MODULAR SMART HOME USING WiFi TECHNOLOGY

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
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ABSTRAK

Malaysia sedang bergerak dengan pesat ke dalam dunia teknologi Internet of Things (IoT). Ini dapat dilihat dengan projek perintis MIMOS seperti Aquaculture Farming: From Pond to Plate, Continuous Health Monitoring, Smart Village: Lanchang and Intelligent Landfill Management. Modular Smart Home Using WiFi Technology adalah projek tindak balas terhadap usaha Malaysia di dalam IoT. Perkakasan dan sistem Smart Home boleh dilihat di seluruh dunia dari Amazon Echo ke Google Home dan sistem buatan Malaysia, VYROX Smart Home tetapi masalah dengan sistem ini adalah banyak fungsi yang dimasukkan ke dalam satu peranti di mana pengguna tidak mempunyai pilihan untuk menambah atau menghapus fungsi dan jika satu bahagian kecil sistem ini rosak, pengguna perlu mengubah keseluruhan peranti termasuk bahagian-bahagian yang berfungsi dengan sempurna. Objektif projek ini adalah untuk melaksanakan teknologi WiFi ke dalam peranti rumah pintar, untuk melaksanakan versi modular peranti rumah pintar dan untuk melaksanakan langkah-langkah keselamatan asas ke dalam aplikasi rumah pintar

ABSTRACT

Malaysia is moving rapidly into Internet of Things (IoT) technology realm. This can be seen with MIMOS pilot projects such as Aquaculture Farming: From Pond to Plate, Continuous Health Monitoring, Smart Village: Lanchang and Intelligent Landfill Management. Modular Smart Home Using WiFi Technology is a project in respond towards the effort of Malaysia in IoT. Smart Home hardware and systems can be seen around the globe from Amazon Echo to Google Home and our home grown system, VYROX Smart Home but problems with these system is many functionality squeezed into one device in which user has no choice to add or remove functionality and if one tiny part of these system is faulty, user need to change the whole device including parts that is working in perfect condition. This project objective is to implement WiFi technology into smart home device, to implement a modular version of smart home device and to implement basic security measures into the smart home application.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AP	Access Point
GB	Gigabyte
IoT	Internet of Things
IP	Internet Protocol
JSON	JavaScript Object Notation
LPG	Liquefied Petroleum Gas
L.E.D	Light Emitting Diode
MIMO	Multiple-input Multiple-output
PTP	Precision Time Protocol
RAM	Random Access Memory
SSID	Service Set Identifier
SSL	Secure Socket Layer
TLS	Transport Layer Security
WiFi	Wireless Fidelity

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Smart home and home automation is a term that is used to describe a house that its appliances such as fan, thermostat, lighting, security and many more is controlled or automate by smart devices. Earlier, smart home devices use Bluetooth and Infrared technology to monitor and control its functions. Nowadays, Wi-Fi is used widely due to its ability to work locally and remotely. This means, Wi-Fi can be used to create a Local Area Network privately for the smart home device alone or be connected to the cloud for remote control and monitoring.

Example of remote monitoring is the ability to view the cameras connected to the smart home devices and the ability to view statistics of smart home devices remotely. Statistic in this case ranging from power consumption, operating hours, amount of data usage to send information to cloud and more. Control means the ability for user to control the smart home devices locally or remotely without the need to physically connected or touch the device.

While the smart home technology keeps getting better year by year, modularity is only tackled by two major companies, Amazon and Google, each with Amazon Echo and Google Home. These two devices is a voice activated smart speaker. They can order products online, play music, search internet for information and many more by using voice command. Both of this company uses their AI to collect and process user request. This is good for western market and not for the eastern side of the world. These AI is only good for people with good English pronunciation as it struggle with other accent.

Modularity in this thesis means the system or the hardware components can be separated and later recombined. This introduces flexibility to user of the system. While these components are separated from the system or hardware, the main function of the system is not affected and can continue running without any disturbance. This also means that a faulty or offline component will not have an impact towards the functioning of the main system function.

In this thesis, a WiFi connected modular smart home device with mobile application is proposed to connect modular smart home device and control it. WiFi is proposed to connect each modular smart device to a central device that will constantly sense each modular device and connect with a mobile application. Android mobile application is proposed to connect with central device to control the entire modular smart device connected to the central device.

1.2 PROBLEM STATEMENT

Followings are the problem statement of this project. The project is in action to solve the following problems.

i. Existing smart home solutions consists of one device that control the whole smart home ecosystem in a house. If a device is found faulty, user need to change the whole solutions.
ii. Existing smart home systems uses voice recognition to process user commands. This does not work fluidly in countries where the English pronunciation is not fully mastered.

1.3 OBJECTIVE

The objective is the goals that is designed to solve the problem arises in section 1.2. The objective of this project is as follows.

i. To propose encrypted data transfer into smart home mobile application.
ii. To design WiFi technology into smart home device.
iii. To implement a modular version of smart home device.

1.4 SCOPE

The scope provides the boundary for this project. The problem solving solutions and features are bounded to the scope. The scope of this project is as follows.

i. Design WiFi technology into smart home device.
ii. Build a smart home device that can work modularly.
iii. Control smart home device using android phone application.
iv. Implement encrypted data transfer into mobile application.

1.5 THESIS ORGANIZATION

This thesis consists of five chapters. Chapter 1 shall discuss on the introduction to the project. This chapter contains introduction, problem statement, objectives, scopes and thesis organization. Chapter 2 shall discuss the literature review of the project. It contains introduction, home automation today, existing systems, proposed system, comparison and conclusion. Chapter 3 shall discuss on the methodology of the project. It contains introduction, methodology, system design, hardware and software design, Gantt chart, implementation and testing. Chapter 4 shall discuss on the results and discussion on the projects based on the testing done during the development of this project. Chapter 5 shall discuss on the conclusion made based on the project findings. This includes the project constrains and future works.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, home automation technology in today's day and age will be discussed briefly. This includes the brief history and the current technology that is available to the mass consumer. Discussion on existing systems will tackle three major home automation products that are Amazon Echo, Google Home and Apple HomePod. Next will be the description of the proposed system. The existing systems will then be compared with the proposed system. A conclusion will be made based on the discussion.

2.2 HOME AUTOMATION TODAY

One of the earliest forms of home automation is the Clapper ®. This device was first released in 1985. This device register sequence of claps from user and it supports up to two appliances(Tristin Hopper, 2010). As an example, two claps and your television turned on automatically. Three claps and your lamp turned off automatically. The Clapper ® supports any appliances that can be plugged into its two electrical outlets.

Today’s form of home automation still uses the same concept but more complicated implementation. Example of today’s home automation is Google Home. Google Home register users command and inject the command into its Artificial Intelligent called Google Artificial Intelligence (AI). This AI will process the command and perform the task, ranging from playing music to turning appliances on and off.

The future of home automation is still cloudy. Recent report made by the Business Insider shows that voice control is becoming popular trend that began with the introduction of Amazon Echo in 2014. The second outcome of the report is the high prices of such device made the consumer yet to show high demand. The survey is done in United States of America (USA) and below is the survey participant perceived benefit of voice assistants(Nicholas Shields, 2018).

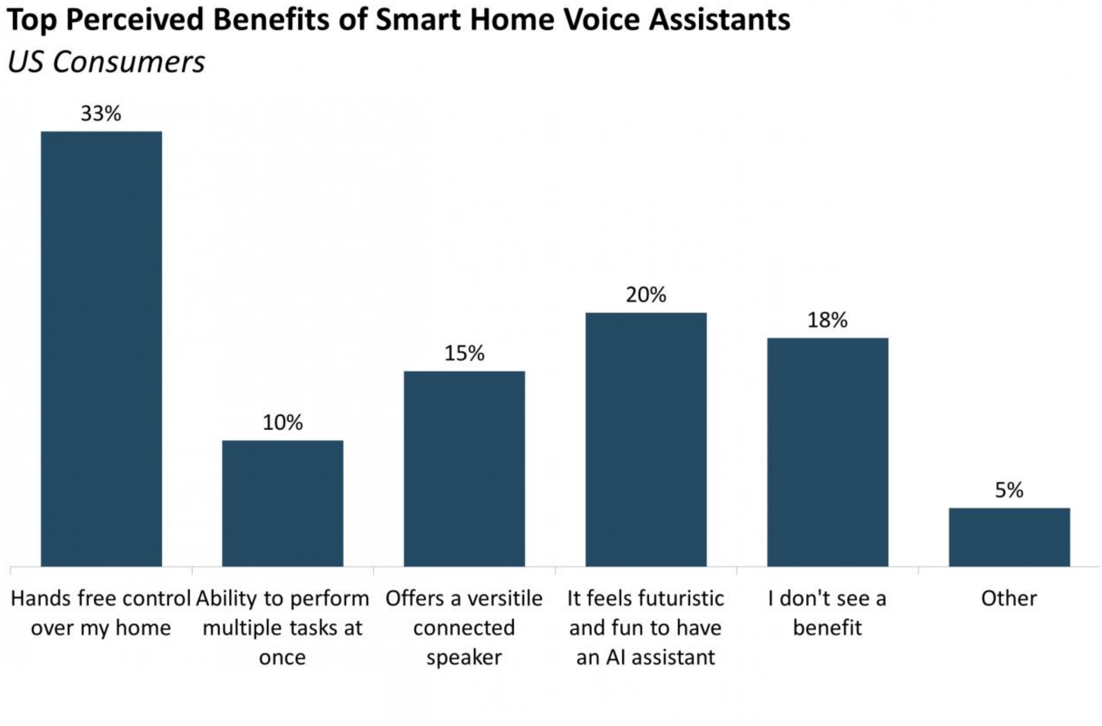

Figure 2.1 Benefits of smart home voice assistant

Data available on Malaysian consumer is limited. The data available is acquired from Statista and the data is latest as of April 2018. Total amount of active smart home device is expected to amount to 0.6 million by 2022 (Statista Team, 2018). Currently, there is 0.2 million active smart home device and its mainly local products where tech giants such as Google and Amazon is expected to make their move into the picture soon.

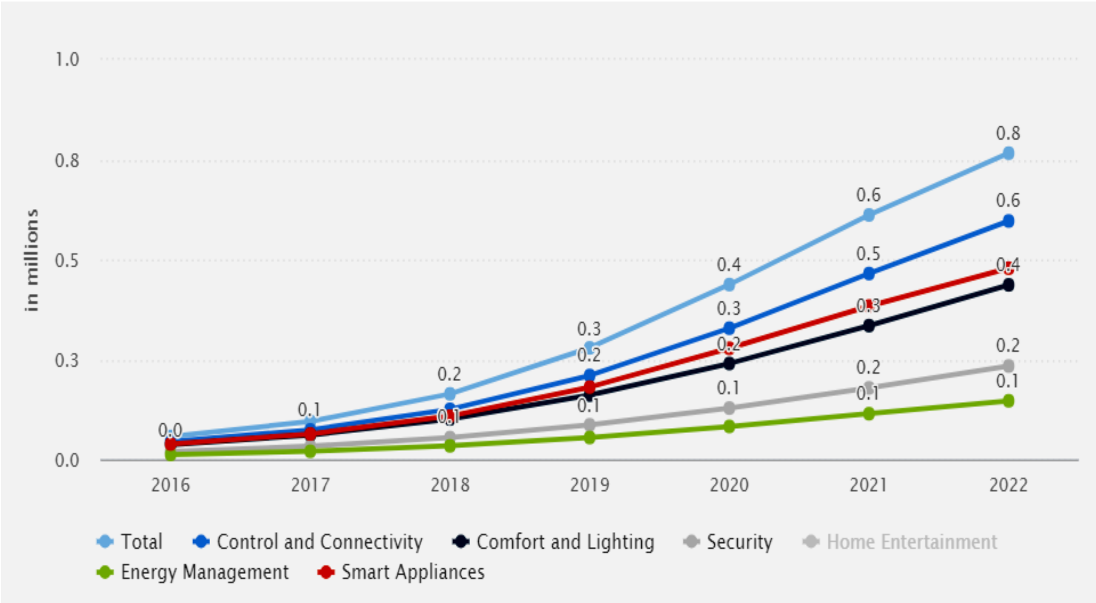

Figure 2.2 Amount of active smart home device in Malaysia

2.3 EXISTING SYSTEMS

In this subchapter, three existing systems will be discussed namely Amazon Echo, Google Home and Apple HomePod.

2.3.1 Amazon Echo

Figure 2.3 Amazon Echo device

Amazon Echo is a smart home device branded as a smart speaker. This device uses its in-house developed AI named Alexa. It will react when user say “Alexa”. The word can be changed to “Amazon”, “echo” or “computer” (Dieter Bohn, 2017).

