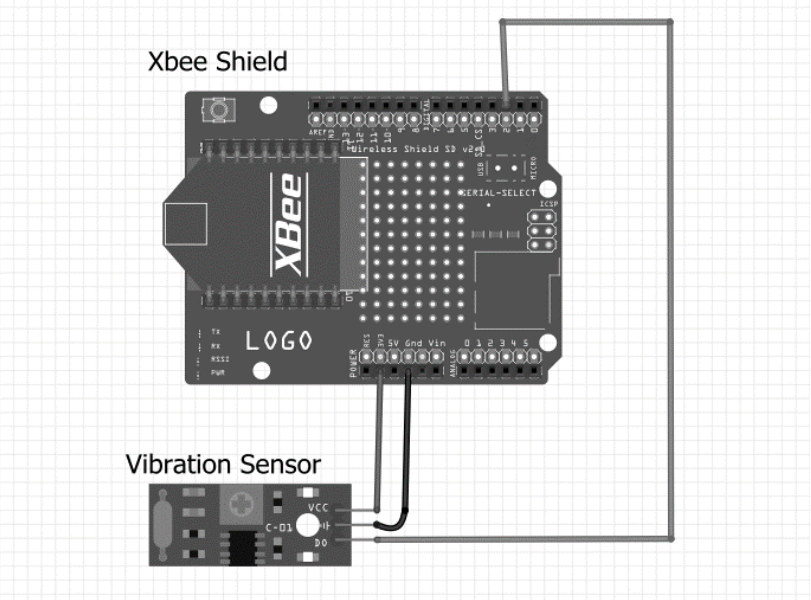


Fig. 2 - The circuit diagram of the tag section of the system

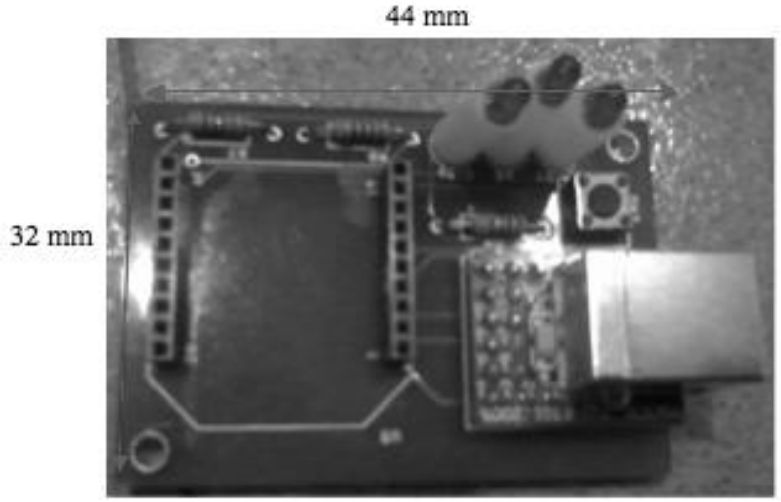


Fig. 3 - The circuit diagram of the reader section of the system

4. Software Architecture

Machine to machine (M2M) communication is a unique deployment that can be used for remote monitoring and to describe any technology that enables networked devices to exchange information and perform actions without the manual assistance of humans. There are five basic stages of communication are implemented in the proposed active RFID system as shown in Figure 4. The first stage refers to the reception of data from the vibration sensor. The data received from the vibration sensor is in the form of digital number "0" (not vibrate) and "1" (vibrate).

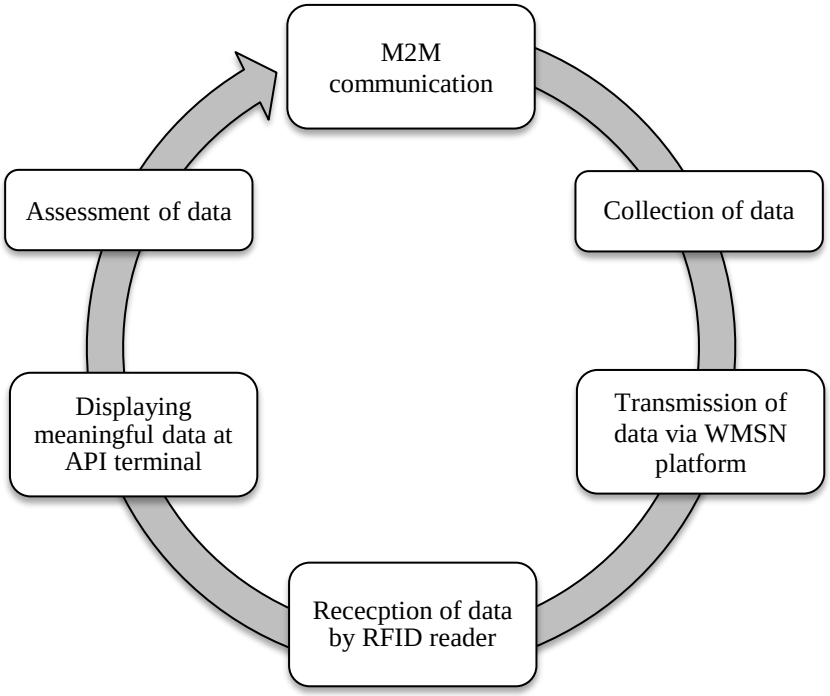


Fig. 4 - M2M stages for proposed system

When the sensor detects vibration or movement, it will trigger the microcontroller and wakeup the system before collects and processes the data from the vibration sensor. The tag send the information in real time through wireless mesh network to the RFID reader. In this case the ZigBee platform based on IEEE 802.15.4 standard for the communication of 2.4 GHz is used in mesh network architecture. The tag will enter sleep mode when there is no vibration or movement detected by the sensor to conserve energy since it is powered by a battery. The data received by the reader is transferred via USB port communication and is processed into meaningful data before displayed on GUI and saved into data logger system. The goal of this communication method is to automate the process of collecting data to user and machine remotely. The overall active RFID system working mechanism as shown in Figure 5.

