Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF MONITORING AND REDUCING POWER CONSUMPTION IN THE HOUSEHOLD

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEVELOPMENT OF MONITORING AND REDUCING POWER CONSUMPTION IN THE HOUSEHOLD

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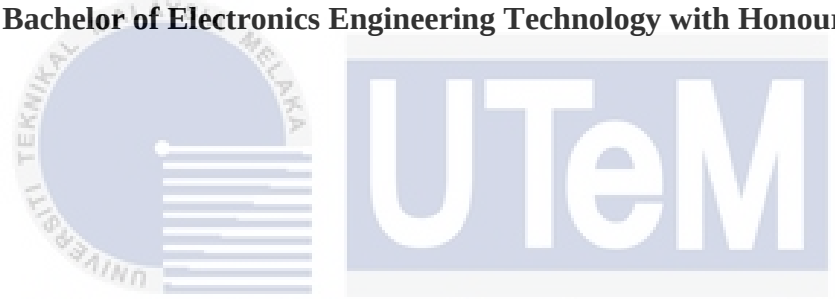
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled “Development of Monitoring and Reducing Power Consumption in the Household” 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 : ROZITAWATI BINTI MUHAMMAD

Date : 10.1.2022

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 : *Azman Awang Teh*

Supervisor Name : EN. AZMAN BIN AWANG TEH

Date : 10.1.2022

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

For Allah's sake, my Creator.

I also dedicate this work to my husband, Nizar bin Ahmad, who has supported me throughout the process and ensured that I give it everything I have to finish what I have started.

Dedicated to my parents-in-law, who always give support and prayer.

My cherished siblings have always provided me with the strength and passion needed to replace my parents who have passed away.

My beloved daughters Nurqaireen Sofia, Nurarissa Sofia, and Nurdaneen Sofia, whom I can't stop loving. The symbol of love and gifting to my entire family.

My friend always encourage support and assisted me throughout this online learning.

ABSTRACT

Electricity, gas, water, and any other energy used to live in a household are all included in energy consumption. There are a variety of approaches to reduce household energy usage and increase energy savings. The two major reasons for conserving energy are to save money on power bills and to safeguard the environment. Reducing our electricity consumption minimizes carbon dioxide emissions into the atmosphere. Consumers are sometimes unaware of the growing use of various electrical products these days. The purpose of this project is to create a circuit that can assist consumers in lowering energy use in their homes. Although this modification is little, it can help you save money on your monthly payments. As a result, the goal of this study is to reduce energy usage throughout the house. The user can learn more about this system by using it. The user can find out the consumption rate using this system. It will show the overall amount of energy consumed over some time. The daily consumption will also be delivered to the smartphone app, so customers can keep track of their electrical usage. Hopefully, this effort will help consumers in lowering their home's energy consumption.

ABSTRAK

Elektrik, gas, air dan apa-apa tenaga lain yang digunakan untuk hidup dalam isi rumah semuanya termasuk dalam penggunaan tenaga. Terdapat pelbagai pendekatan untuk mengurangkan penggunaan tenaga isi rumah dan meningkatkan penjimatan tenaga. Dua sebab utama untuk menjimatkan tenaga adalah untuk menjimatkan wang untuk bil elektrik dan untuk menjaga alam sekitar. Mengurangkan penggunaan elektrik kita meminimumkan pelepasan karbon dioksida ke atmosfera. Pengguna kadangkala tidak menyedari penggunaan pelbagai produk elektrik yang semakin meningkat dewasa ini. Tujuan projek ini adalah untuk mewujudkan litar yang boleh membantu pengguna dalam mengurangkan penggunaan tenaga di rumah mereka. Walaupun pengubahsuaian ini sedikit, ia boleh membantu anda menjimatkan wang untuk pembayaran bulanan anda. Hasilnya, matlamat kajian ini adalah untuk mengurangkan penggunaan tenaga di seluruh rumah. Pengguna boleh mengetahui lebih lanjut tentang sistem ini dengan menggunakannya. Pengguna boleh mengetahui kadar penggunaan menggunakan sistem ini. Ia akan menunjukkan jumlah keseluruhan tenaga yang digunakan dalam beberapa waktu. Penggunaan harian juga akan dihantar ke aplikasi telefon pintar, jadi pelanggan boleh menjejaki penggunaan elektrik mereka. Semoga usaha ini dapat membantu pengguna dalam mengurangkan penggunaan tenaga rumah mereka.

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CHAPTER 1

INTRODUCTION

1.1 Background

Electric power is the most significant component of a building's operating system. This is because all household systems operate on a scale of electrical power. Lighting systems, air conditioning systems, motor equipment systems, communication systems, and so on are examples of building systems.

In energy management, users must be taught how to make efficient use of energy in addition to the factors of using electrical equipment that can conserve energy. In other words, users should be made aware of the need for energy efficiency because it can save both the environment and money. Thus, saving power through efficient and optimal use is the best way for everyone to minimize carbon dioxide emissions while also offering financial benefits from lower utility costs.

One of the main causes of climate change is the increasing human need for energy, whether electricity, gas, or oil, and all this come from fossil fuels. Now many are worried and concerned about the increase in electricity bills. The cause is the increasing cost of energy generation and the profit gained by energy suppliers. The reality is that the more critical issue is that we use limited natural resources at an increasing rate.

Furthermore, the government was forced to increase the amount of energy produced to meet the needs of consumers due to the inefficient use of electricity. Considering these conditions, the government was forced to increase energy rates and utility bills. Excessive use of electricity, especially during peak hours, has resulted in a severe energy crisis around

the world. Among them are insufficient energy supply and erratic market prices and bring destruction to the environment (weather/climate change).

1.2 Problem Statement

How much does power consumption cost you per month? If you live a simple life, your monthly bill might be as low as RM50-60. If you have a large family and use a lot of electrical equipment, though, you may probably have to pay a few hundred ringgit every month. If you fall into the above category, you have been hit hard by the recent increase in electricity rates. However, given the rate at which gas prices are rising across the world, a tariff increase is unavoidable. Malaysia's once-abundant sources of this once-abundant fuel are gradually dwindling; we have had to begin importing coal, and we must begin conserving what remains for future generations.

Following the advice of those who say "turn it off when not in use" is the safest way to reduce energy consumption. When you are not in your home, switch off the lights, air conditioners, and fans. The larger the screen on your television, the more energy it uses. Why not take it a step further and unplug the appliance or turn it off at the source/wall socket? Even when appliances are turned off, they use electricity. Any warning lights or automated indicators are indications that your energy has been depleted, and this will be reflected on your bill.

Another factor worth considering is customer perception and attitude toward standby power use. This loss is not significant enough to pique the consumer's interest. As a result, technological solutions play an important role in ensuring that the settings in the appliances are preserved. The commercial availability of technological solutions, the relatively short replacement time of the equipment in question, and the significantly high and excessive

energy consumption due to outdated technology are all reasons for emphasizing the need to reduce power consumption in households.

There are numerous suggestions for reducing household energy consumption. For instance, set the temperature of air conditioners to between 24 to 26 degrees Celsius, which is a comfortable temperature that does not necessitate the use of sweaters or blankets. Because of the additional factor of water that must be heated, steam irons use more energy than dry irons. It is much more energy efficient to iron clothes all at once rather than piecemeal. If you have a washing machine, only do one load at a time to avoid overloading it. Before purchasing appliances, such as air conditioners, fans, refrigerators, and televisions, look for energy labels. The number of stars (1-5) shows the appliance's energy efficiency.