Alexa is an artificial intelligent virtual assistant created by Amazon and was first used in Amazon Echo and Amazon Echo Dot line-up developed by Amazon Lab126. Alexa is capable of voice interaction, music playback, streaming podcast and other real time information (Amazon Team, 2018).

Amazon echo consists of a 23.5cm tall cylinder speaker equipped with seven-piece microphone setup in an array. It uses DM3725 arm Cortex-A8 processor, 256MB of RAM and 4GB of storage.

2.3.2 Google Home

Figure 2.4 Google Home Device

Google Home is a smart home device branded as a smart speaker. This device uses its in-house developed AI named Google Assistant. It will react when user say “ok Google”. Example of usage is by saying “ok Google, tell me about my day”, it will give information such as, weather, traffic on your work commute and upcoming appointments set in calendars .

Amazon Echo is a smart home device branded as a smart speaker. This device uses its in-house developed AI named Alexa. It will react when user say “Alexa”. The word can be changed to “Amazon”, “echo” or “computer” (Dieter Bohn, 2017).

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Amazon echo consists of a 23.5cm tall cylinder speaker equipped with seven-piece microphone setup in an array. It uses DM3725 arm Cortex-A8 processor, 256MB of RAM and 4GB of storage.

2.3.3 Apple HomePod

Figure 2.5 Apple HomePod device

Apple HomePod is a smart home device branded as a smart speaker same as its rival, Amazon Echo and Google Home. This device same as its competitors, uses its in-house developed AI named Siri. The device will react when user say “Hey Siri”. Example of usage is: “Hey Siri, read me my last message”, it will read user’s last message on their Iphone.

Siri has already been in all Apple’s devices ranging from Iphone to their laptop. It was called the intelligent personal assistant by Apple. It is capable of doing many things but are restricted to Apple’s produce. It can play music but only from Apple Music. It can also set alarm and timer. Shockingly, Siri that is implemented in Apple Homepod cannot make more than two timers.

Apple Homepod consists of an array of seven horn-loaded tweeters, high-excursion woofer and a touch surface (Thuy Ong, 2018). It also contains an array of six microphones. It is 172mm tall, uses the Apple A8 chip, 1GB RAM and 16GB of storage.

2.4 PROPOSED SYSTEM

The proposed system will have two components. First component is the mobile application. The mobile application is the medium for user to send command to the modular NodeMCU based smart home device. The mobile application will consists of normal buttons and sliders.

Second component is the NodeMCU board. Two NodeMCU board will be used in this proposed system. The first board will contain an LPG gas sensor, magnetic door sensor, relay switch and led as a representation of normal household lamp. The second board will contain magnetic door switch and relay. As default, each board will come with WiFi capabilities as ESP8266 WiFi board is build into the NodeMCU board. These two boards will be connected to a WiFi router in order for them to connect to the internet.

2.5 COMPARISON

Diagram below will show the comparison between the existing systems and the proposed system based on its user, hardware, technology, tools, features and cost.

Table 2.1 Comparison between existing systems and proposed system

Devices	Amazon Echo	Google Home	Apple HomePod	Proposed System
User	Home Owner	Home Owner	Home Owner	Home Owner
Hardware	Custom Hardware	Custom Hardware	Custom Hardware	NodeMCU
Technology	Wi-Fi and Bluetooth	Wi-Fi and Bluetooth	Wi-Fi with MIMO, Bluetooth and direct PTP access.	Wi-Fi
Features	Voice Command	Voice Command	Voice Command	Mobile Application
Cost (US$)	179.99	129.99	349.00	30.00

2.6 CONCLUSION

As a conclusion, based on the comparison table, the proposed system will be chosen. The first reason is the form factor of the proposed system is smaller than the existing system. As the existing system uses microphone array to register user command and speaker to provide feedback to user, the systems form factor is bigger than the proposed system. The proposed system only uses NodeMCU board, the form factor of the board is way smaller as it does not require arrays of microphone and speaker.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The chapter will dive into the methodology used in the development of the project; Modular Smart Home Using WiFi Technology. Several methodologies was kept into consideration including Waterfall Methodology, Iterative and Incremental methodology, also Extreme programming. The methodology chosen will be discussed in the Methodology subchapter. The chosen methodology is used as a guideline to ensure that this project will advance smoothly by following the flow orderly. This project also has to achieve its objective stated and goals stated in previous chapter.

3.2 METHODOLOGY

The chosen methodology for this project is agile methodology. Specifically, iterative and incremental development. It is a combination of iterative design and incremental build model. Quoted from the official documentation for United States Department of Defence military standards for developing military computer systems (DOD-STD-2167) in section 4.1.2 of the document; "During software development, more than one iteration of the software development cycle may progress at the same time” and “This process may be described as an ‘evolutionary acquisition’ or ‘incremental build approach’”.

This methodology was chosen as it provides flexibility during the development of this project. During project implementation process, many problems and short coming will manifest, changes is required during that time, by using this methodology, changes can be made into the projects as it is developed in iteration. Other methodology will need redesign of project and will consume more time than the methodology chosen.

Generally, agile development method breaks development task to small increments that minimize planning and design. Iteration or known as sprints are short time frames that last one week to one month. At the end of the iteration, a working product is demonstrated to client. This minimizes risk and allows product adapts to changes made by client or development team.

Iterative and incremental development basic idea is to develop a system in repeated cycles known as iteration and in smaller portion at a time that is known as incremental. At each iteration, few functional capabilities are added and design modifications are made (Craig Larman, n.d.). The cycles involve initial planning, planning, requirements, analysis and design, implementation, testing, evaluation and deployment. The process of initial planning and deployment occurs only one time in the project while the other process will take place a “loop” at a time. Diagram below shows the iterative and incremental development process.

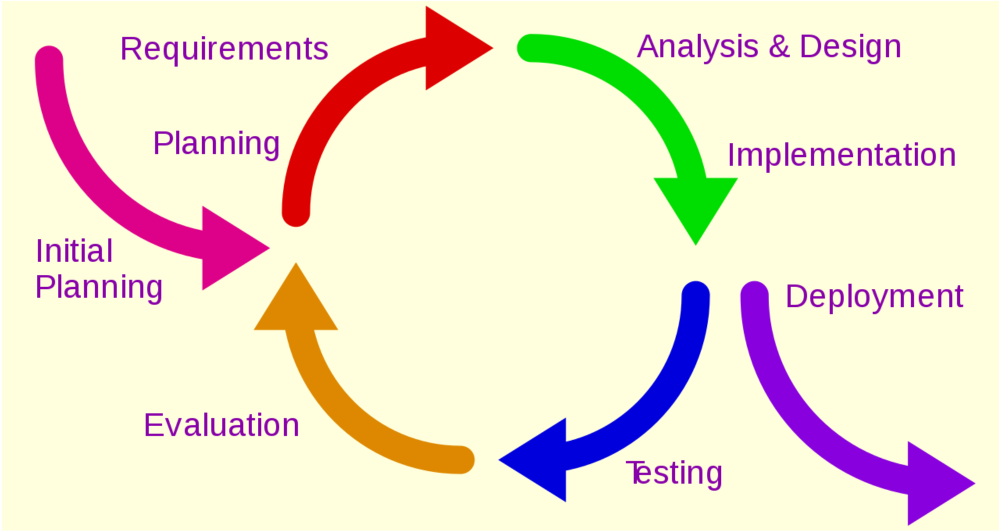


Figure 3.1 Iterative and incremental development process

This project initial planning was conducted with supervisor. Several meeting was conducted where the idea of the project is discussed between them. The first meeting was done in the end of year 2017 with the initial idea of this project. The subsequent meeting was done in year 2018 discussing about the additional things that can be improved.

The project was made to modularize the current implementation of smart home design. Past implementation by Universiti Malaysia Pahang student were only wired system and all the functionality is packed into one device. This project intends to modularize the functions where there are two NodeMCU devices that will connect to WiFi router to gain internet access. These devices will receive user action from a mobile application and execute the action as intended by user. This means that user can add as many NodeMCU devices as they like where each device will have particular functionality that the user need.

The planning and requirement part was done by breaking the initial planning outcome into several chunks. As an example, listing the hardware and software needed. The hardware and software is searched and will be acquired in the next stage.

Analysis and design part is done by analyzing the hardware whether it is really needed in the project. When all the requirement is analyzed and deemed needed for the project, the design project will start. In this stage, how the hardware will be wired and how the software will be coded is discussed and implemented.

Then, the testing and evaluation phase, the hardware and software will be tested to find errors and problems. The connection of the hardware, the compatibility of hardware is tested and the connection between hardware and software is tested to find anomalies.

After all the phase is done, if there is a new additional requirement, the project will continue with planning of the new requirement and end with evaluation of it. When there are no more additional requirements, the project will be deployed.

3.3 SYSTEM DESIGN

In this subchapter, system design for modular smart home using WiFi technology will be shown. This includes the context diagram of the system, use case diagram for the system, system modules, dialogue diagram and user interface design.

3.3.1 Context Diagram

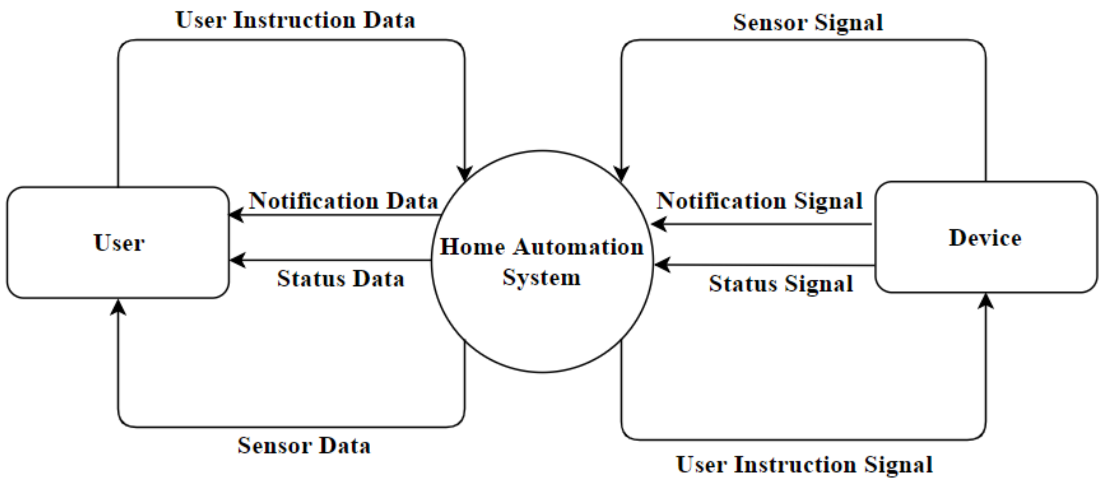


Figure 3.2 Context diagram of the system

Figure 3.2 shows the Context Diagram for the Home Automation System. User interacts with the system by sending instruction to it. The instruction is only to toggle an appliance on or off. System will then interact with the Device by sending it a user instruction signal. This instruction will be send to device based on its token set during the development of the system. The device then will send 3 types of signal. The first signal is sensor signal. This signal shows the value of the sensor data. The signal is sent to the system and the system will send sensor data to user. The second signal is notification signal. This signal will be sent to system if a trigger condition is met. The system will then send a notification data to user. Last signal is status signal. This signal is to inform the system that the device is still connected to the system. If system does not receive status signal, user will receive status data from the system.

