Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SMART HOME CONTROL SYSTEM USING IOT WITH ENERGY CONSUMPTION MONITORING

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEVELOPMENT OF SMART HOME CONTROL SYSTEM USING IOT WITH ENERGY CONSUMPTION MONITORING

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A project report submitted
in partial fulfillment of the requirements for the degree of
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2021

DECLARATION

I declare that this project report entitled "Development of Smart Home System Using IoT With Energy Consumption Monitoring" 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 : WAN ARIF ALIF BIN WAN ABDULLAH

Date : 11/01/2022

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 Computer Engineering Technology (Computer Systems) with Honours.

Signature :

Supervisor Name : EN RADI HUSIN BIN RAMLEE

Date : 11/01/2022

DEDICATION

I dedicated this thesis to my beloved parents, supervisor, and my fellow friends. May Allah bless them.

ABSTRACT

The internet of things (IoT) is a network that connects objects and gadgets to the internet network, allowing them to be managed remotely by websites and smart phone apps, as well as to be controlled by codes and algorithm structures for artificial intelligence problems. If we want to build sophisticated systems utilizing Python algorithms, we will link our tools, equipment, and devices to a Wi-Fi or Ethernet network, which will allow us to control them from smart phone apps or internet websites. That is, in fact, a simple definition of the Internet of Things. Apart from being used as a smart home to control lamps and other home-use devices, the Internet of Things can also be used as a security system or an industrial-use system. Using IoT technology, it is possible to implement even more concepts. A large number of lights may be found in large industrial facilities or government organizations. Employees may forget to switch them off at the end of the day on occasion. Using the Blynk application, this study proposes a method that may help you conserve energy by allowing the security guard to manage the lights in the building from his smart home. Using a certain electrical arrangement, the lights may be controlled by switches that are strategically placed throughout the building and by the Blynk application simultaneously. A basic smart house prototype, or the simple and low-cost method of controlling loads via a Wi-Fi connection ingeneral, is presented in this study.

ABSTRAK

Internet of things (IoT) adalah rangkaian yang menghubungkan objek dan alat ke rangkaianinternet, memungkinkan mereka dikendalikan dari jarak jauh oleh laman web dan aplikasi telefon pintar, serta dikendalikan oleh struktur kod dan algoritma untuk masalah kecerdasan buatan. Sekiranya kita ingin membina sistem yang canggih menggunakan algoritma Python, kita akan menghubungkan alat, peralatan, dan peranti kita ke rangkaian Wi-Fi atau Ethernet, yang akan membolehkan kita mengendalikannya dari aplikasi telefon pintar atau laman web. Sebenarnya, itu adalah definisi ringkas mengenai Internet ofThings. Selain digunakan sebagai rumah pintar untuk mengendalikan lampu dan peralatan penggunaan rumah lain, Internet of Things juga dapat digunakan sebagai sistem keselamatan atau sistem penggunaan industri. Dengan menggunakan teknologi IoT, adalah mungkin untuk menerapkan lebih banyak konsep. Sebilangan besar lampu boleh didapati dikemudahan industri besar atau organisasi kerajaan. Pekerja mungkin lupa untuk mematikannya pada bila-bila masa. Dengan menggunakan aplikasi Blynk, kajian ini mencadangkan kaedah yang dapat membantu andamenjimatkan tenaga dengan membiarkanpengawal keselamatan menguruskan lampu di bangunan dari rumah pintarnya. Dengan menggunakan susunan elektrik tertentu, lampu boleh dikendalikan oleh suis yang diletakkansecara strategik di seluruh bangunan dan oleh aplikasi Blynk secara serentak. Prototaip rumah pintar asas, atau kaedah mudah dan rendah untuk mengawal beban melalui sambungan Wi-Fi secara umum, disajikan dalam kajian ini.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Radi Husin Bin Ramlee for the precious guidance, words of wisdom and patient throughout this project. My highest appreciation goes to my parents and family members for their love and prayer during the period of my study. Finally, I would like to thank all my fellow colleagues and classmates as well as other individuals who are not listed here for being co-operative and helpful.

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CHAPTER 1

INTRODUCTION

1.1 Background

Housing is one of the most fundamental requirements of civilization. The desire fora safe and comfortable residence is increasing with the strengthening of the economy. Technology is one of the variables that might affect the safety and comfort of a house. When a homeowner is inside or outside the house, an intelligent home is designed to make him more comfortable and safer. Intelligent homes were traditionally seen as affluent property, but due to their inequality, prices fall year after year for many of the population in urban regions. In many locations, the Internet of Things helps to achieve intelligent home adoption,and many consumers are attracted by safety and automated control capabilities.

Technology impacts and is present in many parts of human existence. One approach to using technology is to simplify and make our lives smarter. This is shown by the development of automation systems that monitor and run a wide variety of equipment used in the industrial, agricultural, military and domestic industries [1]. In-Home automation systems are linked together to achieve automation in many devices and software applications [2]. These systems are created according to a number of approaches to achieve two fundamental objectives: remote control and home device monitoring. The gadgets are notably helpful in helping handicapped and elderly people more efficiently and intelligently utilize their home equipment [3]. In this era of interconnected devices, the Internet of Things (IoT) is the key facilitator for remotely controlling and monitoring equipment.

There's no new concept of a clever home. The first smart home technology called X10 was created in 1975 in Scotland. Because its computer systems can monitor numerous ordinary aspects, a smart home seems "smart." With the growing number of controlled home appliances, the ability to digitally connect and communicate these devices has become a practical and desirable function. In 1999, Kevin Ashton invented the term "Wired Internet of Things" to describe the connection between a device that is not usually connected to a network and that can be monitored and remotely managed by a user. Most intelligent home research now focuses only on one or two main areas and seldom studies how several components may be integrated, such as energy efficiency, intensive monitoring, improving security and privacy conservation. We design and develop an intelligent home prototype using Raspberry Pi and NodeMCU to solve the gaps in IoT research with internet stuff.

The major objective of this project is to construct a Node MCU based real-time home control system design and prototype implementation which can be used to remotely monitor home appliances via the Internet. Three devices, a light, a fan, and an air conditioner, can be remotely controlled and monitored using Blynk apps. Results indicate that our system can easily handle a range of devices in an interactive fashion, offer device monitoring to guarantee power consumption in order to regulate the process, and save real-time data into the cloud, so that it is available everywhere and at any time.

1.2 Problem Statement

House automation is the utilization of home equipment control computer technologies. Computer technologies enable this, ranging from remote control to sophisticated microcontrollers or computer-based networks with different degrees of intelligence and automation. Due to its safety, energy efficiency and usability, home automation is becoming more popular. It also provides a smartphone application for controlling and monitoring domestic appliances with a remote interface. Many people continually move from place to place due to business demands. Some people may leave all their household appliances unattended and unmanaged for a few days. Some devices are supposed to be connected to and from power outlets at different times according to the time of day, while others are supposed to be plugged into and out of power supplies at different intervals. All of this requires someone to be regularly involved directly with each gadget. All of this surveillance and administration may be done there or within the home without being required. Certain devices take up a lot of energy, if not appropriately handled, leading to excessive expense of electricity. In addition, emergencies may need to be dealt with if we are not at home. We therefore propose the development of a home automation system on the Internet that enables customers to control their equipment from anywhere on the internet at any time.

1.3 Project Objective

In this project, there are a few goals that must be met. The following are the project's objectives:

a) To build monitoring to monitor electrical appliances for the energy usage.

b) To develop the device that have the capabilities to be able to controlled from the mobile device application.

c) To analyze a IoT platform with capability of monitoring and logging energy usage for all tapped electrical devices.

1.4 Scope of Project

The scope of this project will cover developing a smart home system based on controlling and monitoring. The project will make use of a NodeMCU ESP8266, which hasa Wi-Fi connection and will be used to connect with the Blynk application. This smart application is used to view the humidity and current value that has been detected using the sensor and to control the on/off switch button of electrical appliances. With this application, users can control and monitor their electrical appliances using a smart phone.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter provides past achievements achieved by other researchers pertinent to the topic. The sources gathered were thoroughly examined in order to determine their knowledge of their argument. To make this chapter organized, the best arrangement was selected and used. The arrangements developed are the consequence of the popular preliminary study platforms. The literature review is a textual body that reviews the essential issues of current knowledge in order to increase the comprehension of the idea and particular terms used in the project. The materials are taken from publications, books and websites that give more information on IoT applications.

2.2 Home Automation System

In this subtopic, we have covered the Bluetooth based home automation system using cell phones, Zigbee, GSM, Wi-Fi, home automation using RF module, using Android ADK, cloud-based home automation system, Raspberry pie with wireless sensor using smart phone and lastly wireless home automation system using IoT[1].

2.2.1 Bluetooth based home automation system using cell phones

The home devices are connected to the Arduino BT board at the input and output ports using a Bluetooth-based home automation system with Relay. In the high-level C language of the microcontroller, you will write the computer code and link through Bluetooth. Since the devices are secured by password, the permitted user alone has access to them. Between the Arduino BT board and the wireless phone lies the Bluetooth connection. This approach employs a Python script which can be installed and portable in any Symbian OS environment. A circuit is created and run to receive input from the telephone, which displays the device's status[2].

2.2.2 Zigbee based home automation system using cell phones

The system is created and deployed using Zigbee to monitor and operate household appliances. Network coordinators record and preserve the performance of the gadget. A four-ports standard, the current wireless ADSL router with four switch ports is used for the Wi-Fi network. SSID network and Wi-Fi security are available. The message will be evaluated for security considerations using a virtual home algorithm, and it will be re-encrypted and transmitted to the real network device of the home when it is assessed as safe. The Zigbee controller transmits a message to the end across the Zigbee network. The safety and security of all messages received from the virtual home algorithm. The usage of Zigbee communication may help to reduce the cost and intrusion of a system[3].

2.2.3 GSM based home automation system using cell phones

GSM home automation attracts research due to mobile phone and GSM technologies. Three options we investigated for communication in GSM are SMS based home automation, GPRS-based homemaker automation and Dual Tone Multiple Frequency (DTMF) domestic automation.

The logical diagram below shows the interaction between devices and house sensors and the home network, and how GSM and SIM are communicated via the work of A. Alheraish. The system uses a transducer to transform machine operations into electric pulses which are sent into a microcontroller. Physique characteristics like temperature, moisture and sound are translated in the sensors of the system into a different voltage, for example. In order to comprehend this, the microcontroller transforms the instruction by analyzing all the signals. The appropriate communication modes will be selected from among GPRS, SMS, and DTFC based on the instruction received by the GSM module[4].

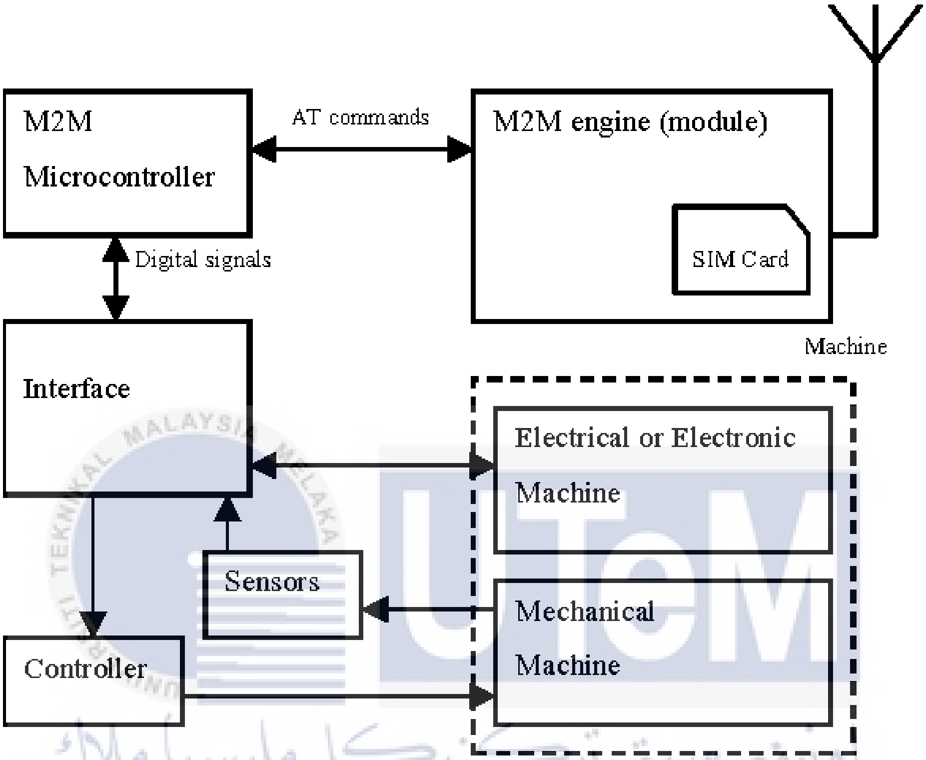

Figure 2.1 Mobile-based home automation from the work of A. Alheraish [4]

2.2.4 Wi-Fi based home automation system using cell phones

The home automation system based on Wi-Fi mainly consists of three modules:

1) The server
2) Module of hardware interface
3) The packages for software

A diagram shows the model layout system. Wi-Fi technology connects the hardware interface module and the server. It is the same technology used in the web-based application of the server. Due to the Internet connection and the usage of an appropriate web browser for the server, distant users may access the web-based application on the server. The software of the present home automation system is separated into two parts: the Arduino microcontroller and application software of the server. Arduino's software is written in C and runs on a microcontroller IDE. The software Arduino receives events from linked sensors and then implements actions on the server and preprogramme them. The server database's history should also be maintained and reports created. A web-based application created using asp.net is the server application package used for the suggested home automation system. Any web browser that supports Asp.net technologies may use internet or internal network server application software if the server has valid IP addresses. The software for server applications is in charge of setting up, configuring and maintaining the whole home automation system. We opted to preserve system logs as XML files, rather than utilizing a database for tracking home automation components.

