Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF HOME APPLIANCES CONTROL SYSTEM USING MICROCONTROLLER FOR SMART HOME

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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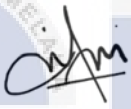
2022

DECLARATION

I declare that this project report entitled "DEVELOPMENT OF HOME APPLIANCES CONTROL SYSTEM USING MICROCONTROLLER FOR SMART HOME" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : NIK ADLI BIN NIK A'SRY

Date : 17/02/2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

Signature : 

Supervisor Name : DR. NOR AZLAN BIN MOHD ARIS

Date : 17/02/2023

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

To my beloved mother, ROHANI BINTI MOKHTAR, and father, NIK A'SRY BIN NIK MAN

and

To my family members.

ABSTRACT

A smart home is equipped with technology that allows smart gadgets to communicate with one another and gives users more control over their house. As a result of recent technological advancements, numerous devices can now link to one another using wireless control settings like Bluetooth and Wi-Fi through microcontroller. This project is carried out to develop a system that utilises the ESP8266 WiFi module as a microcontroller and various sensors to identify home appliances. It focuses primarily on the development of an IOT-based household appliances control system that can be automatically programmed based on user's preferences or be able to be managed via the internet. The ESP8266 WiFi module is used to send data to web servers and applications. In this project, a software for smart control is developed that can be automated while requiring minimal amount of human involvement, protecting the integrity of all the electrical appliances in the house. The technology also alerts the user to the quantity of electricity that is being used by displaying the data on the website that is linked to the system. In conclusion, the wireless system for controlling household appliances has been successfully developed, and can be monitored via a web browser or website.

ABSTRAK

Rumah pintar dilengkapi dengan teknologi yang membolehkan alat pintar berkomunikasi antara satu sama lain dan memberikan pengguna lebih kawalan ke atas rumah mereka. Hasil daripada kemajuan teknologi terkini, banyak peranti kini boleh berkomunikasi antara satu sama lain menggunakan tetapan kawalan wayarles seperti Bluetooth dan Wi-Fi melalui mikropengawal. Projek ini dijalankan untuk membangunkan sistem yang menggunakan modul WiFi ESP8266 sebagai mikropengawal dan pelbagai sensor untuk mengenal pasti peralatan rumah. Ia memberi tumpuan terutamanya kepada pembangunan sistem kawalan perkakas rumah berasaskan IOT yang boleh diprogramkan secara automatik berdasarkan pilihan pengguna atau boleh diuruskan melalui internet. Modul WiFi ESP8266 digunakan untuk menghantar data ke pelayan web dan aplikasi. Dalam projek ini, perisian untuk kawalan pintar telah dibangunkan yang boleh diautomasikan sambil memerlukan jumlah minimum penglibatan manusia, melindungi integriti semua peralatan elektrik di dalam rumah. Teknologi ini juga memberi amaran kepada pengguna tentang kuantiti elektrik yang sedang digunakan dengan memaparkan data di laman web yang dipautkan ke sistem. Kesimpulannya, sistem wayarles untuk mengawal perkakas rumah telah berjaya dibangunkan, dan boleh dipantau melalui pelayar web atau laman web.

ACKNOWLEDGEMENTS

Assalammualaikum and Peace Be Upon You. First and foremost, I would like to take this opportunity to express my grateful to Allah S.W.T because gave me a good health to finish up my final year project. I also would like to express my gratitude to my supervisor, DR. NOR AZLAN BIN MOHD ARIS for their precious guidance, words of wisdom and patient throughout this project.

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CHAPTER 1

INTRODUCTION

1.1 Background

The Internet of Things, or IoT, is the collective term for the billions of physical objects that are now linked to the internet and actively collecting and exchanging data. This smart home control system brings the iot system to easily user control the home appliances wireless even far from home. Smartphone, laptop, tablet and other that has been connected to the internet can be used by users to control their own home equipment.

The internet of things (IoT) can make physical manufacturing and distribution as efficient as the internet has long made information work. Hundreds of millions, if not billions, of embedded internet-enabled sensors throughout the world offer an incredibly rich set of data that organisations can use to track assets, automate processes, and collect information about the safety of their operations. Researchers can use the IoT to gather information on people's preferences and behaviours, but doing so carries significant privacy and security risks.

A smart home is one that has technology that enables communication between smart devices and provides you more control over your home. Recent developments in technology have made it possible to use wireless control settings like Bluetooth and Wi-Fi, enabling various devices to connect with one another. The Arduino board can be connected to the computer wirelessly by using a WIFI shield as a Micro web server, which reduces costs and enables the Arduino to work independently[1]. A wireless router or hotspot is required for the Wi-Fi shield since it acts as the gateway for the Arduino to connect to the internet. In

order to control and monitor household appliances remotely, a web-based home automation system is being developed.

1.2 Problem Statement

In the present era, very rapid and sophisticated technological change is always a conversation. The topic that is always discussed when new devices are released in the market is how long they last, how good they are. However, in doing research on something new, there are some problems that need to be faced. This problem is not only faced by individuals but also faced by large organizations in problem solving. Home appliances control system is not something usual in this country but there are some issues that arise in doing reforms. One of them is the selection of suitable equipment according to specifications. It also needs to be compatible with other equipment in order to function properly.

The smart home project this time will make it easier for users to control and status a device at home that can be controlled anywhere. The problem that existed before the project was thought of was the excessive consumption of electricity so that the bill soared and in turn made it difficult to make payments. The project is very efficient as it helps calculate automatically and display the total electricity bill over time. In addition, to facilitate one's daily work, the control of this home appliance is only at your fingertips where it can be controlled through the respective devices.

1.3 Project Objective

1) To develop a system that can control home appliances using microcontroller.
2) To display the status of the home appliances on website.
3) To display information of electricity's power consumption information (Ampere).

1.4 Scope of Project

The scope of this project is to develop a home appliances control system that control and monitoring an appliance, send information and store in the webpage. The webpage platform system can display the current electricity consumption in watts in real-time. This system consists of a microcontroller (NodeMcu) as the brain of the system and as a medium of transmitting the information through wireless network. The sensor that uses in this system is ACS712 current sensor to measure the energy of LED and Dc Motor that act as Lamp and fan home appliances.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction Home appliances control system

Today, upgraded service especially in internet sector cause all information is easily to search. The technology of IoT will facilitate the collection and exchange of data through the cloud. Therefore, such ideas are used for community work that will facilitate human daily routines. In home automation, there are some appliances that connect and control through phone such as fan, lamp, refrigerator and other. To achieve it, a sensor is need to respond with all appliances. A sensor is a device that monitors and responds to environmental input.

Home appliances control system (HACS) is appliances which can control over internet. Using Internet of Things(IOT) the all appliances can manage through devices which phone, laptop, tab and other. IoT technology can also be used to construct a new idea and a large development zone for smart homes in order to achieve intelligence, comfort, and improve people's lives[1]. In order to operate household appliances like lights, fans, air conditioners, room heaters, televisions, refrigerators, dishwashing machines, and others, simple Arduino software with a sensor is required[3]. This is accomplished by combining microcontroller-based device such as the Arduino UNO with sensor like accelerometer, magnetic and flame sensor. The readings from the sensor affect the state of our appliances, which can then be viewed on the cloud platform.

We know, the main key in the success of a smart home is IoT, but we should also look at how to manage home appliances by saving electricity to reduce costs. The characteristic of smart home not just viewing at the system, but also seeing how it may

minimize electricity waste. Energy saving in smart home is wattage reduce to avoid the waste of electricity in our house. A smart home can be created utilising simulation software as a scheduling system and end-user application interface for tracking and managing energy usage in the house using user-controlled hourly energy-usage schedules. The outcome shown that energy waste can be avoided by organizing, monitoring, and controlling daily power consumption[4].

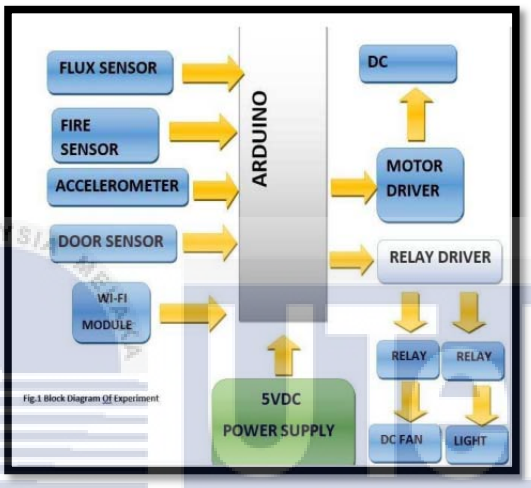


Figure 2.1: Block Diagram Of System[5]

2.2 Smart Electricity Monitoring and Control system

Smart electricity is measure the energy use in home like television, washing machine, refrigerator, and other home appliances. Energy use is efficient maintains a balance between supply and demand. Waste of energy can lead to an increase in financial capital, environmental quality and human comfort. Therefore, the government advises consumers to manage their electricity consumption well. As such, this paper will explore the widespread application of the Internet of Things (IoT) to achieve energy efficiency[6]. To control and monitoring the data, the home devices need connect with the network. This project is attaches the IoT in order to control or remotely by mobile devices. The sensor will have embedded

with home appliances so that the sensor can send the data on microcontroller and lastly control the appliances through mobile. On the mobile application, the statistic of power consumption will display in detail which are voltage, current, power and so on. When the circuit detect the overloading through application the alarm will triggers.

A smart monitoring and control system (SMACS) is a system that uses hardware and the Internet of Things to monitor household appliance power use (IoT)[2]. It features an Arduino Uno, LCD, ACS712 current sensor module, relays, and AC sources. Then, thingspeak is used to store the data in cloud storage. A mobile application (Virtuino) also has access to the data and uses graphical and numerical displays to visualise it. This study uses mobile applications to give consumers with a simple method for monitoring and controlling the power usage of household equipment. Below show the overall system of reading current supply using thingspeak.