3.3.2 Use Case diagram

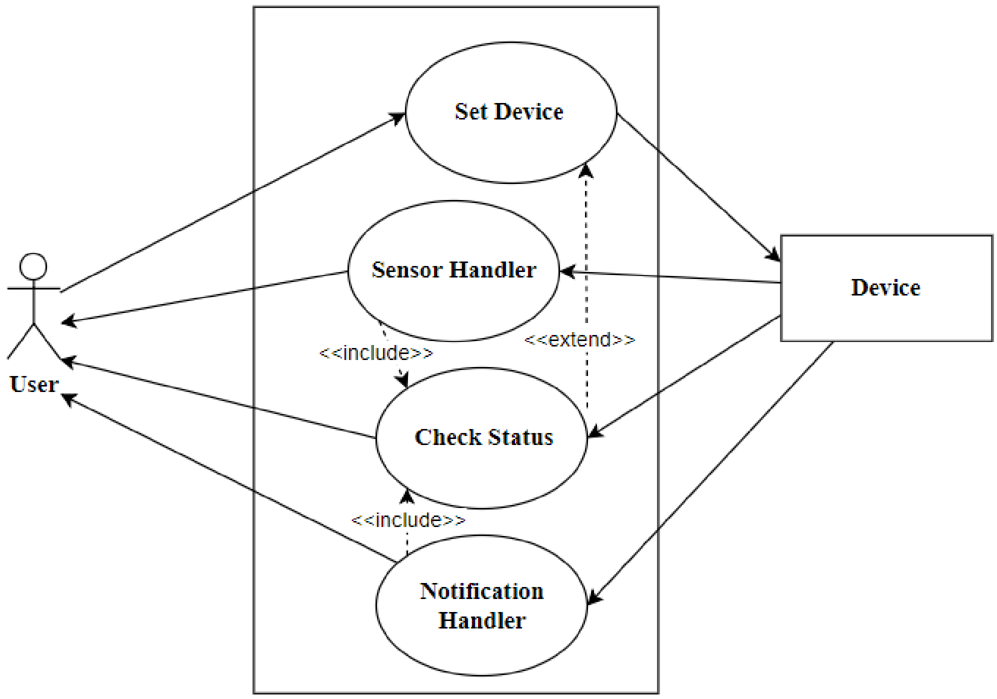


Figure 3.3 Use Case diagram of the system

Figure 3.3 shows the Use Case Diagram for the Home Automation System. There is an actor that is the User that interacts with the system. There are devices that interact with the system. Inside the system boundary, there are four use cases namely set device, sensor handler, check status and notification handler. Set device use case includes the feature of turning appliances on and off, user command handler and user command executer. Check status use case is in extend relationship with set device use case. This use case will check the availability of the appliance device. Sensor handler is in include relationship with check status. Sensor handler will stream sensor data to user. Lastly, notification handler is in include relationship with check status. Notification handler will handle all notification triggered by the device for user to see in the mobile application.

3.3.3 Modules

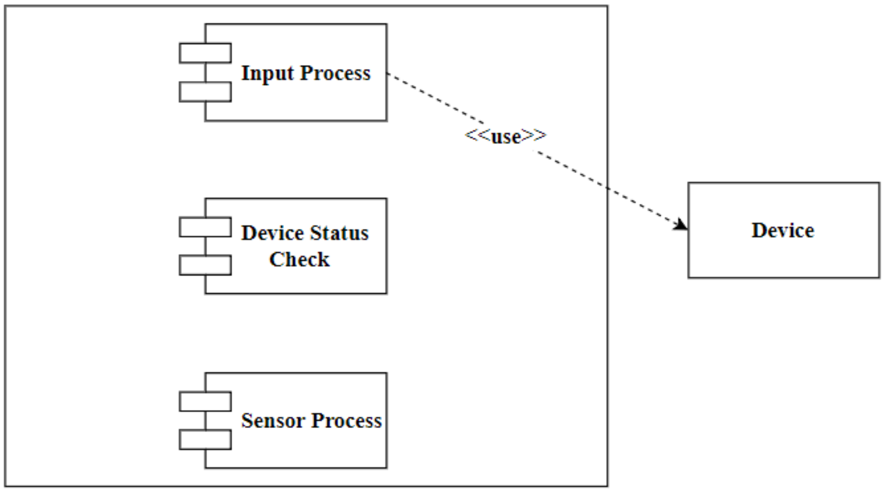


Figure 3.4 Module diagram of the system

Figure 3.4 shows the Module Diagram for the Home Automation System. Three modules are available in the system as shown in Figure 3.4. The first package is Input Process. Input Process module deals with user input, turning appliances on and off, user command handler and user command executer. Second is Device Status Check module where it will check the availability of device for command execution and for the packages consist of all presentation logic pertaining to each module issues. Third is sensor process, this package will deals with sensors and sensor data from device to user.

3.3.4 Dialogue diagram

As the mobile application used only have one page where all of the function and tools is rendered in it, therefore, the dialogue diagram only have 1 level only as shown in Figure 3.5.

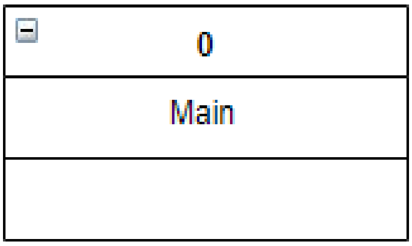


Figure 3.5 Dialogue diagram of the system

3.3.5 User Interface

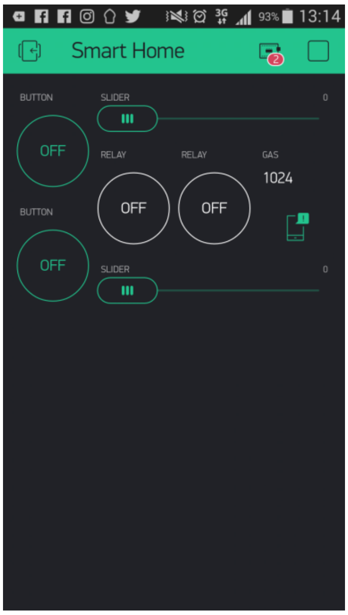


Figure 3.6 User interface of main page

Figure 3.6 shows the main user interface for the system. This interface includes the name of appliances connected to the Appliance Device. The name on top of each button and User is able to turn the appliances on and off by clicking the toggle button available on the appliances name.

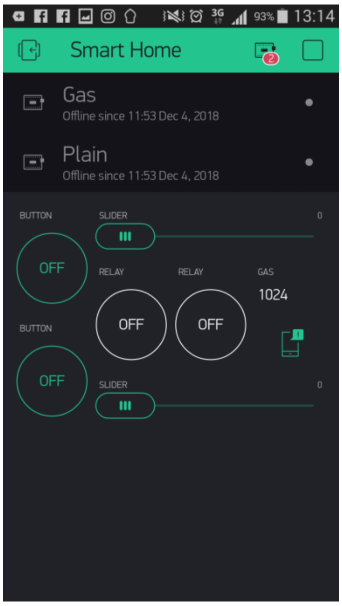


Figure 3.7 User interface of device status

Figure 3.7 shows the user interface of the device status. The status was shown on top of the interface. This interface will show a brief description of the device and its status. If the wordings are in white colour, the device is online, if the wordings are in grey colour, the device is offline.

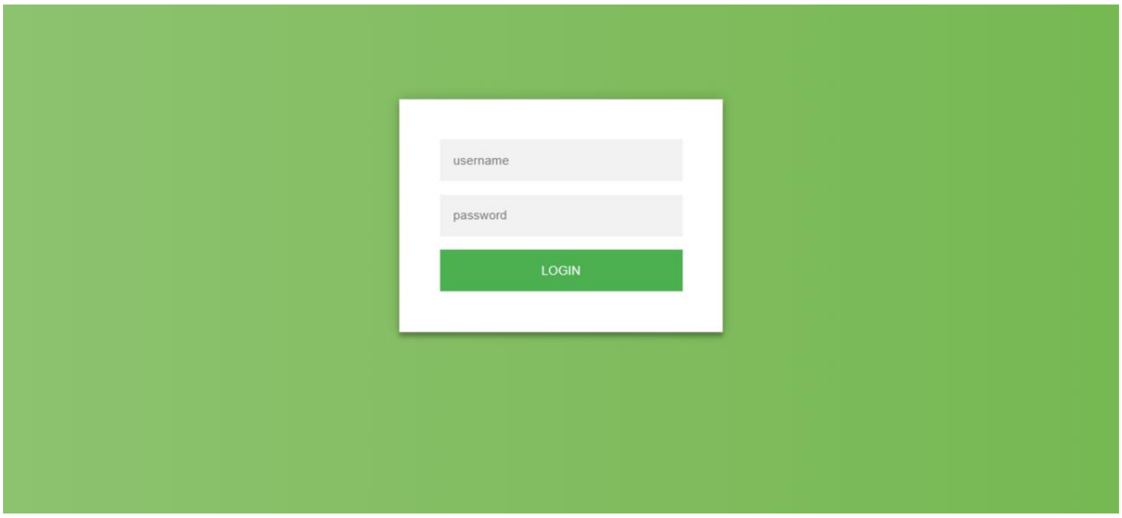


Figure 3.8 WiFi credential setup page

Figure 3.8 WiFi credential setup page shows the WiFi credential setup page that is accessed by user to reconfigure their device connection to the internet. This page can only be accessed by user when the device is in Access Point mode and through IP address of 192.168.11.4. Credentials such as SSID and password entered will be stored in the device non volatile memory.

3.3.6 System flow

This subchapter will show how this system works in the form of flow chart. There will be one flowchart. Figure 3.9 will show user the process of this system from boot till the end.

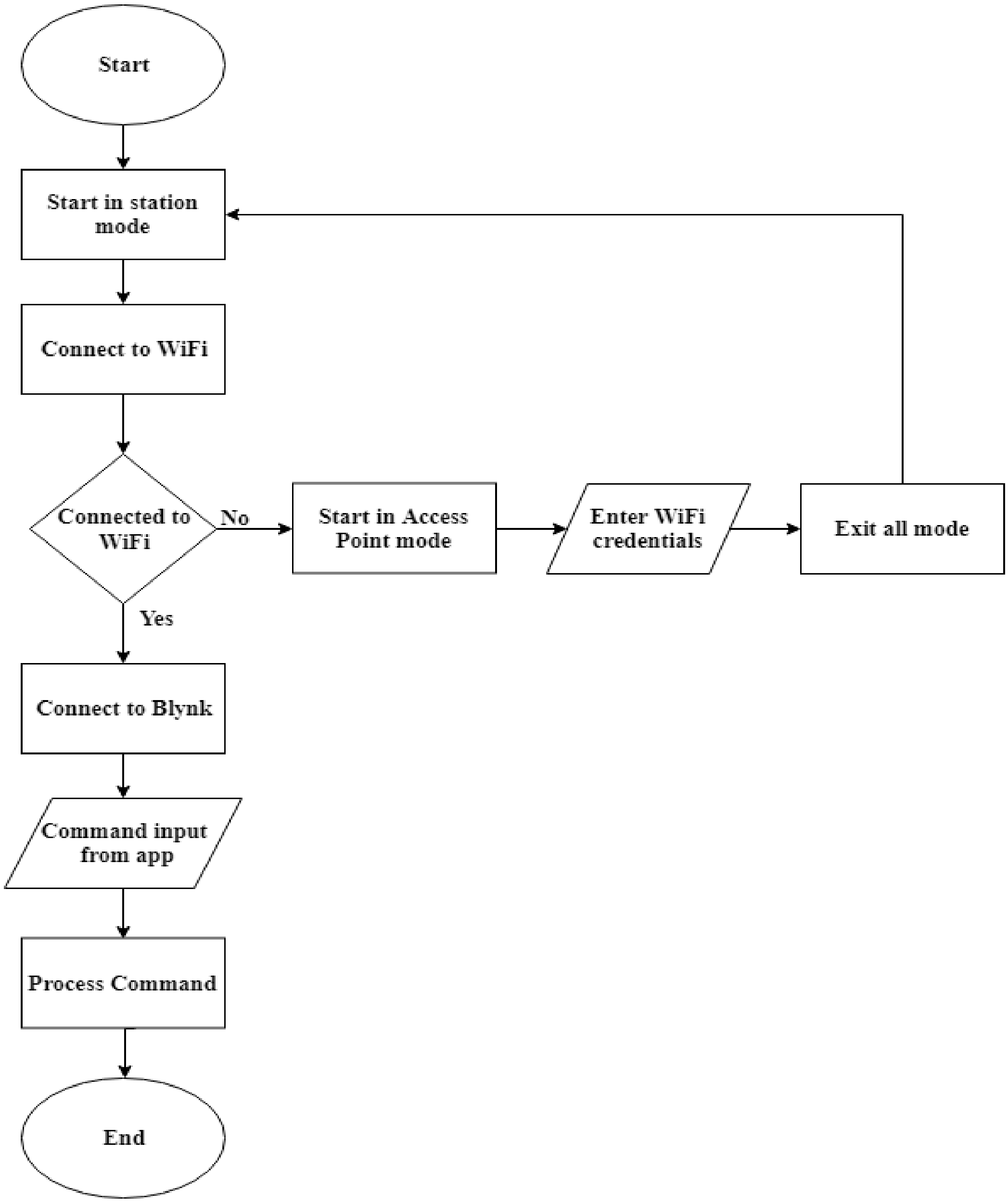


Figure 3.9 Main system flow

3.4 HARDWARE AND SOFTWARE REQUIREMENT

In this subchapter, hardware and software use in this project is discussed and identified. Both elements are important in developing this project.

3.4.1 Hardware Requirement

Table 3.1 Hardware requirement of the system

Item	Minimum Requirement	Function / Purpose
Laptop	Intel Core i7 550 RAM: 8GB Storage: 1TB	The computer used for the development and documentation of the system.
NodeMCU Device	ESP8266 NodeMCU	This will be the device for this project. Without this device, the projects will not success.
Android Phone	Android KitKat 4.4.2 RAM: 3GB Internal Storage: 16gb	The Android phone will be for installing the mobile application and testing tool for the Android mobile application.