Figure 2.2 The proposed home automation system layout[4]

2.2.5 Home automation using RF module

The main objective of the Home Automation system is to build a home automation system which can be controlled by a remote RF system. With technological advances, dwellings are also becoming smarter. In favor of a centralized control system in contemporary dwellings, traditional switches are phased out by RF control switches. Traditional wall switches are now dispersed around the house and make control and use difficult for the end user. For senior people or physically challenged people, this gets harder. Home Remote Automation employs RF technology to provide you with a more practical solution.

A RF Remote on the transmitter side is linked with a microcontroller that transmits ON/OFF signals to the receiver connecting the devices. The loads can be turned on and off globally using wireless technology via the distance switch defined on the transmitter.

2.2.6 Home automation using Android ADK

The ADK is linked to the home devices, while Android is linked with the ADK. The EMBEDDED SYSTEM board input/output ports are connected to the devices at home and their present state is related to the ADK. The ATmega2560 is used on the microcontroller board (Arduino ADK). The MAX3421e IC features a USB host connection, which is available for Android phones. Android Open Accessory Protocol 2.0 (AOAP) has two major features:

It may be used to send audio from the Android smartphone to the component, as well as the component which works as a human interface device (HID). This post builds on platforms Android and Arduino, both open source (Free Open Source Software). When movie sensors are used in safety systems and the user is promptly notified via mobile phone or a security system, an improper action is discovered.

2.2.7 Cloud based home automation system

Home Automation uses a cloud-based system to develop and construct a Home Gateway for collection and transmission of data from home devices on a cloud-based data server for storage in the Hadoop distributed file system. It is a MapReduce method used to create remote monitoring jobs for users. At the same time, its resistance is constantly being increased by integrating current characteristics which attract the growing curiosity of individuals. This search describes the creation and design of a home automation system using cloud computing as a service. There are three main components: a cloud server that manages and saves customer, user and device status. The second component of the hardware interface module provides the necessary connections to the actuators and sensor devices that deliver physical service. Home Server is the last component and the hardware and the user interface are accountable for it. This article focuses on making advantage of the cloud to provide online services essential for data protection, storage and accessibility. The current approach is cost-efficient, dependable and pleasant and safe for the whole family.

The system comprises a number of customer modules which may be utilised on a variety ofplatforms.

1. The Cloud Server is a server with a number of submodules. The central server provides the lungs and brain data. It incorporates three submodules, namely the homesystem, the online settings and the mobile device. The server processes the data fromthe house and provides the mobile device with the most up-to-date status, and vice versa. The server monitors a database that is updated in response to the client's modifications.

2. Circuit Hardware Embedded Program for microcontrollers.
3. Internet Client for PCs and mobile phones.

2.2.8 Raspberry Pi home automation with wireless sensor using smart phone

The Raspberry Pi is used to construct a home automation system based on the algorithms and the theme of an email. The Raspberry Pi provides a reliable platform to develop sophisticated and cost-effective smart home automation systems. Raspberry Pi home automation operates in many ways over standard home automation systems. The call charge is an enormous downside if you use DTMF with home automation. This is not their proposed solution. The design of the Web server and the memory space necessary to use the Web server in Home Automation are avoided as this strategy just uses the current Web server service provided by G-mail. For the switching action, LEDs were employed. This is both effective and multi-faceted.

2.2.8.1 Sending commands to the Raspberry Pi

The script that runs on our server or web server receives user's input instructions and sends them to the client (Raspberry Pi). In this example, these input instructions will be used to switch a light on and off. The information and information are provided to the Raspberry Pi when used with the server script, which is activated through its GPIO pin. The system may provide the server with current updates to detect whether the light is on or off.

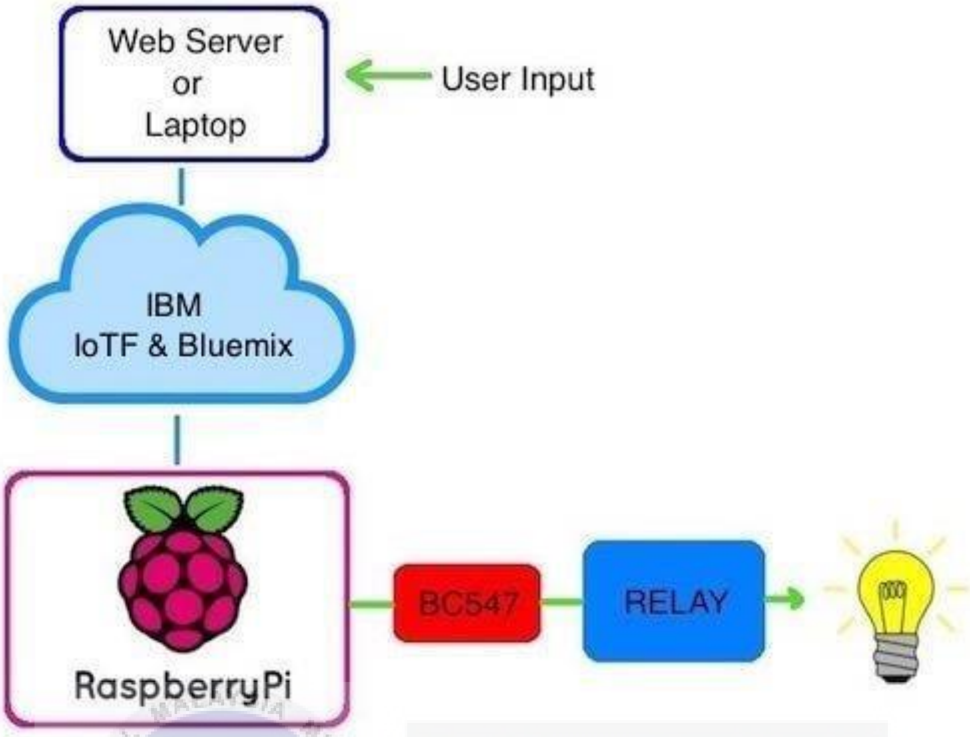

Figure 2.3 Sending Commands to Raspberry Pi[4]

2.2.8.2 Receiving data from the Raspberry Pi

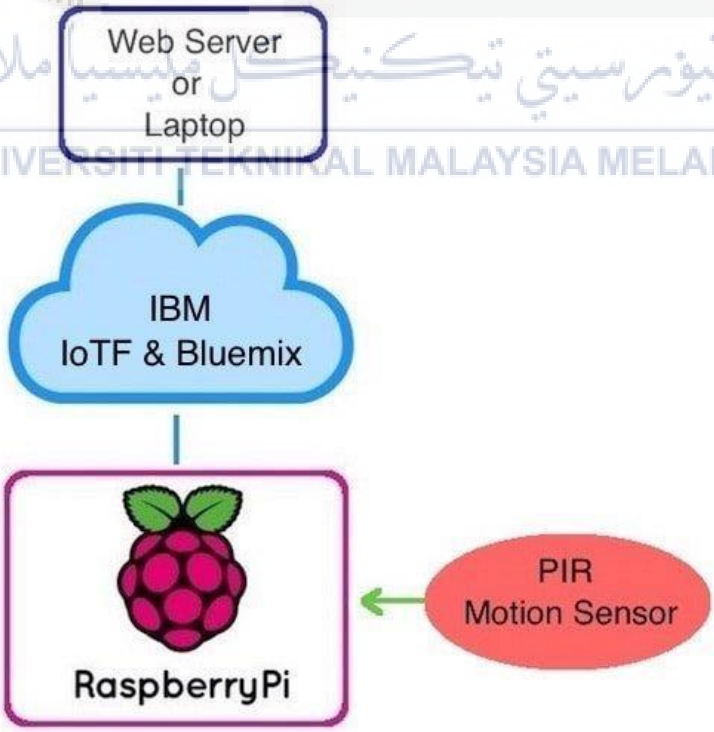

Figure 2.4 Receiving data from Raspberry Pi[4]

Data signals may be sent to the Raspberry Pi through a PIR motion sensor. We just run a script which reads the sensor through a GPIO pin and transmits the data to the complete system through the IoTF platform. This may then be checked using the IoTF console.

2.2.9 Wireless home automation system using IoT

This technology employs mobile phones or computers to automate basic house administration and operation from across the globe through the Internet. An intelligent home is a description of an automated residence. It is aimed at saving energy, both electricity and humans. The technology described is a distributed automation system with a server, wireless Internet access and sensors. The servers manage and monitor sensors and more hardware interfaces may be expanded to include (sensors). This web server is an Arduino board with a Wi-Fi module built in. The automation system may be accessed locally by a web browser or by the web browser on a computer or by a mobile device linked with the Internet through the IP server (internet IP). The Wireless Internet is the network architecture that connects the server and the sensors. In order to improve security (through the use of secure Wi-Fi), movability and scalability, Wi-Fi has been picked.

2.3 Popular platforms for home automation system

In order to deploy home automation, three components must be present:

1. All activities are controlled by human input, such as remote control or hardware based on speech recognition.
2. Secure communications or order channel.
3. Turn on/off, prepare coffee, change heater/AC settings, etc. are all functions that enddevices may do.

Table 2.1 Comparison between Wi-Fi and ZigBee Network Technologies[4]

	Wi-Fi	**ZigBee**
Basic Technology	Uses a router of longer range to send data.	It is designed to carry small amounts of data over a short distance, while consuming very little power.
Networking Type	Centralized hub type network.	It is a mesh networking standard, as each node in the network is connected to each other.
Power Consumption	Needs lots of power as compared to ZigBee.	Very low power consumption. The battery can last for months, even years sometimes.
Speed	Up to 5 Gbps.	250 Kbps.
Cost	Higher than ZigBee, but affordable $50 to $500.	Very cheap, $10 - $50.
Type of content that can be sent	Streaming music, videos, and high bandwidth data.	At max, text-based data can be sent.
Ease of use and implementation	Lots of online documentation, and support for general public to use, and implement Wi-Fi based network.	Very technical for general users to understand and implement the technology. Require some knowledge regarding embedded systems.
Availability	Huge number of United States households and work places have Wi-Fi availability for Internet sharing as basic goal	Not widely implemented. It has to be implemented by manufacturers in their devices. Although, a lot of manufacturers use ZigBee for the device implementation, they are mostly hidden from common user.

2.3.1 Study of Apple home kit

Apple unveiled iOS 8 and showcased some of the further advancements during its WWDC in June 2014. Two new ‘kit’ technologies have been introduced to the mix, HealthKit and HomeKit, in order to integrate iOS with two rising trends in the digital age: quantified self-health and smart house [4]. HomeKit is for your house and your appliances, whereas HealthKit is for your body and fitness equipment.

HomeKit is not simply a single control application. Rather, it’s a database system and hardware certification platform that enables developers to build gadgets. It also supports hardware integration via iOS to facilitate the discovery, configuration, control and communication of a variety of intelligent home products including locks, lighting, safety equipment and other domestic automation products.

The lights may be set up so that you may wake one, armed with HomeKit goods and your iOS smartphone, at a certain time. In addition, the thermostat may switch on the air conditioner while driving home on a hot day. In addition, at the end of the day, you may go to bed and instruct HomeKit to turn the home off at night by speaking loudly using your iOS smartphone.

Accreditation criteria for home kit producers include:

1. Goods must meet two requirements in order to be compatible with the HomeKit platform. First, Apple’s MFi (Made For iPhone/iPad) programme must certify them, a certification method Apple has been implementing for years (dating back to the first “Made for iPod” certification in 2005 in some form or another). The purpose of this certification is to certify that any Apple-based device works correctly with Apple hardware and iOS. Developers say that hardware must follow certain rules and security processes.