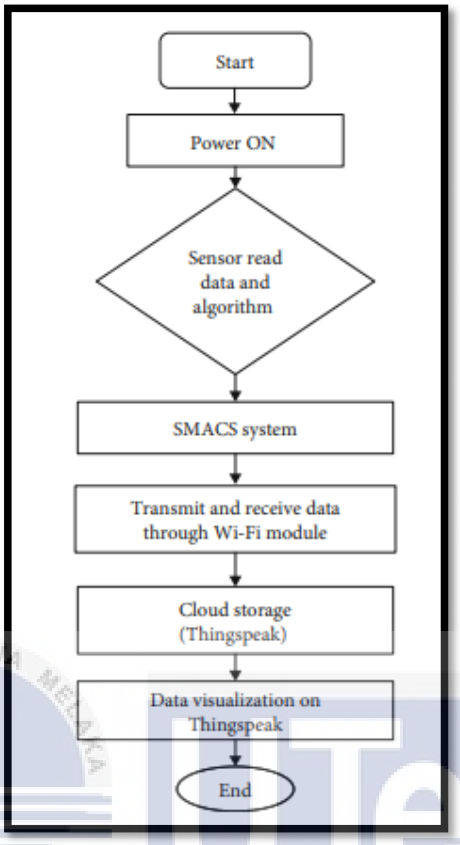


Figure 2.2: The flowchart of SMACS system[2]

2.3 System Implementation in Smart home

Smart home control system uses many ways in order the home appliances can be controlled and monitor wirelessly. There have two implementations to making smart home which are using Bluetooth and using Wi-Fi.

2.3.1 Smart Home System Using Bluetooth

Automation has made rapid advancements during the past ten years. One of the latest developments in smart home technology is the ability to control a variety of household appliances, such as lights, fans, air conditioners, heaters, televisions, refrigerators,

dishwashing machines, and others. To establish a Smart Home, we used Bluetooth and an Android smartphone.

The Arduino Uno, Bluetooth module, Power supply, Relay module, and Android application on the smartphone are the system's primary components. This smart home system work by turn ON the Bluetooth controller in smart phone. Bluetooth controller is application to pairing the smart phone with Bluetooth HC-05 module.[3] After pairing, configure unique keys for each appliance in the app. After that one layout will appear on screen of smart phone which is many button that can turn On and Off. Overall appliance now can turn On or Off. Best feature is the other appliances can control even some appliances is turn on.

This smart home system using Arduino as brain to control appliances via Bluetooth device. Its bring benefit for user because of user friendly. Next, the system implements the LDR to control the street light operation for energy efficiency. Lastly, it simplifies the procedures involved in switching using the conventional technique to save time and extend the life of the switch.

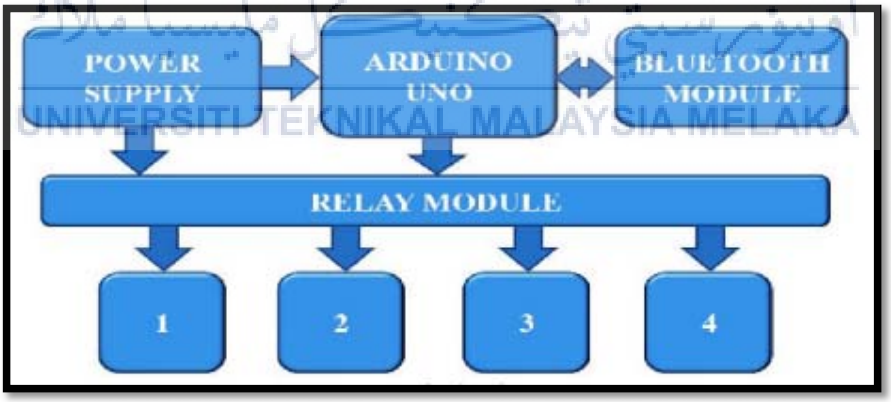


Figure 2.3: Block Diagram of using Bluetooth system[3]

2.3.2 Smart Home System Using Wi-Fi module

The internet of things (IoT) is the system that can control or monitor through internet connection. Iot's system important in industry for this era because it can manage the equipment through wireless network. Apart from factory use, The internet of things (IoT) is also used for private purposes such as to control the home appliances. The Internet of Things (IoT) is the network of physical objects like furniture, machinery, cars, and buildings that are equipped with electronics, software, sensors, actuators, and network connections to facilitate data gathering and exchange. (5). Depending on what needs to be controlled, the control system is a system that has the ability to control other entities. In the control application, both local and remote control are available. The challenge of smart home system is the protocol to transfer the data. WebSocket protocol has lower average latency than both HTTP and lengthy polling. For Internet of Things applications, it is highly advised to use the protocols CoAP, MQTT, XMPP, RESTFUL, AMQP, and WebSocket.[7]

Users can manage their energy more effectively and efficiently with the use of control systems. The current in this experiment is managed by the control system, and it will be stopped if an overcurrent is discovered. The use of household appliances can be made more conscious among users due to this control system. Relay is utilised in the portion of the control system where it serves as protection by cutting off and delaying the current when an overcurrent situation arises. To run the IoT with smart home system, the open source IOT platform with the lowest cost is the ESP8266 Wifi module. This device important to control appliances through web server and mobile application.

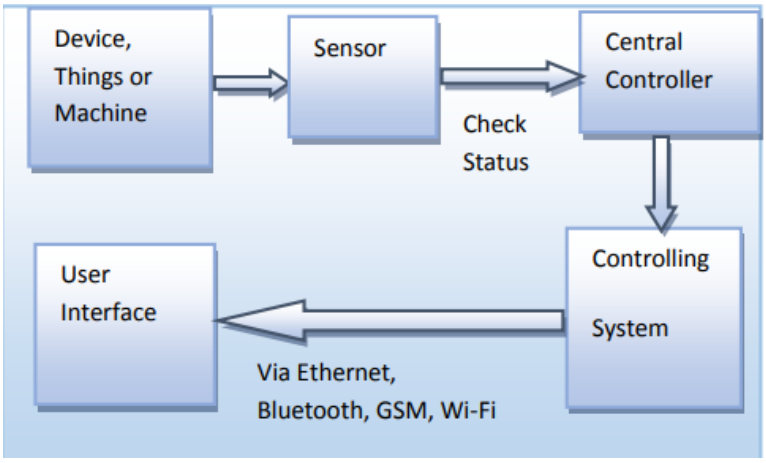


Figure 2.4: Basic Block Diagram of using Wifi connection[8]

2.3.3 Comparison Bluetooth Module And Wifi Module

Table 2.1: Comparison Bluetooth and Wifi Module

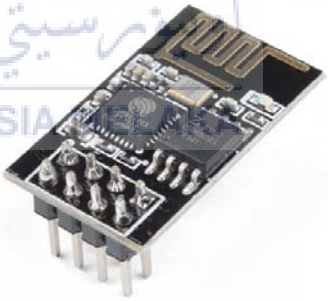
	Bluetooth Module	Wifi module
Brand name	 HC-05	 ESP8266
Range (m)	40m - 400m	46m - 1000m
Security protocol	None	WEP, WPA, WPA2, and WPA3
Power Consumption	Less power	High power

Table above show the strong and weak sides of 2 device module. The Wi-Fi module more compatible from Bluetooth module because of some causes. First one is data transfer, where the Wi-Fi can transfer more data per second than Bluetooth that can transfer just 25Mbps. In addition, wireless network is enabling real-time information access on smartphones will allow users to roam freely without disconnecting from the network.

2.4 Smart home system using ESP8266 Wifi Module

Smart Electricity Monitoring System is to utilize hardware and the Internet of Things(IoT) to track the energy use of home appliances. The creation of these initiatives has improved the world's ability to save energy, practice energy conservation, and increase the effectiveness and efficiency of power use. The Internet of Things (IoT) has been developed using the ThingSpeak language and is compatible with the ESP8266 Wi-Fi module. Additionally, it can display, evaluate, and calculate the necessary data and then save it in the cloud either publicly or privately.[2] Data from the sensor-based IoT is analyzed and stored using ThingSpeak. As long as Wi-Fi is connected, it may be examined remotely using either a laptop or a mobile device. The ACS712 current sensor module is a device used to measure the current and compute the power usage.

The one of features in Smart Home System Using Internet of Things (IoT) is communicating the ESP8266 Wi-Fi Module through the Web Server using ThingSpeak. To have a ownership in ThingSpeak, user need to sign up the account. After that, a channel is established to determine how much data needs to be watched. The data of home appliances can visualize a chart to monitored the current, power consumption and voltage. Besides that, Using the Virtuino mobile application, household appliances may remotely and wirelessly monitor their usage. ThingSpeak and Virtuino Web servers may be connected. The

smartphone app will receive real-time data from ThingSpeak and display it on mobile application. The data of current and power for each appliance will monitor in ThingSpeak and will display it through web server and mobile application. When an overcurrent happens, Virtuino has the ability to sound an alert. A sound will be produced by the alarm to alert user to the overcurrent.[2]

2.5 Comparison of The Smart Home Project

Table below show the comparison of some project using Arduino as microcontroller in achieve smart home project.

Table 2.2 Comparison of Smart Home Project

Project	Result
Smart Home Automation And Security System Using Arduino And Iot	An Arduino board will be attached to the sensors. The information from home appliances will be sent to a cloud platform via a wireless module. The mobile device and system should be connected to the same wireless network. A sensor will have the ability to turn on or off users' controllable sensors.[5]
Design Of A Home Automation System Using Arduino With Wireless Control	The Wi-Fi connection and web browser functionality on the Arduino are initially set up. After that, the system is set up to work with house-model appliances. The home automation system design is finished with the creation of a simple HTML user interface to make the system user-friendly. The design of the home automation system was successfully put into practice.