Table 3.1 shows the hardware requirement of this project. Laptop is needed to develop the mobile application and the credential setup page in NodeMCU device. NodeMCU device is the home automation device. Without the NodeMCU device, this project won’t be able to proceed. Lastly, the Android phone is needed to run the Android mobile application that will be the source of user action.

3.4.2 Software Requirement

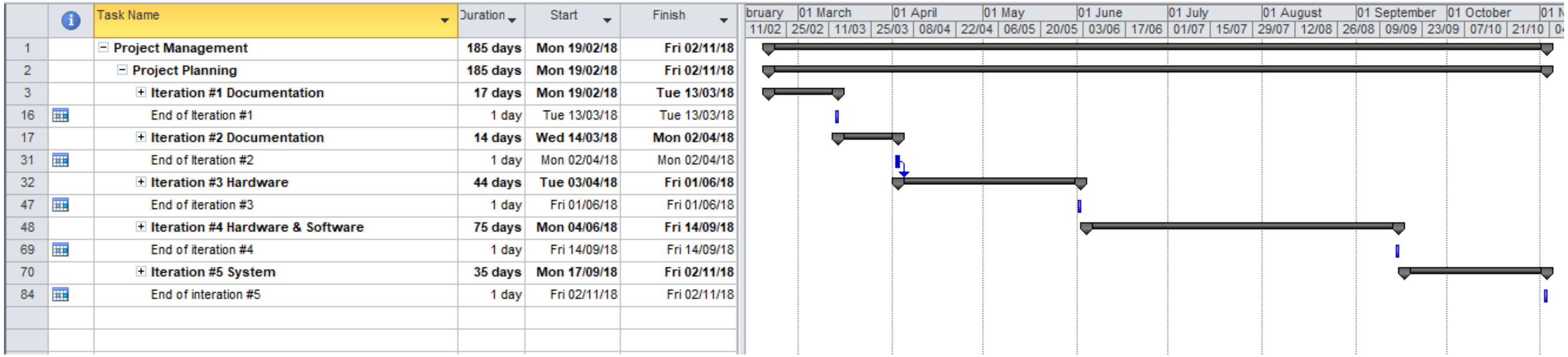
Table 3.2 Software requirement of the system

Software	Function / Purpose
Microsoft Office 2007 Microsoft Word Microsoft PowerPoint Microsoft Project	Microsoft Word used to document the proposal and system development. Microsoft PowerPoint used as a tool to prepare presentation of the project and to assist project presentation and Microsoft Project used to design the Gantt chart.
Blynk	Blynk is the third party IoT platform that hosts the project in the internet.
Arduino IDE	Arduino is used to develop Arduino logic using C language and transfer the logic into Arduino device.

Table 3.2 shows the software requirement of this project. Microsoft Office is needed to document the project. Microsoft word is used to document the project and the system development. Microsoft PowerPoint is used to prepare and assist project presentation. Microsoft project is used to design and build the Gantt chart. Without Microsoft Office, this project can’t be documented. Blynk is used as a platform for the application to connect with the devices through internet. Without it, this project can’t be done. Lastly, Arduino software, It is used to develop and load the logic into Arduino device. Without it, developer cannot develop Arduino logic and the project will not be able to move forward and finish.

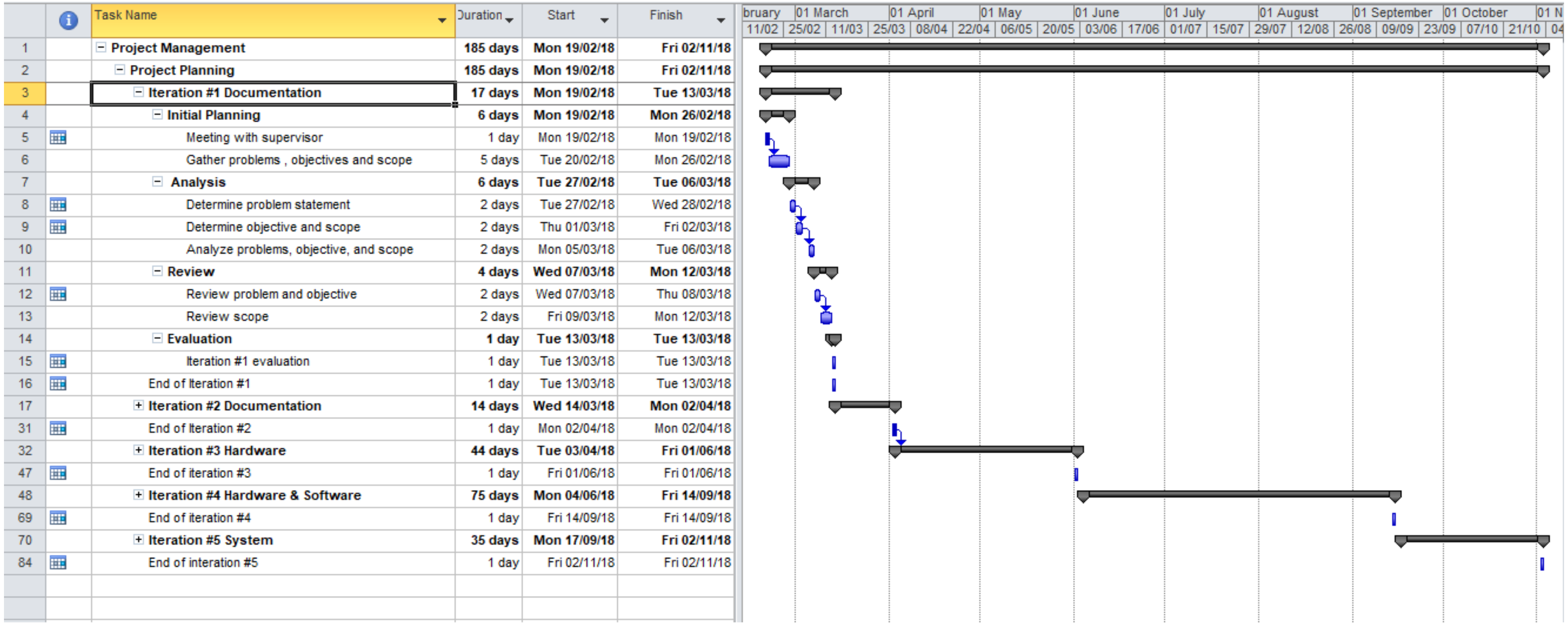
3.5 GANTT CHART

Gantt chart is a way to organize a project into a timeline that contain a start and a finish date. It can further be broken into smaller task that can be put into certain amount of time. The following diagrams will show the planned duration of this project that will undergo 5 iteration at least.



		Task Name	Duration	Start	Finish
1		Project Management	185 days	Mon 19/02/18	Fri 02/11/18
2		Project Planning	185 days	Mon 19/02/18	Fri 02/11/18
3		Iteration #1 Documentation	17 days	Mon 19/02/18	Tue 13/03/18
16		End of Iteration #1	1 day	Tue 13/03/18	Tue 13/03/18
17		Iteration #2 Documentation	14 days	Wed 14/03/18	Mon 02/04/18
31		End of Iteration #2	1 day	Mon 02/04/18	Mon 02/04/18
32		Iteration #3 Hardware	44 days	Tue 03/04/18	Fri 01/06/18
47		End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48		Iteration #4 Hardware & Software	75 days	Mon 04/06/18	Fri 14/09/18
69		End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70		Iteration #5 System	35 days	Mon 17/09/18	Fri 02/11/18
84		End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

Figure 3.10 Overview of project duration



	Task Name	Duration	Start	Finish
1	**Project Management**	**185 days**	**Mon 19/02/18**	**Fri 02/11/18**
2	**Project Planning**	**185 days**	**Mon 19/02/18**	**Fri 02/11/18**
3	**Iteration #1 Documentation**	**17 days**	**Mon 19/02/18**	**Tue 13/03/18**
4	**Initial Planning**	**6 days**	**Mon 19/02/18**	**Mon 26/02/18**
5	Meeting with supervisor	1 day	Mon 19/02/18	Mon 19/02/18
6	Gather problems , objectives and scope	5 days	Tue 20/02/18	Mon 26/02/18
7	**Analysis**	**6 days**	**Tue 27/02/18**	**Tue 06/03/18**
8	Determine problem statement	2 days	Tue 27/02/18	Wed 28/02/18
9	Determine objective and scope	2 days	Thu 01/03/18	Fri 02/03/18
10	Analyze problems, objective, and scope	2 days	Mon 05/03/18	Tue 06/03/18
11	**Review**	**4 days**	**Wed 07/03/18**	**Mon 12/03/18**
12	Review problem and objective	2 days	Wed 07/03/18	Thu 08/03/18
13	Review scope	2 days	Fri 09/03/18	Mon 12/03/18
14	**Evaluation**	**1 day**	**Tue 13/03/18**	**Tue 13/03/18**
15	Iteration #1 evaluation	1 day	Tue 13/03/18	Tue 13/03/18
16	End of Iteration #1	1 day	Tue 13/03/18	Tue 13/03/18
17	**Iteration #2 Documentation**	**14 days**	**Wed 14/03/18**	**Mon 02/04/18**
31	End of Iteration #2	1 day	Mon 02/04/18	Mon 02/04/18
32	**Iteration #3 Hardware**	**44 days**	**Tue 03/04/18**	**Fri 01/06/18**
47	End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48	**Iteration #4 Hardware & Software**	**75 days**	**Mon 04/06/18**	**Fri 14/09/18**
69	End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70	**Iteration #5 System**	**35 days**	**Mon 17/09/18**	**Fri 02/11/18**
84	End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

Figure 3.11 Duration of iteration 1

	Task Name	Duration	Start	Finish
1	Project Management	185 days	Mon 19/02/18	Fri 02/11/18
2	Project Planning	185 days	Mon 19/02/18	Fri 02/11/18
3	Iteration #1 Documentation	17 days	Mon 19/02/18	Tue 13/03/18
16	End of Iteration #1	1 day	Tue 13/03/18	Tue 13/03/18
17	Iteration #2 Documentation	14 days	Wed 14/03/18	Mon 02/04/18
18	Planning	8 days	Wed 14/03/18	Fri 23/03/18
19	Solution for Iteration #1 Problems	3 days	Wed 14/03/18	Fri 16/03/18
20	Meeting with supervisor	1 day	Mon 19/03/18	Mon 19/03/18
21	Gather information for literature review	4 days	Tue 20/03/18	Fri 23/03/18
22	Analysis	5 days	Mon 26/03/18	Fri 30/03/18
23	Iteration #1 problems analysis	1 day	Mon 26/03/18	Mon 26/03/18
24	Write literature review	2 days	Tue 27/03/18	Wed 28/03/18
25	Analyze literature review	2 days	Thu 29/03/18	Fri 30/03/18
26	Review	2 days	Fri 30/03/18	Mon 02/04/18
27	Review Iteration #2	1 day	Fri 30/03/18	Fri 30/03/18
28	Review the literature review	1 day	Mon 02/04/18	Mon 02/04/18
29	Evaluation	1 day	Mon 02/04/18	Mon 02/04/18
30	Iteration #2 evaluation	1 day	Mon 02/04/18	Mon 02/04/18
31	End of Iteration #2	1 day	Mon 02/04/18	Mon 02/04/18
32	Iteration #3 Hardware	44 days	Tue 03/04/18	Fri 01/06/18
47	End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48	Iteration #4 Hardware & Software	75 days	Mon 04/06/18	Fri 14/09/18
69	End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70	Iteration #5 System	35 days	Mon 17/09/18	Fri 02/11/18
84	End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