2. Every HomeKit approved device must have a customised HomeKit co-processor encryption.

2.3.1.1 Home kit working

HomeKit is the basis for your smart home experience with Apple. There is no central HomeKit control panel. For example, in the background, HomeKit is always accessible on your iOS smartphone, which enables you to control all your gadgets with only one touch. The true connection takes place in four ways: a third-party app built by iOS developers from the manufacturer’s app, voice control through Siri, and digital and physical activators.

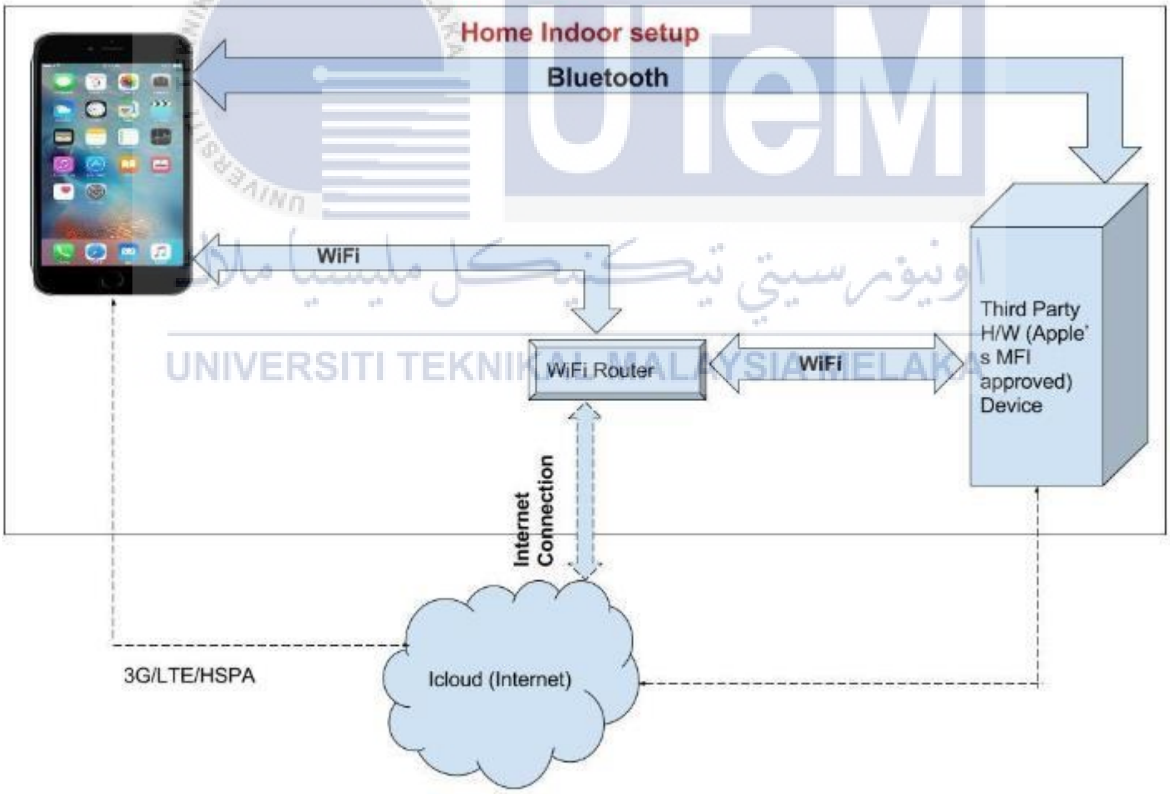

Figure 2.5 Speculated Architecture of Apple Home Kit[4]

2.4 IoT based energy management system

We will briefly review several literatures accessible relevant to Energy Management and Smart Home Systems in this section.

2.4.1 IoT based automated temperature and humidity monitoring and control system using Raspberry Pi

One study reported on IoT-based automated temperature and humidity monitoring and control systems built with the Raspberry P[5].The Pi senses temperature and humidity measurements and transmits them to the Internet. On the other hand, this study led to the fabrication of a prototype that is both functional and viable for automatic temperature and humidity regulation.

2.4.2 Smart home control and monitor using IoT

In addition, research has been carried out on an IoT-based Smart Home Control and Monitoring System to produce a user-friendly GUI that can be accessed worldwide through any device that has an internet connection.

A smart Home Monitoring prototype was constructed using an Android phone and wireless sensor devices, in addition to the aforementioned study. This system checks the electrical power use characteristics of the socket outlet continually. This system regularly examines the voltage current and temperature of the plug outlets in each room and transmits data to the system to calculate the threshold breach for the user to respond prior to a circuit breaker or a fire break.

2.4.3 Automatic lighting and control system for classroom

Research was also undertaken on the construction of an automatic lighting and control system for classrooms to conserve energy. They also provide mobility and remote-control execution through Bluetooth, which enables lights to be controlled using voice commands.

2.4.4 Energy management system for smart home

The Smart Home Energy Management System has been designed to regulate energy at the appliance level. This led to the development of a Smart Home Energy Management System Architecture. Sensors control the energy consumption of home appliances in this system. Solar energy is also used as a backup supply to exchange resources depending on the weather. The PC server gathers and compares energy data from many home servers for statistical research.

2.4.5 IoT based home energy management system for rural area

Furthermore, an IoT-based home energy management system has been created for rural Myanmar. In this research, the requirement for power was planned and suitable processes were developed to satisfy the demand. In order to satisfy the energy requirement, non-conventional energy sources such as solar and thermal might be utilised.

2.5 Sample of quotation

In this journal, we had done the research about the energy management and Internet of Thing (IoT). Uncontrolled use of energy will definitely cause environmental harm, which will exacerbate global warming in turn. Energy management is a recommended practice in order to properly control energy usage.

2.5.1 Energy management

Energy management is a recommended practice in order to properly control energy usage. Indonesia, a nation that is attempting to improve its economic development rates, is also impacted by the state of the energy market in the world. Indonesia's installed capacity for power plants is still dominated by fossil fuels, particularly coal, according to the World Energy Council[6]. In 2018, the total installed capacity of power plants reached 64.5 GW, representing a 3% increase over 2017. The majority of power plants use fossil fuels, with coal accounting for 50% of total installed capacity, natural gas accounting for 29%, fuel accounting for 7%, and renewable energy accounting for 14%. When it comes to energy savings, it is important to utilize energy intelligently, efficiently, and to avoid wasting energy on things that are not necessary. The advantage of conserving energy is that it may lower energy consumption expenses while simultaneously increasing environmental value and comfort. The basic aim of energy management is to develop methods for decreasing energy consumption, expenditures, and environmental impact while maintaining the comfort of individuals who are carrying out activities in the building or area in question. An electric power monitoring system is built in order to allow for monitoring at each measurement point of the energy distribution network. Numerous techniques have been used to do research on monitoring electrical energy usage. The Internet of Things (IoT) is a highly developed technology that may be used to monitor energy usage. This article summarizes the development of Internet of Things-based applications and energy management research that has occurred in Indonesia to date. Energy is a critical resource for life and social welfare, which implies that an adequate and dependable supply is required to guarantee sustainable development, yet the consumption and conversion of primary energy generates the majority of emissions. Energy management is the most effective method of reducing energy use.

2.6 Smart, low-cost and IoT enabled system for energy management

In this journal, we have done the research about the smart home using the smart sockets and meters and web application[7]. Not only does the Internet enable us to transmit and receive data from our peers or other people, but it also enables us to transmit and receive data from our gadgets. This is referred to as the Internet of things (IoT) idea, and it offers enormous possibilities, some of which may be used to resolve the increasing problem of power/energy management.

2.6.1 Smart sockets and meters

A solution to the increasing problem of energy monitoring and management is a low-cost, smart electrical socket that can display the amount of energy used by each of the user's gadgets at any moment in time (in monetary terms). The socket enables users to establish power consumption restrictions by remotely turning on and off their gadgets[7]. Additionally, a database of household appliances was created to raise awareness about the varied energy profiles of various devices and appliances and to provide energy-efficient replacements for such items, depending on their use and location, through intelligent online technologies. The Smart Socket utilises the Internet of Things idea of Smart Metering to collect critical energy usage data and transmit it instantly to a web server where it is stored in a database and accessible to authorised users.

2.6.2 Energy usage in Nigeria

Even though Nigeria is an energy-rich nation, we have historically behaved more as an energy store rather than as an energy consumer. Nigeria's energy usage has increased throughout the years. Figure 6 depicts Nigeria's electricity usage (in kilowatt-hours per capita) from the 1970s to 2011, according to World Bank statistics.

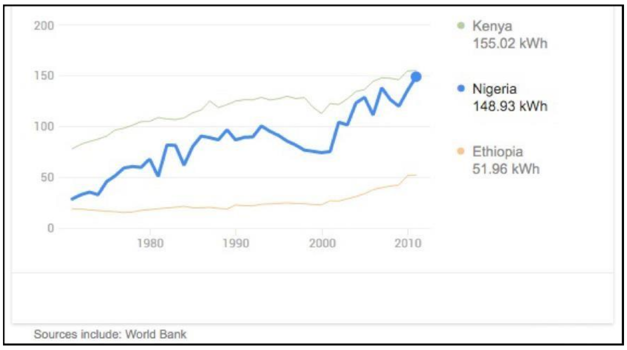

Figure 2.6 Energy consumption in Nigeria[7]

2.7 Smart-home automation using IoT based sensing and monitoring platform

This section covers the usual setting of a home automation system utilising an IoT platform. Figures 2.7 and 2.8 depict a data sensing, collection, processing, transmission and display platform.

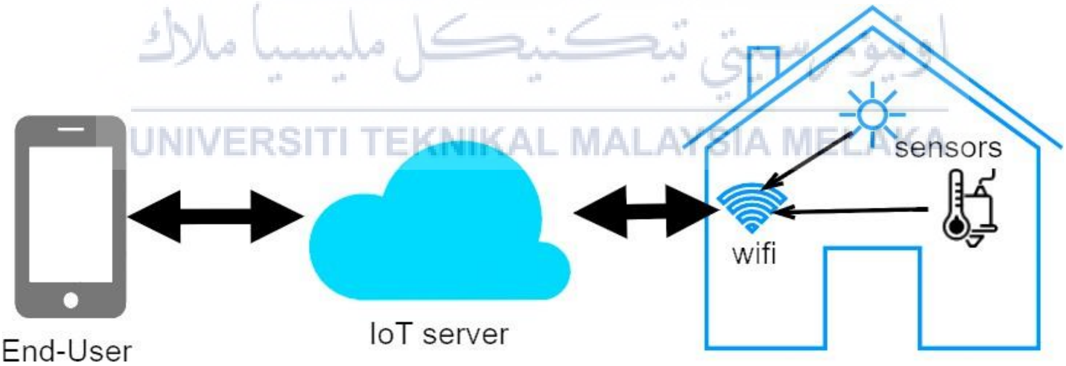

Figure 2.7 IoT home monitoring system illustrative diagram[8]

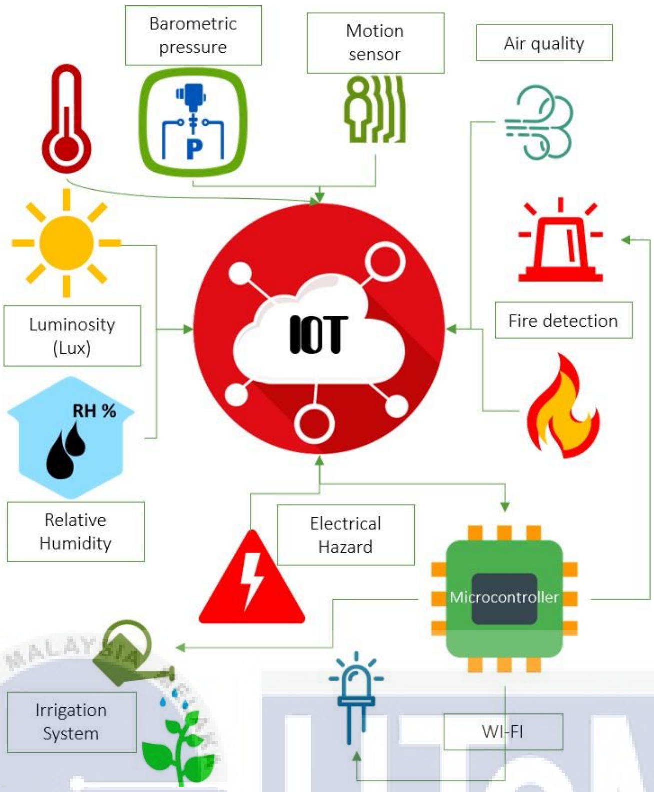

Figure 2.8 Typical configuration of a home[8]

2.7.1 Data sensing and acquisition

Temperature, moisture, luminosity and air quality are routinely monitored for good comfort in houses, as indicated in Fig. 15. (i.e. amounts of CO2 and dust)[8].