	The Arduino needs to join a wireless network before it can browse on a laptop or smartphone and enable management of the appliances in the house model.[9]
Intelligent Smart Home Automation And Security System Using Arduino And Wi-Fi	Using an Android-based smartphone app, a micro-web server with internet protocol (IP) connectivity can be accessed and used to remotely access and operate equipment and devices. The system in this place has connections for lamp control and temperature control.
Smart Home Energy Management System based on the Internet of Things (IoT)	These systems are only applicable to already intelligent devices and are not suitable for many locations where most appliances are not yet IoT-capable. It makes the case for paying attention to older appliances and suggests a way to include them in an energy-efficient Internet of Things. We suggest Homergy as a remedy, a clever Internet of Things-based home energy management solution that works for both developed and emerging markets.[6]
Improving Smart Home Concept with the Internet of Things Concept Using RaspberryPi and NodeMCU	This project involves a smart home system with a Raspberry Pi and a NodeMCU as the backend that not only replaces switches but also records and reports important events to the home's owner, such as when someone enters the house without permission or when the cost of using electrical appliances has been calculated. We successfully test our suggested system in

	a real-world working environment. Telegram Bot is used for communication between users and the system.[11]
Internet of Things based Smart Energy Management for Smart Home	In addition to being able to capture the data containing operating times and energy consumption statistics for each item, household energy consumption can be tracked in real time. Additionally, it is made sure that the energy requirements are met to the greatest extent possible during the times when energy costs are lowest because of the SEM system.[12]

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will include how the project will be carried out to achieved the objective. The information that will consist of this chapter is the project workflow. The workflow will be the flow chart is the flow from start to the end of the project. Next, Hardware and software specification that will be used in this project. Other than that block diagram, there is also a block with the hardware that will be used, and the circuit diagram is more in dept of the block diagram, which consists of a connection between modules or sensors.

3.2 Study Design

This project aims to develop the Home Appliances Control System using Microcontroller. The primary device that will be used is an ESP8266 in this system. The ESP8266 that will be chosen to use in this system will be nodemcu. The software used in this project is Arduino IDE as both editor and compiler to control LED and DC motor through Website. Besides, the website's UI will sketch on brackets software to create html and css style.

In this project, IoT is included which is the website act as interface show the status of home appliances. The total electricity usage of home appliances such as lamp and fan will record on website. So that, user can monitor the electricity usage every time. After that, the interface also creates to control the appliances through internet. Then the user can't worry

about the status of home appliances because them can know the status of lamp and fan by control it from website.

To make it, Nodemcu Esp8266 is use as the microcontroller and connect the device between application and the sensor. The sensor use is ACS712. The sensor will be connecting to Microcontroller and the data of the sensor will keep in it. Next, the Wi-Fi module will allow the data through Wi-Fi network and communicate with Hardware component which is LED and DC motor and lastly the data or status of component will show in the website.

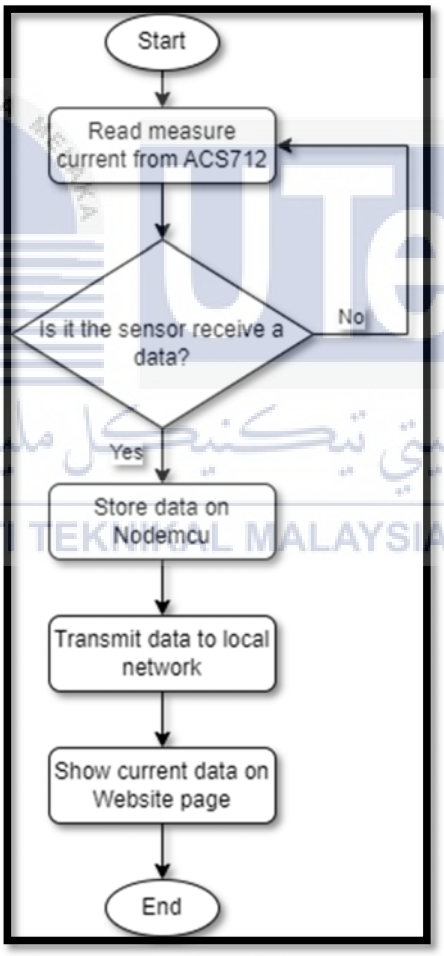


Figure 3.1: The flowchart of the Monitoring Current(Amps)

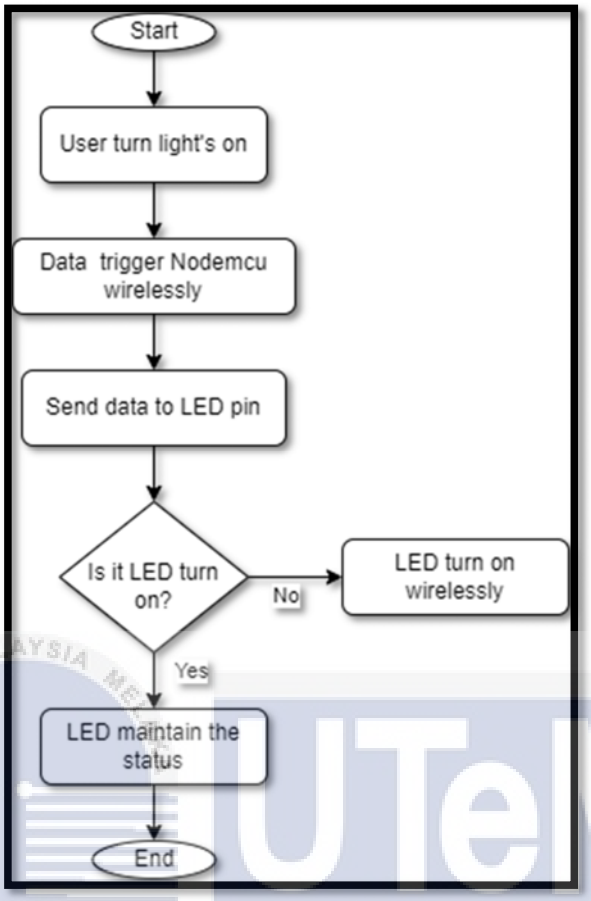


Figure 3.2: The flowchart of the Control System

3.3 Hardware Specification

3.3.1 Nodemcu ESP8266

It takes a few lines of Lua code and the NodeMCU V3 open-source firmware and development kit to build your own IoT device. When linked to additional peripherals, the board's numerous GPIO pins can be used to generate PWM, I2C, SPI, and UART serial communications.

Figure 3.3: Nodemcu

3.3.2 ACS712 Current Sensor

A current sensor that can function in both AC and DC settings is the ACS712. This sensor requires 5 volts to operate and generates an analog voltage proportional to the measured current. This device is a group of precision Hall sensors with copper wires. There are three different ACS712 models: 5A, 20A, and 30Amps. Sensing and controlling current flow is a critical requirement in a wide range of applications, including over-current protection circuits, battery chargers, switching mode power supplies, digital watt meters, programmable current sources, etc. This ACS721 current module is built on the ACS712 sensor, which can accurately detect AC or DC.

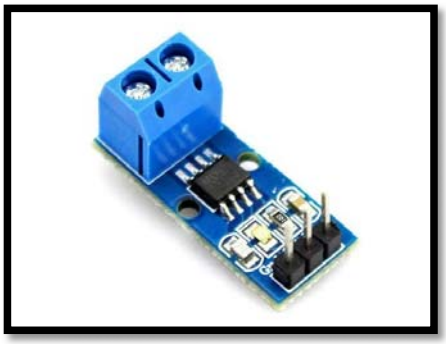


Figure 3.4: ACS712

3.3.3 5V OptoCoupler Relay Module

An efficient piece of kit for controlling high voltage, high current loads, such as AC loads, motors, solenoid valves, and lighting, is the single-channel relay module. The Arduino, PIC, and other microcontrollers can be connected to it. The relays terminals (COM, NO, and NC) are eliminated using a screw terminal. A LED is also added to display the status of the relay.

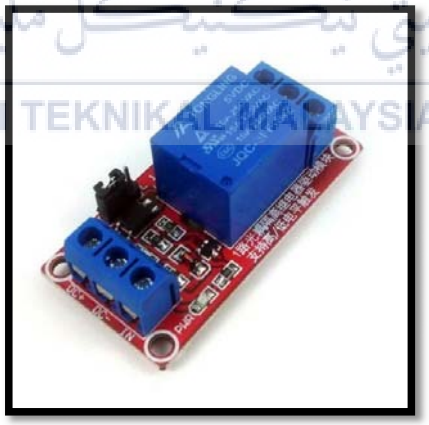


Figure 3.5: 5V Relay Module

3.3.4 5V DC Motor

This DC motors are rotary electrical machines that convert electrical energy into mechanical energy (Rotation). In this project the dc motor act as fan. The voltage supply is 5Volt which is capable with relay and other device.

Figure 3.6: 5V DC Motor

3.3.5 Light-Emitting Diode (LED)

A light-emitting diode (LED), a semiconductor device, emits light when current flows through it. The semiconductor releases energy in the form of photons as a result of the recombining of electrons and electron holes. The color of the light, which relates to the energy of the photons, depends on the energy required for electrons to cross the semiconductor's band gap.

Figure 3.7: LED

3.4 Software Specification

This part focuses on the software that is used to complete the project, such as the Arduino IDE to code the microcontroller of the system, and the cloud platform that is used for this project.

3.4.1 Arduino IDE

The Arduino IDE comes with a text editor for writing code, a message box, a text console, a toolbar with buttons for common activities, and a number of menus. It connects to the Nodemcu hardware, enabling programme upload and communication.

3.4.2 Brackets sotware

A source code editor with a main emphasis on web development is called Brackets. It is a cutting-edge text editor designed with web designers and front-end developers in mind. Its use to design webpage with html and Cascading Style Sheetstext style(CSS).

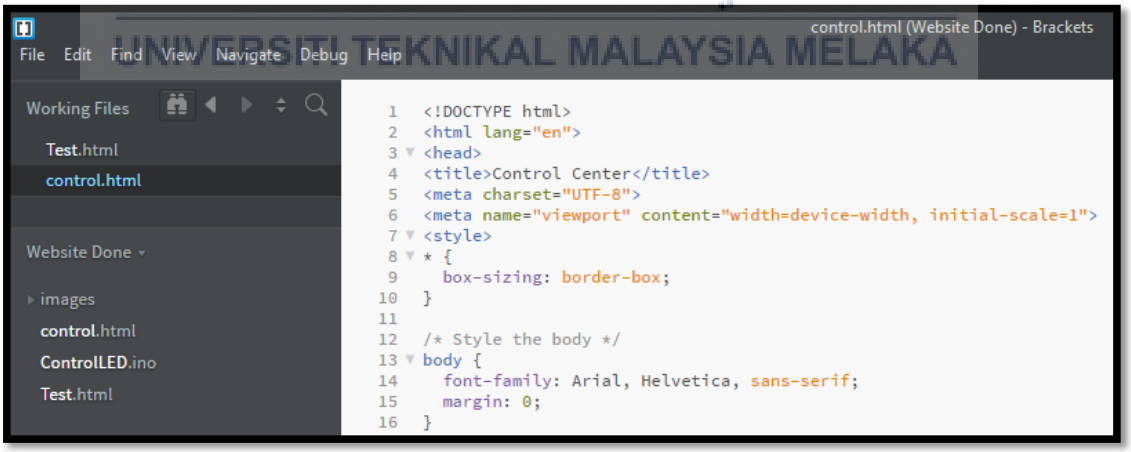


Figure 3.8: UI of bracket software

3.4.3 Sweet Home Software

It has the ability to test furniture configurations, sketch the layout of house or business, and view the results in three dimensions. It may also encompass the exterior and interior of the house. Figure 3.10 show the 3D prototype design using this software.