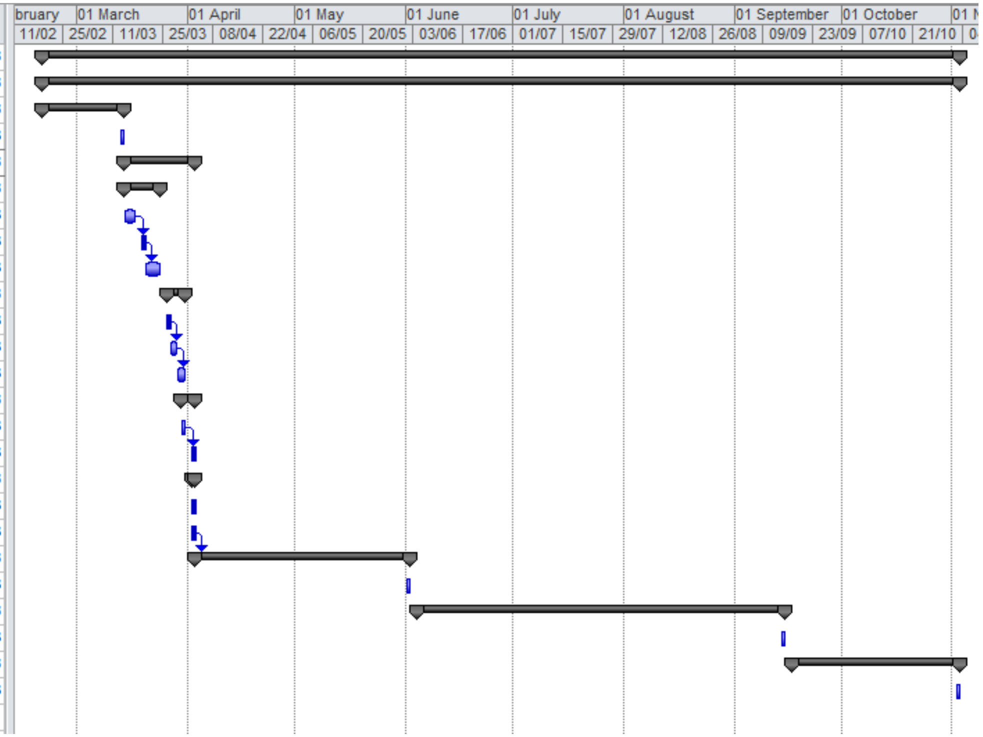
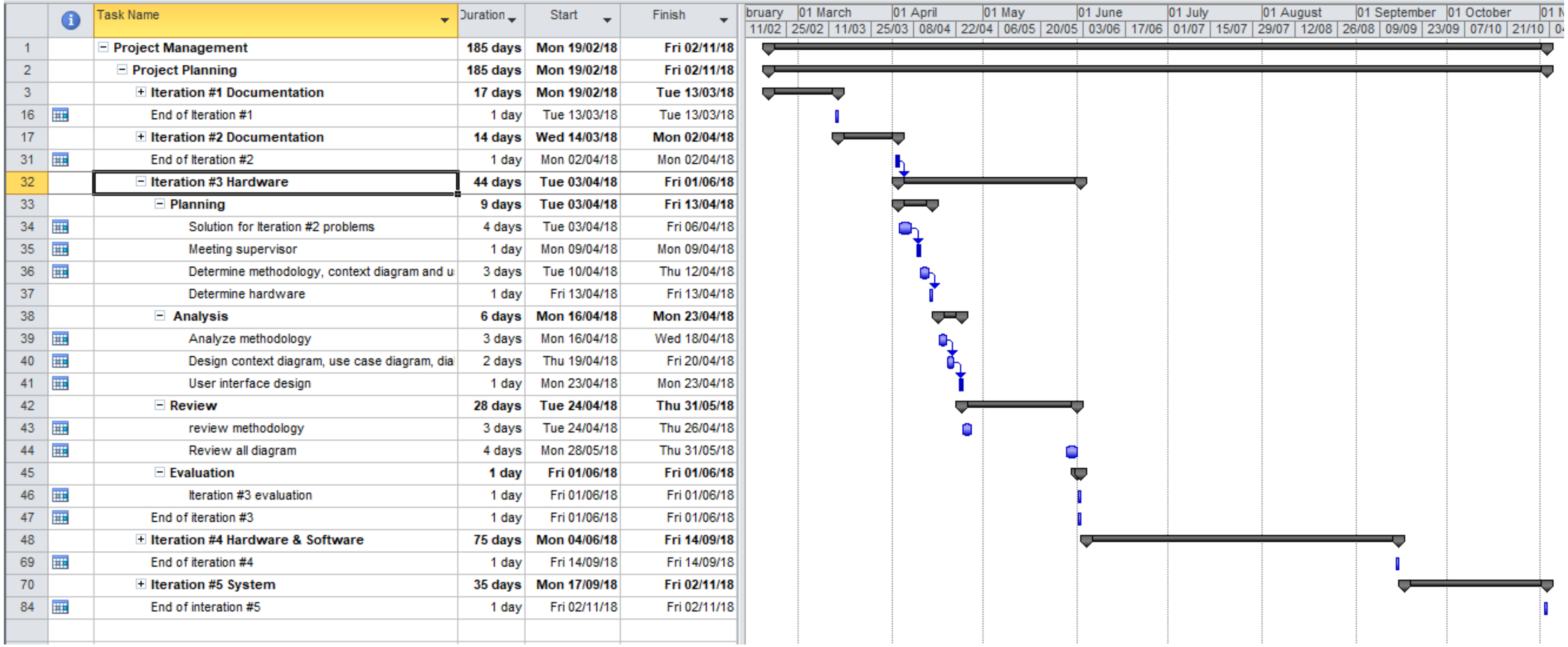
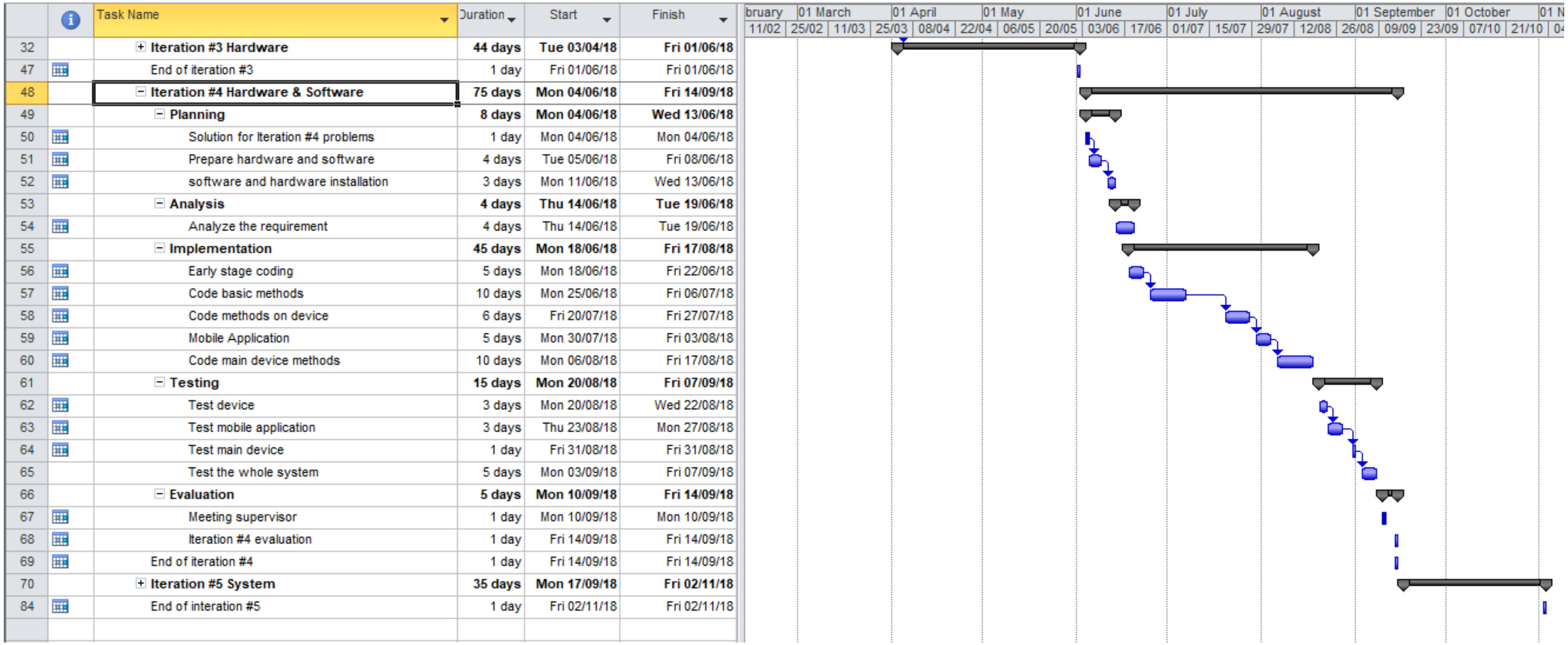


Figure 3.12 Duration of iteration 2



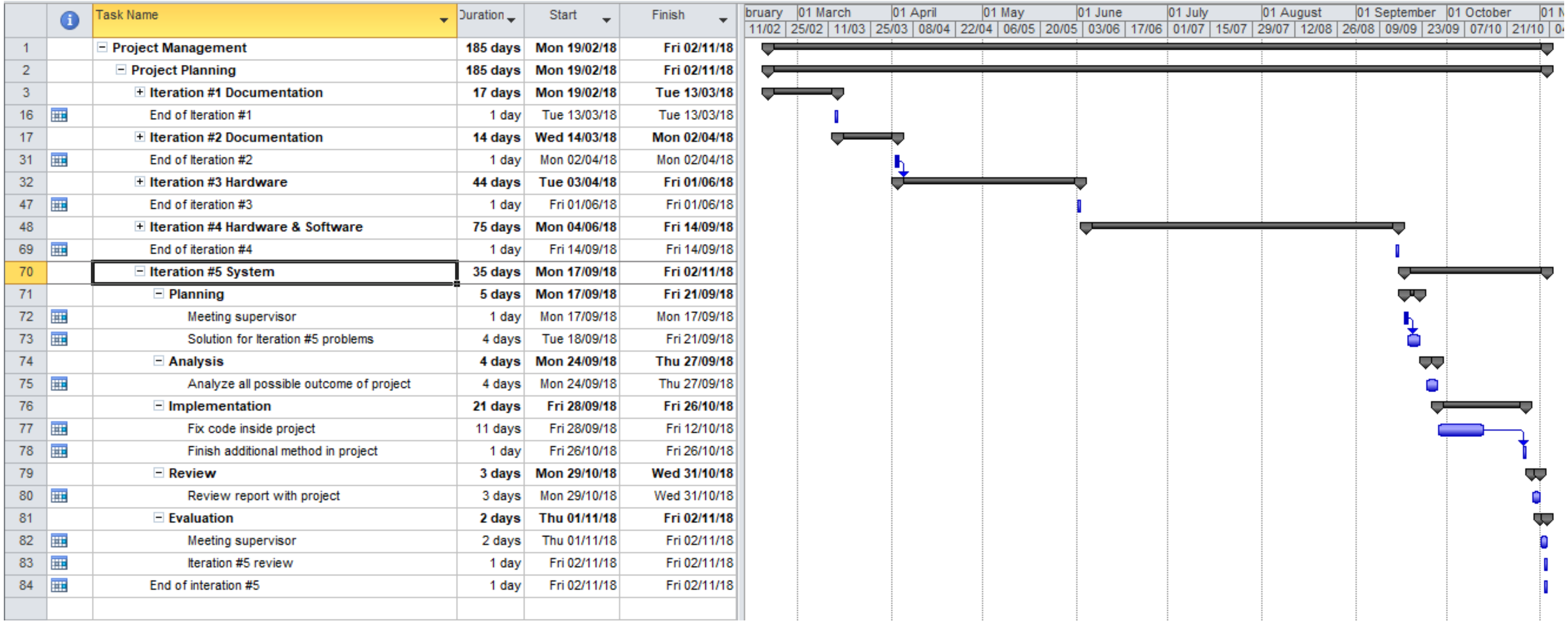
		Task Name	Duration	Start	Finish
1		Project Management	185 days	Mon 19/02/18	Fri 02/11/18
2		Project Planning	185 days	Mon 19/02/18	Fri 02/11/18
3		Iteration #1 Documentation	17 days	Mon 19/02/18	Tue 13/03/18
16		End of Iteration #1	1 day	Tue 13/03/18	Tue 13/03/18
17		Iteration #2 Documentation	14 days	Wed 14/03/18	Mon 02/04/18
31		End of Iteration #2	1 day	Mon 02/04/18	Mon 02/04/18
32		Iteration #3 Hardware	44 days	Tue 03/04/18	Fri 01/06/18
33		Planning	9 days	Tue 03/04/18	Fri 13/04/18
34		Solution for Iteration #2 problems	4 days	Tue 03/04/18	Fri 06/04/18
35		Meeting supervisor	1 day	Mon 09/04/18	Mon 09/04/18
36		Determine methodology, context diagram and u	3 days	Tue 10/04/18	Thu 12/04/18
37		Determine hardware	1 day	Fri 13/04/18	Fri 13/04/18
38		Analysis	6 days	Mon 16/04/18	Mon 23/04/18
39		Analyze methodology	3 days	Mon 16/04/18	Wed 18/04/18
40		Design context diagram, use case diagram, dia	2 days	Thu 19/04/18	Fri 20/04/18
41		User interface design	1 day	Mon 23/04/18	Mon 23/04/18
42		Review	28 days	Tue 24/04/18	Thu 31/05/18
43		review methodology	3 days	Tue 24/04/18	Thu 26/04/18
44		Review all diagram	4 days	Mon 28/05/18	Thu 31/05/18
45		Evaluation	1 day	Fri 01/06/18	Fri 01/06/18
46		Iteration #3 evaluation	1 day	Fri 01/06/18	Fri 01/06/18
47		End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48		Iteration #4 Hardware & Software	75 days	Mon 04/06/18	Fri 14/09/18
69		End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70		Iteration #5 System	35 days	Mon 17/09/18	Fri 02/11/18
84		End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