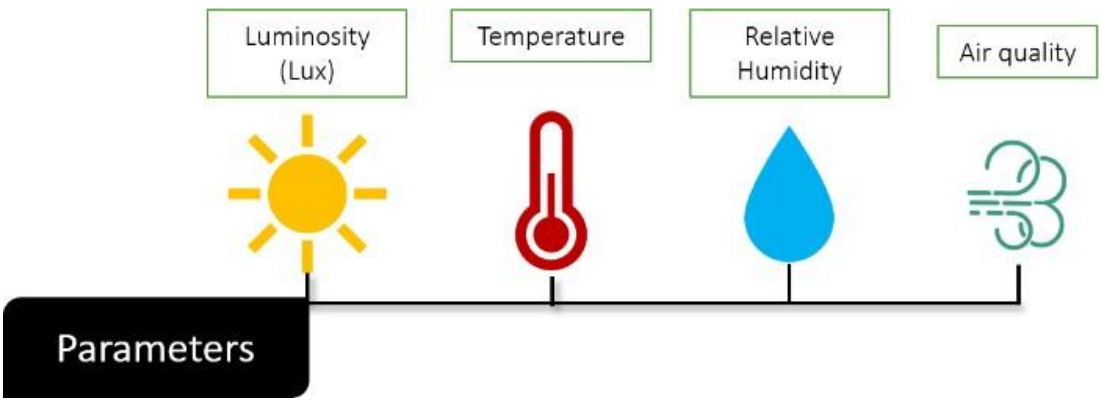

Figure 2.9 Measured Parameters in the proposed monitoring system[8]

The phrase "big data" often relates to the Internet of Things and refers to the massive quantity of data created from a huge number of sensors and devices, like here. The phrase "big data" is often associated with the Internet of Things and refers to the massive volume of data gathered from a large number of sensors and equipment to be analysed.

2.7.2 Data transmission

For sending data between devices and controllers, one or more communication methods are utilised. Examples of such technologies are Bluetooth, ZigBee, Wi-Fi, Ethernet and GSM. Bluetooth and ZigBee are common in-house protocols for data transmission and control connecting sensors to central processing devices. These data transfer technologies are particularly popular because of their low power consumption and simplicity of installation. In addition, IoT devices must connect through Wi-Fi or Ethernet to the internet. While Ethernet is far faster than Wi-Fi, for home automation applications, massive transmission rates are not necessary. In addition, Wi-Fi offers the advantage of mobility, which is offered more extensively in most systems. The Wi-Fi system needs more power than ZigBee or Bluetooth. In order to decrease power consumption, the frequency of data upload may be reduced.

2.7.3 Data processing (Microcontroller)

The most most widely utilised data acquired in the home automation system is a microcontroller like Arduino, Raspberry Pi or NodeMCU. The Pi Raspberry is a small microcontroller computer. Because the large 256MB or 512MB RAM depending on the model, it can execute more complicated functions than other controllers and mostly is used as a central processing unit for many devices. Most of the newer Raspberry Pi versions are equipped with USB and Ethernet plugs, which simplify sending data to the web.

Arduino, on the other hand, is a microcontroller with a single board which can be readily programmed for tasks. There are several versions for Arduino, with flash memory from 32kB to 512kB on-board, and usually 2kB of RAM. Obviously, this controller is less powerful than the Raspberry Pi. On the other hand, most Arduino devices are less costly, easy to use and powerful enough to carry out home automation tasks.

Alternatively, use the NodeMCU. The ESP8266 Wi-Fi chipset is an Arduino-based microcontroller. The 128kB Memory and 4MB Storage are included in that microcontroller. It is usually used to replace a central processing device or for a single IoT application. The coding and communication chain is reduced since each component of this system may automatically upload data to the server. The much-reduced cost of a controller that can connect to the internet over Wi-Fi without the requirement of any other peripherals or modules is the key advantage of NodeMCU over the competitors. As the NodeMCU board has only one analogue input, its use is confined to a single data surveillance system. This failure may be addressed, however, by utilising the ASD115, a digital converter-analog with four analogue input ports with a higher 16-bit conversion resolution.

2.7.4 Data display and user interface

The user and the system may interact in several ways. One approach is to use an application. There are various easy methods to build a mobile or Web-based app to display data, even with an initial grasp of programming. The mobile GSM also enables the user to input code instructions through SMS to the microcontroller. This control solution requires a specific GSM module to be added to the circuit. In this way, emails may also be utilised.

2.8 Table of comparison

Table 2.2 Comparison of previous project in terms of technique, components, advantages and disadvantages

No	Author/year	Title	Component used	Method/system used	Pro/cons
1	(Malik & Bodwade) (2017)	Home automation system	-Bluetooth -Zigbee -GSM -Wi – Fi -RF Module -Android ADK -Cloud -Raspberry Pi -IoT	-This technology employs mobile phones or computers to automate basic house controls and functions from anywhere on the globe through the internet.	-Simplicity -Low cost -Reliability
2	(Malik & Bodwade) (2017)	Popular platforms for home automation system	-Apple Home Kit -Google's Nest Thermostat -Amazon Echo	- All operations, such as remote control or speech recognition-based devices, are controlled by user input. A secure channel for sending	-Cost effective -Low energy

No	Author/year	Title	Component used	Method/system used	Pro/cons
				messages and orders. Turning on/off, making coffee, adjusting heater/AC settings, and so on are all tasks that electronic devices can execute.	
3	(Amri & Setiawan) (2018)	Improving smart home concept with the IoT	-Raspberry Pi -NodeMCU -MQTT -Telegram bot -PIR sensor	- The communication between Raspberry with NodeMCU are using MQTT, while the communication between users and Raspberry using a Telegram bot.	-Replaces the manual switch at home -Command to the system by sending a message, that is not practical for the user
4	(Dhobale et al.) (2017)	IoT based energy management system	-Humidity and temperature sensor -Light intensity sensor -Darlington resistor	-An IoT system for energy management that considers humidity, temperature, and light intensity. calculates and sends the	-Save power electricity

No	Author/year	Title	Component used	Method/system used	Pro/cons
			-Hall resistor -ESP8266 Wi – Fi Module -Arduino IDE	current drawn from each device depending on its use to the Raspberry Pi3. As a result, each household's energy use has decreased.	
5	(Bagus et al.) (2020)	Application of IoT based system for monitoring energy consumption	-Arduino -Current sensor -Voltage sensor -Arduino IDE	- A microcontroller is used to link all of the sensors and modules. Microcontrollers use internet-connected communication protocols to deliver data to the cloud. Data transferred to the cloud is saved on a storage media/server and processed as needed, with the processed data being shown on the client's side, such as websites, mobile apps, APIs, and so on.	-Cost – effective -Modules compact with the microcontroller

No	Author/year	Title	Component used	Method/system used	Pro/cons
6	(Omole et al.) (2016)	Smart, low – cost and IoT enabled system for energy management	-Arduino Uno -Wi – Fi module -Arduino IDE -GUI	- The designed system enables power consumption monitoring with the goal of giving intelligent energy consumption information. In the household context, smart metering provides the user with more information and control over their power consumption. Users may learn about their usage trends by using the produced Smart Metering prototype.	-More efficient to develop strategies -Most environmentally – friendly -Affordable
7	(Al – Kuwari et al.) (2018)	Smart home automation using IoT based sensing and monitoring platform	-NodeMCU ESP8266	EmonCMS was chosen as the platform because it leverages the Internet of Things to gather data from sensor nodes through a cloud server. The data collected may be viewed, stored, or analysed and utilised to operate various devices around the home. The NodeMCU	-Flexible -Easily expanded

No	Author/year	Title	Component used	Method/system used	Pro/cons
				was utilised in conjunction with the ESP2866 as the primary processing unit for collecting, processing, and uploading data from the sensors to the EmonCMS cloud server. Additionally, the NodeMCU may receive data and executeorders from the same server, as well as control switching devices.	

2.9 Summary

According to the study undertaken, the Internet of Things (IoT) will be very beneficial in improving the interface between physical objects and virtual software, allowing for anything to be done remotely. However, in order for this technology to function properly, it must be connected to the internet through a Wi-Fi connection at all times. Furthermore, for the Internet of Things to work properly, a mainframe server is required, and in this project, the NodeMCU ESP8266 is utilised as the base server, which will monitor the input and output data from devices.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will outline the flow of the project and methods along with procedures that were undertook in the process of this project. In overall, this chapter discuss about planning to make sure that progress of project will proceed smoothly.

3.2 Process Work Flow

In a project progress, to obtain neat and good outcome, process work flow is very important to ensure that all procedures are planned and followed correctly without missing any parts. A reliable and good process work flow begin with requirement analysis which is the process of collecting data from related researches and planning the overview of project flow. Next phase is the system design which is to build and run a simulation of project. This is done to ensure that correct components are used and fix any errors obtained in the circuit design. Third phase is implementation that is to create the project based on the system design. After that, system testing needs to be run in case there are overlooked errors during the process of design and implementation. With that, the errors can be fixed accordingly. Finally, good system features are systems that are able to minimize and control the possibility of system failure. Thus, the system needs to be observed and improved from time to time to get rid of any future problems. The waterfall diagram for the process flow is show below.

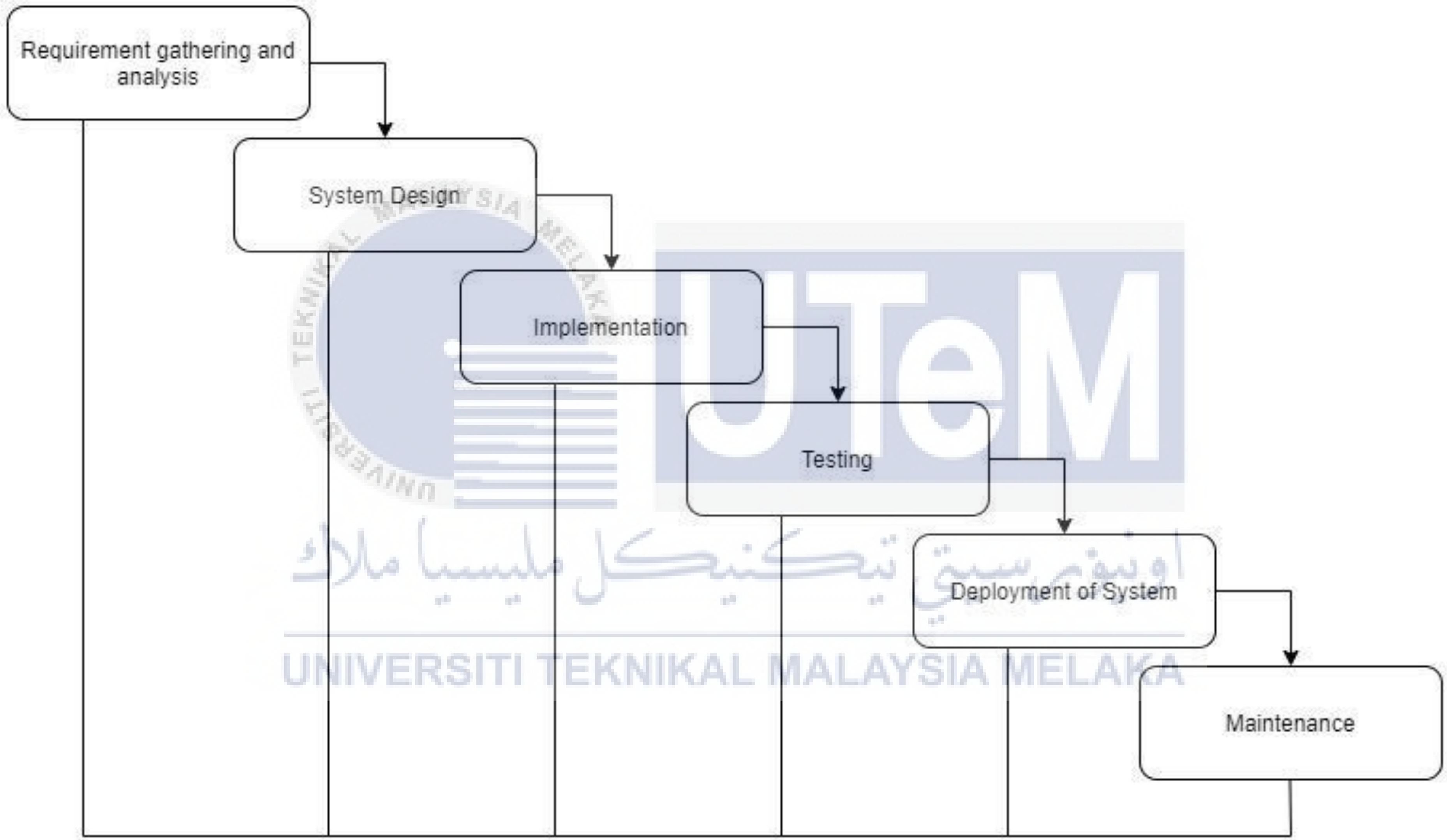

Figure 3.1 Waterfall Model Diagram for Process Flow.