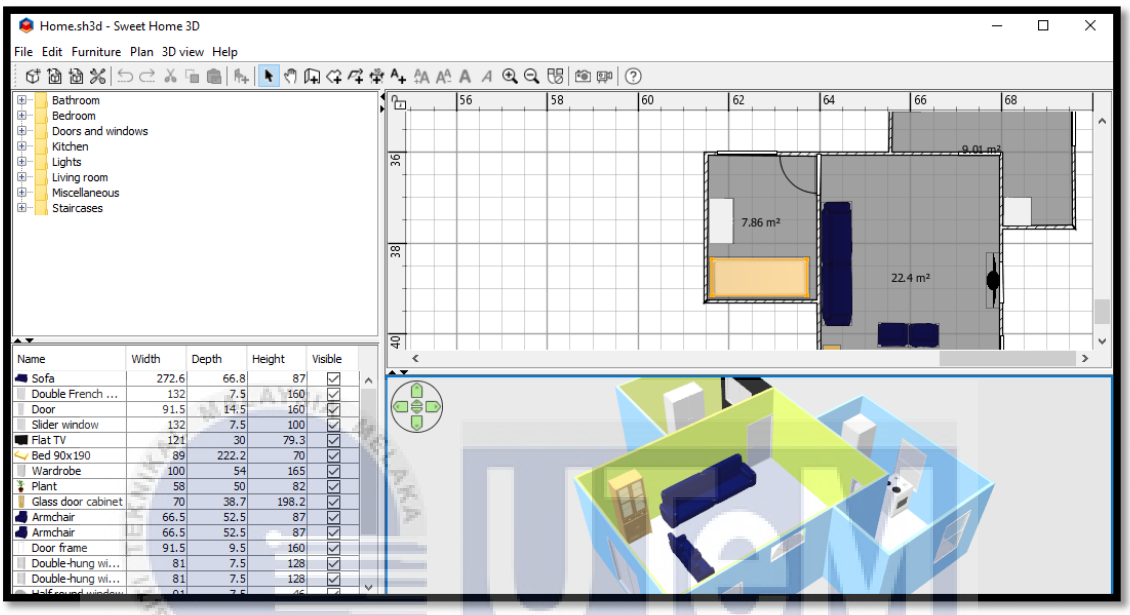


Figure 3.9: Sweet Home software UI

Figure 3.10: Smart home 3D design

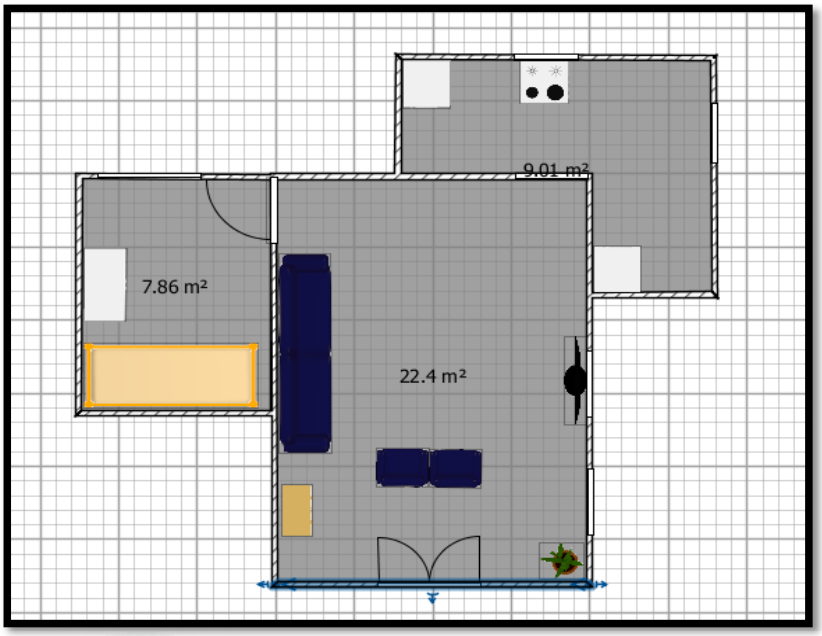


Figure 3.11: Top view of smart home prototype

3.5 Block Diagram

Based on the Figure 3.12, the block diagram represents the basic concept of Development of Home Appliances Control System Using Microcontroller for Smart Home. The power source of the diagram is represented as the battery that will provide power to the Nodemcu. After the microcontroller receives power, the ACS712 current sensor will ready to record the value, and it will display on website. After that, the LED and DC motor also ready to control which is turn on and off. All measured value and control is wireless.

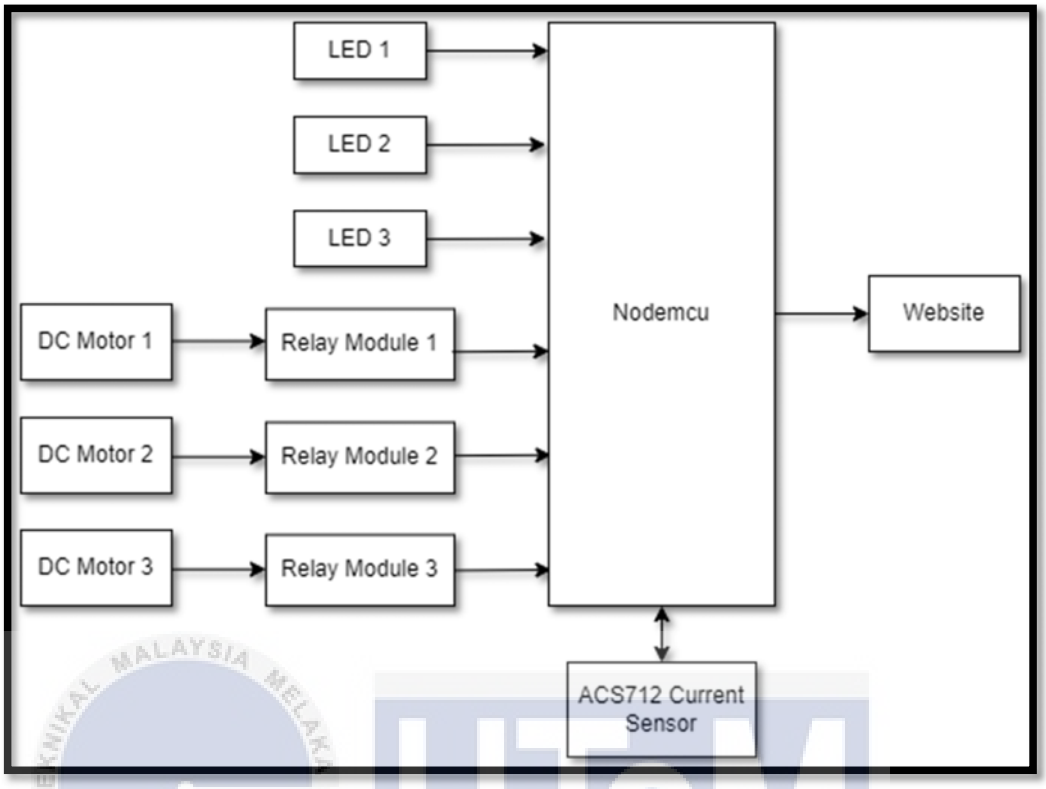


Figure 3.12: The block diagram of overall system

3.6 Circuit diagram connection

The figure 3.13 shows the circuit diagram of Home Appliances Control System using Nodemcu. The diagram shows the wiring setup using LED, resistor 330ohm, Relays module, Nodemcu V3, ACS712 sensor, and 6V battery supply.

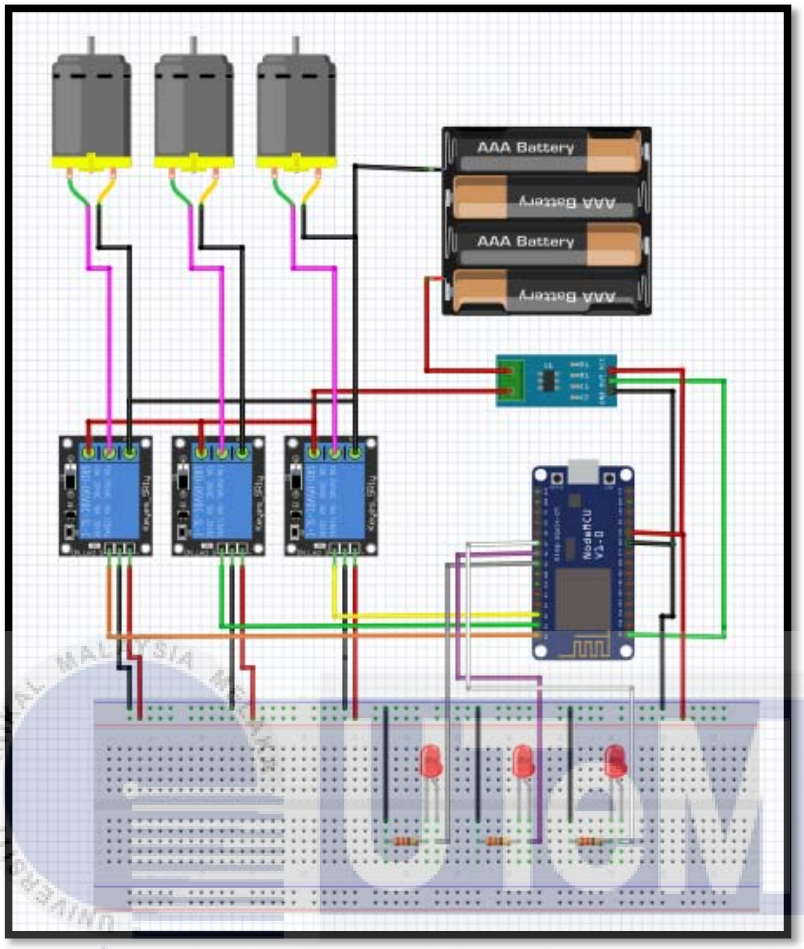


Figure 3.13: Circuit Diagram of Home Appliances Control System

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will explain the software and hardware development of the project. The result and analysis of the development of Home Appliances Control System Using Nodemcu and ACS712 current sensor. The data collected and displayed in the webpage will be demonstrated.