1.3 Project Objective

The objective of this project is:

a) To develop a system that can record the power, current, and total power consumption.

b) To produce energy-saving electrical devices that users need

c) To analyze the power consumption to adjust the usage and help in lowering the electricity bill

1.4 Scope of Project

This project's goal was to keep track of and reduce residential energy consumption. The goal is to design a circuit that assists consumers in tracking their electrical energy use and protects us from additional charges paid because of slight changes in slab categories, as even tiny adjustments can have a significant impact on the bill.

Electricity usage is read from the Ada fruit and communicated to Node MCU ESP8566 regularly in this project. The Node MCU ESP8566 is the microcontroller utilized in this project. For monitoring our electricity consumption from anywhere in the world and receive a telegram/e-mail when it hits a certain threshold.

In this project, requires to construct a Smart Electricity Energy Meter using the Node MCU ESP8266 Wi-Fi, which can not only send you a Telegram/Email of your electricity bill but also allow you to check your energy usage at any time. To monitor the energy consumption, used an ACS712 Current Sensor.

Other than that, need to use an MQTT broker to monitor our energy usage via the internet. To make an IoT Energy Meter, utilize the MQTT broker as the Ada Fruit IO platform and follow the steps below.

- Create an Ada Fruit account to save electricity meter readings.
- IFTTT Applet for Energy Meter Telegram/Email Triggering
- Codes for Node MCU ESP8566 and current sensor ACS712.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

According to the study, there are numerous methods for reducing household energy consumption. Because the cost of power is increasing every day, customers are looking for ways to reduce their usage. There are products on the market that can help with energy consumption monitoring and appliance reduction. These devices allow you to keep track of how much electricity various devices use. Some of these suggestions will be discussed briefly in this section.

2.2 Theoretical Background

Nowadays, electrical equipment is quite essential. Electrical appliances are required in every home. If electrical equipment is not used properly, the cost of the bill may rise. As a result, we need to know a little bit about how to lower the monthly increase in the price of electricity bills.

For instance, air conditioners: Ideally, temperatures should be adjusted to between 24 and 26 degrees Celsius, which is a comfortable temperature. Air conditioners should also be installed out of direct sunlight, maintained regularly, and have a horsepower that is appropriate for the size of the room. This will ensure that they function at their best. When the air conditioners are on, close the windows and doors.

Guide for Appropriate Air Conditioning and Room Size

Room Size	Air Conditioner Unit Size (HP)
12 x 12 feet	<1
14 x 14 feet	1 – 1.5
14 x 16 feet	1.5
15 x 16 feet	1.5 – 2.0
18 x 18 feet	2.0 – 2.5
21 x 21 feet	2.5 – 3.0

Source: CETREE, Your guide to Energy Efficiency at Home, July 2003

Table 2.2.1: Guide for Appropriate Air Conditioning and Room Size.

Refrigerators should not be placed near a stove, oven, or another heat source, and should not be exposed to direct sunlight. Air should be able to circulate freely above, behind, and around it. Adjust the temperature according to the amount of food in the refrigerator - never overfill it. 15°C is a good temperature, while -18°C is a good temperature for the freezer. When defrosting, never allow the frost to accumulate more than 6mm and always turn off the machine. Before restarting, make sure all the extra water has been removed.

Steam irons consume more electricity than dry irons due to the additional element of water that must be heated. It is also more energy-efficient to iron clothes all at once rather than piecemeal. Washing machines: If you have one, use it only with a full load and avoid overloading it. If possible, use the cold-washing cycle instead of the hot-washing cycle. Lights: Replace your incandescent bulbs with energy-saving bulbs. Change your bulbs to light-emitting diodes (LED) if you can afford it, as they last far longer, use less energy, are eco-friendly, robust, light up instantaneously, and can be turned on and off repeatedly without impacting their lifetime or light emission.

On various items, such as air conditioners, fans, refrigerators, and televisions, look for energy labels. The number of stars (1-5) shows the appliance's energy efficiency (more stars

mean less energy used). The sticker should also state how much energy this appliance will save you when compared to a typical 3-star model.

The amount of electricity you use is measured in kilowatts per hour (kWh). The number of kilowatts utilized is determined by the size and number of electrical equipment in your home (ranging from small items like lights and phone chargers to large appliances like refrigerators). The larger the capacity and the number of appliances you have, the more electricity you will need.

The kWh value of an 'hour' is determined by the length of time that the electrical appliances are used. The more time they are turned on, the more energy they consume. We can do our energy audit at home. What you require is:

1. Power rating/energy usage of the appliances
2. The number of hours we spend using appliances
3. The electricity tariffs

(i) Calculate the energy consumption in kWh:

$$\text{A: kWh} = \frac{\text{Power (Watt)} \times \text{Hours of operation}}{1000}$$

(ii) Calculate the cost of energy:

B: Cost per day = kWh x TNB tariff

C: RM X 30 days = Energy cost of a month.

Figure2.2.1: Energy audit formula that you can do by yourself at home.

2.3 Related Research

Based on research from Korakot Luechaphonthara, Vijayalakshmi at the Department of Computer Science, CHRIST (Deemed to Be University) in India, traditional electrical meters provided by energy suppliers assess a building's power use for a month and give the consumers the reading for that month. In this circumstance, the consumer is unable to examine and monitor the daily electricity use of his building/appliances. Electricity usage of various appliances can be monitored and managed separately using electricity meters. This will help the consumer identify the main sources of electricity usage about any equipment so that appropriate measures can be taken to help the environment. In this project, we used both hardware and software.

The ESP8266 Wi-Fi Module is a self-contained SOC with an integrated TCP/IP protocol stack that can connect any microcontroller to your Wi-Fi network. The ESP8266 may either host an application or offload full Wi-Fi networking capabilities to another processor. Each ESP8266 module is pre-programmed with AT command set software, so all you have to do is put it into your Arduino and you'll have roughly as much Wi-Fi functionality as a Wi-Fi Shield. The ESP8266 module is a low-cost board that has a huge and growing community.

The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, as well as a self-calibrated RF that allows it to work in any environment without the need for extra RF parts. There is an almost infinite quantity of information for the ESP8266, all of which has been made possible by great community support.

Second, it used the ACS712 current sensor that detects currents. The ACS712 Current Sensors are designed for ease of use, and full-scale values of 5A, 20A, and 30A are available. Each of these devices has the same basic functional procedure. The scale factor of the output is the only difference. This sensor can measure positive and negative current and 5V from

the power supply and the middle sensing voltage is 2.5V when there is no current. This current sensor accurately measures current in both AC and DC signals.

Via a Wi-Fi networking device, the next module is the Data Processing module, where we can collect information on the electricity consumption sensed from each of the sensors mounted on the appliance. Furthermore, this data is saved in a MySQL database and can be used to respond to user requests. The proposed system aims to provide consumers with smart energy consumption monitoring services.

According to (Md Sadequr Rahman Bhuiyan of Georgia Southern University's) research, electricity is used for a variety of purposes. It is one of the most significant areas of a country's economic development. The energy infrastructure in Bangladesh is quite tiny, insufficient, and poorly managed. Many technical and non-technical losses are among the problems in Bangladesh's electric power sector. Non-technical losses include meter tampering, illicit methods of paying electricity bills, and so on. Due to the inconsistent review of meter data, the home meter billing system is ineffective, and most invoices are issued based on assumptions. As a result, even though consumers use roughly the same amount of energy each month, they are subjected to uneven invoicing. The network meter reading management system is created based on the given specifications. This system is based on network technology, automatic meter-reading technology, and modern management ideas, allowing for controllable, customizable, and predictable energy consumption management.