3.3 Hardware Requirement

This part will list out the physical components that is used to complete the project as NodeMCU ESP8266 is the base for the system. Other electronic components will be integrated to the USB ports and GPIO of the NodeMCU.

3.3.1 NodeMCU ESP8266

NodeMCU is a low-cost IoT open source platform. It was supported by software on the ESP8266 Wi-Fi SoC and hardware of Espressif Systems that were initially based on the ESP-12 module. The mix was then applied to the ESP32 32 -bit MCU. The NodeMCU, an open source firmware, offers open source prototype board designs. The term "NodeMCU" combines the term "node" with the phrase "MCU" (micro-controller unit). The word "NodeMCU" refers not to the development kits but to the firmware. Both the firmware and the board designs are open-source. Lua is the firmware's script language. The firmware is based on the eLua project, and is produced using the Espressif Non-OS SDK for ESP8266. A variety of open source projects, including lua-cjson and SPIFFS, are used. Based on resource limits, users must pick the modules that are important for their project and create a firmware adapted to their requirements. The 32-bit ESP32 support has also been implemented. The prototype hardware is usually used as a circuit board, which functions as a Dual Inline Package (DIP) that merges a USB controller with a smaller surface-mounted MCU board and antenna. The usage of the DIP format makes breadboard prototyping easy. The design was built on the module ESP8266 ESP-12, a Wi-Fi SoC that is used extensively in IoT applications, with a Tensilica Xtensa LX106 core.

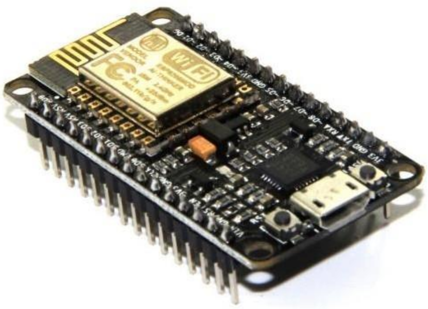

Figure 3.2 NodeMCU ESP8266

Table 3.1 Specifications of NodeMCU ESP8266

Features / Specifications	**NodeMCU ESP8266**
Microcontroller	Tensilica 32-bit RISC CPU Xtensa LX106
Operating Voltage	3.3 V
Input Voltage	7 – 12 V
Digital I/O Pins (DIO)	16
Analog Input Pins (ADC)	1
UARTs	1
SPIs	1
I2Cs	1
Flash Memory	4 MB
SRAM	64 KB
Clock Speed	80 MHz
Power By	USB – TTL based on CP2102 is included onboard, Enabling Plug and Play
Code	Arduino Cpp
IDE Used	Arduino IDE

Size	Small Sized module to fit smartly inside IoT projects
Type	Single – board microcontroller

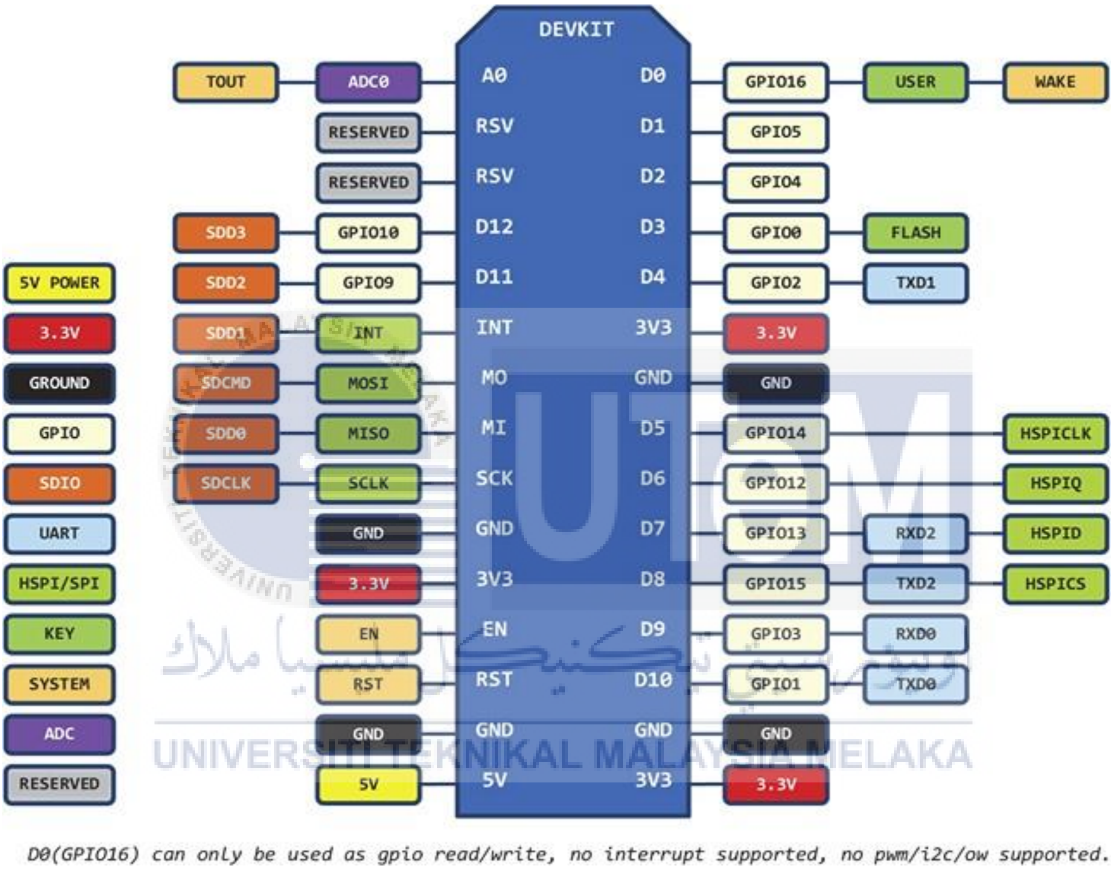

Figure 3.3 GPIO of NodeMCU ESP8266

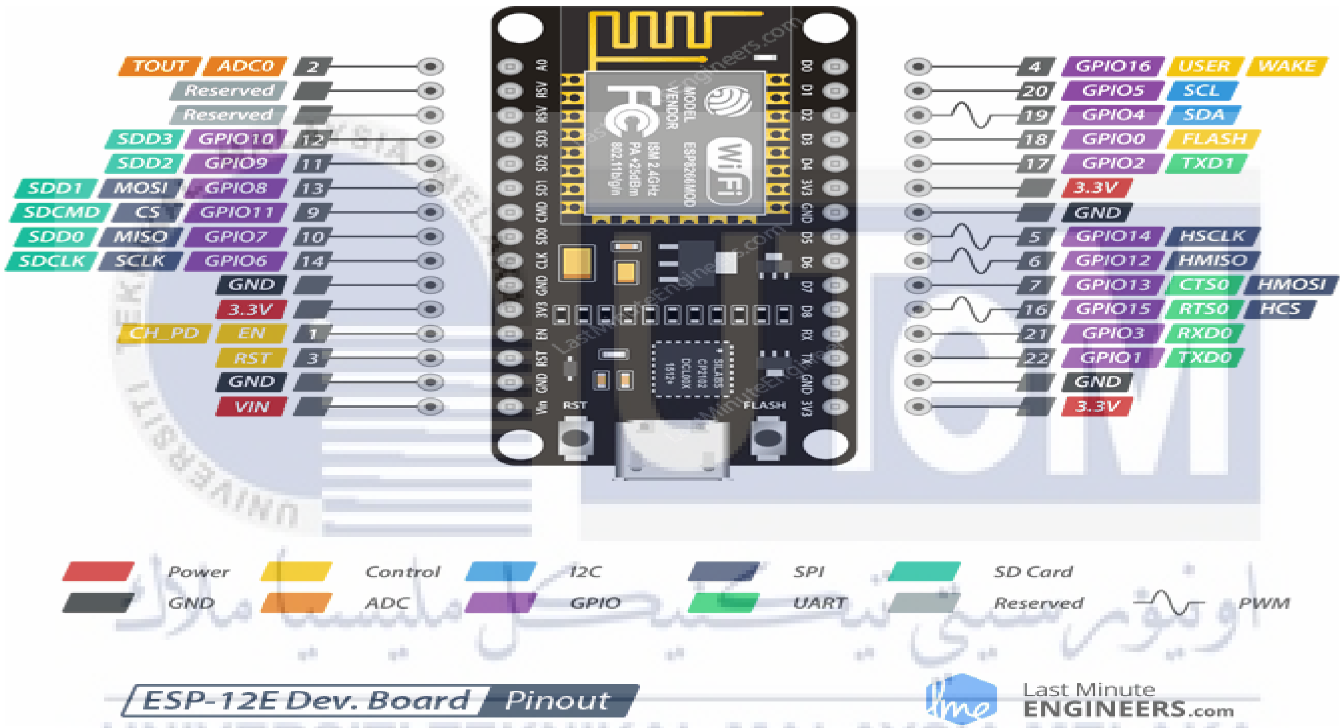

Figure 3.4 Pinout Diagram of NodeMCU ESP8266

3.3.2 Humidity Sensor

The DHT11 is a simple digital sensor for low-price temperature and humidity. It detects the environment using a capacitive moisture sensor and thermistor and transmits a digital signal to the data pin (no analogue input pins needed). It is easy to use, but the collecting of information requires precise timing. The sensor readings may take you from the library once every 2 seconds so that youmay read the Adafruit library for up to 2 seconds. It has a 4.7K or 10K resistor, which should be used as a pull-up from the VCC data pin.

Table 3.2 Specification of Humidity Sensor DHT11

Specifications	**DHT11**
Operating Voltage	3.5V to 5.5V
Operating Current	0.3mA (measuring) 60uA (standby)
Output	Serial data
Temperature Range	0°C to 50°C
Humidity Range	20% to 90%
Resolution	Temperature and Humidity both are 16 – bit
Accuracy	±1°C and ±1%

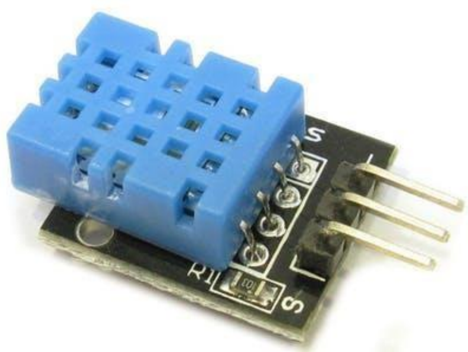

Figure 3.5 DHT11 Humidity Sensor

3.3.3 Current Sensor

A bi-directional hall-effect current sensor chip from Allegro ACS712ELCTR30A detects the positive and negative current flowing in this current sensor board ranks from minus 30 Amps up to 30 Amps. It operates on a 5V DC board and converts the current flowing over the sensor into an output voltage starting at 1/2Vcc(or 2.5V) without a current flow and moving up or down 66mV per amp for either positive or negative current.

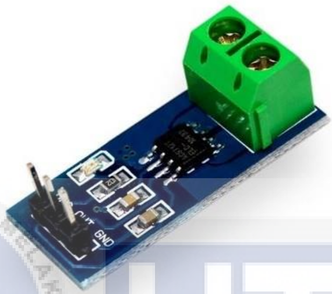

Figure 3.6 Current Sensor ACS712

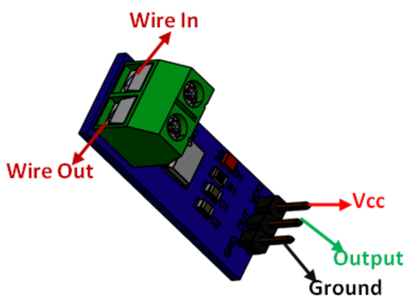

Figure 3.7 Current Sensor Pinout

Table 3.3 Pin Configuration of ACS712 Current Sensor

Pin Number	**Pin Name**	**Description**
1	Vcc	Input voltage is +5V for typical applications
2	Output	Outputs Analog voltage proportional to current
3	Ground	Connected to ground of circuit
T1	Wire In	The wire through current has to be measured is connected here
T2	Wire Out	

Specification:

- Measures both AC and DC current
- Available in 5A, 20A, and 30A module
- Provides isolation from the load
- Easy to integrate with MCU since it outputs in analogue voltage
- Scale factor

3.3.4 5V Single-Channel Relay

A relay is an electromechanical device which uses an electric current to openor shut a switch's contacts. It features components that make it easier to move and connect, and indicators that indicate whether your module is powered, and whether the relay is active or not. The single-channel relaying modulus is more than simply a relay.