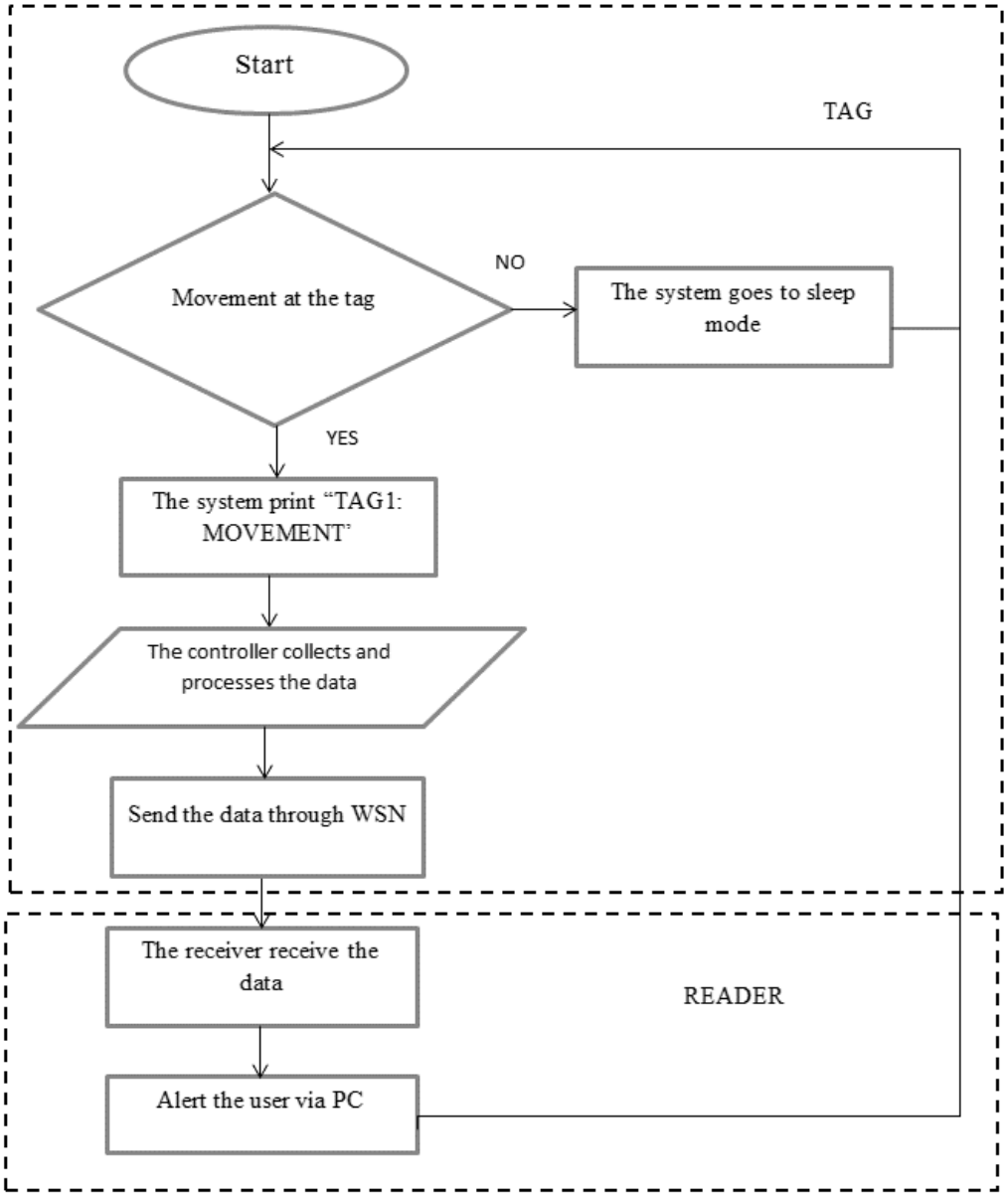


Fig. 5 - Overall active RFID system working mechanism

5. Network Architecture

For the purpose of developing a communication network that suits the application requirements, a point-to-point (P2P) communication test is conducted between one RFID tag and one RFID reader to confirm that the proposed active RFID system components are functioning well before going in depth to complex network. The successful of transmission or reception totally depends on the speed of data transmission, PAN ID and channel applied in the WMSN network. Figure 6 illustrates the testing configuration for the proposed active RFID system.

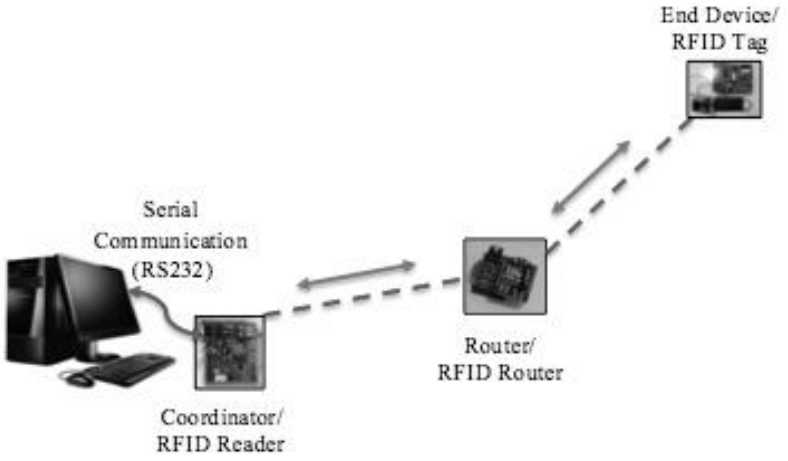


Fig. 6 - Basic ZigBee mesh network configuration

6. Monitoring System

The monitoring system consists of an active RFID reader connected to a Personal Computer (PC) that is link to a GUI developed using Visual Basic (VB) software to view, store and retrieve the incoming and outgoing data easily. The GUI will alert user if there is any movement of equipment based on the data given by the vibration sensor. The sequences of data displayed is based on the format as "DD-MM-YYYY HH:MM:SS:SSS TAG#: STATUS". Figure 7 shows the GUI terminal developed in the proposed active RFID system.

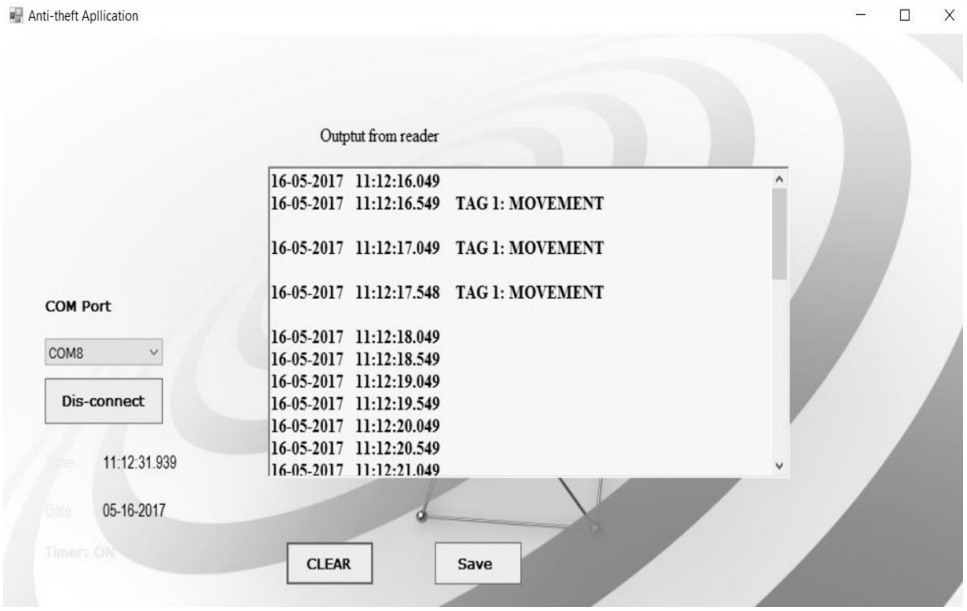


Fig. 7 - GUI using Visual Basic software

7. Performance Analysis

Several tests are conducted to evaluate the performance of develop system including power consumption and tags collection time. The results of the following evaluation are explained accordingly in each subtopic.