Traditional meter reading methods are replaced by the proposed system, which allows authorities to remotely view current energy meters. It may also regularly monitor meter readings without having a person visit each household. A GSM 900 module is integrated with each entity's electronic energy meter to provide remote access to electricity usage and to form a wireless network.

All customers' homes have a GSM modem and other essential equipment installed on the server end. The blinking LED of a meter is used to collect data from an energy meter. The LED impulse rate per unit can be estimated using energy meter specifications.

Another GSM 900 module receives this SMS as a string on the server end. This string is segmented, and a C# form application program performs numerous logical and arithmetical methods to obtain essential information such as meter issue date, paid energy, last payment date, payment status, current used energy, and bills. A MySQL database holds all of the customer's information.

On the consumer end, the setup includes a load, an energy meter, an LCD, and a GSM module, among other things. Each unit performs a distinct function, making up the entire consumer-end system. After a month, the consumer receives a bill SMS. It tells the customer how much energy they used last month and how much they paid. Figure 1 also depicts the procedure for paying a bill.

Figure 2.3.1: Consumer unit

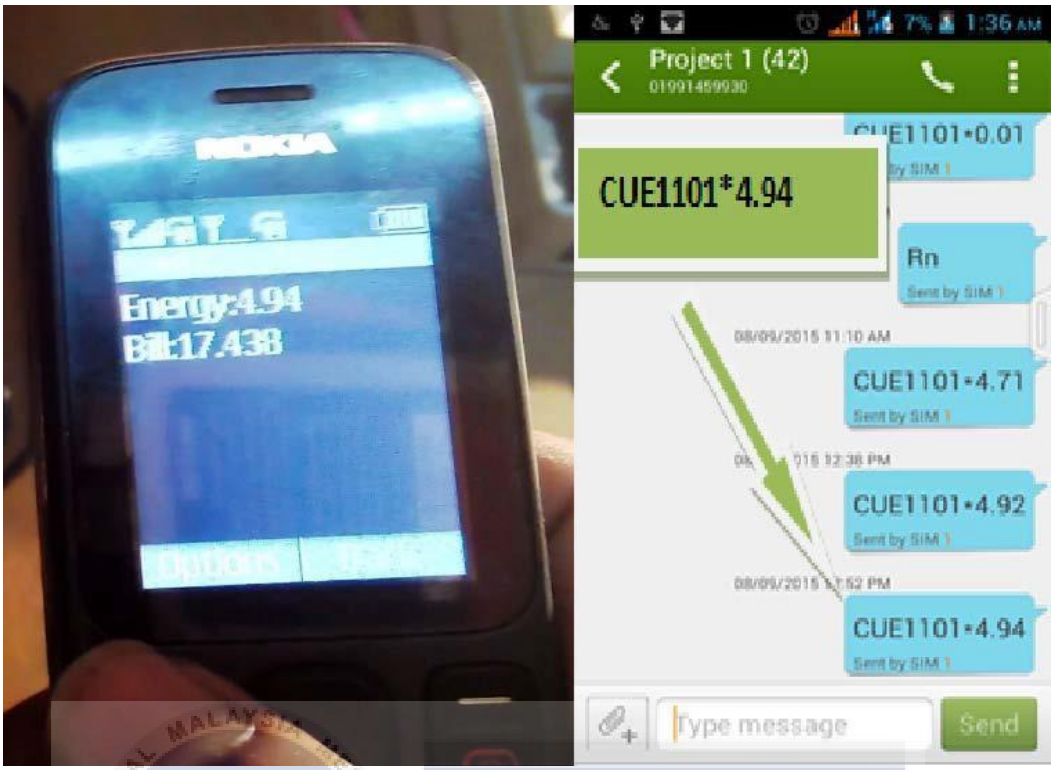


Figure 2.3.2: Monthly bill SMS and Bill payment SMS

Based on research by Md. Rakib Hossain, Sadia Afrin Setu, and Md. Ahsan Habib from Daffodil International University, the project is about smart IoT-based energy-saving home automation that uses relative distance and power usage to save energy. This project focuses on lowering energy costs, allowing people to save money and time every day. Reduced waste and loss, greater efficiency through technology upgrades, enhanced operation and maintenance can all help to save energy.

There are two aspects to this project: software and hardware, each with its own set of requirements. The day's energy bill was calculated using the Arduino in the hardware section. The automation feature built using Python and image processing can be found in the software part.

In the hardware part, the Arduino UNO was used to measure temperature, detect lighting conditions, and control a relay in this circuit design. One relay module is used to

control the light, while the other is utilized to control the fan. The Light Dependent Resistor was utilized to detect the illumination condition in this case. For taking input, one pin is connected to a voltage, while the other is attached to Analog (A1) and connected to the ground pin using resistance.

The LM35 sensor was used to measure the temperature. The Bluetooth module is linked to the Arduino through pins RX and TX to receive and transfer information from the processed image. The ACS712 current sensor measures the total current consumed in real-time.

For the software part, the system was created using the Python programming language and the Anaconda platform. Before acting, technology must first detect the presence of humans. Image processing was employed to detect the presence of a human. Open-CV was used to detect our faces, features, and shape.

We also measured the distance between an object and a human being in this project. There is a coordinate value for detecting objects when a face and another object are detected. First and foremost, when we capture a room, we are capturing a 2D surface. We may compute the distance from a 2D surface using the formula Distance=√ (X2−X1) + 2 (Y2−Y1 +2). To do that, we will need the coordinates (X, Y) and draw a box around the detected object, determine the center, and then calculate the distance between the middle point of the box and the human.

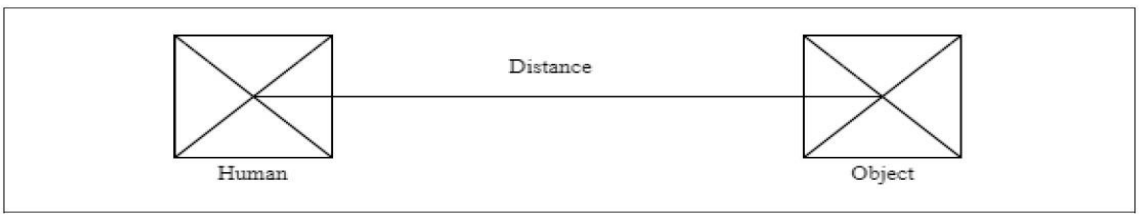


Figure 2.3.3: Finding coordinates

To obtain the system's consumption outcome, daily energy costs must be monitored. To compute the current use for a day, this system utilizes a current sensor to detect current, which it then converts into power using the law of power (Power=V × I (watt)).

Bedir handled the research for this chapter. The data was acquired using OTB's data collection methodologies and a Guerra Santin and Bedir-created questionnaire. Bedir carried out the analysis and wrote the paper. The co-author highlights the research strategy (E.C. Kara). The co-author has provided his consent for the paper to be included in the thesis. This research was published in the journal Energy and Buildings. In this paper, occupant behavior was defined as the presence in a location, the usage of lighting and appliances, and activities at home that directly affect power usage.