4.2 Software Development

Arduino IDE is the software development of this project. Arduino IDE is code and compiler software where we start by choosing out the library that will be used and apply it to the software. The library allows the software to be recognized and easier for the coder to use the component that will be assembled.

TestWebsite

```
// NODEMCU-8266
#include <ESP8266WiFi.h>
// ESP32
// #include <WiFi.h>
// #include <HTTPClient.h>
// Filter lib
#include <Filters.h>
// Enter your wifi network name and Wifi Password
const char* ssid = "Asry_2.4G";
const char* password = "NIK0133081411";
```

Figure 4.1: Arduino IDE

4.3 Interface of the system

User interface of this system is using website. There have 2 webpage created which is Home page and control center. The IP address of 172.20.10.2 will act as our web link to view the webpage. All the information that has been measured using current sensor will be sent to control center page. Before the information is received, it will check the pin connected into Nodemcu. If the pin is the same, the data will send the reading and if not, the reading not appear on webpage. The data show on control center page is appear in every second without refresh. Besides, control center page also control LED and DC motor wirelessly. Lastly, the home page created to brief about this project.

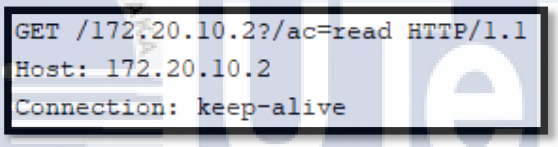


Figure 4.2: IP address of website 172.20.10.2

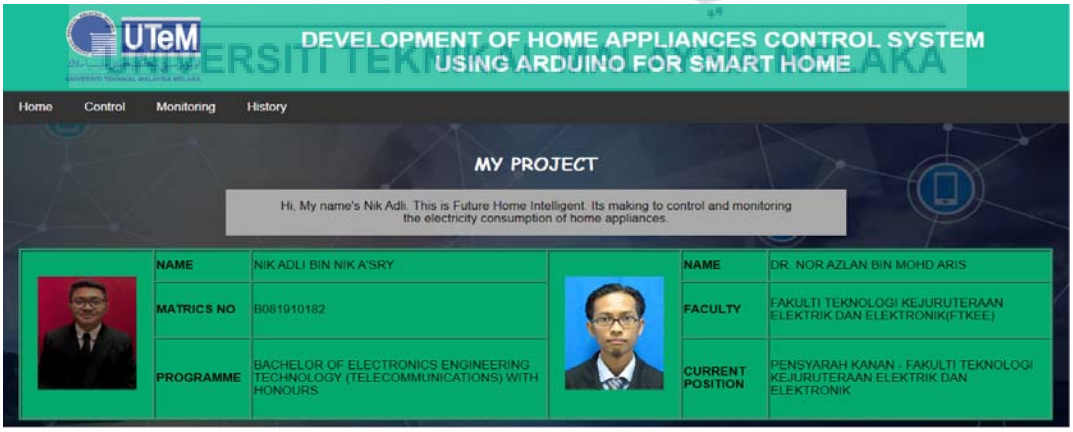


Figure 4.3: Home page UI

Figure 4.2 is the main User Interface design of webpage. There have detail information about Development of Home Appliances Control System Using Microcontroller for Smart Home project. The detail about myself and my supervisor also show in table layout to introduce myself. Below of the table have the 3 objective that appear as figure 4.3.

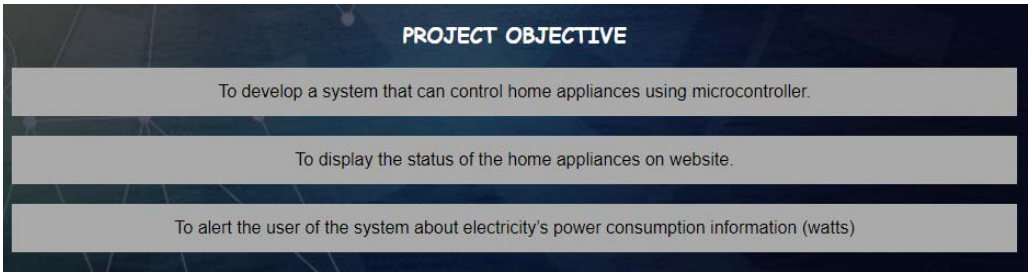


Figure 4.4: Project Objective in Main page

Figure 4.4 below show the Control Center layout of website. The User Interface of this page show the 3 room with each room has light room and fan that control by slider button. Besides control light and fan, there also appear the live reading of ACS712 current in ampere unit.

Figure 4.5: Control page UI

4.4 Hardware Development

The hardware use in this project are Nodemcu V3, LED, resistor 330ohm, Relays module, ACS712 sensor, and 6V battery supply. The configuration of hardware is shown as in figure 4.4.

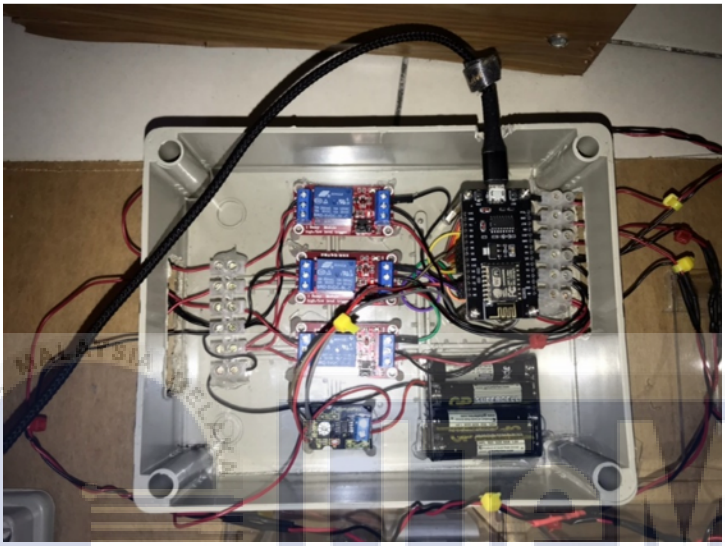


Figure 4.6: The Hardware

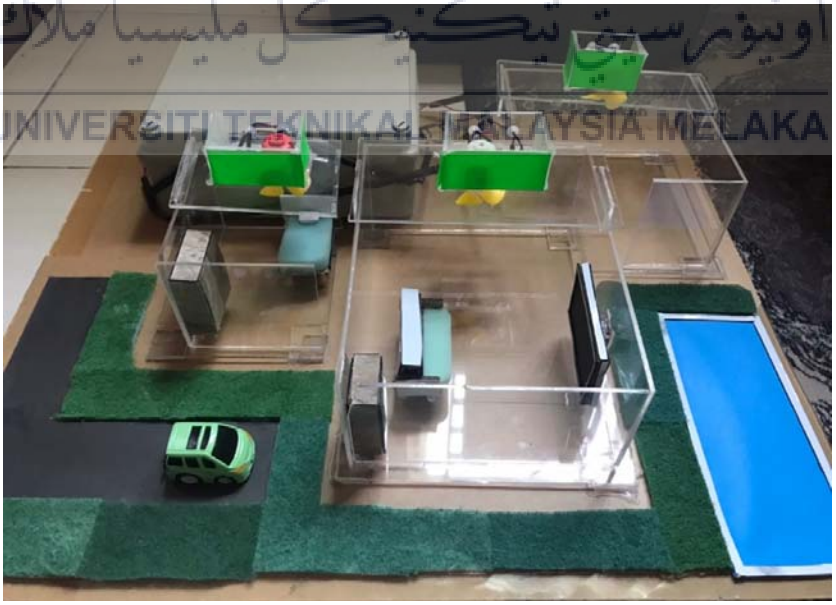


Figure 4.7: Home Prototype

In the figure 4.5 is show how the home will look like with the enclosure with it. There will 3 room created that place 1 led and 1 Dc motor in every room. The room created is living room, bedroom and kitchen. In addition, there are miniatures of home furniture made of boxes.

4.5 Result of the project

The result of this project is divided by two part which is the control and measure current reading. For control part, the LED and DC motor will act to 'ON' and 'OFF' wirelessly through website page. Besides, to measure the current, only DC motor will apply for read the data of current. The data also will appear on Webpage in live reading box.

4.5.1 Control LED and DC Motor

Figure 4.8 show the DC motor of Room 1 is spin when the slider button in right side. The LED of Room 1 also light up after the slider button in right side. Figure 4.9 show the DC motor of Room 2 is spin when the slider button in right side. The LED of Room 1 also light up after the slider button in right side. Lastly, figure 4.10 show how to control the kitchen section in same term, the DC motor and LED is on after slider button in right side.