7.1 Power Consumption

The power consumption of the developed system is tested by measuring the current usage during wakeup and sleep mode. The current is measured by using multimeter that is connected in series with the power supply (9V battery) and Arduino. While, the voltage is measured from the supply voltage. The output of the measurement in the form of current and voltage are indicates in Table 2 which is measured for 10 times to get the average value of current and voltage.

Table 2 - Result for voltage and current in wakeup mode

No	Voltage (V)	Current (mA)
1	12.17	182.9
2	12.20	187.3
3	12.22	188.5
4	12.23	183.7
5	12.22	180.9
6	12.24	186.7
7	12.19	181.2
8	12.23	183.5
9	12.15	188.6
10	12.22	184.2
Average	**12.21**	**184.75**

Therefore, power is calculated by using $P = IV$ from the measured current and voltage, while the battery life is obtained by assuming that the efficiency of the system is 70 % after taking into account the external factor that might reduce the performance of the system.

$$P = VI = (12.21\ \text{V}) \times (184.75\ \text{mA}) = 2.26\ \text{Watts} \quad (1)$$

$$\begin{aligned} \text{Battery Life} &= (\text{Battery Capacity in mAh/ Load Current in mA}) \times \\ &\quad 0.70\ \text{efficiency} \\ &= (2000\ \text{mAh} / 185.3\text{m}) \times 0.7\ \text{efficiency} \quad (2) \\ &= 7.57\ \text{hours} \end{aligned}$$

The sleep mode is introduced in the algorithm to save more power as the tag of system uses batteries to power up the circuit. The connection is similar from the previous test. The value of current and voltage measured is stored in Table 3. The system will wake up if there is movement detected from the sensor and return back to the sleep mode after the task is carried out.

Table 3 - Result of voltage and current in sleep mode

No	Voltage (V)	Current (mA)
1	12.22	153.04
2	12.23	151.2
3	12.31	154.6
4	12.33	157.6
5	12.22	155.8
6	12.23	155.9
7	12.22	152.4
8	12.19	153.6
9	12.20	153.5
10	12.18	154.3
Average	**12.233**	**154.194**

The value of current during sleep mode is in between 152 mA to 158 mA and when the interrupt function is activated in the system, the value of current rises up to194 mA. The battery reading during sleep mode is 12.23 V. Thus, power can be calculated from the recorded value. As previous, the battery life time is obtained by assuming that the efficiency of the system is 70 % after taking into account the external factor that might reduce the performance of the system. Thus, the power is equal to 1.88 W and battery live increase to 9.07 hours.

The total power saved during sleep mode is calculated as shown in equation (3).

$$\% \text{ Power saved} = \frac{P1-P2}{P1} \times 100\ \% \qquad (3)$$

$$\% \text{ Power saved} = \frac{2.26-1.88}{2.26} \times 100\ \% = 16.81\% \approx 15\ \%$$

7.2 Tags Collection Time

The tags collection time is the time taken for the reader to receive the response starting from sensor detect vibration, process the input, sending to the reader and received acknowledgement. The configuration of tags collection time measurement is shown in Figure 8, while the platform used to capture the tags collection time in milliseconds (ms), which is later saved in the data logger shown as in Figure 7.

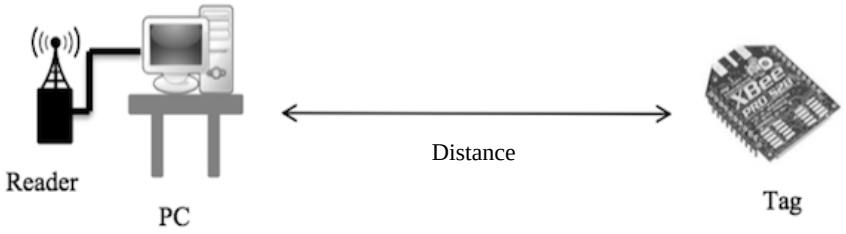


Fig. 8 - Tags collection time configuration

The measurement are taken for 5 times and the average value of tags collection time is obtained which indicates the time it takes to complete the transmission and reception between tag and reader. From the results shown in Table 4, it can be seen that the average latency is about 190 ms, which indicates that the tag takes a short amount of time to complete the transmission and reception compared to the work done by [4].

Table 4 - Tags collection time

No	Latency (ms)
1	189.92
2	190.00
3	190.08
4	190.00
5	190.00
Average	**190.00**

8. Conclusion

A prototype of the 2.4 GHz embedded active RFID for Anti-Theft Application utilizing Wireless Sensor Network (WSN) platform has been designed, developed and tested. The system able to detect any object movement using vibration sensor, send the movement data from the tag through WSN platform to RFID reader located at monitoring station to be displayed on the GUI and saved into data logger system. The project is successfully developed using the Arduino, 2.4 GHz RF transceiver and vibration sensor, while the GUI is developed using Visual Basic software. The power consumption of the tag is approximately 2.26 W during wakeup mode and 1.88 W during sleep mode. The percentage of power saving when the system enter the sleep mode is approximately 15%. The battery lifetime is about 7.57 hours during wakeup mode and 9.08 hours during sleep mode with 70 % efficiency. The average tags collection time is about 190 ms per transmission which is better than previous system developed by other researchers [4].