The research framework is depicted in the figure below. First are the determinants of behavior. There are dwelling features, household features, lifestyles, and attitudes to consider. The second is behavior-related electricity consumption. There are three parts: lighting behavior, presence, and appliance use behavior's final section is about electricity consumption.

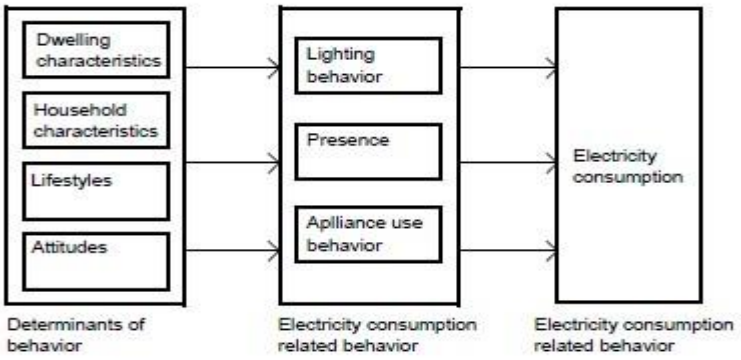


Figure 2.3.4: A research framework

The information was gathered through a survey conducted in two Netherlands districts: (Wateringse Veld and Leidsche Rijn). Household characteristics (size, composition, years in the dwelling, changes in household composition in the previous year), individual characteristics (age, education, occupation, hours spent outside the home), and economic characteristics were all covered in the database of 323 cases, which was in the form of a questionnaire (income, ownership, electricity tariff).

From the article Bluetooth for the Internet of Things: A fuzzy approach to improving power management in smart homes: The mechanization and automatic control of numerous residential activities are referred to as home automation. Home Automation often allows for centralized control of electrical equipment such as air conditioners, lighting, security systems, and even home theatre systems. It would be able to achieve exceptional levels of comfort by incorporating intelligence into the living environment, and another factor to explore is energy savings. Furthermore, the lack of low-cost, standardized communication protocol between various electrical equipment in the home makes integration a difficult task. In any case, practically every home now has a wireless network. Smartphones and tablets are natural gadgets for allowing electrical gadgets to be controlled. Wireless protocols have become an easy way for home automation systems to be self-installed in these circumstances. Several wireless technologies have been proposed to allow remote data transfer, sensing, and control in smart homes, including Bluetooth Low Energy (BLE), IEEE 802.15.4/ZigBee, and IEEE 802.11/Wi-Fi. The healthcare business is embracing Bluetooth Low Energy (BLE) for medical and lifestyle devices that are portable.

On the other hand, the competition for home control and automation between ZigBee and low-power Wi-Fi technologies has only just begun. Machine-to-machine communication and location-based services appear to be ideal bets, particularly for wireless device manufacturers looking for new revenue streams. Bluetooth Low Energy offers a lot

of potential as a low-power, low-cost, and small-device technology for the Internet of Things. However, IEEE 802.15.4-based technologies are still employed in some situations, particularly in locations where they are well-established.

2.4 Comparison Table

In a few projects, several approaches and methods were employed to reduce power consumption. The comparison table below shows a few previous techniques to reduce system power consumption. The table can be used to draw conclusions and make comparisons, and it can also be used to plan the implementation and upgrading of this project

Title	IoT based application for monitoring electricity power consumption in home appliances	Design and Implementation of Remotely Located Energy Meter Monitoring with Load Control and Mobile Billing System through GSM	Smart IoT based energy saver home automation system by measuring relative distance and power consumption	Bluetooth for Internet of Things: A fuzzy approach to improve power management in smart homes
Author	Korakot Luechaphonthara, Vijayalakshmi A Department of Computer Science, CHRIST	Md Sadequr Rahman Bhuiyan Georgia Southern University	Md. Rakib Hossain, Sadia Afrin Setu and Md. Ahsan Habib from Daffodil International University	M. Collotta ⇑, G. Pau The Kore University of Enna, Faculty of Engineering and Architecture,

	(Deemed To Be University), India			Cittadella Universitaria, 94100 Enna, Italy
Hardware	- Current sensor ACS 712 - Electronic Device (water dispenser and refrigerator) - ESP8266 Wi-fi module	- Energy meter - GSM 900 - LCD Display - Relay - Mobile phone	- Arduino - Relay Module - Light Dependent Resistor - LM 35 Temperature Sensor - Node MCU Epson Wi – Fi module - ASC 712 Current Sensor - Bluetooth Module HC-05	- Fuzzy logic control - Bluetooth Low Energy -
Software	- MySQL database	- MySQL database	- Python	-
Result / output	In a four-person household in Bangalore, India, an energy meter was connected to the following gadgets to collect	In terms of digital billing system advancement, this system is one step ahead of the competition, with a new feature that benefits both	This system can determine the distance between a person and an object, although it is not completely accurate. This	The goal of this research is to extend the life of devices in a home automation wireless network. Bluetooth Low Energy

	electricity consumption statistics during six weeks. The data is separated into two categories: daytime and night-time. Daytime runs from 6 a.m. to 6 p.m., while nighttime runs from 6 p.m. to 6 a.m. The information was gathered from the following devices: 1. Refrigerator 2. Water dispenser	the consumer and the energy provider, as well as regular monitoring and remote load control, providing system resilience above the previously constructed system.	technology can only switch on the light and the fan automatically. In the future, more appliances will be added. For security purposes, such as unlocking a door, the detection of a human face.	could be an important factor of the Internet of Things.

Table 2.4.1: Comparison table

2.5 Summary

Oil prices have risen considerably in the worldwide markets during the last two years, and our country has felt the effects of this rise as well. Because local gas prices are connected to oil prices, a spike in oil prices in the worldwide market has had an impact on local gas prices. As a result, the cost of coal on the global market has risen. Because gas and coal are the country's primary sources of electricity, any increase in their prices will have an impact on energy generation costs. Therefore, various studies have been conducted to overcome the increase in electricity tariff rates in both residential and industrial areas. This is to ensure that every residential or industrial house can reduce its consumption, and this allows the monthly bill to go down and we do not have to pay more.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the process of how to reduce daily power consumption in a household is going to be discussed. Since this is modest to medium-sized project, the waterfall method will be used. This waterfall model is a standard approach that is frequently used in system development to design systems that are linear and sequential in design. The process will continue in downward order from one phase to the next, and this model is easy to follow because the subsequent phases can only begin after the previous phase is finished. There are several processes involved in generating daily power consumption in a household, including identifying the material and selecting the specific method that is appropriate for this project. Before starting a project, the methodology is important, and the methodology discussed in this chapter includes requirements, system design, implementation, and cutting. Using this model, the project will be completed at a specific time. The project will run more smoothly if this methodology is used, and it will provide an overview of the processes that must be completed.