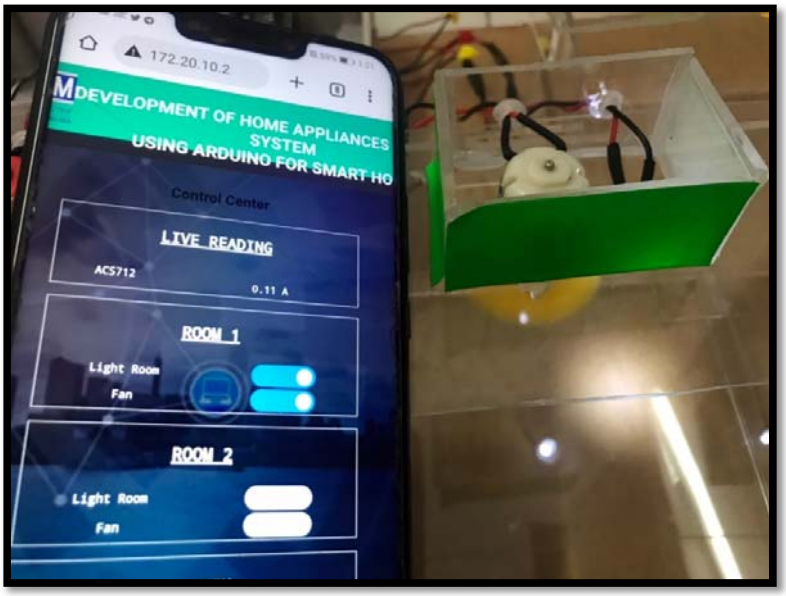


Figure 4.8: DC Motor and LED in Room 1 is spin and light up

Figure 4.9: DC motor in room 2 is 'ON'

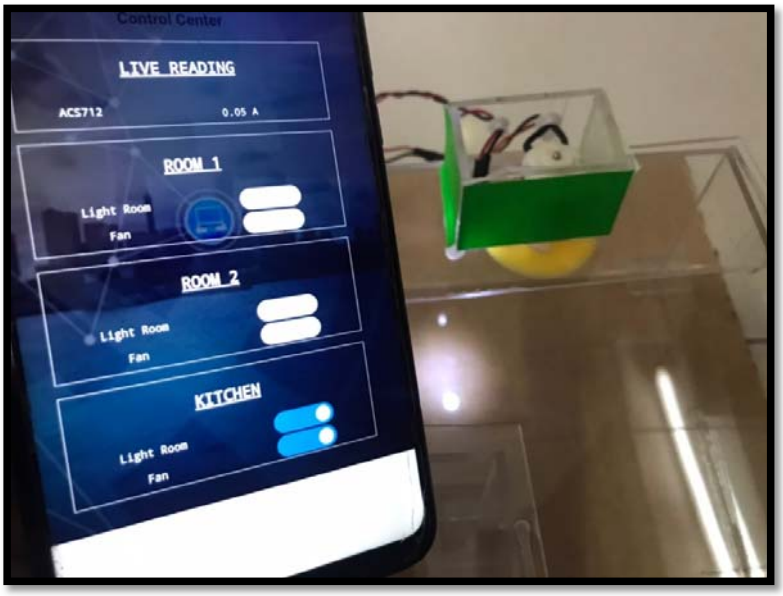


Figure 4.10: DC Motor and LED in Kitchen is spin and light up

4.6 The analysis of the system

The analysis will be done with a number of tests with the generic device to find the comparison. The aim is to read data of LED and DC motor using Nodemcu and ACS712 current sensor. The data will shown in website known as control page. Besides, LED and DC motor also can control wirelessly through same webpage.

4.6.1 Wattage reading of LED and DC motor

Figure 4.11: Reading of current on Webpage

Figure above is measurement of DC motor that appear in website. The wattage reading is read from ACS712 current sensor and connected to Nodemcu as wifi to send the reading wirelessly on website. The total reading value of DC motor when 'ON' condition is 0.11A.

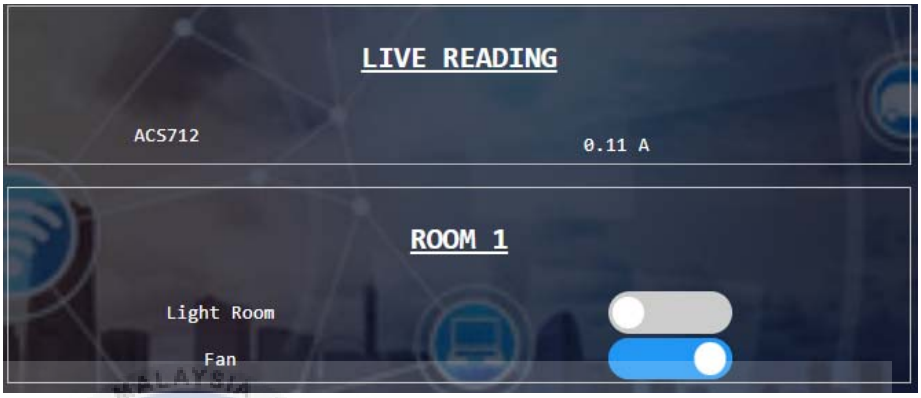


Figure 4.12: Reading of DC motor in 'ON' condition

Table 4.1: Reading of Component in 'On' and 'Off' condition

COMPONENT	STATUS	READING
1) Room 1		
Lamp (LED 1)	On	0.05A
	Off	0.05A
Fan (DC Motor 1)	On	0.11A
	Off	0.05A
2) Room 2		
Lamp (LED 2)	On	0.05A
	Off	0.05A
Fan (DC Motor 2)	On	0.12A
	Off	0.05A

3) Kitchen		
Lamp (LED 3)	On	0.05A
	Off	0.05A
Fan (DC Motor 3)	On	0.12A
	Off	0.05A

Table 4.1 is current reading of each component where it measures the current of all DC motor only. To control and measure DC motor, relay is use to supply the power of battery with 6Volt supply. Because the LED cannot be measured, the reading not working for that component and always read 0.05A. Besides, the DC motor can measure for that component and the value in 'off' condition is .0.05A, while current reading is 0.12A when Dc Motor in 'On' Condition.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This project aims to make certain improvements to the Home Appliances Control System using Nodemcu. The project was a success in terms of control and monitoring the home appliances by adding IoT technologies and features in order to improve the control device. A side from that, the monitoring has been keep a data in webpage.

Based on the results of the analysis, we can conclude that we have successfully achieved certain objective such as connected the LED and DC motor using Nodemcu. This project's system is more useful than the current method. The project has a lot of improvements, such as being able to display data in website. The analysis that compared the project with the current market device shows positive out.

5.2 Future Works

With the development of new innovations created every year such as the Helium P2P wireless network, it brings benefits to consumers and smart homes. This technology is real-time monitoring, so that the data transferring will faster without any delay. The small packets of information that move very quickly and amount to a large impact versus high-bandwidth data dumps.

We will see technologies that are complementary to LTE and 5G when it comes to high bandwidth. High-energy and high-power connectivity will be designated for specific

applications such as video streaming, television, and gaming, as well as enabling remote-first work rules.

In the production of smart homes, 5G technology is still under observation because it is still not suitable for use in many applications. We are still a long way from having it as standard in the house. As a result, IoT devices that run on these complimentary connectivity protocols will be the ones to move the needle for meaningful smart home invention in many communities.

5.3 Project Potential

Development of Home Appliances Control System Using Microcontroller for Smart Home is an ability to use electronically controlled, internet-connected technologies to regulate household appliances. This project will also grow in the future because of the ability to control home appliances just by using the internet. In addition, many countries in Europe have started using this technology. So, Asia country also needs to improve technology from the point of view of the internet which is now the future of communication called 5G. Lastly, this project is good business for fully centralized in Asian country.