Figure 3.13 Duration of iteration 3



		Task Name	Duration	Start	Finish
32		Iteration #3 Hardware	44 days	Tue 03/04/18	Fri 01/06/18
47		End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48		Iteration #4 Hardware & Software	75 days	Mon 04/06/18	Fri 14/09/18
49		Planning	8 days	Mon 04/06/18	Wed 13/06/18
50		Solution for Iteration #4 problems	1 day	Mon 04/06/18	Mon 04/06/18
51		Prepare hardware and software	4 days	Tue 05/06/18	Fri 08/06/18
52		software and hardware installation	3 days	Mon 11/06/18	Wed 13/06/18
53		Analysis	4 days	Thu 14/06/18	Tue 19/06/18
54		Analyze the requirement	4 days	Thu 14/06/18	Tue 19/06/18
55		Implementation	45 days	Mon 18/06/18	Fri 17/08/18
56		Early stage coding	5 days	Mon 18/06/18	Fri 22/06/18
57		Code basic methods	10 days	Mon 25/06/18	Fri 06/07/18
58		Code methods on device	6 days	Fri 20/07/18	Fri 27/07/18
59		Mobile Application	5 days	Mon 30/07/18	Fri 03/08/18
60		Code main device methods	10 days	Mon 06/08/18	Fri 17/08/18
61		Testing	15 days	Mon 20/08/18	Fri 07/09/18
62		Test device	3 days	Mon 20/08/18	Wed 22/08/18
63		Test mobile application	3 days	Thu 23/08/18	Mon 27/08/18
64		Test main device	1 day	Fri 31/08/18	Fri 31/08/18
65		Test the whole system	5 days	Mon 03/09/18	Fri 07/09/18
66		Evaluation	5 days	Mon 10/09/18	Fri 14/09/18
67		Meeting supervisor	1 day	Mon 10/09/18	Mon 10/09/18
68		Iteration #4 evaluation	1 day	Fri 14/09/18	Fri 14/09/18
69		End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70		Iteration #5 System	35 days	Mon 17/09/18	Fri 02/11/18
84		End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

Figure 3.14 Duration of iteration 4



		Task Name	Duration	Start	Finish
1		Project Management	185 days	Mon 19/02/18	Fri 02/11/18
2		Project Planning	185 days	Mon 19/02/18	Fri 02/11/18
3		Iteration #1 Documentation	17 days	Mon 19/02/18	Tue 13/03/18
16		End of Iteration #1	1 day	Tue 13/03/18	Tue 13/03/18
17		Iteration #2 Documentation	14 days	Wed 14/03/18	Mon 02/04/18
31		End of Iteration #2	1 day	Mon 02/04/18	Mon 02/04/18
32		Iteration #3 Hardware	44 days	Tue 03/04/18	Fri 01/06/18
47		End of iteration #3	1 day	Fri 01/06/18	Fri 01/06/18
48		Iteration #4 Hardware & Software	75 days	Mon 04/06/18	Fri 14/09/18
69		End of iteration #4	1 day	Fri 14/09/18	Fri 14/09/18
70		Iteration #5 System	35 days	Mon 17/09/18	Fri 02/11/18
71		Planning	5 days	Mon 17/09/18	Fri 21/09/18
72		Meeting supervisor	1 day	Mon 17/09/18	Mon 17/09/18
73		Solution for Iteration #5 problems	4 days	Tue 18/09/18	Fri 21/09/18
74		Analysis	4 days	Mon 24/09/18	Thu 27/09/18
75		Analyze all possible outcome of project	4 days	Mon 24/09/18	Thu 27/09/18
76		Implementation	21 days	Fri 28/09/18	Fri 26/10/18
77		Fix code inside project	11 days	Fri 28/09/18	Fri 12/10/18
78		Finish additional method in project	1 day	Fri 26/10/18	Fri 26/10/18
79		Review	3 days	Mon 29/10/18	Wed 31/10/18
80		Review report with project	3 days	Mon 29/10/18	Wed 31/10/18
81		Evaluation	2 days	Thu 01/11/18	Fri 02/11/18
82		Meeting supervisor	2 days	Thu 01/11/18	Fri 02/11/18
83		Iteration #5 review	1 day	Fri 02/11/18	Fri 02/11/18
84		End of interation #5	1 day	Fri 02/11/18	Fri 02/11/18

Figure 3.15 Duration of iteration 5

3.6 IMPLEMENTATION

Adapted from Malaysia National IoT Strategic Roadmap document that's made available for access on 2014, Internet of things consists of Connected Things, Connectivity & Infrastructure and Analytics & Applications(Malaysian Institute of Microelectronic Systems, 2014). This project focuses mainly on Connected Things and Connectivity, especially static connected things. Therefore, the platform used which is Blynk falls under the roof of Infrastructure. That is why the platform is not developed in this project. Industry player today only focuses their energy on one of this three category as to focuses on all three at the same time will increase the time spent on the project, development cost and system complexity. These tree problem will be translated to reduced earnings and being late in to the market.

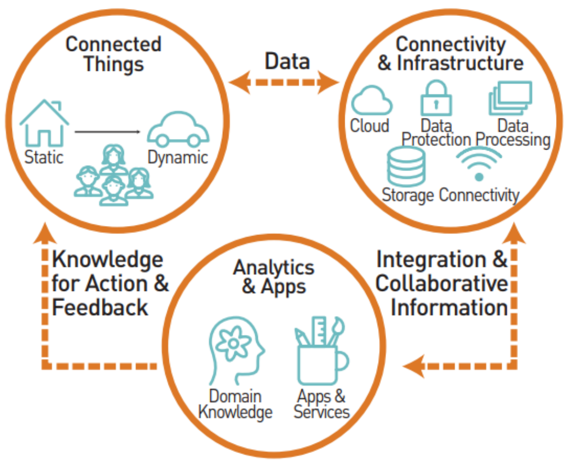


Figure 3.8 IoT Components

The system starts by setting itself into Station mode. Station mode means that it is ready to connect to any available WiFi network it had been setup to connect to. Then it will try to find the network and connect to it. If the network is not found or the password is incorrect, the device will set itself into Access Point mode. This mode changes the device into an access point that other device can connect to.

While being in Access Point mode, the device is setup to host a website locally. The website can be accessed through the ip address of 192.168.11.4. This website function is to collect new SSID which is the network name and its password. Users task is to connect to the network, go to the ip address using a browser and fill in the information into the website.

The website will process the data fetched and save it into the internal non volatile memory of this device in JSON format. An algorithm is added into every device to perform the process of saving and reading of the JSON file.

Upon completing the step, the device will exit all mode and starts back in Station mode and connect to the network that was entered by the user. If successful, the device will then connect itself to Blynk server and will appear online in Blynk mobile application. Then, user can control the device using Blynk mobile application.

Then the system fetch user input from the mobile application. The input is user pressing a toggle button. This button acts as an indication whether an appliance is turned on or off. Upon receiving the input, mobile application will send the input to the device through internet. The processing of user command and connecting multiple devices to the Blynk mobile application is done by Blynk server algorithm

3.7 TESTING

To test the modular smart home using WiFi technology, black box testing will be used. Black box testing is also known as a behavioural testing. This method tests the internal structure, design and the implementation of the item that is not known to the tester when testing it.

User Acceptance test will be conducted under black box testing as user acceptance test is considered as a black box test (Swati, 2017). In this testing method, user will test the functionality of the modular smart home. This means, user will use the mobile application, test each function and record the output. As an example, if user clicks a button to turn on a fan, the fan is turned on.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

The chapter will dive into the testing phase of the Modular Smart Home Using WiFi Technology. The testing phase discusses in the method used on this project and the fully assembled system would be tested. All parts will be connected to become a full complete system. This chapter show the entire configuration used on the hardware side of this system. Light Emitting Diode will be used in this phase to simulate modern Light Emitting Diode based light used in homes around the world.

4.2 TESTING AND RESULT DISCUSSION

In this section, the system functions are tested to assure that all the function set on this system is fully operational. The Blynk mobile application will connect to the Blynk online server through port 443; SSL/TLS which encrypt user connection with the server. At the same time, the device will also connect to the server through port 443 and can be recognized by the mobile application through its unique authentication token. After both had connected to the internet, sensor data will be streamed to the mobile application and the mobile application will wait for user command through the mobile application. At the same time, the server will constantly ping the device in 5 second interval in order to check the availability of the device in the internet.

4.2.1 Project Setup

The following figure below will show the project setup of each component and the last figure will show the full setup of this project. The setup will be represented by diagram of device and its corresponding schematics.

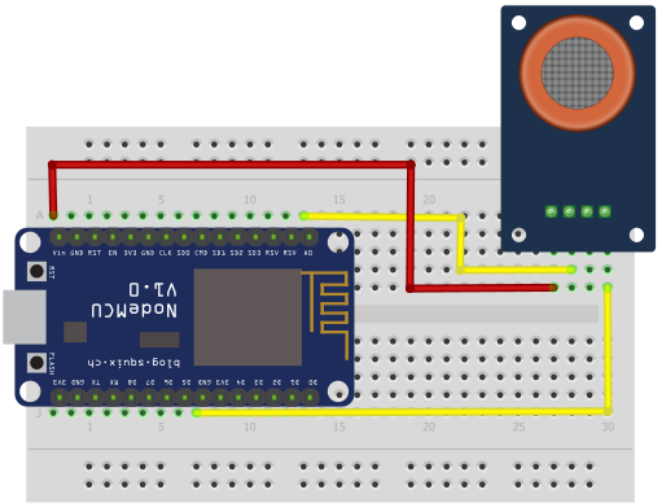


Figure 4.1 LPG Gas Sensor Diagram

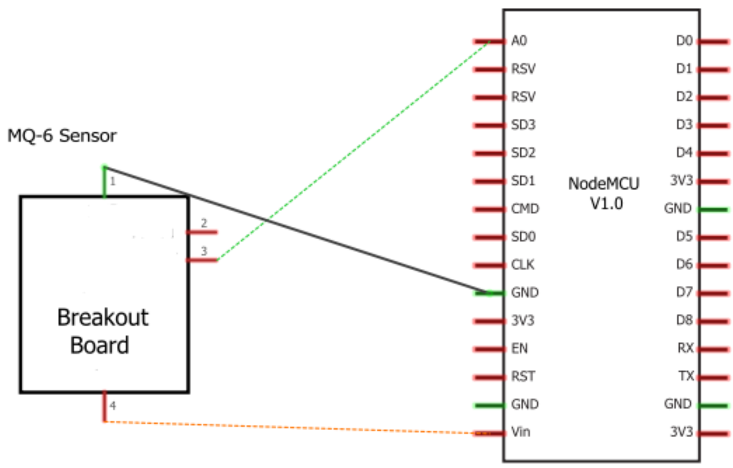


Figure 4.2 LPG Gas Sensor Schematic

Figure 4.1 shows the diagram of MQ-6 LPG Gas sensor used in this project. The red wire represents connection from the breakout board to the VCC or power input pin of NodeMCU. The Vin pin in NodeMCU provides the needed power for the gas sensor to operate. Figure 4.2 represent the schematic of the connections. Here, more detailed information of the connection can be seen where the 1st pin of the breakout board is connected to the ground pi of NodeMCU.