Figure 3.8 5V Single-Channel Relay Module

Table 3.4 Relay Module Pin Description

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

Specifications:

- Supply voltage from 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: 70mA
- Relay maximum contact voltage: 250VAC or 30VDC
- Relay maximum current: 10A

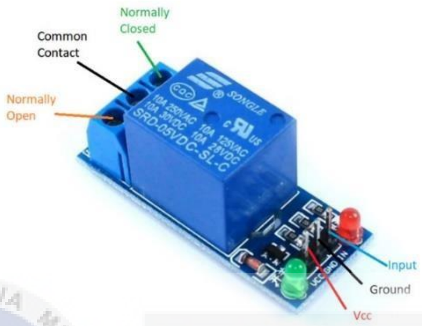

Figure 3.9 Single-Channel Relay Module Pinout

3.3.5 I2C 16x2 LCD

A 16x2 LCD display panel with an I2C interface is seen in this image. It has the capability of displaying 16x2 characters on two lines, with white characters on a blue backdrop (see image).

Typically, Arduino LCD display projects, particularly those using the Arduino Uno, will quickly run out of pin resources. In addition, the soldering and joining of the wires is quite difficult to do. The I2C communication interface is used to communicate with this 16x2 Arduino LCD Screen. This implies that just four pins are required for the LCD display: VCC, GND, SDA, and SCL. It will allow you to conserve at least 4 digital/analogue pins on your Arduino board. All connections are the XH2.54 industry standard (Breadboard type). You may connect straight to the jumper wire if you choose.

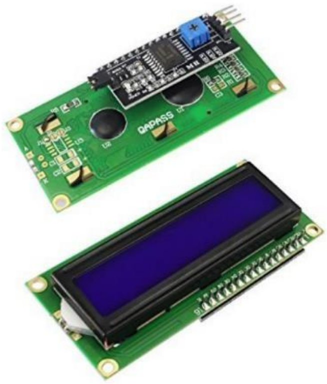

Figure 3.10 I2C 16x2 LCD

3.4 Software Requirement

Software involved in developing the system and assisting the hardware component by controlling the input and output of hardware components.

3.4.1 Arduino IDE

The Arduino IDE is a free open source coding software for Arduino Module authoring and compilation. It is official Arduino software that makes code compilation so easy as to make the learning process even a non-technical person's feet wet. It works on the Java platform with MAC, Windows and Linux compatible platforms. This comprises integrated functions and instructions, which are beneficial for debug, modifying and compiling environmentally friendly programmes. A number of Arduino modules are provided, such as Arduino Uno, Arduino Mega, Arduino Leonardo and Arduino Micro. Each microcontroller is on the board and takes data as code, coded and provided.

In the end, the primary code, also called an IDE Sketch, creates a hex file thatwill be copied and uploaded into the controller of the board. There are two pieces in the IDE environment: a compiler and an editor. The editor is used for writing the appropriate code and the compiler is utilised in the Arduino Module to compile andupload the code. In this environment, both C and C++ are supported.

3.4.2 Blynk Application

Blynk is a new platform for fast creating interfaces from your iOS or Android mobile to control and monitor your hardware projects. After you download the Blynk software to set up buttons, sliders, charts and other widgets on the screen, you may establish a project dashboard. You may use the widgets to activate and deactivate pins and show sensor data.

Blynk presently supports most Arduino boards, Raspberry Pi versions, ESP8266, Particle Core, and a few more popular single-board and microcontrollers. Although devices connected to a USB port may be controlled, Wi-Fi and Ethernet shields are supported by Arduino.

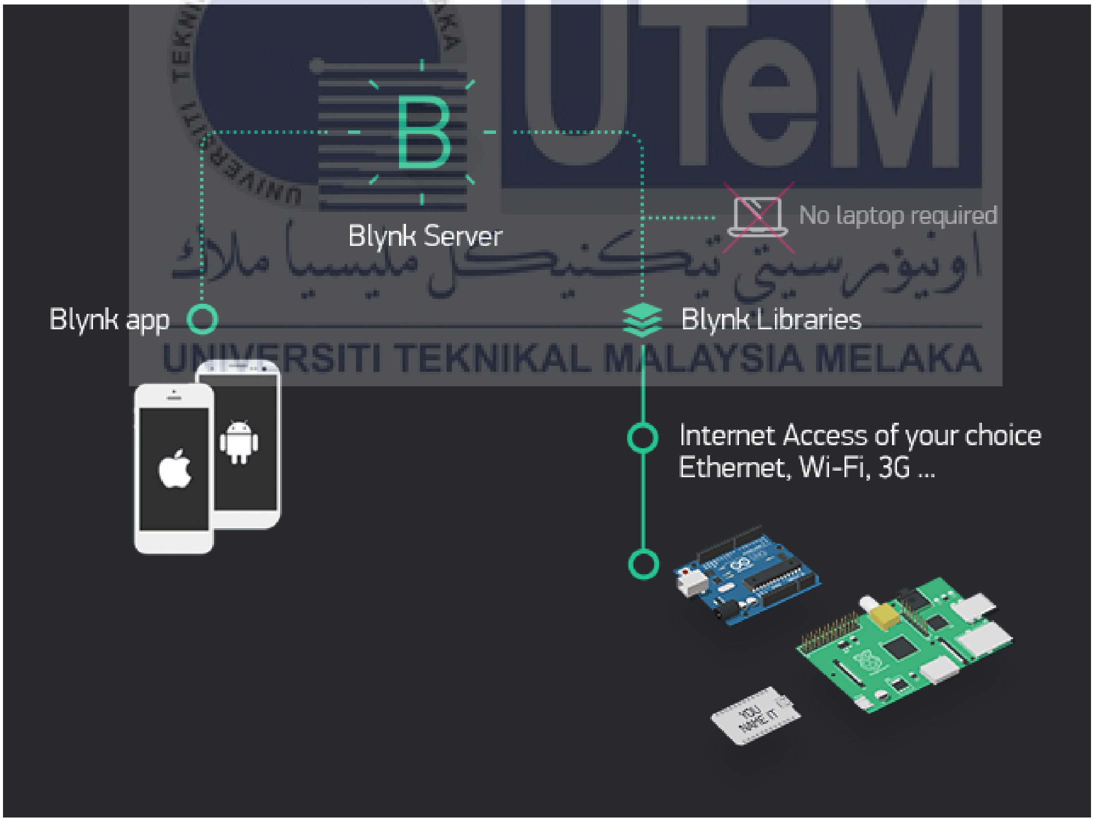

Figure 3.11 How Blynk Work

3.5 Block Diagram

Figure below is the block diagram of the system for this project. The main core or base of the system is NodeMCU ESP8266 as it acts as the central figure between input and output signal. The Power Supply will deliver electricity to the system via the relay and NodeMCU ESP8266 modules, allowing all of the equipment to operate and perform as intended. The NodeMCU ESP8266 microcontroller will receive the temperature and current from the current sensor LM35 and temperature sensor ACS712, and then transfer the data to the Blynk server in TCP / IP format for display on the smart phone using the temperature sensor LM35 and current sensor ACS712. It will also read directives that have been supplied by the Blynk Server in TCP / IP format, which will then be adjusted by applying logic "HIGH" or "LOW" to certain pins of the NodeMCU ESP8266 microcontroller to regulate the on / off of the house lights. By leveraging Wi-Fi, the cloud (internet) is transformed into the core link between the Blynk programme and the NodeMCU project.

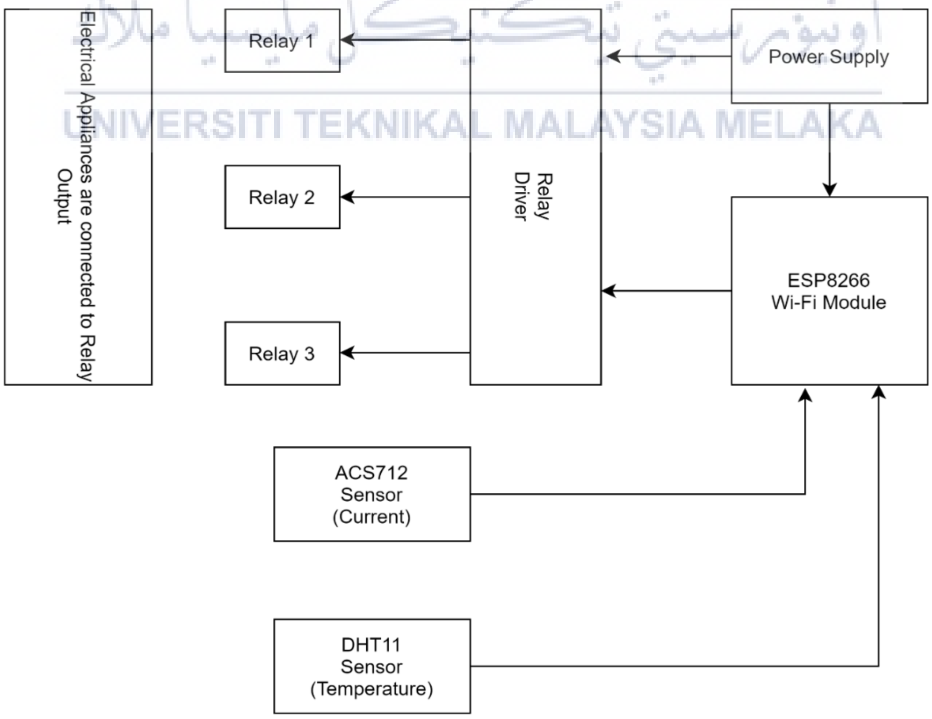

Figure 3.12 Block Diagram of Project

3.6 Flowchart

Figure below indicates the flow chart of the project's system which represents the way the system operates. As an Internet of Things system, the system is built around the NodeMCU board. It is possible to connect to the internet via a WIFI connection on the NodeMCU since it features an ESP8266 circuit for connecting to the internet. It is necessary to identify NodeMCU by the name of the WIFI, the password, and the token code, in order for the Blynk server to join them together before they can be linked. It is possible that you will need to use the computer just once to transfer code from the Arduino IDE to the NodeMCU kit in order to build the software for the project's software portion. Blynk libraries are compressed ZIP files that may be downloaded from the Github website and then imported into the Arduino IDE library as necessary.

If there is an internet connection, the Blynk server will check for it. If there is a NodeMCU with a WIFI connection, the Blynk server will check for it. The information supplied in the code must match the information included in the WIFI configuration to enable the ESP8266 to connect with the WIFI and act as a channel for exchanging instructions between the smart phone and the NodeMCU. The remaining processes consist only of instructions transmitted from the Blynk application to the NodeMCU in order to manage the loads that are connected to the relay kit, as seen in Figure 3.16. In addition, the sensor output value is transferred backwards from the NodeMCU kit to the Blynk application.

It is necessary to submit the sensor output voltage to the Blynk application online in order to display the temperature and current values in Celsius degrees and voltage on the smart phone. A similar process flowchart to the ON/OFF process flowchart is shown below. The Blynk server will check for an internet connection, a WIFI name and password, and the sensor output value in order to display the temperature and current values accurately. After configuring the input pin, temperature scale, and current scale as shown in Figure 3.16, the gauge tool in the Blynk programme displays the current and temperature.