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APPENDICES

Coding For NodeMCU

```
// NODEMCU-8266
#include <ESP8266WiFi.h>
// ESP32
// #include <WiFi.h>
// #include <HTTPClient.h>
// Filter lib
#include <Filters.h>
// Enter your wifi network name and Wifi Password
const char* ssid = "Asry_2.4G";
const char* password = "NIK0133081411";

// Set web server port number to 80
WiFiServer server(80);

// Variable to store the HTTP request
String header;

// These variables store current output state of LED
String room1_light1 = "off";
String room2_light1 = "off";
String kitchen_light1 = "off";

String room1_motor1 = "off";
String room2_motor1 = "off";
String kitchen_motor1 = "off";
#define Motor1 16
#define Motor2 5
#define Motor3 4
#define Led1 14
#define Led2 12
#define Led3 13

// Current time
unsigned long currentTime = millis();
// Previous time
unsigned long previousTime = 0;
// Define timeout time in milliseconds (example: 2000ms = 2s)
const long timeoutTime = 2000;
int count = 0;

#define ACS_Pin A0  //Sensor data pin on A0 analog   input

float ACS_Value;                    //Here we keep the raw   data valuess
```

```
float testFrequency = 50;                    // test signal frequency   (Hz)
float windowLength = 40.0 / testFrequency;  // how long to average the   signal, for
statistist

float intercept = 0;   // to be adjusted based   on calibration testing
float slope = 0.0752;  // to be adjusted based on calibration   testing

float Amps_TRMS;  // estimated actual current in amps


        } else if (header.indexOf("/kl1=on") >= 0) {
          Serial.println("Kitchen Light 1 is on");
          digitalWrite(Led3, HIGH);

        } else if (header.indexOf("/kl1=off") >= 0) {
          Serial.println("Kitchen Light 1 is off");
          digitalWrite(Led3, LOW);

        } else if (header.indexOf("/kf1=on") >= 0) {
          Serial.println("Kitchen Fan 1 is off");
          digitalWrite(Motor3, HIGH);

        } else if (header.indexOf("/kf1=off") >= 0) {
          Serial.println("Kitchen Fan 1 is off");
          digitalWrite(Motor3, LOW);

        } else if (header.indexOf("/ac=read") >= 0) {
          client.println(String(Amps_TRMS) + " A");
          Serial.println("Sending AC reading");
          count += 1;

        } else {
          // Display the HTML web page
          client.println(showWeb());
        }

        // The HTTP response ends with another blank line
        client.println();
        // Break out of the while loop
        break;
      } else {  // if you got a newline, then clear currentLine
        currentLine = "";
      }
    } else if (c != '\r') {  // if you got anything else but a carriage return character,
      currentLine += c;      // add it to the end of the currentLine
    }
  }
}
// Clear the header variable
header = "";
```

```
    // Close the connection
    client.stop();
    Serial.println("Client disconnected.");
    Serial.println("");
  }
  readAC();
}

String showWeb() {
  String web = "<!DOCTYPE html> <html lang=\"en\"> <head> <title>Control
Center</title> <meta charset=\"UTF-8\"> <meta name=\"viewport\"
content=\"width=device-width, initial-scale=1\"> <style> * { box-sizing: border-box; } /*
Style the body */ body { font-family: Arial, Helvetica, sans-serif; margin: 0; } /*
Header/logo Title */ .header { width: 100%; padding: 10px 80px; position: relative;
background: #1abc9c; color: white; } img.utem { width: 170px; height: 100px; } /*
Increase the font size of the heading */ .header h1 { position: absolute; top: 15px; right: 0;
width: 80%; height: 50px; color: #fff; text-align: center; font-size: 30px; } /* Style the top
navigation bar */ .navbar { overflow: hidden; background-color: #333; } /* Style the
navigation bar links */ .navbar a { float: left; display: block; color: white; text-align:
center; padding: 14px 20px; text-decoration: none; } /* Right-aligned link */ .navbar
a.right { float: right; } /* Change color on hover */ .navbar a:hover { background-color:
#ddd; color: black; } .row { background-image: linear-gradient(rgba(4, 9, 30, 0.7), rgba(4,
9, 30, 0.7)), url(https://iili.io/HuM1WV2.md.jpg); background-position: center;
background-size: cover; position: relative; } .side { -ms-flex: 30%; /* IE10 */ flex: 30%;
padding: 20px; } /* Main column */ .main { -ms-flex: 70%; /* IE10 */ flex: 70%;
background-color: white; padding: 20px; } table.center { width: 50%; border: 1px solid
#BEBEBE; margin-left: auto; margin-right: auto; font-family: FreeMono, monospace;
color: #FFFFFF; line-height: 1.6; text-align: center; } /* The switch - the box around the
slider */ .switch { position: relative; display: inline-block; width: 100px; height: 34px; } /*
Hide default HTML checkbox */ .switch input { opacity: 0; width: 0; height: 0; } /* The
slider */ .slider { position: absolute; cursor: pointer; top: 0; left: 0; right: 0; bottom: 0;
background-color: #ccc; -webkit-transition: .4s; transition: .4s; } .slider:before { position:
absolute; content: \"\"; height: 26px; width: 25px; left: 4px; bottom: 4px; background-
color: white; -webkit-transition: .4s; transition: .4s; } input:checked+.slider { background-
color: #2196F3; } input:focus+.slider { box-shadow: 0 0 1px #2196F3; }
input:checked+.slider:before { -webkit-transform: translateX(26px); -ms-transform:
translateX(26px); transform: translateX(66px); } /* Rounded sliders */ .slider.round {
border-radius: 34px; } .slider.round:before { border-radius: 50%; } </style> </head>
<script src=\"https://code.jquery.com/jquery-3.3.1.min.js\" integrity=\"sha256-
FgpCb/KJQlLNfOu91ta32o/NMZxltwRo8QtmkMRdAu8=\" crossorigin=\"anonymous\">
</script> <body> <div class=\"header\"> <img class=\"utem\"
src=\"https://iili.io/HuMaeQS.png\"> <h1>DEVELOPMENT OF HOME APPLIANCES
CONTROL SYSTEM <br>USING ARDUINO FOR SMART HOME</h1> </div> <div
class=\"navbar\"> <a href=\"Test.html\">Home</a> <a href=\"control.html\">Control</a>
<a href=\"#\">Monitoring</a> <a href=\"#\">History</a> </div> <div class=\"row\"> <div
class=\"side\"> <h2 style=\"text-align:center\" \"color:beige\">Control Center</h2> <table
class=\"center\"> <tr> <th colspan=\"2\" style=\"color: #FFFFFF;\"> <h2><u>ROOM
1</u></h2> </th> </tr> <tr> <td>ACS712</td> <td><label class=\"switch\"> <p
id=\"AC\">Value </p> <!-- <span class=\"slider round\"></span> --> </label></td> </tr>
<!-- href=\"/2/on\" --> </table><br> <table class=\"center\"> <tr> <th colspan=\"2\"
```

```
style=\"color: #FFFFFF;\"> <h2><u>ROOM 1</u></h2> </th> </tr> <tr> <td>Light
Room</td> <td><label class=\"switch\"> <input type=\"checkbox\"
onchange='handleRoom1L(this, \"r1l1\")' ";
  if (room1_light1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label> </tr> <tr> <td>Fan</td>
<td><label class=\"switch\"> <input id=\"check1\" type=\"checkbox\"
onchange='handleRoom1L(this, \"r1f1\")' ";
  if (room1_motor1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label></td> </tr> </table><br> <table
class=\"center\"> <tr> <th colspan=\"2\"> <h2><u>ROOM 2</u></h2> </th> </tr> <tr>
<td>Light Room</td> <td><label class=\"switch\"> <input type=\"checkbox\"
onchange='handleRoom1L(this, \"r2l1\")' ";
  if (room2_light1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label></td> </tr> <tr> <td>Fan</td>
<td><label class=\"switch\"> <input type=\"checkbox\" onchange='handleRoom1L(this,
\"r2f1\")' ";
  if (room2_motor1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label></td> </tr> </table><br> <table
class=\"center\"> <tr> <th colspan=\"2\"> <h2><u>KITCHEN</u></h2> </th> </tr> <tr>
<td>Light Room</td> <td><label class=\"switch\"> <input type=\"checkbox\"
onchange='handleRoom1L(this, \"kl1\")' ";
  if (kitchen_light1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label></td> </tr> <tr> <td>Fan</td>
<td><label class=\"switch\"> <input type=\"checkbox\" onchange='handleRoom1L(this,
\"kf1\")' ";
  if (kitchen_motor1 == "on") web += "checked";
  web += "> <span class=\"slider round\"></span> </label></td> </tr> </table><br>
</div> </div> <script> function handleRoom1L(checkbox, room) { if (checkbox.checked
== true) { $(\"a\").load(window.location.hostname + \"?/\"+room+\"=on\"); } else {
$(\"a\").load(window.location.hostname + \"?/\"+room+\"=off\"); } } </script> <script>
$(document).ready(function () { setInterval(function () {
$(\"#AC\").load(window.location.hostname + \"?/ac=read\") }, 2000); }); </script>
</body>";
  return web;
}

void readAC() {
  RunningStatistics inputStats;  // create statistics   to look at the raw test signal
  inputStats.setWindowSecs(windowLength);

  ACS_Value = analogRead(ACS_Pin);  // read the analog in value:
  inputStats.input(ACS_Value);      // log to Stats   function

  Amps_TRMS = intercept + slope * inputStats.sigma();

  Serial.print("\   Amps: ");
  Serial.print(Amps_TRMS);
}
```

Coding of *HOME* page using HTML and CSS textstyle

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>Introduction</title>
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width, initial-scale=1">
<style>
* {
  box-sizing: border-box;
}

/* Style the body */
body {
  font-family: Arial, Helvetica, sans-serif;
  margin: 0;
}

/* Header/logo Title */
.header {
    width: 100%;
  padding: 10px 80px;
  position: relative;
  background: #1abc9c;
  color: white;
}

img.utem{
    width:170px;
    height: 100px;
}

/* Increase the font size of the heading */

.header h1{
    position: absolute;
    top: 15px;
      right: 0;
      width: 80%;
      height: 50px;
```

```
    color: #fff;
    text-align: center;
    font-size: 30px;
}

/* Style the top navigation bar */
.navbar {
  overflow: hidden;
  background-color: #333;
}

/* Style the navigation bar links */
.navbar a {
  float: left;
  display: block;
  color: white;
  text-align: center;
  padding: 14px 20px;
  text-decoration: none;
}

/* Right-aligned link */
.navbar a.right {
  float: right;
}

/* Change color on hover */
.navbar a:hover {
  background-color: #ddd;
  color: black;
}

/* Column container */
.row {
  display: -ms-flexbox; /* IE10 */
  display: flex;
  -ms-flex-wrap: wrap; /* IE10 */
  flex-wrap: wrap;
    background-image: linear-gradient(rgba(4,9,30,0.7),
rgba(4,9,30,0.7)),url(images/smarthome.jpg);
        background-position: center;
        background-size: cover;
        position: relative;
}


/* Create two unequal columns that sits next to each other */
/* Sidebar/left column */
.side {
  -ms-flex: 30%; /* IE10 */
```

```
  flex: 30%;
  padding: 20px;
}

/* Main column */
.main {
  -ms-flex: 70%; /* IE10 */
  flex: 70%;
  background-color: white;
  padding: 20px;
}

/* Fake image, just for this example */
.Me {
      width: 125px;
      height: 160px;

}

table.center {
  margin: auto;
    background-color: #04AA6D;
}
    center.td{
       height:12px;
    }

    .objective{
       font-family: Comic Sans MS, Comic Sans, cursive;
       color: white;
       text-align:center;
    }

    .fakeimgIntro{
       margin: auto;
       background-color: #aaa;
         width: 60%;
         padding: 15px;
    }
.fakeimg {
    margin: auto;
    text-align:center;
  background-color: #aaa;
  width: 70%;
  padding: 13px;
}

/* Footer */
.footer {
  padding: 20px;
```

```
  text-align: center;
  background: #ddd;
}

/* Responsive layout - when the screen is less than 700px wide, make the two columns
stack on top of each other instead of next to each other */
@media screen and (max-width: 700px) {
  .row {
    flex-direction: column;
  }
}

/* Responsive layout - when the screen is less than 400px wide, make the navigation links
stack on top of each other instead of next to each other */
@media screen and (max-width: 400px) {
  .navbar a {
    float: none;
    width: 100%;
    height: 100%;
  }
}
</style>
</head>
<body>

    <div class="header">
        <img class="utem" src="images/UTeM.png" >
        <h1>DEVELOPMENT OF HOME APPLIANCES CONTROL SYSTEM
<br>USING ARDUINO FOR SMART HOME</h1>
    </div>

    <div class="navbar">
      <a href="Test.html">Home</a>
      <a href="control.html">Control</a>
      <a href="#">Monitoring</a>
      <a href="#">History</a>
    </div>

    <div class="row">
      <div class="side">
        <h2 class="objective" style="text-align:center"> MY PROJECT</h2>
          <p class="fakeimgIntro" style="text-align:center;" >Hi, My name's Nik Adli. This is
Future Home Intelligent. Its making to control and monitoring <br>the  electricity
consumption of home appliances.</p><br>
          <table class="center" border="1">
              <tr>
                  <td rowspan="3" style="padding: 20px;"><p ><img class="Me"
src="images/Me.jpeg"></p></td>
                  <td style="width: 10%;"><b>NAME</b></td>
                  <td style="width: 40%;">NIK ADLI BIN NIK A'SRY</td>
```