References

1. S. H. Kim, D. H. Kim and H. D. Park, "Animal Situation Tracking Service Using RFID, GPS, and Sensors," *2010 Second International Conference on Computer and Network Technology*, Bangkok, 2010, pp. 153-156.
   doi: 10.1109/ICCNT.2010.40
2. Kun-Ying Lin, Ming-Wei Hsu and Shi-Rung Liou, "Bicycle management systems in anti-theft, certification, and race by using RFID," *Proceedings of 2011 Cross Strait Quad-Regional Radio Science and Wireless Technology Conference*, Harbin, 2011, pp. 1054-1057.
   doi: 10.1109/CSQRWC.2011.6037138
3. S. B. A. Hamid, A. Diyana Rosli, W. Ismail and A. Z. Rosli, "Design and implementation of RFID-based anti-theft system," *2012 IEEE International Conference on Control System, Computing and Engineering*, Penang, 2012, pp. 452-457.
   doi: 10.1109/ICCSCE.2012.6487188
4. F. H. Mohd Zanal and W. Ismail, "Motion sensitive RFID in wireless sensor network platform," *2013 IEEE International Conference on RFID-Technologies and Applications (RFID-TA)*, Johor Bahru, 2013, pp. 1-5.
   doi: 10.1109/RFID-TA.2013.6694533
5. Z. Liu, A. Zhang and S. Li, "Vehicle anti-theft tracking system based on Internet of things," *Proceedings of 2013 IEEE International Conference on Vehicular Electronics and Safety*, Dongguan, 2013, pp. 48-52.
   doi: 10.1109/ICVES.2013.6619601
6. P. More and S. Markande, "Design and implementation of anti-theft module for ATM machine," *2016 International Conference on Inventive Computation Technologies (ICICT)*, Coimbatore, 2016, pp. 1-4.
   doi: 10.1109/INVENTIVE.2016.7830141
7. W. Koodtalang and T. Sangsuwan, "Improving motorcycle anti-theft system with the use of Bluetooth Low Energy 4.0," *2016 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS)*, Phuket, 2016, pp. 1-5.
   doi: 10.1109/ISPACS.2016.7824705
8. M. J. Hussain, L. Lu and S. Gao, "An RFID Based Smartphone Proximity Absence Alert System," in *IEEE Transactions on Mobile Computing*, vol. 16, no. 5, pp. 1246-1257, May 1 2017 . doi: 10.1109/TMC.2016.2591524
9. M. Geetha, T. Priyadarshini, B. Sangeetha and S. Sanjana, "Anti-theft and tracking mechanism for vehicles using GSM and GPS," *2017 Third International Conference on Science Technology Engineering & Management (ICONSTEM)*, Chennai, 2017, pp. 252-255.

Fire Alarm Smart System Technology (FASTech)

Sharifah Saon[1*], Amirrul Atiman[1] and Abd Kadir Mahamad[1]

[1]Faculty of Electrical and Electronic
Engineering,
Universiti Tun Hussein Onn Malaysia,
Batu Pahat, 86400, Johor,
MALAYSIA
sharifa@uthm.edu.my

1. Introduction

Fire alarm system is the most essential elements of building's safety systems. This is one of the protection systems that can be used to safe human life from the fire strikes in the building whether at home, warehouse, office or etc. Not only to save lives when fire strikes happen but, it is often regulate other systems in the building and able to save huge amounts of money by reducing damage to the building structures and the appliances. Besides that, fire alarm system also contribute in reducing environmental damage cause from fire accident. The first action toward halting a fire is identifying the incident properly, raise the occupant alarm and then notify the incident to professional's emergency response. This is often functioning of fire alarm system and fire detection. Several system types and option are available depend on the specific characteristics of the protected space.

The existing fire alarm system can be categories into two, which are conventional and addressable. Conventional fire alarms are ideal for small buildings such as individual offices, retail shop or residential [1]. The system activated automatically when smoke or heat are detected and warn people in the building. Almost all countries are using a set of conventional fire alarm control panels and detectors as fire alarm systems because it is economic compare to addressable fire alarm control panel. The traceable fire alarm system able to trace the exact location of a fire, detect multiple fires location that may occur simultaneously and can be used with conventional detectors without disrupting the other detectors operation. The traceable fire alarm system consists of a traceable fire alarm control panels based on the conventional fire alarm control panels and a traceable heat detector based on the rate-of-rise spot-type conventional heat detector.

Addressable fire alarms are necessary for large building such as complexes, campuses or government offices. Addressable fire alarm systems are typically more complex than conventional [2]. An addressable fire alarm system provides user with a device that initiates status consist with network system. Addressable fire alarm devices identifying the type and location of fire strikes. They are depending on the data communication path which interconnects the fire alarm devices. Addressable fire alarm meets the requirements for the electrical supervision of field devices and it provides the means of identifying the point in a building where the alarm has been initially activated [3]. This makes the system ideal for large buildings and particularly commercial premises for all countries.

However, data from "JBPM Statistik Bilangan Kematian Dan Kecederaan Dalam Kes Kebakaran Dan Menyelamat Tahun 2011 Hingga 2015" posted by Fire and Rescue Department of Malaysia, 20% - 50% from the total number of fire accident victims in 2011 to 2015 are deaths [5]. In normal condition, time taken to escape from the fire strikes in the building, are estimated more than 20 minutes [6],[7].

However, the time taken for the survivors to escape from the fire may be the cause of death, as the fire spreads very quick. People do not know the nearest and safe path of the targeted exits way. This may cause people using wrong exit path and the best escape opportunity can be easily lost [8]. Beside that the probability of victims to escape from this accident is low [6]. Therefore, this project was aimed the Fire Alarm Smart System Technology (FASTech) that intelligently guide user to escape from the building trough nearest exit.

FASTech is an Internet of Things (IoT)-based intelligent fire emergency response system that detects smoke from fire strikes and alarming the people in a building, notify victims about the fire accident occurred through smartphone, and light up the exit pathway navigators that able to navigate the people in the building escape through the nearest and safe exit path. This system automatically stores the information about the fire accident when a fire strikes happen in the building. The information consists of date, time and location of the incident which then can be stored in cloud storage service online, along with collaboration of fire department.

2. A Review of Fire Alarm Technology

Fire alarm systems detect and warn people when smoke or fire is present. Common fire alarm system will activated automatically when smoke detectors or heat detectors is activated [9][10]. Smoke detectors is activated when smoke is present and heat detectors is activated if the temperature increase more than normal condition. Standard fire alarm system are using motorized bell to alarm people inside the building [10].

Conventional fire alarm systems able to be set up in zones with each zone hardwired to control panel [10],[11]. Lamp on the fire alarm control panel is shows as a zones, the lamp will light up once fire strike occur. These systems are using bells, electronic sounders or other audible devices as a sounder to warn people. These systems are inexpensive and require significantly less labour to install.

Other technology is called addressable fire alarm systems, which use digital encoding and multiplex technology to more accurately identify alarm location and device conditions [9][11]. Each fire alarm device in a system is programmed with a unique address [9]. When the detectors active, the devices address shows up on the main control panel to telling exact location of the activated detectors [9].

Wireless fire alarm systems are managed in simple installation [10]. These systems installed with no hardwire between the panel and devices. This also means that the system is easy to install at anywhere without any disturbances. It is a simple concept, that provides many unique benefits with a full of analogue addressable fire alarm system [12]. Most of the wireless fire alarm device are integrated with the smoke detector, horn and build in battery as a set of devices [13].

While, intelligent fire alarm system use advance devices to detects fire or smoke and warn people as fast as possible. This system easy to install at the small building or large building and the cost is effective. Besides that, this system can identify the location of a fire and it is easy for maintenance. The design of intelligent system to monitoring the situation of fire and the leakage of housing is based on microcontroller and sensor. Once there is encounter dangerous, it trigger the alarm system, same as system for intelligent residential burglary, fire, gas leakage prevention function so that protect residences from the loss of life and property [14].