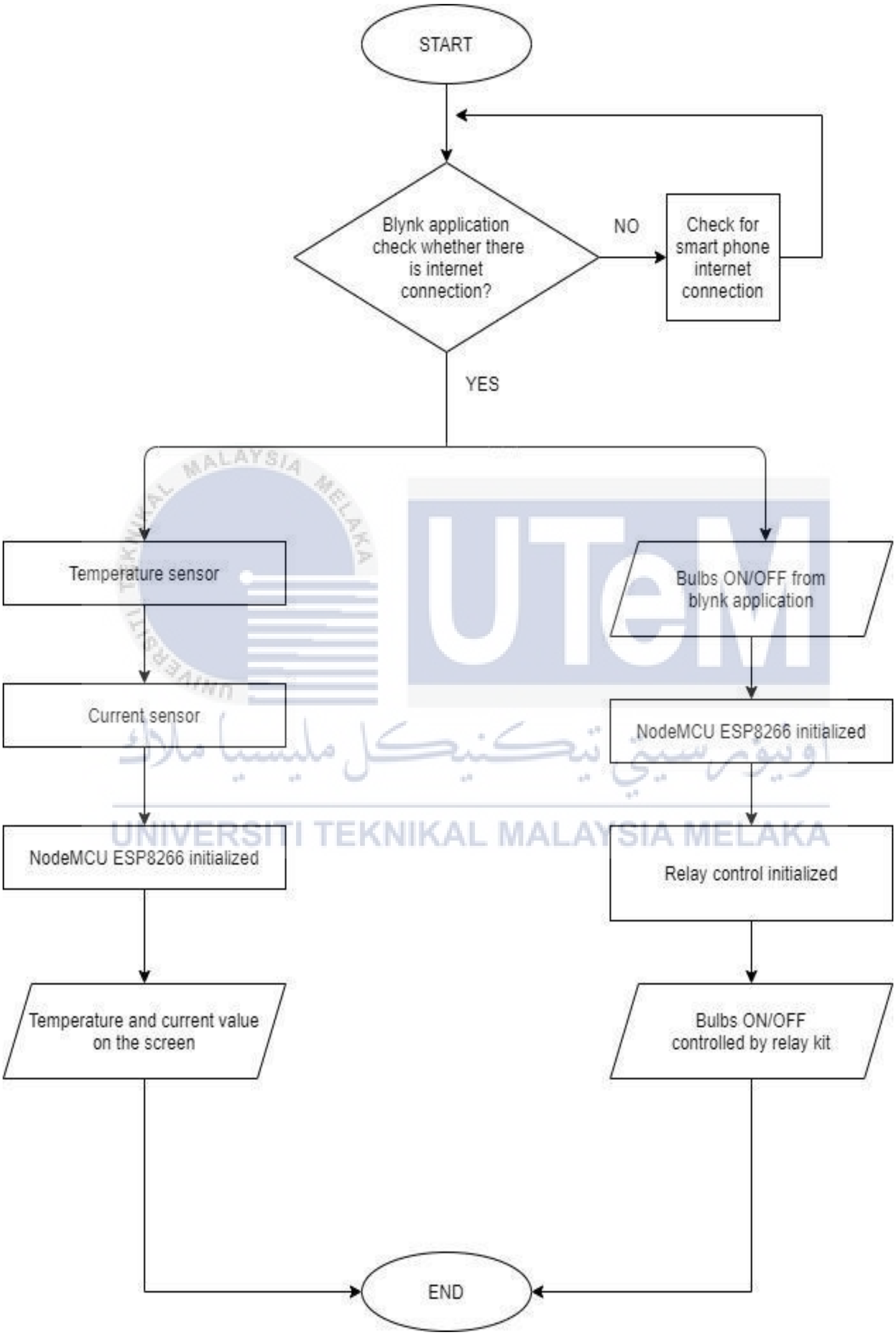

Figure 3.13 Flowchart of project outcome

3.7 Project Costing

The project involves hardware implementation, thus there were some costings involved to complete the project. All the cost for items is listed in Table 3.5 which will be used to show whether the project is expensive or inexpensive based on the function or availability in market. Table 3.5 highlights the overall costing of hardware involved for this project. The most expensive component is the NodeMCU ESP8266 module and others item cost less than RM30.00.

Table 3.5 List of hardware and price

NO	ITEM	UNITS	COST (RM)
1	NodeMCU ESP 8266	1	30.00
2	Humidity Sensor	3	21.00
3	Current Sensor	3	30.00
4	5V Relay Module	3	20.00
5	I2C 16x2 LCD	1	11.00
TOTAL			112.00

3.8 Summary

This chapter presents the proposed methodology in order to develop smart home control system using IoT with energy consumption monitoring. This part explained about the process and method on how the project will be design and develop. Therefore, this section will discuss about the structure of the project, block diagram, hardware and software needed, simple circuit programming and the flowchart of the project.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents to preview the result and provide discussion from the data collection while undergoing the project process. This includes testing and analysis to measure the accuracy and preciseness of the data. This chapter is to ensure that every objectives of the project are fulfilled.

4.2 Overall Project and Operation

To run this project, the main software is needed to be use as the programming part. This project was using Arduino IDE as the main software to program and compile the main component of this project which is NodeMCU ESP 8266 module. Therefore, there are no errors during the execution process will run this project.

4.3 Software Implementation

Software is one of the main components for this project. This part tells the detail about how the software involved in the project.

4.3.1 NodeMCU ESP8266 Board Installation

Every microcomputer including the NodeMCU ESP8266 module requires an operating system. To function the ESP8266 board in the Arduino IDE, library of the ESP8266 board needs to be install first to make the board available in Arduino IDE. As shown in Figure 4.1, on the preferences part, the URL needs to fill in the additional boards manager URLs before we can find nd install the ESP8266 on the board manager as shown in Figure 4.2.

Figure 4.1 ESP8266 URL library

Figure 4.2 ESP8266 board installed

4.3.2 Blynk Application Setup

The Blynk application function is to control and monitor smart home automation system. Download the programme from the app store on a smart phone and then build a project on it with one switch and three gauges to act as a temperature, humidity and current scale. Figure 4.3 shows the setup interface for Blynk application. The firt step to setup the Blynk application by open the new project in the Blynk app and click on the "+" icon on the top. Next, Configure the buttons to be switched on D0. Then, since the sensor output is connected to V0, V1 and A0 on the NodeMCU board, set the gauge to V0, V1 and A0.

Figure 4.3 Interface Blynk Application

4.4 Hardware

Hadrware is one of the main components for this project. This part tells the detail about the hardware involved in the project.

4.4.1 Hardware Design

Figure 4.4 below shows the project connection of the smart home automation system project. All components listed on project costing on chapter 3 is shown where everything had been in connection to be test and analyze their functionality.

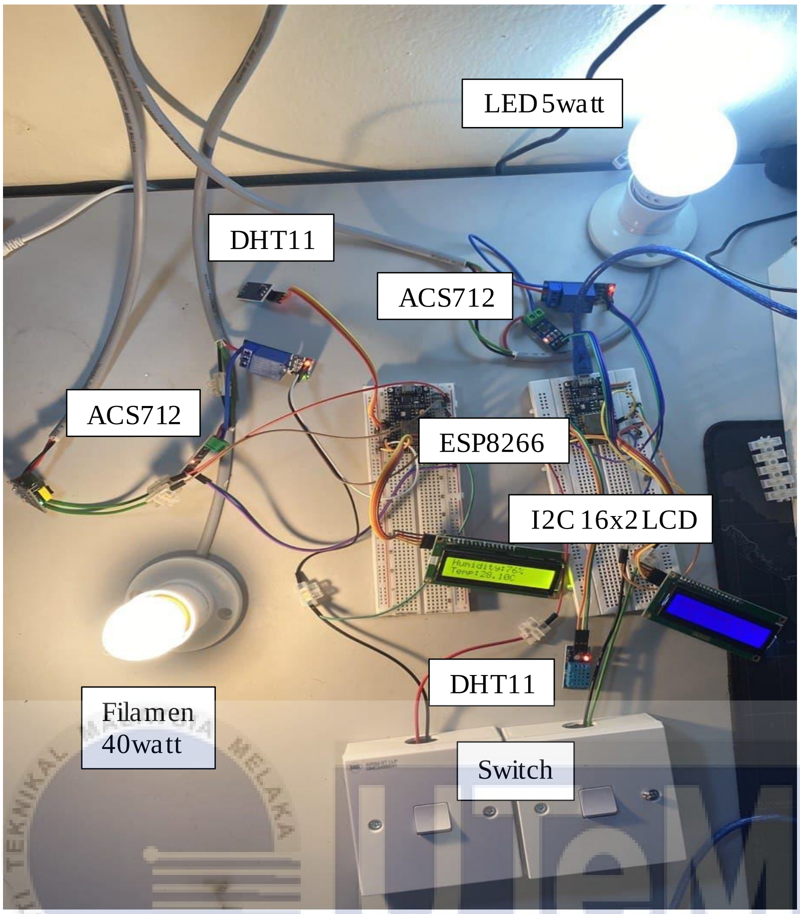

Figure 4.4 Project connection

4.4.2 Testing

Figure 4.5 below shows the prototype of the smart home automation system project. All components listed on project costing on chapter 3 is shown on the Figure 4.4 where everything had been in connection to be test and analyze their functionality.

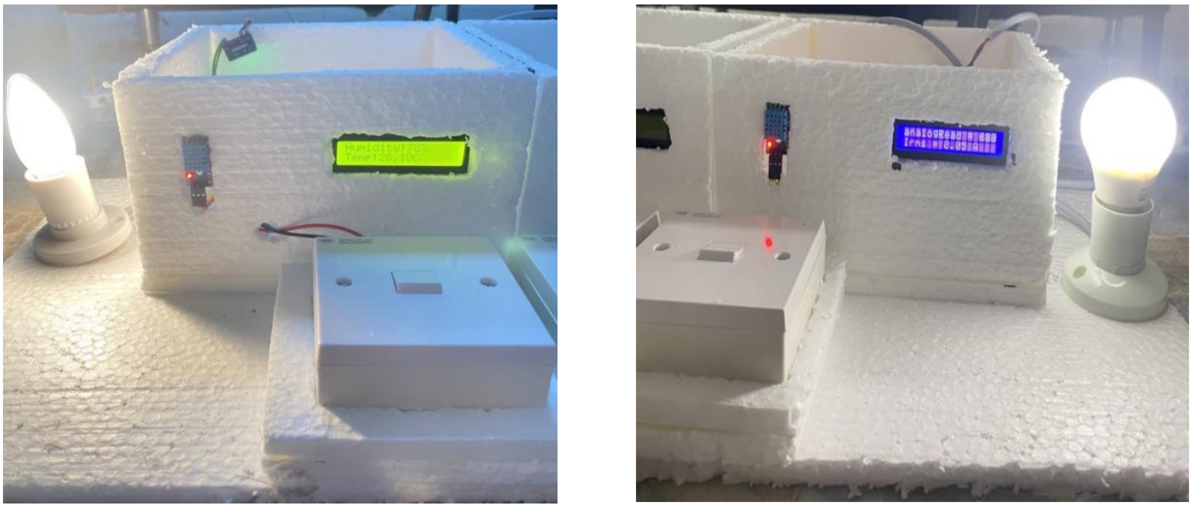

Figure 4.5 Prototype of project

4.5 Software

Software is used to programmed the code of the project. This part tells the details about the software involved in the project.

4.5.1 Coding for Library Use in Arduino IDE

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "secrets.h"
#include "DHT.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
```

Figure 4.6 Coding for Library

4.5.2 Coding for NodeMCU ESP8266

```
//-----------------------------------------Auth Token
// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "BTBr_8DvmSRJGrixMFA-uAmSeq5DS9-m";

//-----------------------------------------Your WiFi credentials
// Set password to "" for open networks.
char ssid[] = "kron 2.4ghz";
char pass[] = "0129690728";
```

Figure 4.7 Coding for NodeMCU ESP8266

4.5.3 Coding for DHT11 sensor

```
//------------------------------------------DHT11 Sensor Configuration
#define DHTPIN D1 //--> DHT11 sensor output is connected to PIN D1 on NodeMCU
#define DHTTYPE DHT11 //--> DHT sensor type declaration
DHT dht(DHTPIN, DHTTYPE);
//------------------------------------------
```

Figure 4.8 Coding for DHT11 Sensor Configuration


```
void sendDHT11SensorVal() {
  //----------------------------------------Get data from sensor and display on serial monitor
  // Reading temperature or humidity takes about 250 milliseconds!
  // Sensor readings may also be up to 2 seconds 'old' (its a very slow sensor)
  int h = dht.readHumidity();
  // Read temperature as Celsius (the default)
  float t = dht.readTemperature();

  // Check if any reads failed and exit early (to try again).
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read data from DHT sensor!");
    delay(500);
    return;
  }
```

Figure 4.9 Coding for read the data from DHT11 sensor

```
Serial.print(F("Humidity: "));
Serial.print(h);
Serial.print(F("% | Temperature: "));
Serial.print(t);
Serial.println(F("°C"));
```

Figure 4.10 Coding to display the output at the serial monitor

```
//--------------------------------------------Sending data from DHT11 sensors to Blynk Server
// You can send any value at any time.
// Please don't send more that 10 values per second.
String Hum = String(h);
String Tem = String(t);
Blynk.virtualWrite(V0, Hum);
Blynk.virtualWrite(V1, Tem);
//--------------------------------------------
```

Figure 4.11 Coding to send the data from DHT11 to Blynk server