3.2 Methodology

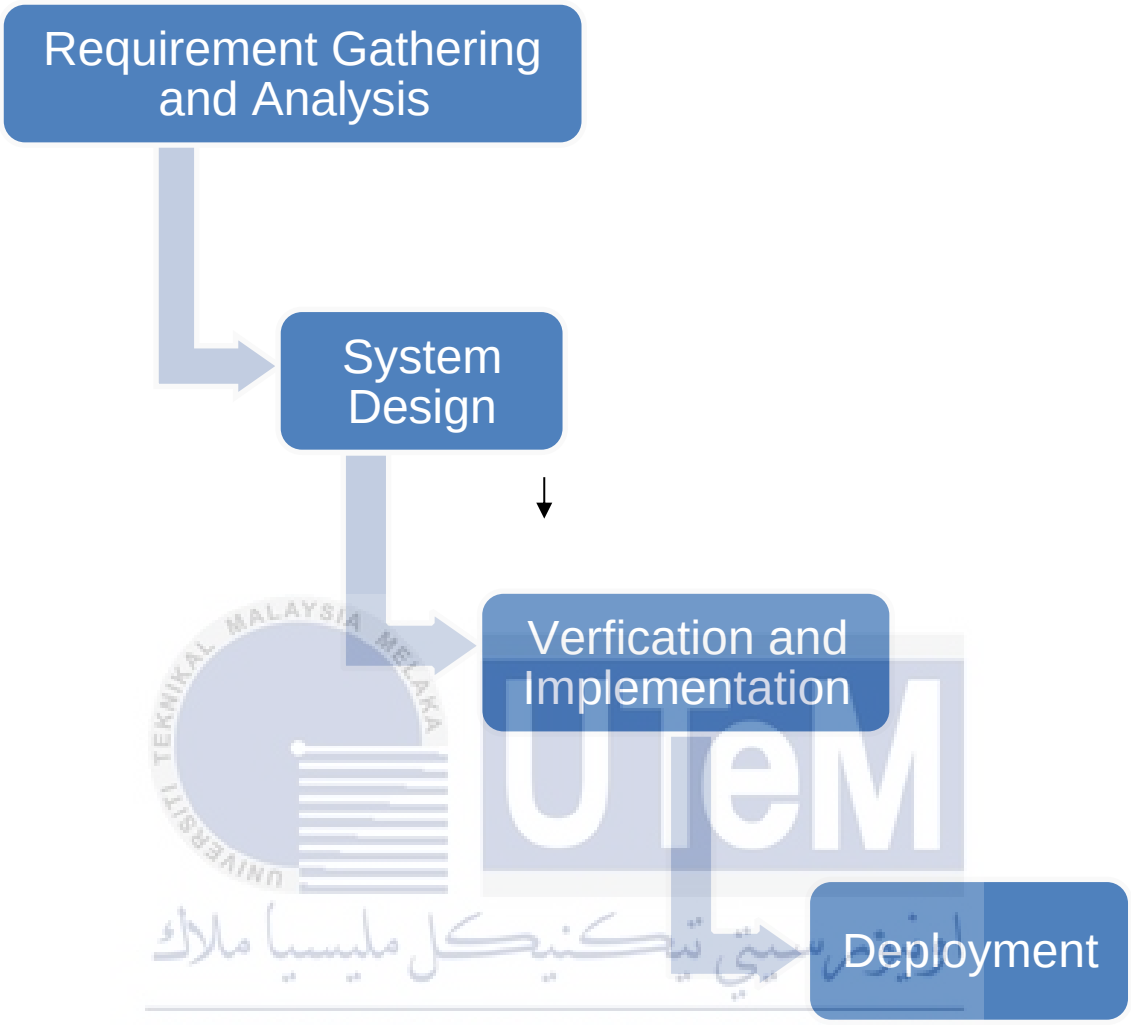


Figure 3.2.1 Waterfall Model

3.3 Requirement Planning Phase

During this phase, various literature analyses were carried out to aid in the creation of a new technique for monitoring power use. The proposed system is explained using an architecture diagram and a module description. The following is a list of everything that you will need to get started on this project.

Hardware:

i. Microcontroller

NodeMCU is an open-source platform based on the ESP8266 that allows things to be connected and data to be transferred using the Wi-Fi protocol. Furthermore, it may solve many of the project's demands on its own by providing some of the most important functionalities of microcontrollers such as GPIO, PWM, ADC, and so on.

The following are the general characteristics of this board:

- Has an internal antenna
- Has 13 GPIO pins, 10 PWM channels, I2C, SPI, ADC, UART, and 1-Wire
- Can be programmed with Arduino IDE or IUA languages
- Can be used as an access point or station
- Can be used in Event-driven API applications
- simple to use

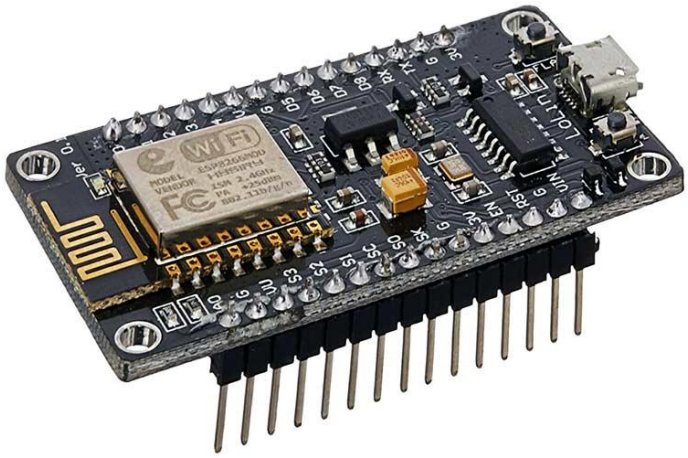


Figure 3.3.1 NodeMcuESP8266

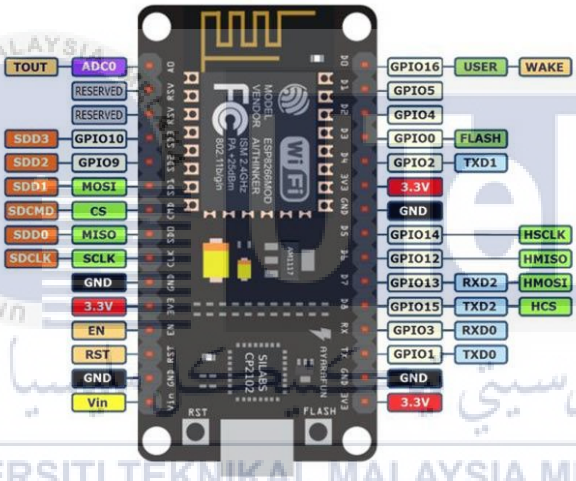


Figure 3.3.2 Pinout NodeMcuESP8266

ii. Current sensor ACS712

The ACS712 is a current sensor that can work in both AC and DC environments. This sensor runs on 5 volts and outputs an analog voltage proportionate to the current recorded. A collection of precision Hall sensors with copper lines make up this gadget.

When the current through the copper principal conduction line increases, the output of this instrument displays a positive slope (from pins 1 and 2 to pins 3 and 4). The conduction path's internal resistance is 1.2 m.

With an input current of 0A and a 5V Vcc power source, this sensor produces an output voltage of Vcc x 0.5 = 2.5. Based on the readable current range, there are three types: 5A, 20A, and 30A, with output sensitivity of 185mV / A, 100mV / A, and 66mV / A, respectively.

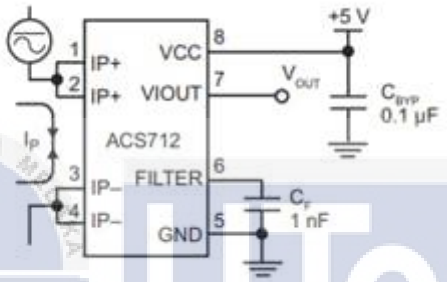


Figure 3.3.3 Pin IC of ACS 712

Figure 3.3.4 The working principle of the Hall effect on ACS712

iii. Load

The electric load is the device that consumes electrical energy. In other terms, an electrical load is a device that consumes electrical energy in the form of current and converts it into heat, light, work, and other types of energy. The electrical load could be resistive, inductive, capacitive, or a mix of the three.