```
                <td rowspan="3" style="padding: 20px;"><p><img class="Me"
src="images/DrAzlan.gif"></p></td>
                <td style="width: 10%;"><b>NAME</b></td>
                <td style="width: 40%;">DR. NOR AZLAN BIN MOHD ARIS</td>
            </tr>
            <tr>
                <td><b>MATRICS NO</b></td>
                <td>B081910182</td>
                <td><b>FACULTY</b></td>
                <td>FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN
ELEKTRONIK(FTKEE)</td>
            </tr>
            <tr>
                <td><b>PROGRAMME</b></td>
                <td>BACHELOR OF ELECTRONICS ENGINEERING TECHNOLOGY
(TELECOMMUNICATIONS) WITH HONOURS</td>
                <td><b>CURRENT POSITION</b></td>
                <td>PENSYARAH KANAN - FAKULTI TEKNOLOGI KEJURUTERAAN
ELEKTRIK DAN ELEKTRONIK</td>
            </tr>

        </table>

    <h3 class="objective" >PROJECT OBJECTIVE</h3>
    <div class="fakeimg" >To develop a system that can control home appliances using
microcontroller.</div><br>
    <div class="fakeimg" >To display the status of the home appliances on
website.</div><br>
    <div class="fakeimg" >To alert the user of the system about electricity's power
consumption information (watts)</div>
  </div>
 </body>
</html>
```


Coding of *CONTROL* page using HTML and CSS textstyle

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>Control Center</title>
<meta charset="UTF-8">
<meta name="viewport" content="width=device-width, initial-scale=1">
<style>
* {
  box-sizing: border-box;
}
```

```
/* Style the body */
body {
  font-family: Arial, Helvetica, sans-serif;
  margin: 0;
}

/* Header/logo Title */
.header {
    width: 100%;
  padding: 10px 80px;
  position: relative;
  background: #1abc9c;
  color: white;
}

img.utem{
    width:170px;
    height: 100px;
}

/* Increase the font size of the heading */

.header h1{
    position: absolute;
    top: 15px;
      right: 0;
      width: 80%;
      height: 50px;
    color: #fff;
    text-align: center;
    font-size: 30px;
}

/* Style the top navigation bar */
.navbar {
  overflow: hidden;
  background-color: #333;
}

/* Style the navigation bar links */
.navbar a {
  float: left;
  display: block;
  color: white;
  text-align: center;
  padding: 14px 20px;
  text-decoration: none;
}

/* Right-aligned link */
```

```
.navbar a.right {
  float: right;
}

/* Change color on hover */
.navbar a:hover {
  background-color: #ddd;
  color: black;
}

.row{
        background-image: linear-gradient(rgba(4,9,30,0.7),
rgba(4,9,30,0.7)),url(images/smarthome.jpg);
        background-position: center;
        background-size: cover;
        position: relative;
}
.side {
  -ms-flex: 30%; /* IE10 */
  flex: 30%;
  padding: 20px;
}

/* Main column */
.main {
  -ms-flex: 70%; /* IE10 */
  flex: 70%;
  background-color: white;
  padding: 20px;
}
```



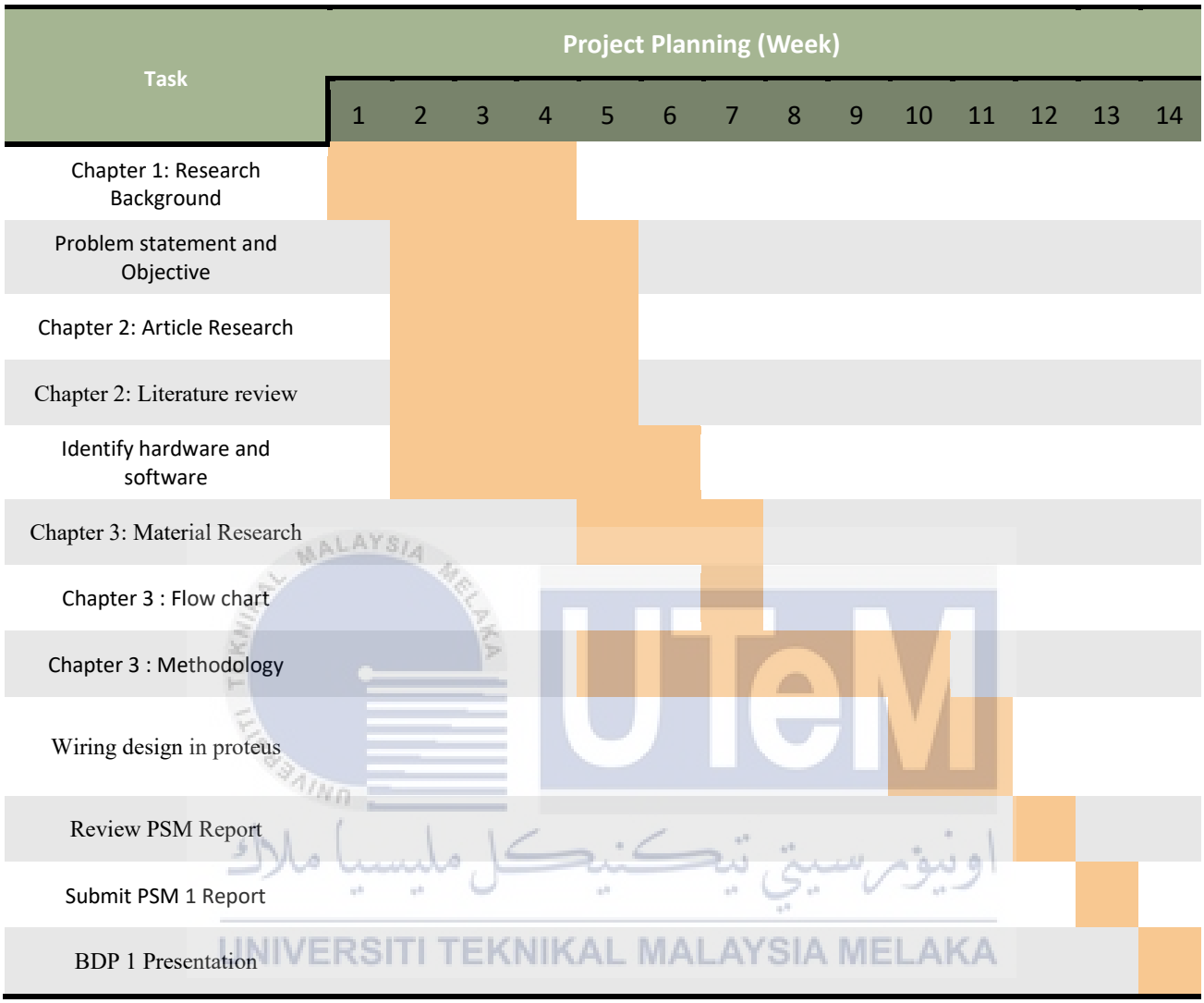
```
table.center{
    width: 50%;
    border: 1px solid #BEBEBE;
    margin-left: auto;
    margin-right: auto;
    font-family: FreeMono, monospace;
    color: #FFFFFF;
    line-height: 1.6;
    text-align: center;
}

/* The switch - the box around the slider */
.switch {
  position: relative;
  display: inline-block;
  width: 100px;
  height: 34px;
```

```
}

/* Hide default HTML checkbox */
.switch input {
  opacity: 0;
  width: 0;
  height: 0;
}

/* The slider */
.slider {
  position: absolute;
  cursor: pointer;
  top: 0;
  left: 0;
  right: 0;
  bottom: 0;
  background-color: #ccc;
  -webkit-transition: .4s;
  transition: .4s;
}

.slider:before {
  position: absolute;
  content: "";
  height: 26px;
  width: 25px;
  left: 4px;
  bottom: 4px;
  background-color: white;
  -webkit-transition: .4s;
  transition: .4s;
}

input:checked + .slider {
  background-color: #2196F3;
}

input:focus + .slider {
  box-shadow: 0 0 1px #2196F3;
}

input:checked + .slider:before {
  -webkit-transform: translateX(26px);
  -ms-transform: translateX(26px);
  transform: translateX(66px);
}

/* Rounded sliders */
.slider.round {
```

```
  border-radius: 34px;
}

.slider.round:before {
  border-radius: 50%;
}

</style>
</head>


<body>

   <div class="header">
      <img class="utem" src="images/UTeM.png" >
      <h1>DEVELOPMENT OF HOME APPLIANCES CONTROL SYSTEM
<br>USING ARDUINO FOR SMART HOME</h1>
   </div>

   <div class="navbar">
     <a href="Test.html">Home</a>
     <a href="control.html">Control</a>
     <a href="#">Monitoring</a>
     <a href="#">History</a>
   </div>
<div class="row">
   <div class="side">
      <h2 style="text-align:center" "color:beige">Control Center</h2>
      <table class="center">
                <tr>
                    <th colspan="2" style="color: #FFFFFF;"><h2><u>ROOM
1</u></h2></th>
                </tr>
                <tr>
                  <td>Light Room</td>
                  <td><label class="switch">
                       <input type="checkbox">
                       <span class="slider round"></span>
                  </label></td>
                </tr>
                <tr>
                  <td>Fan</td>
                  <td><label class="switch">
                       <input type="checkbox">
                       <span class="slider round"></span>
                  </label></td>
                </tr>

            </table><br>
          <table class="center">
```

```
        <tr>
          <th colspan="2"><h2><u>ROOM 2</u></h2></th>
        </tr>
        <tr>
          <td>Light Room</td>
          <td><label class="switch">
              <input type="checkbox">
              <span class="slider round"></span>
          </label></td>
        </tr>
        <tr>
          <td>Fan</td>
          <td><label class="switch">
              <input type="checkbox">
              <span class="slider round"></span>
          </label></td>
        </tr>

    </table><br>
  <table class="center">
        <tr>
          <th colspan="2"><h2><u>KITCHEN</u></h2></th>
        </tr>
        <tr>
          <td>Light Room</td>
          <td><label class="switch">
              <input type="checkbox">
              <span class="slider round"></span>
          </label></td>
        </tr>
        <tr>
          <td>Fan</td>
          <td><label class="switch">
              <input type="checkbox">
              <span class="slider round"></span>
          </label></td>
        </tr>

    </table><br>
</div></div>
```

Gantt Chart BDP 1



Gantt Chart BDP 2