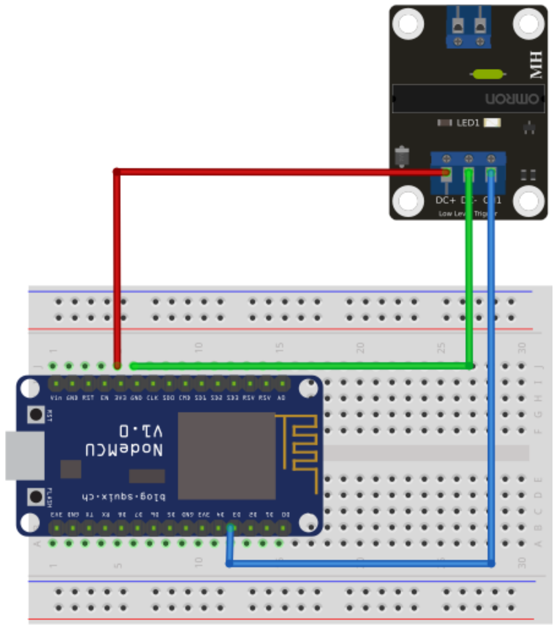


Figure 4.3 Solid State Relay Diagram

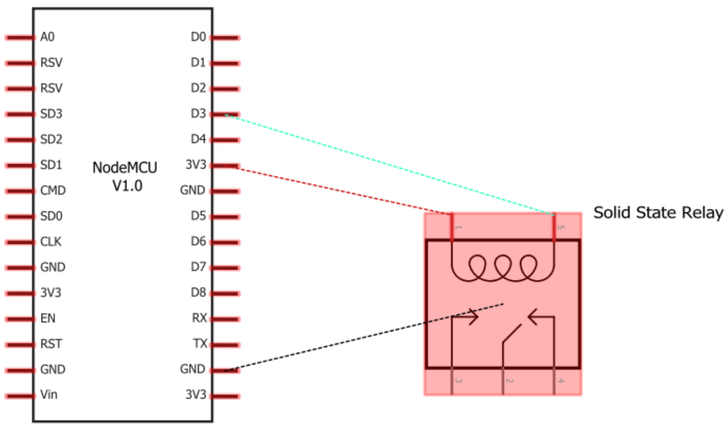


Figure 4.4 Solid State Relay Schematic

Figure 4.3 shows the physical connection seen by user of the solid state relay to the NodeMCU board. Although it seems that there is no appliance connected to the relay, during test, several appliance was tested on the relay board that resulting one of the relay to malfunction. Figure 4.4 shows the schematic of the connection. In the schematic, we can see that the low level trigger is connected to pin D3. Therefore, pin 3 will be manipulated to turn the relay on or turn the relay off.

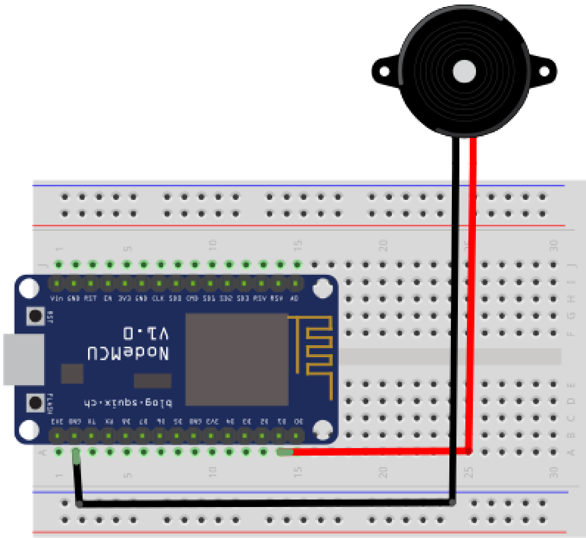


Figure 4.5 Buzzer Diagram

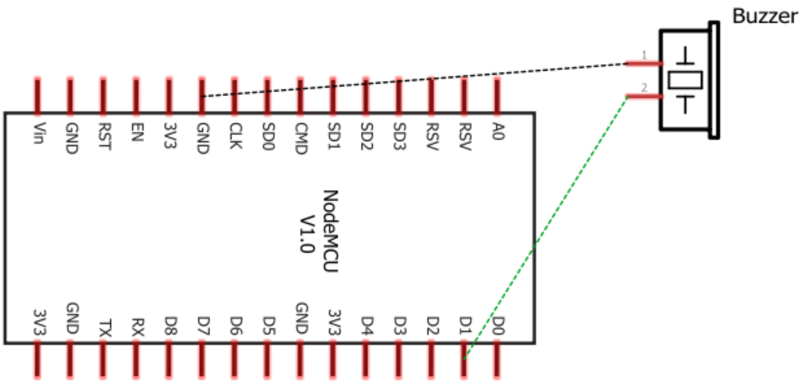


Figure 4.6 Buzzer Schematic

Figure 4.5 and Figure 4.6 each shows the buzzer diagram and its schematics. Buzzer acts as an alarm in this project. Whenever LPG gas is detected by the MQ-6 sensor, the buzzer will be turned on. Other than that, a notification will also be sent to the Blynk application as configured in the system.

Although the buzzer is turned on after gas is detected in the vicinity of the sensor, the volume of the buzzer is worrying as it is not as loud as the fire alarm or emergency alarm available in the market now. Due to budget constrain, the buzzer was not changed and still remain in the project as an alarm to user.

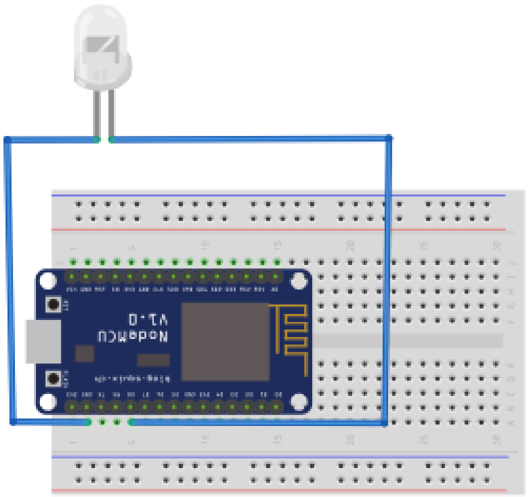


Figure 4.7 Light Emitting Diode Diagram

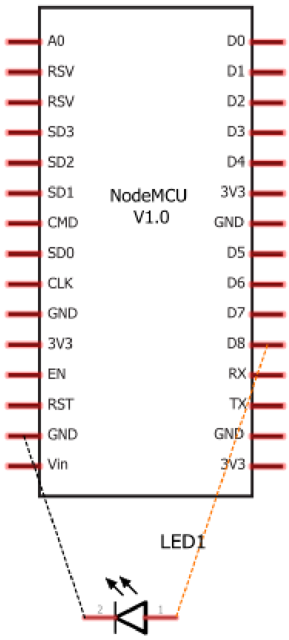


Figure 4.8 Light Emitting Diode Schematic

Figure 4.7 and Figure 4.8 shows the Light Emitting Diode diagram and schematic. L.E.D is used in this project to simulate the real world Light Emitting Diode that is used in household around the world. User who still uses fluorescent light can still control the light by using the previously mentioned Solid State Relay.

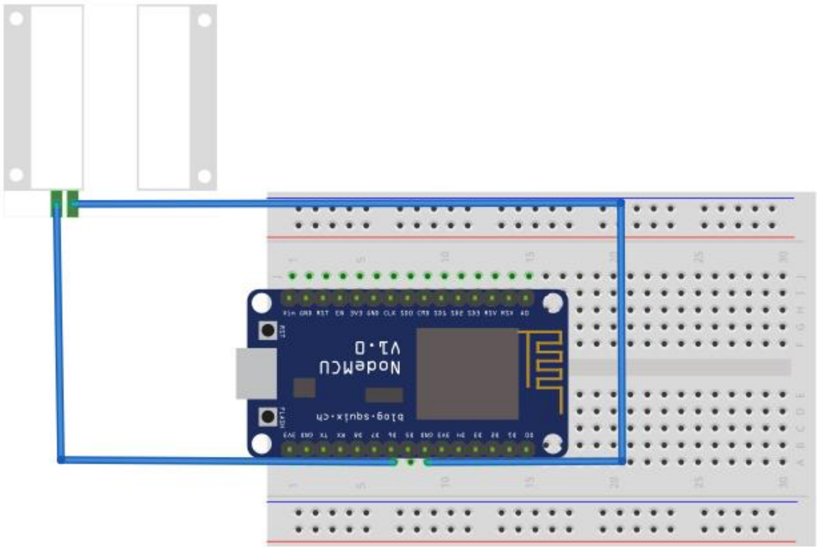


Figure 4.9 Magnetic Contact Switch Diagram

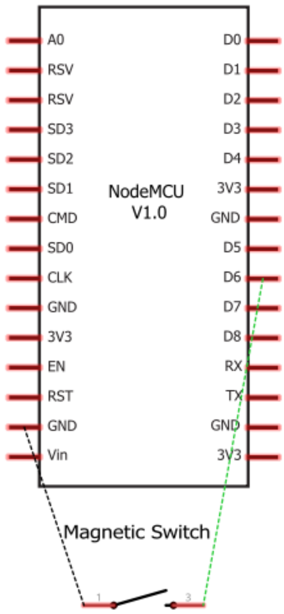


Figure 4.10 Magnetic Contact Switch Schematic

Figure 4.9 and Figure 4.10 shows the diagram and schematic of magnetic contact switch. This component relies on its other pair to detect if a current is flowing or not. This component is used to detect if any door in the house is opened mainly front door and door at the back of the house. Upon door opening, the current flowing in the circuit is stopped as its conductor is not present. The system will detect that there is no current flowing and in 5 second, the system through Blynk application will notify user that door at their house is open.

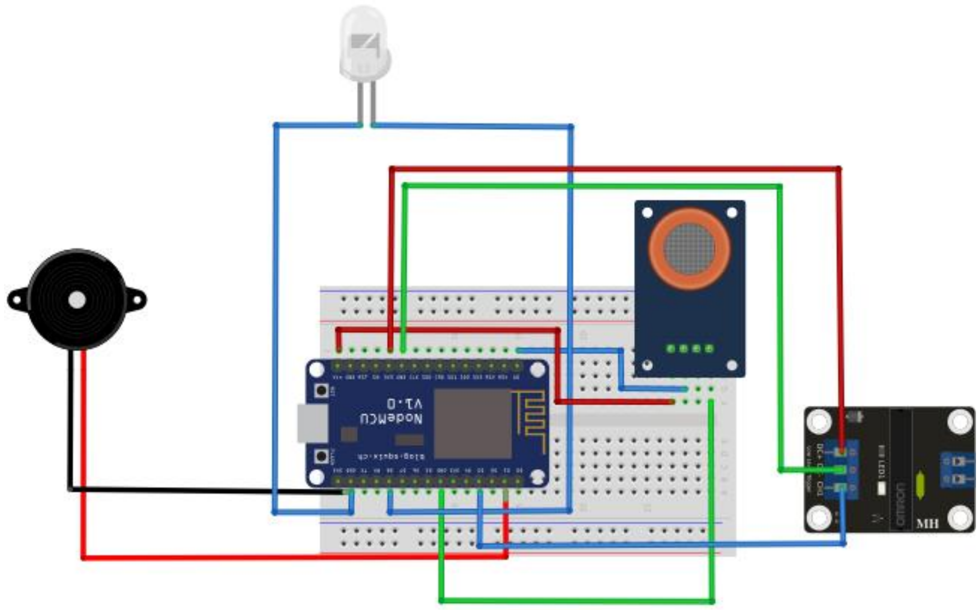


Figure 4.11 Full System Diagram

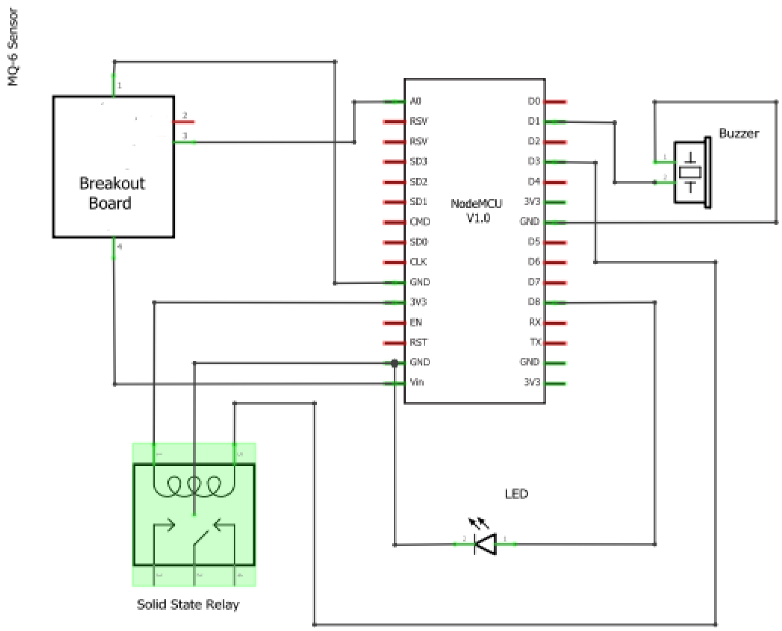


Figure 4.12 Full System Schematic

Figure 4.11 and Figure 4.12 shows the complete diagram and schematic of this project. Magnetic Contact switch was implemented on another device. While there are components who shared their ground or Vcc pins, the project runs smoothly. A backup had been setup if user cannot connect to the WiFi network. That function will be tested in the next section of this thesis. Figure 4.13 shows the image of these components combined and wired on a breadboard.