In order to solve the problem of complex cabling, missing in declaration and alarm of traditional fire alarm system, an intelligent fire alarm system based on global system for mobile communications (GSM) network is designed [15]. Besides that, an intelligent system can use general packet radio service (GPRS) to send notification to user. GPRS is for long-distance wireless communications. GSM and GPRS send short message service (SMS) as a fire strikes notification, to the user. Compared with traditional fire detection alarm system, the system saves a lot cost of hardware and improves the efficiency of the fire detection alarm [16].

Nevertheless, IoT technologies is an intelligent system that is combination of electronic devices and system that has internet connection, gave an excellent opportunity. The system called IoT, need cloud computing to store or control data. While, cloud computing is a platform to store and share data with has internet connection by using electronic devices [17]. The information in cloud can be accessed everywhere at any time. Besides that, cloud is a safe place to store data due to security protection. This is one of the technologies that enables elasticity and provide flexibility of system deployment, dynamic, auto-provisioning and cloud management [18][19].

3. Research Methodology

Developing of this intelligent fire alarm system is divided into four phases; which are, Phase 1: design system architecture, Phase 2: develop the hardware circuit, Phase 3: programming development and Phase 4: develop building prototype.

3.1 Phase I: Design System Architecture

Figure 1 shows the operation flow of the FASTech system. Once the smoke detector triggered by the fire smokes, information automatically sends to the mobile phone application, showing location of fire. At the same time, the LED strip indicators that placed on the pathways of the building, automatically lighted up showing the safe and nearest escape and the buzzer was turn on. As an example, the fire strikes occurs at level 2 on left side of the building, the LED strip indicator lighted up the pathway toward exit path to nearest door at right side of building for level 2 and both side door for level 1 and ground level.

On the other hands, the fire incident information is recorded. The recorded data are the information of date, time, level of the floor and the location of the fire incident occurs. This data captured and recorded on the Blynk cloud. The data can be view at the smartphone Blynk application.

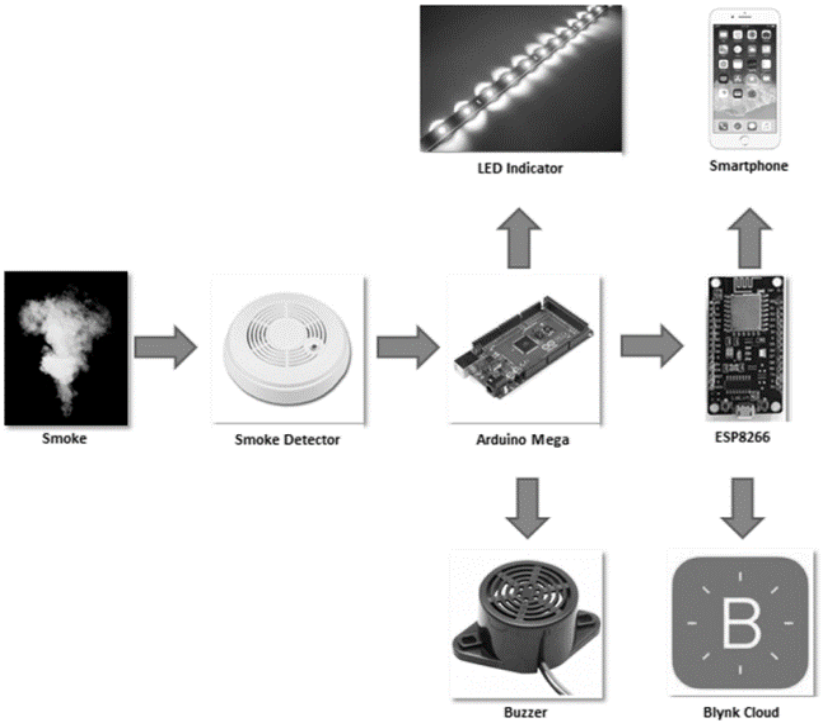


Fig. 1 - Diagram of the system

3.2 Phase II: Develop the Hardware Circuit

The main circuit of this project are power supply circuit, backup power supply circuit, LED controller circuit and buzzer controller circuit. Proteus 8 was used for the circuit simulation. Once the circuit was successful developed and tested on Proteus 8, circuit was printed on the transparent paper thus can be transferred on PCB board. UV light was used in order to transfer the printed circuit to the PCB board. Next, PCB board was placed to the developing machine to remove the dry film that not exposed to UV light. The process was continued with etching process for corrosive layer of cooper PCB which is not needed throughout the chemical process. Then PCB board was placed to the stripping machine for removal all dry film and then get the desired layout circuit. Once the process of the desired circuit layout on the PCB board was completed, components were soldered on the board properly to ensure the functionality of the circuit.

3.3 Phase III: Programming Development

Arduino are used for developing the program of FASTech system. The generated program is uploaded to the Arduino Mega 2560 board and ESP8266 NodeMCU module. Arduino Mega Board 2560 is used to control the whole system and ESP9266 is used to send data to the Blynk application.

Arduino Mega 2560 program is the main program of the FASTech system. In this program, 27 pins was declared and used as an input/output; which are 6 pins for input and 21 pins for output. The input pins A0 until A5 are used for smoke detectors. The digital output pins 30 until 43 and pin 50 are used for LED strips and buzzer. The others output pins are pins 44 until 49 used to send signal to ESP8266 NodeMCU module.

Program for ESP8266 NodeMCU module is setup to connect the system with the Wi-Fi and send notification to victims through smartphone. Besides that, ESP8266 was send data to Blynk apps for recorded on the database. Figure 2 shows the command to connect the ESP8266 with Wi-Fi. Character for SSID and PASS is important to allow ESP8266 connected with the Wi-Fi.

```
char auth[] = "6c5860987c644b6ca92ca673f7d2db16";
char ssid[] = "DiGi_Internet_00F5";
char pass[] = "digiwifi1234";
SimpleTimer timer;
```

Fig. 2 - Command to connect ESP8266 with Wi-Fi

3.4 Phase IV: Develop Building Prototype

There are three level of building prototype, which are ground level (GL), level 1 and level 2. Each level divided into two side, right (R) and left (L). The building prototype has two stairs at the left and right site of the building. The dimension of the building prototype is 39.5cm X 27.5cm X 51.5cm, as in Figure 3.