Figure 3.3.5 Resistive load

iv. Mobile phone

In this project, the phone will be utilized as a mobile device that will be linked to the internet and notification application.

Figure 3.3.6 Mobile phone

v. Jumper wire

A jumper wire as in figure 3.3 is an electrical wire that has a connecting pin at each end. It is used to connect items on a breadboard for prototyping or circuit testing without the need for soldering. There are many colors and have 3 types of jumper wires namely male-to-male, male-to-female and female-to-female.

Figure 3.3.7 Jumper wire

vi. Breadboard

A breadboard is a solderless device used to prototype electronics and tests circuit designs temporarily. Most electronic components in electronic circuits can be connected by slipping their leads or terminals into the holes and connecting them with wires where necessary. Underneath the breadboard are metal strips that connect the holes on the top of the board.

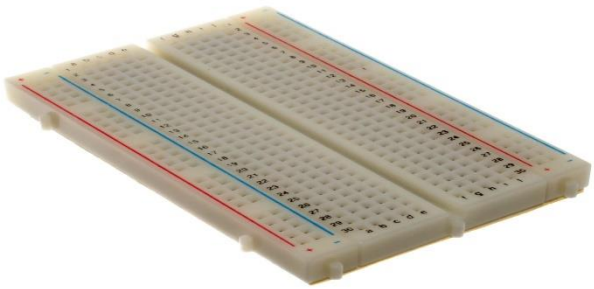


Figure 3.3.8 Breadboard

Software:

i. IDE MICROCONTROLLER

The IDE microcontroller application is an open-source program for writing and uploading code to several types of microcontroller boards. The Arduino IDE is an example of a commonly used IDE. Notification application.

ii. NOTIFICATION APPLICATION

Adafruit.io is a cloud service, which simply means that we handle it for you. You can get online and connect to it. It is primarily intended for data storage and retrieval.

3.4 System Design

In the system design phase, smart electricity energy meters are designed to satisfy the requirement identified during the requirement planning phase. This phase will assist in defining the overall system architecture and designing the project. Related diagrams such as Data Flow Chart diagram and functional diagram. The development of smart electricity energy meters has two categories which are hardware and software.

3.4.1 FLOW CHART

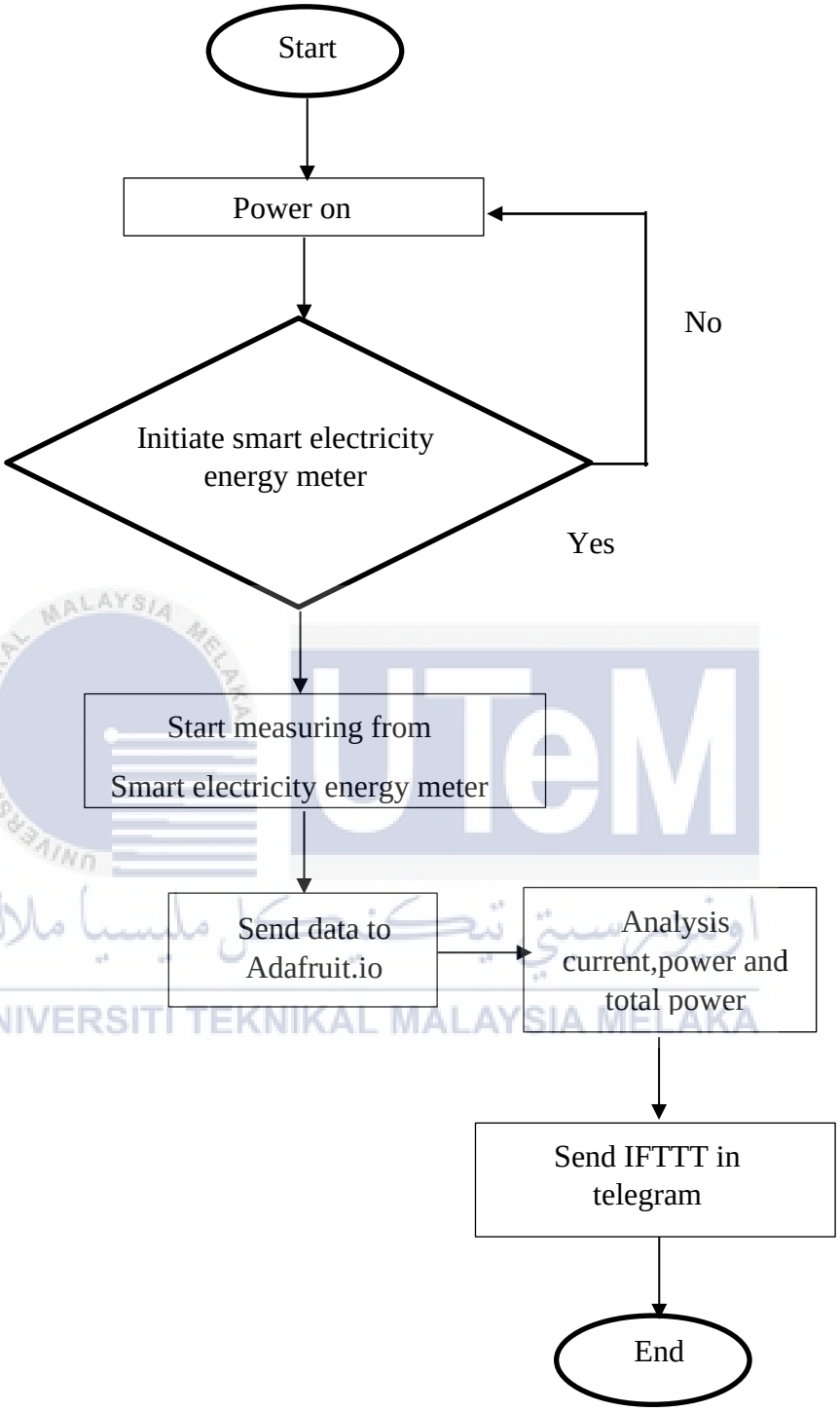


Figure 3.4.1 Flow chart

3.5 Implementation Phase

This implementation phase will begin after the system design phase is over. During the implementation phase, the current sensor ACS712 will be developed and completed. The programming code will be written the IDE for a suitable and compatible microcontroller. To achieve this project objective, three stages can be described namely input, process, and output. The designing process is illustrated by the block diagram below.