```
lcd.clear();
lcd.setCursor(0,0);
lcd.print(F("Humidity:"));
lcd.print(h);
lcd.print(F("%"));
lcd.setCursor(0,1);
lcd.print(F("Temp:"));
lcd.print(t);
lcd.print(F("C"));
```


Figure 4.12 Coding for display the output at the LCD

4.5.4 Coding for ACS712 sensor

```
#define PIN A0
float resolution  = 3.3 / 1024;

uint32_t period = 1000000 / 60;                      // One period of a 60Hz periodic waveform
uint32_t t_start = 0;

// setup
float zero_ADC_Value = 0;

// loop
float ADC = 0, Vrms = 0, Current = 0, Q = 0.000;
float sensitivity = 0.185;
```

Figure 4.13 Coding to define the CAS712 sensor

```
/*----Vrms & Irms Calculation----*/
t_start = micros();
uint32_t ADC_Dif = 0, ADC_SUM = 0, m = 0;
while(micros() - t_start < period) {
  ADC_Dif = zero_ADC_Value - analogRead(PIN);
  ADC_SUM += ADC_Dif * ADC_Dif;
  m++;
}
ADC = sqrt(ADC_SUM / m);
Vrms = ADC * resolution ;
Current = (Vrms  / sensitivity) - Q;          //
//------------------------------//
```

Figure 4.14 Coding for calculation using ACS712 sensor

```
Serial.print("analogRead = ");
Serial.println(analogRead(PIN));

Serial.print("Vrms = ");
Serial.print(Vrms, 6);
Serial.println(" V");

Serial.print("Irms = ");
Serial.print(Current, 6);
Serial.println(" A ");
Serial.print("\n");
```

Figure 4.15 Coding for display the output at the serial monitor

```
lcd.clear();
lcd.setCursor(0,0);
lcd.print("analogRead = ");
lcd.print(analogRead(PIN));
//lcd.print(F("%"));
lcd.setCursor(0,1);
lcd.print("Irms = ");
lcd.print(Current);
lcd.print(" A ");

delay(1000);
```


Figure 4.16 Coding to display the output at the LCD

4.6 Project Implementation

The project implement the hardware and software to ensure the project archieve the objectives.

Figure 4.17 Hardware that have been used

Figure 4.18 Software that have been used

4.6.1 Testing the project

The multimeter have been used to test the current and the voltage of the project.

Figure 4.19 Multimeter to measure current

4.7 Results and Analysis

The result and data were recorded and shown in Figure and table. This data was recorded based on the functionallity of the sensor. The scenario of this project is user can easily control the home appliances from the smartphone using Blynk App. And user can also monitor the energy power consumption from the electrical appliances that have been tapped. User can also control the home appliances manually from the switch. Even if there is no internet sill user can use the switch to control the home appliances.

Table 4.1 Expected result of each components

No	Component	Expected Condition	Actual Result
1	ESP8266	Can read and transfer the data	Good
2	DHT11	Sense the temperature and humidity	Good
3	ACS712	Calculate power consumption	Good
4	Relay	Connect electrical appliances	Good
5	I2C 16x2 LCD	Display the result	Good

Table 4.2 Measurement from the multimeter and sensor

No	**Electrical Appliances**	**Multimeter Measurement**	**Sensor Measurement**
1	LED Bulb 5 watt	0.02 A	0.02 A
2	Filament Bulb 40 watt	0.20 A	0.17 A

Table 4.3 Energy usage for Electrical Appliances

No	Electrical Appliances	Energy Usage (kw/h)
1	LED Bulb 5 watt	0.0048
2	Filament Bulb 40 watt	0.0408

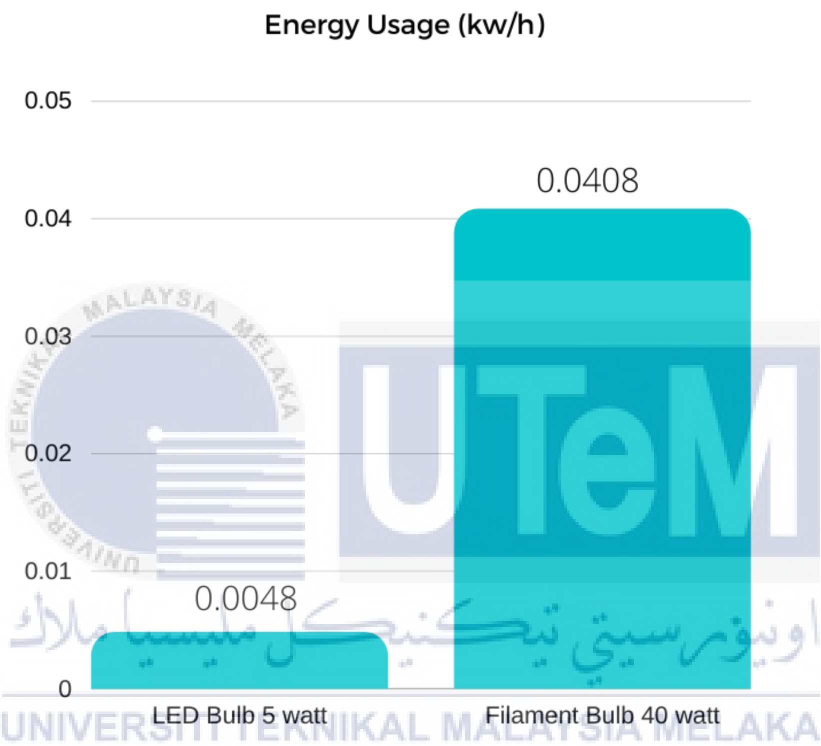

Figure 4.20 Energy Usage for Electrical Appliances

Table 4.4 Tariff electricity for 1 month

No	Electrical Appliances	Tariff for a month (RM)
1	LED Bulb 5 watt	RM 3.46
2	Filament Bulb 40 watt	RM 29.38

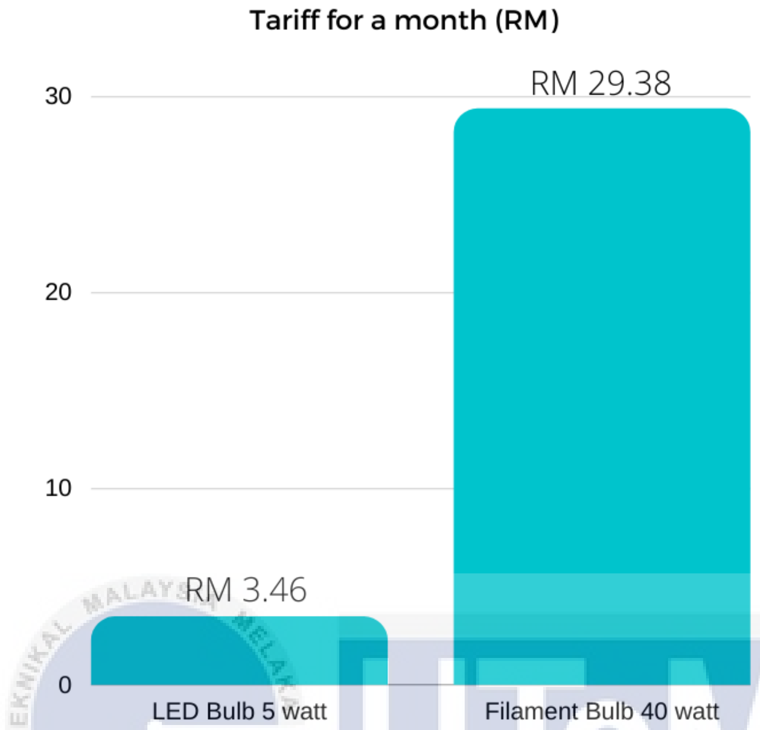

Figure 4.21 Tariff electricity for a Month

Figure 4.20 shows the energy usage for the both electrical appliances. LED bulb use 0.0048 of energy while Filament bulb use 0.0408 of energy. From the figure, it can be analyse that the higher the watt of the electrical appliances, the more energy usage. Next, from the figure 4.21 shows the tariff of electricity for a month. For the LED bulb, the tariff of electricity is RM 3.46 while for the Filament bulb is RM 29.38. By referring to the graph, it can be said that tariff for the Filament bulb is higher rather than LED Bulb. The use of LED bulb can save the usage of the energy rather than filament bulb.

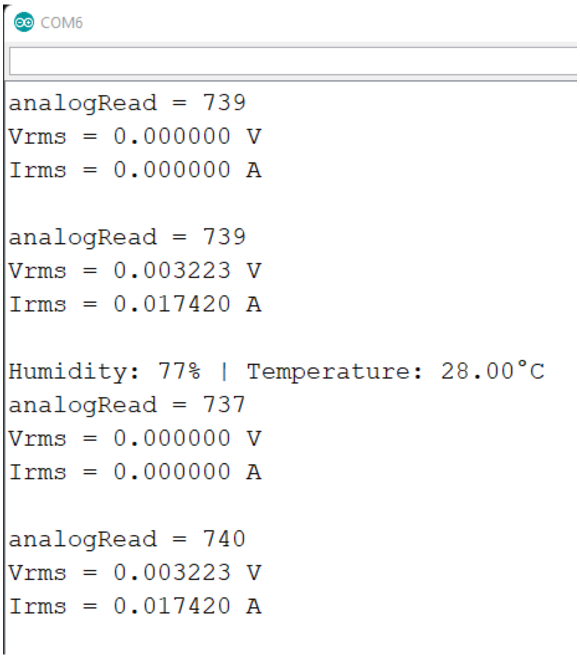

Figure 4.22 Output from the serial monitor

Figure 4.23 Bulb Light Up Control with Blynk Application

4.8 Summary

The smart house operates according to the aim of this study after testing the complete system above. This study utilizes temperature sensors and control buttons to compare this investigation with prior investigations, thereby expanding the variety of the smart home system itself. In addition, the NodeMCU ESP8266 module is a microcontroller that is distinct from previous research, but offers benefits in relation to other microcontrollers. The intelligent house has been successfully constructed with hardware organized such that outcomes may be achieved as anticipated. In this instance, the NodeMCU ESP8266 module is the hardware that plays a very significant function as the primary unit. The benefit of the NodeMCU ESP8266 is more practical than purchasing and assembling different components yourself.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter will discuss about the ending of the project and future proposal planning for this project. Certainly, this part will clarify the true methodology and knowledge gain from the task. This also includes several suggestions that can be used or applied in the future for related project

5.2 Conclusion

The following conclusions may be made from the results of the analysis of all data collected when testing the smart home with the NodeMCU ESP8266 module, which is based on Internet of Things technology:

a) An Internet of Things (IoT) based NodeMCU ESP8266 Module may be built with different components, hardware and software support so that it can be assembled into a smart home system that can be operated using the Blynk android application according to the intended use.

b) Using this Internet of Things (IoT)-based NodeMCU ESP8266 Module, the Smart House may be deployed to manage parts of the home electronics performance, such as lighting controls, fan control, temperature monitoring systems, and early warning systems, among others.

5.3 Future Works

There are still certain flaws in the design and manufacturing of this final projectthat need to be addressed in order to make it flawless, including the following:

a) Reducing the power control consumption of the NodeMCU ESP8266 module in order to further its development in wireless-based technology applications, taking into consideration that current technology emphasises low cost yet efficient operation.

b) The certain of an internet-based smart home system of things must be tested on other electronic devices used in daily life before it can be considered complete.

5.4 Summary

The aim of this chapter is to conclude up the project and make recommendations for future projects. The goal of this project is to provide ideas for creating effective ones, as well as to assist in evaluating papers and advising on what to avoid. The above suggestion is intended to improve the project's quality.

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APPENDICES

Appendix A Gantt Chart of BDP1

ACTIVITY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
PSM briefing	X													
Confirmation project's title	X	X												
Research journals (Literature review)		X	X	X	X	X	X	X	X	X				
Project progress						X						X		X
Update Logbook						X						X		X
Methodology (Chapter 3)								X	X	X	X			
Survey components and Price										X	X			
Introduction (Chapter 1)											X	X		
Preliminary result analysis										X	X	X		
Full report progress						X						X	X	
Presentation PSM 1														X

Appendix B Gantt Chart of BDP2

ACTIVITY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
BDP2 briefing	■													
Construct Circuit	■	■	■	■										
Research journals (Literature review)	■	■												
Logbook progress and weekly report	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Result and Discussion Chapter 4									■	■	■	■		
Survey components and price	■	■	■											
Conclusion & recommendation (Chapter 1)											■	■		
Full result analysis										■	■	■		
Full report progress						■						■	■	
Presentation BDP2														■