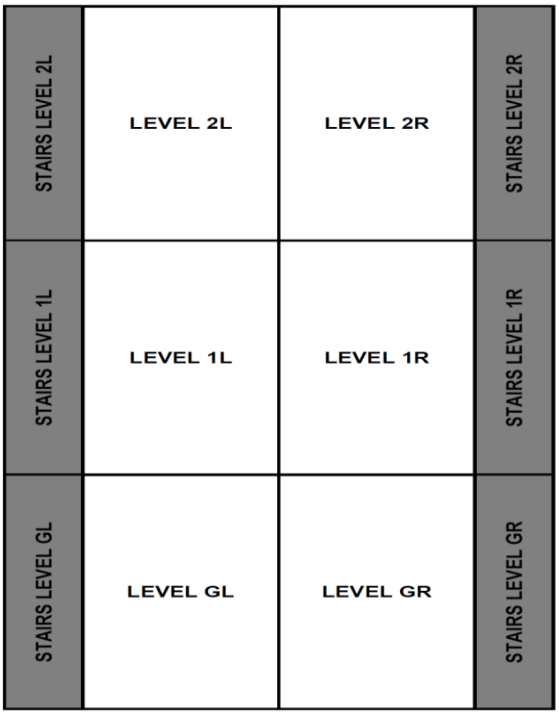


Fig. 3 - Layout of building prototype

4. Results and Analysis

The result and analysis of the FASTech system is based on the method that has been described and discussed. This section shows the result of the FASTech system performance according the desired operating with the actual operating. FASTech system was installed on the building prototype to test the performance of the system. iPhone 7Plus with operating system iOS 12.1 was used to evaluate the respond of the system with the Blynk application. The analysis is focusing on the performance of the fire alarm system operation and impact to society.

4.1 Programming of FASTech System

Three parts of programming of FASTech System, which are programme for FASTech system, programme for the Wi-Fi connection and programme for mobile application.

Program for FASTech system is to operate the process of the system and control the input and output. This programme actually focuses the operation of the system works if the smoke is present. The command code is uploading to the Arduino Mega 2560 board. Figure 4 shows a part of the generated command of the ground level sensor using Arduino software.

Programming to ensure the communication between the Ardunio Mega 2560 board and Wi-Fi connection is done by assisting with ESP8266 NodeMCU module. ESP8266 NodeMCU module is connected with Wi-Fi and sends data to the Blynk application. Figure 5 shows a part of command for ESP8266 NodeMCU module.

```
WidgetMap myMap(V7);

char auth[] = "6c5860987c644b6ca92ca673f7d2db16";
char ssid[] = "RumahParitDaun";
char pass[] = "2444666668888888";
SimpleTimer timer;

void setup()
{
  pinMode(16,INPUT);
```

Fig. 4 - Command of FASTech System

```
if (inputState1 == LOW) {
tone(buzzer, 10000);
digitalWrite(44, HIGH);
digitalWrite(led2, HIGH);
digitalWrite(led6, HIGH);
digitalWrite(led11, HIGH);
delay(250);
```

Fig. 5 - Command coding of ESP8266 Node MCU module

Blynk apps are programmed to trigger notification when the smoke detectors detect smoke. The program is setup on the Eventor Blynk apps on the smartphone. Figure 6 shows a part of Blynk apps command.

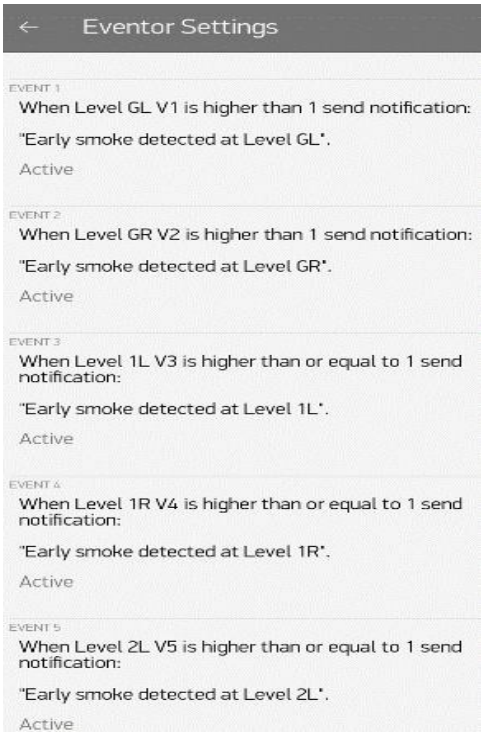


Fig. 6 - Eventor Bynk apps

4.2 Hardware Circuit

Four parts of circuits, which are power supply circuit, backup power supply circuit, LED circuit controller and buzzer circuit controller. Figure 7 shows power supply and backup power supply circuit. The input is from DC adapter 9V. The power supply circuit are separate the voltage between 9V and 5V. 9V power supply is for LED strip and 5V power supply are for buzzer, Arduino Mega 2560 Board, ESP8266 NodeMCU Module and LED indicator. For 9V power supply is direct from the DC adapter and 5V power supply is regulate from DC adapter power supply by using voltage regulator 7805. Relay is used for backup power supply that connected with Li-Ion Battery 7.9V 2200mAH. Backup power supply is for backup power supply when the main supply is breakdown. Thus, system is continuing operate if the main supply is breakdown.

Figure 8 shown a buzzer circuit controller. Once the smoke is present and detected, buzzer is activated and turn ON. Figure 9 shows a LED controller circuit to control the LED strip that light up and functioning as running light to navigate victims for safe and nearest exit path. The circuit is controlling 14 LED strips that was built in the building prototype. The circuit is receiving signal from Arduino Mega 2560 board to activate the LED strip by sequence operate as a running light.