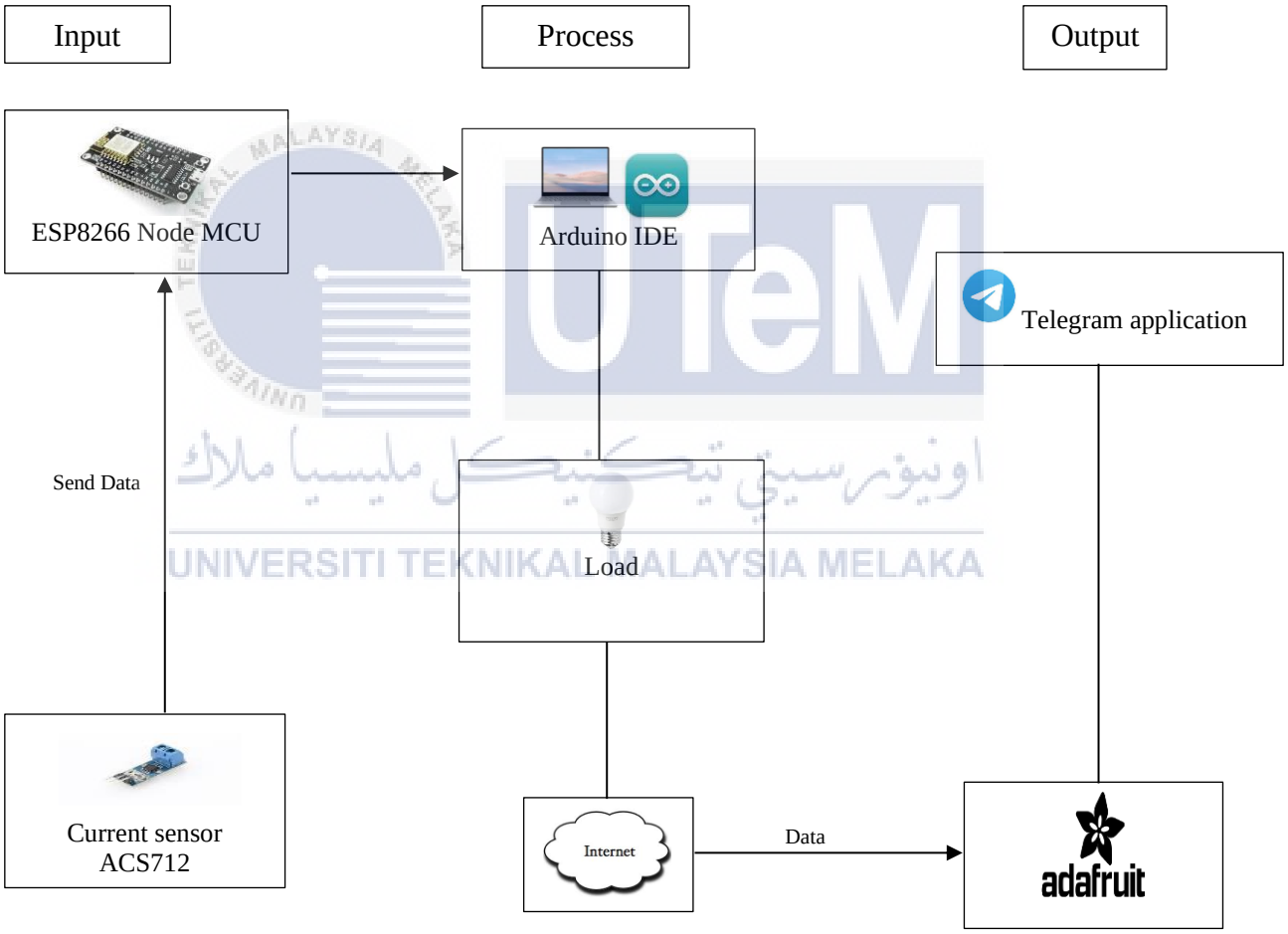


Figure 3.5.1 Block diagram smart electricity energy meter

3.6 Project Milestones

A milestone is a project marker that serves as a direction indicator during the project's duration. This milestone assists in keeping the project on track and highlights significant project accomplishments. This milestone allows the project to be run in order until it is completed. The diagram below shows a project milestone flow chart.

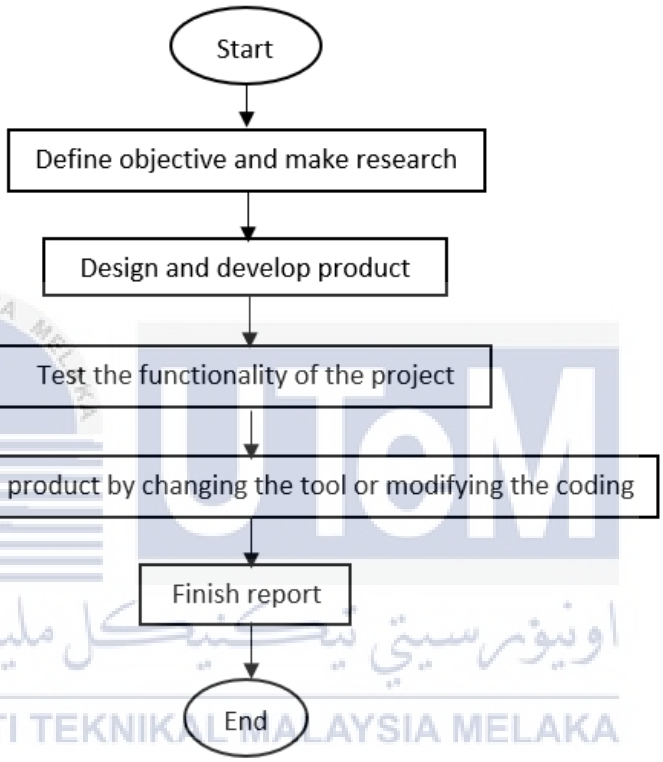


Figure 3.6.1 Project milestone

3.7 Summary

In summary, the methodology considerably aids project progress and ensures that the project is completed on time. A step-by-step analysis is also shown in this chapter. Project stages that are defined by the approach used can result in a great project. The linked project diagram is used to track the project's progress and ensure that it is completed according to the project timeline.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This project develops how to measure energy consumption in the household. This project will be implemented in the household. This project will be implemented using a microcontroller, current sensor ACS712, Adafruit, IFTT, and load.

4.1.1 Circuit Design

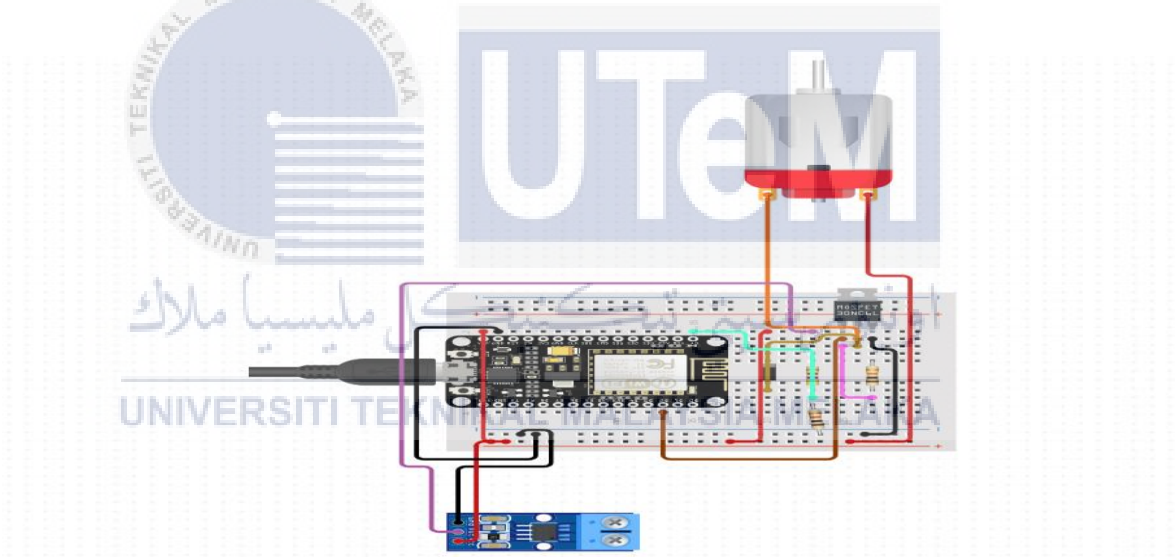


Figure 4.1.1 Circuit design

4.2 Project Environment Setup

The tasks involved in the implementation phase will be detailed, as well as the expected outputs after the implementation phase is completed. The steps of how to display data for energy consumption is controlled by Adafruit and send the message to the Telegram will also be discussed. This section explains the environment architecture and how the

hardware components for this project are connected. The connection of Node MCU ESP8266 environment, load, current sensor ACS712, Adafruit, IFTTT, Telegram Application environment, and Arduino IDE environment configuration were all done in phases.