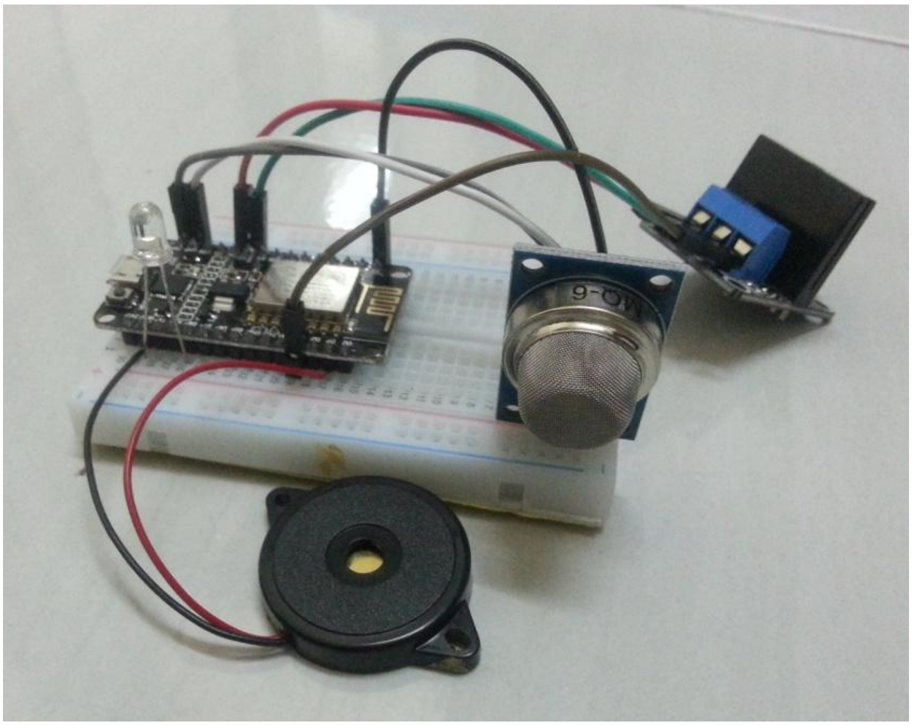


Figure 4.13 Project Hardware

4.3 SYSTEM TESTING

In this project, MQ-6 sensor will detect any leakage of LPG gas, if there is any, the buzzer will be activated and a notification will be sent to the user. Other than that, if any door of the house is opened, user will get a notification through Blynk application. Lastly, the application can be used to control almost any appliances that are compiled with Blynk library.

The first test is that the device can't connect to the WiFi network and user needs to enter the credential details. During testing, the device managed to change itself from station mode into Access Point Mode and then back into station mode. The website hosted on NodeMCU to collect WiFi credential also works without a problem.

The second test is the modularity test. During usage, one smart home device is on while the other is turned off. Although the mobile application does detect that the other board is not online, the board that is online can be controlled normally without any problem or the need to make the other device online first.

The last test is smart home functionality test. In the mobile application, all button, slider, and function are tested. They were clicked simultaneously and one after another. It looks that every function does work.

User acceptance test is also done for tester that is completely having no experience with smart home. The tester was given the Blynk application and the project for them to test it. For the test, please refer the appendix.

4.3.1 User Acceptance Test

User Acceptance Test had been widely used in software development to test the finished product for errors, oversight and bugs. This test will be done by a team of tester consisting o people who has no idea how the system works. A series of task will be given to the testers for them to execute and record the outcomes. Approval of this testing implies that reviewers are confident that following the execution of the best plan, the resulting system will be considered fully-tested and eligible for implementation.

4.3.1.1 Blynk Application

This part of the test will evaluate whether the button allocated for certain task in Blynk Application is connected to the correct pins of NodeMCU.

Table 4.1 User Acceptance Test of Blynk Application

Test Case	Test Action	Expected Result	Actual Result	Pass/Fail	Comment
Turn on an LED lamp	Tap on the off button	The LED turn on and the button turned into on			
Turn off an LED lamp	Tap on the on button	The LED turn off and the button turned into off			
Brighten an LED lamp	Drag the slider button to the right	The LED will be brighter			
Dimming an LED lamp	Drag the slider button to the left	The LED will dim			
Turning on a relay switch	Tap on the off button	The relay switch will turn on and the button will turned into off			
Turning off the relay switch	Tap on the off button	The relay switch will turn off and the button will turned into on			
Monitor gas sensor value	Expose gas sensor to LPG gas	The sensor value on screen will change and there will be a notification			
Disconnect device from internet	Turn off the device	Blynk app will show that the device is unavailable			

4.3.1.2 WiFi Credential Setup Page

This part of the test will evaluate whether the web page hosted by the NodeMCU microcontroller able to process user input and connect to available WiFi network.

Table 4.2 User Acceptance Test of WiFi Credential Setup Page

Test Case	Test Action	Expected Result	Actual Result	Pass/Fail	Comment
Unable to connect to WiFi network	Boot the device and wait	Device will enter Access Point mode			
Connect to device Access Point	Find ESPCONFIG network and connect to it	User connected to the device			
Access WiFi credential setup page	Open browser and access 192.168.11.4	Webpage with SSID textbox and password textbox appear			
Enter correct WiFi credential	Fill the form with correct WiFi credential	The device will exit Access Point mode and connect to the network specified			
Check device status	Open Blynk application and view device status	Device status will be online			

Please refer Appendix B for User Acceptance Test document that has been filled up by testers who tested this system using Table 4.1 and Table 4.2.

4.4 USER MANUAL

Please refer Appendix A for User Manual.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

The chapter will dive into the conclusion of the project, project fit with objectives, methodology and implementation conclusion, and future suggestion.

As the conclusion for the project, Modular Smart Home Using WiFi technology has achieved its objective to design a WiFi technology into smart home device. Although the device used already came with WiFi capabilities, the capabilities are harnessed to make a backup WiFi connection in case of network problem. The objective to implement a modular version of smart home device was also achieved as the device in this project is independent of each other but still connects to the same mobile application; Blynk. The last objective was to propose basic security measure into smart home mobile application, this objective was a success as Blynk connects to its server using SSL port which is port 443, therefore, all data sent and received using the mobile application is secure and encrypted

By using the agile methodology, many high impact and high importance decision can be made and implemented into the project rather than using other methodologies that needs user to start back from data gathering, planning and so on. Decision from changing type of microcontroller board used for the project until implementing the device with existing mobile application can be made and be represented by iteration rather than starting back from scratch.

5.2 PROJECT CONSTRAINT

During development process, there are constrains and challenges met that must be considered for a successful implementation of this project.

The first constraint is Arduino Uno problem with nRF24L01. The first idea is to use radio frequency as the transmitter of data packet. The problem starts way back upon receiving the components itself. The components were all originates from China. China version of Arduino is very famous for its power problems. To cater the problem, capacitor was used but it does not solve the problem at the time.

The second and last constrain is NodeMCU softAP and station mode. The initial plan was to have several NodeMCU talking to each other while receiving data from and sending data to the internet. Although NodeMCU can run in both modes simultaneously, the station mode network is completely isolated from Access Point mode networks. There is no bridge between the two networks. Here, the decision of having devices connected to the internet and to mobile application was made.

5.3 FUTURE WORK

There is several improvement and suggestion that can be implemented for the project future improvement of Modular Smart Home Using WiFi Technology.

The first improvement that can be done in the future is having more sensors in the project. An example of implementation is collecting sensor data and process it on a web server. Combination of sensor data will determine an outcome. So, data from temperature sensor combined with data from humidity sensor and data from local weather forecast can determine the thermostat settings or air conditioner settings.

The second improvement can be made on the security section of this project. As of now, the project security is only on the transmission of data that uses port 443 that is SSL port. The improvement that can be made is local data encryption or server data encryption depending on the needs of the project in the future. As there is multiple cases of data breaches happening, data encryption is a must even for normal sensor data.

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APPENDIX A
USER MANUAL

This part of the thesis will bring user through the steps needed to operate this project. It starts from installing application, acquiring devices until the project run successfully.

1.1 SYSTEM OVERVIEW

Modular Smart Home Using WiFi Technology is a smart home product that can be swapped in and out of an ecosystem of smart home devices without affecting the entire ecosystem or even the need to turn off the entire system in order to swap it in or out. This product will need internet connection through wireless WiFi Access Point. After connected to the internet, the product is ready to use.

1.2 SYSTEM CONFIGURATION

Modular Smart Home Using WiFi Technology has 2 components. One component is the mobile application and another is the device itself. The mobile application operates on mobile devices with Android operating system. It is compatible with Android 4.4.2 and higher versions. The mobile application requires internet connection in order to send user command to its server and the server will relay the command to the intended devices through secure port 443 SSL channel.

The devices require internet connection through WiFi medium. After connected to the internet, the device will connect to the mobile application server. After the process of connecting is done, the devices will listen for user command through the mobile application server.

1.3 CONTIGENCIES AND ALTERNATE MODE OF OPERATION

In case of unsuccessful connection to users WiFi router or WiFi Access Point, the device will automatically change its mode to Access Point mode. In this mode, user is able to connect to the device in order reconfigure the device connection credentials which include the network SSID and password. In order for user to enter the device, user need to connect to a network called ESPCONFIG with password of espconfig. After doing so, using the same device the user use to connect to the Access Point, user need to open an internet browser and enter the following IP address 192.168.11.4. Upon entering the IP address, a website will appear and user is advised to enter their network SSID and password. Upon pressing submit button, the device will change to station mode and connect to user wireless WiFi network.

1.4 INSTALLATION

To use this product, users firstly need to have Blynk mobile application. The application is available with this product. After installing the Blynk application, the mobile application will connect to its server and authenticate itself with the devices available with user. If the devices are online, the mobile application will show it in the application. If not, the device name will be in grey colour on the system.

As for the product itself, users need to power it and connect it to the internet through WiFi connection. If user failed to do so, refer Contingencies and alternate mode of operation chapter of this user manual.

1.5 GETTING STARTED

Upon finishing installation, in users Blynk application, there will be several user interface such as buttons, sliders and labels showed in the application with labels on them.

The first user interface is an on/off button. This button is used to turn on and off Light Emitting Diode in the product. The Light Emitting Diode is used to simulate real world Light Emitting Diode lamp. User may just swap the component with a real lamp provided the voltage and the ampere is not lower than the devices pins power.

The second user interface is the sliders. The slider is used to regulate the power send to the device pin. By doing so, the Light Emitting Diode can be dimmed. User who always have a small lamp by their bedside now does not have buy a separate product as this product can dim their existing lamp in the room to simulate the bedside lamp.

The third user interface is relay on/off button. The relay is used to turn on and off existing electrical devices in users' room such their stand fan, study lamp, decoration lamp and even appliances such as air conditioning unit. It is not advisable to use relay to turn off air conditioning unit before turning it off using the provided remote from the manufacturer as this can cause short circuit.

Lastly, there is a label that shows reading of MQ-6 LPG gas sensor. This sensor is used to detect cooking gas leakage. The reading on the label is a raw reading. It is the reading of analog pin. Any volume of cooking gas sensed by the device will trigger the alarm and a notification will be send to user through Blynk application.

APPENDIX B
USER ACCEPTANCE TEST

USER ACCEPTANCE TEST FORM

Provided below is the user acceptance test form for Modular Smart Home Using WiFi Technology. User are needed to follow the test action and observe the outcome. If the outcome is same as expected result, the test case is a success or pass, if else, it's a fail. If user has any comment, write it in the comment box.

Table 1.1 User Acceptance Test of Blynk Application

Test Case	**Test Action**	**Expected Result**	**Actual Result**	**Pass/ Fail**	**Comment**
Turn on an LED lamp	Tap on the off button	The LED turn on and the button turned into on			
Turn off an LED lamp	Tap on the on button	The LED turn off and the button turned into off			
Brighten an LED lamp	Drag the slider button to the right	The LED will be brighter			
Dimming an LED lamp	Drag the slider button to the left	The LED will dim			
Turning on a relay switch	Tap on the off button	The relay switch will turn on and the button will turned into off			
Turning off the relay switch	Tap on the off button	The relay switch will turn off and the button will turned into on			
Monitor gas sensor value	Expose gas sensor to LPG gas	The sensor value on screen will change and there will be a notification			
Disconnect device from internet	Turn off the device	Blynk app will show that the device is unavailable			

Table 1.2 User Acceptance Test of WiFi Credential Setup Page

Test Case	**Test Action**	**Expected Result**	**Actual Result**	**Pass/Fail**	**Comment**
Unable to connect to WiFi network	Boot the device and wait	Device will enter Access Point mode			
Connect to device Access Point	Find ESPCONFIG network and connect to it	User connected to the device			
Access WiFi credential setup page	Open browser and access 192.168.11.4	Webpage with SSID textbox and password textbox appear			
Enter correct WiFi credential	Fill the form with correct WiFi credential	The device will exit Access Point mode and connect to the network specified			
Check device status	Open Blynk application and view device status	Device status will be online			

Verified by,

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DEVELOPER

Approved by,

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CLIENT

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