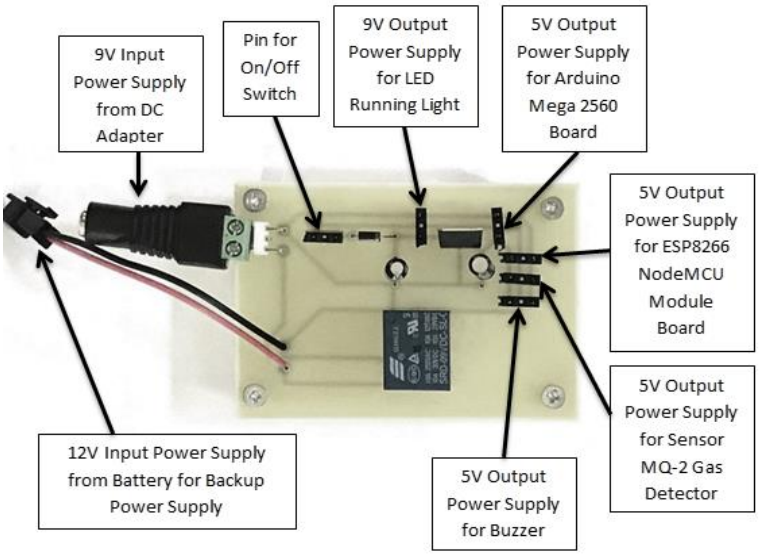


Fig. 7 - Power supply and backup power supply circuit

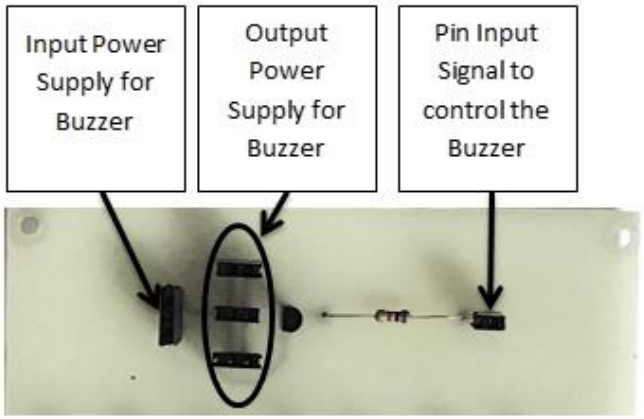


Fig. 8 - Buzzer controller circuit

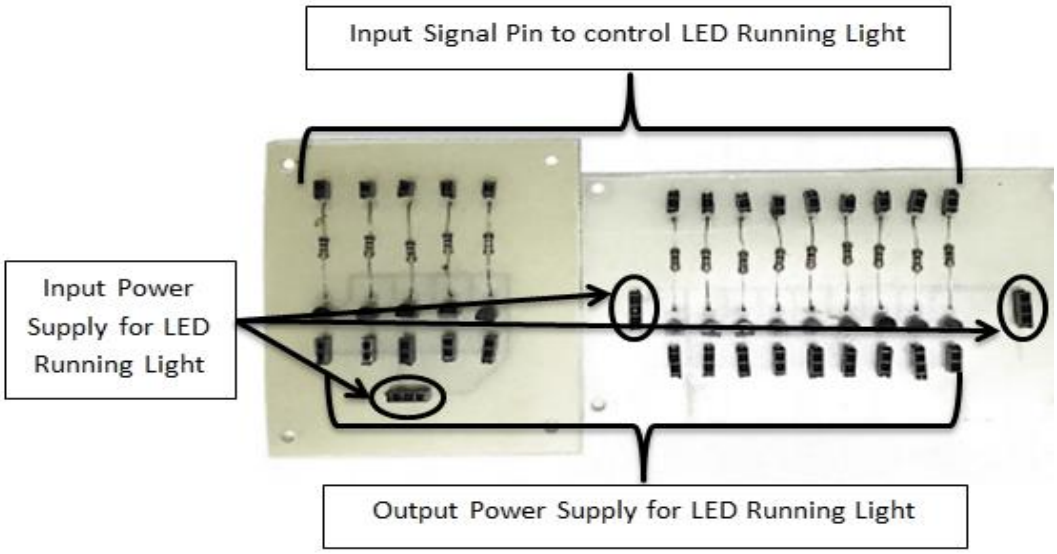


Fig. 9 - LED controller circuit

4.3 Operation of FASTech System

The operation of FASTech system are starting from detecting smoke from fire strikes, then buzzer was turn ON to warning people in the building and the pathway LED strip was light up to navigate people exit from the building by using the safe pathway. At the same time FASTech system was send notification through the smartphone to notify people are occurrences fire strikes in the building and was inform where the fire strikes occurs. Table 1 shows how the FASTech system operates when each sensor are trigged.

Table 1 - Operation of FASTech

	Sensor GL	**Sensor GR**	**Sensor 1L**	**Sensor 1R**	**Sensor 2L**	**Sensor 2R**
Level G	LED strip to the right	LED strip to the left	LED strip to the right and left	LED strip to the right and left	LED strip to the right and left	LED strip to the right and left
Level 1	LED strip to the right	LED strip to the left	LED strip to the right	LED strip to the left	LED strip to the right and left	LED strip to the right and left
Level 2	LED strip to the right	LED strip to the left	LED strip to the right	LED strip to the left	LED strip to the right	LED strip to the left

4.4 FASTech Notification

The notification is sended to the smartphone victims in the building when fire strikes exist. Notification indicated a parts of the fire strikes location, that can help victims to decide which safe pathway by assisting with running light to rescue their self. Figure 10 shows the example of notification on mobile phone. Smartphone notification is an alternative of warning, beside sounder bell to warn people in the building about the fire incident.

4.5 Result of Cloud Computing

The function of cloud computing is storing data of the fire strikes accident. The stored data are date, time and location of the accident. Figure 11 shows the interface of Blynk platform, graph represented data of date and time of the accident, while the map show the location of the building. The colour for every sensor is different, which are light blue for sensor Level Ground Left (GL), black for Level Ground Right (GR), orange for Level 1 Left (1L), red for level 1 Right (1R), dark blue for Level 2 Left (2L) and green for Level 2 Right (2R).

The data also can be monitored through computer on Google Sheet, which can accessed online and downloaded for future action. Figure 12 shows the interface of Google Sheet. Recorded data, which are column A for date and time, column B shows the device used and column C shows the location of fire strikes occur.

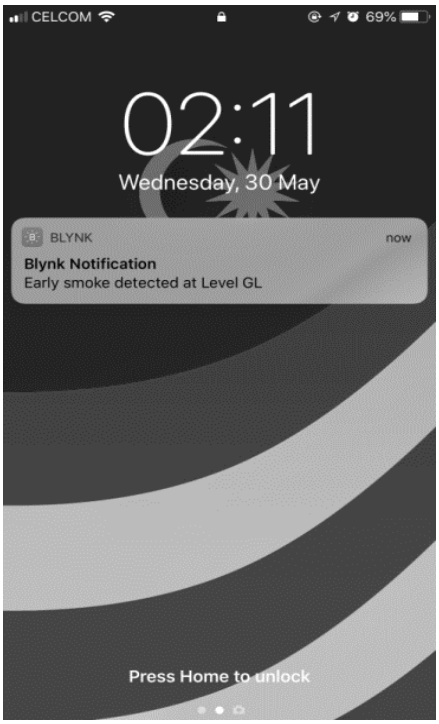


Fig. 10 - Notification on smartphone

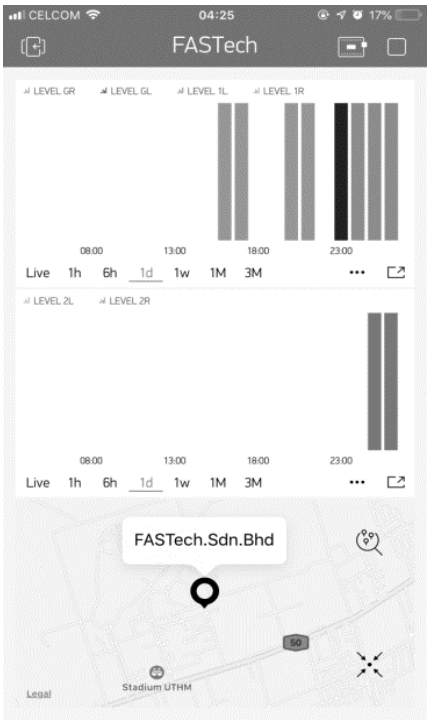
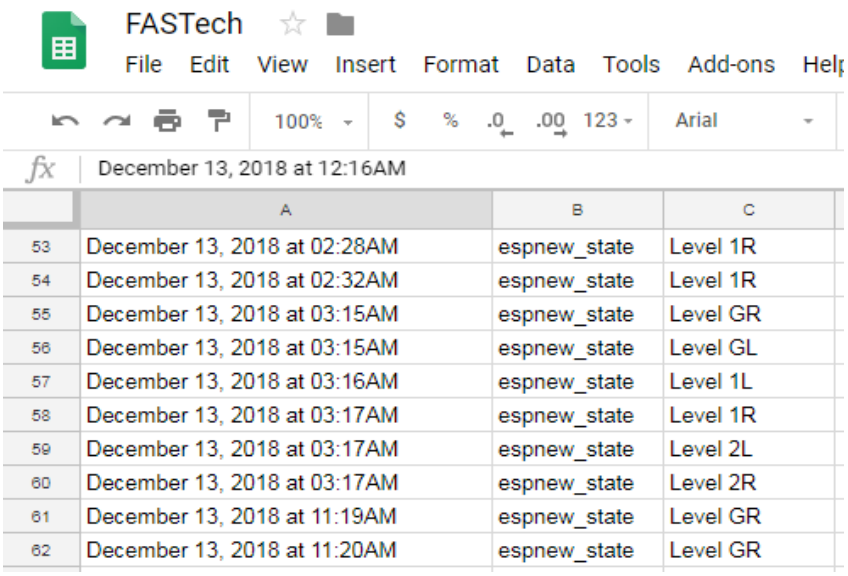


Fig. 11 - Data on Blynk apss



	A	B	C
53	December 13, 2018 at 02:28AM	espnew_state	Level 1R
54	December 13, 2018 at 02:32AM	espnew_state	Level 1R
55	December 13, 2018 at 03:15AM	espnew_state	Level GR
56	December 13, 2018 at 03:15AM	espnew_state	Level GL
57	December 13, 2018 at 03:16AM	espnew_state	Level 1L
58	December 13, 2018 at 03:17AM	espnew_state	Level 1R
59	December 13, 2018 at 03:17AM	espnew_state	Level 2L
60	December 13, 2018 at 03:17AM	espnew_state	Level 2R
61	December 13, 2018 at 11:19AM	espnew_state	Level GR
62	December 13, 2018 at 11:20AM	espnew_state	Level GR

Fig. 12 - Data recorded on Google Sheet

5. Conclusion

FASTech was successful designed and functioned as an intelligent fire emergency response system. Three-level building prototype and the main circuit for the system was successfully developed to ensure the successfulness of the system. Besides that, the IoT concept was interfaced using Blynk apps.

FASTech system able to detect the present of smoke from fire strikes and alarming person inside the building. Besides that, the incoming notification through the smartphone with Blynk apps is activated and data is stored on the Blynk database. Thus, we believe this project can give positive impact and awareness to the society on the important of fire alarm system.

References

1. “Conventional Fire Alarm | ORR Protection Systems.” [Online]. Available: https://www.orrprotection.com/fire-alarm/conventional. [Accessed: 13-Nov-2018].
2. “Pentagon | Fire Alarm System.” [Online]. Available: http://pentagonautomation.com/fire_alarm_system.html. [Accessed: 03-Apr-2018].
3. D. Goodyear Fire Consulting of Toronto, “Addressable fire alarms,” vol. 47, no. 5, pp. 45–48, 2006.
4. “What is an Addressable Fire Alarm System?,” 2012. [Online]. Available: http://www.eurofireprotection.com/blog/what-are-addressable-fire-alarm-systems/. [Accessed: 13-Nov-2018].
5. “JBPM Statistik Bilangan Kematian Dan Kecederaan Dalam Kes Kebakaran Dan Menyelamat Tahun 2011 Hingga 2015 - Statistik Bilangan Kematian Dan Kecederaan Dalam Kes Kebakaran Dan Menyelamat Tahun 2011 Hingga 2015 - MAMPU,” 2016. [Online]. Available: http://www.data.gov.my/data/ms_MY/dataset/statistik-bil-kematian-dan-kecederaan-dalam-kes-kebakaran-dan-menyelamat-tahun-2011-hingga-2015/resource/f11cff0a-d534-45c6-b4c0-72154c7fbf43#. [Accessed: 13-Nov-2018].
6. K. Almand, “Emerging Issues for Fire Safety in Tall Buildings : A view from the NFPA HRBSAC and FPRF,” 2015.
7. C. S. Ryu, “IoT-based intelligent for fire emergency response systems,” Int. J. Smart Home, vol. 9, no. 3, pp. 161–168, 2015.
8. I. M. P. Doyle, G. Dale, H. Choi, and B. City, “(12) UnIted States Patent,” vol. 2, no. 12, 2012.
9. P. G. Smith, "Fire-detection and alarm systems. Wiring Install," Supplies, vol. 1977, no. 3, p. 9. 1977
10. John I.Reed, "Fire Alarm Systems. Wiring Install". Supplies. pp. 16-21. 2010
11. B. E. E. Moore and A. Member (1913). THE ‘ K N I G H T ’ PUBLIC FIRE-ALARM SYSTEM. pp. 1-28.
12. S. F. Roca and R. Cited (2006). (12) United States Patent. vol. 2, no. 12.
13. Honeywell (2008). Wireless photoelectric smoke detector. Honeywell Security & Communications, Melville, pp. 1–2.
14. P. Jiru (2013). Design of Intelligent Monitoring System. 2013 Third Int. Conf. Instrumentation, Meas. Comput. Commun. Control, pp. 407–410.
15. K. Muheden (2016). Design and Implementation of the Mobile Fire Alarm System Using Wireless Sensor Networks. IEEE Int. Symp. Comput. Intell. Informatics, pp. 243–246.
16. H. Hu, G. Wang, Q. Zhang, J. Wang, J. Fang, and Y. Zhang (2009). Design wireless multi-sensor fire detection and alarm system based on ARM. ICEMI 2009 - Proc. 9th Int. Conf. Electron. Meas. Instruments, pp. 3285–3288.
17. A. Huth and J. Cebula (2011). The Basics of Cloud Computing. pp. 1–4.
18. E. Gorelik (2013). Cloud Computing Models. Working Paper CISL# 2013-01, pp. 1-28.
19. Torry Harris, CLOUD COMPUTING – An Overview An Overview. CLOUD Comput. – An Over, pp. 1-6.