4.2.1 Node MCU ESP8266 microcontroller Environment Setup

The Node MCU ESP8266 is a microcontroller that serves as the hub for all of the project's hardware connections. A USB connection to a personal computer or laptop is required to upload the source code to the Node MCU ESP8266.

4.2.2 Current Sensor ACS712

The current sensors ACS712 used in this project. ACS712 can be connected from its pin to a dedicated sensor pin on the Node MCU ESP8266 using a jumper wire.

4.2.3 Arduino IDE Environment Setup

The Arduino IDE software is used to run Arduino board microcontroller source code. The following is a step-by-step guide on setting up the Arduino IDE environment:

Step 1: Download the Arduino IDE software

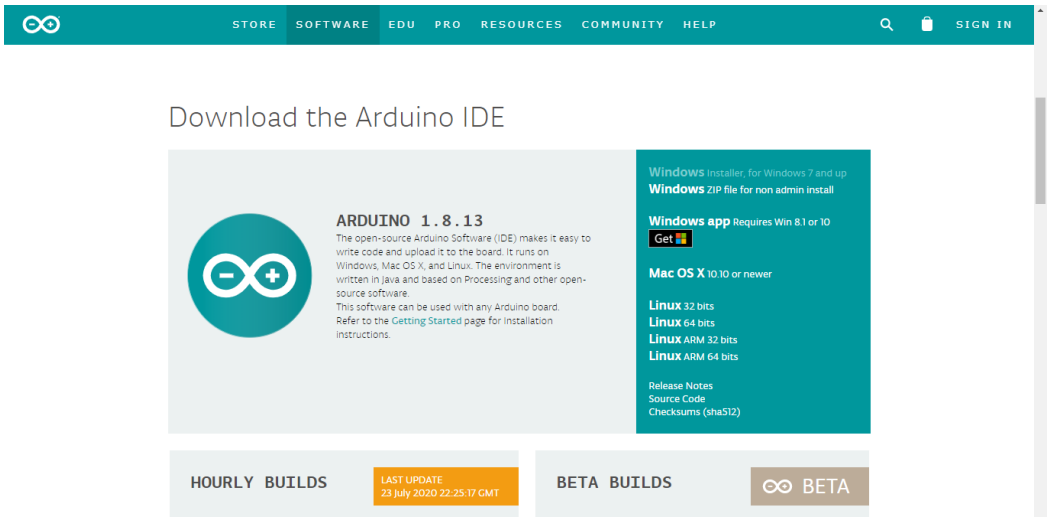


Figure 4.2.3.1 Download Arduino IDE

Step 2: Install and download the Arduino IDE installer.

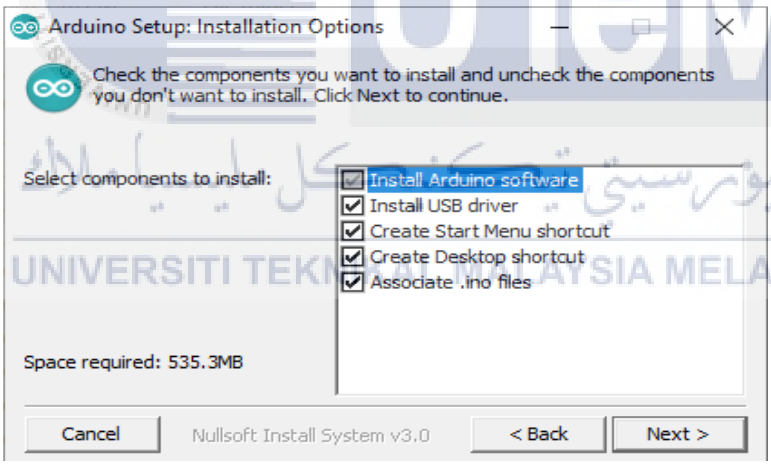


Figure 4.2.3.2 Installation options

Step 3: Run the Arduino IDE and the source code interface will be displayed for the implementation of source code for the microcontroller.

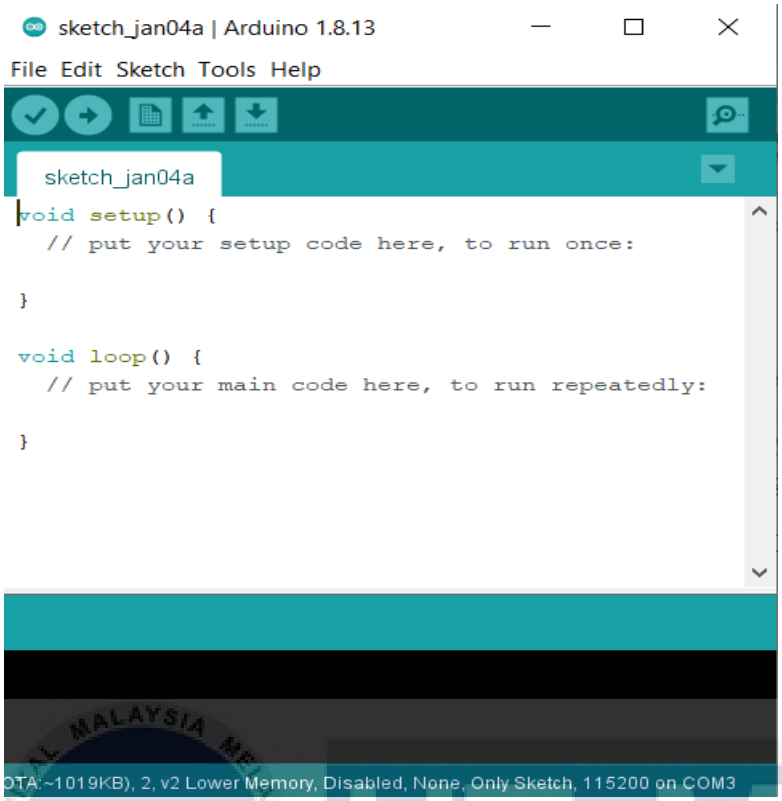


Figure 4.2.3.3 Arduino IDE interface

4.3 Project Configuration Management

This section will describe the configuration and the source code required to fulfill the prototype device function as proposed. The configuration of the software is divided into several stages which are the configuration of Current Sensor ACS712, Node MCU ESP8266, Ada Fruit, IFTTT, and Telegram Application.

4.3.1 Configuration Sensor

Declare variables and their datatype that will be used

```
ACS712  ACS(A0, 3.3, 1023, 100);
float cr;
float pwr;
float totalpwr;
int crcount;
```

Figure 4.3.1.1 Configuration sensor

4.3.2 Configuration of Node MCU ESP8266

Setup function (Connect to Adafruit.io)	`void setup() {`
	
	`  // start the serial connection`
	`  Serial.begin(115200);`
	
	`  // wait for serial monitor to open`
	`  while (! Serial);`

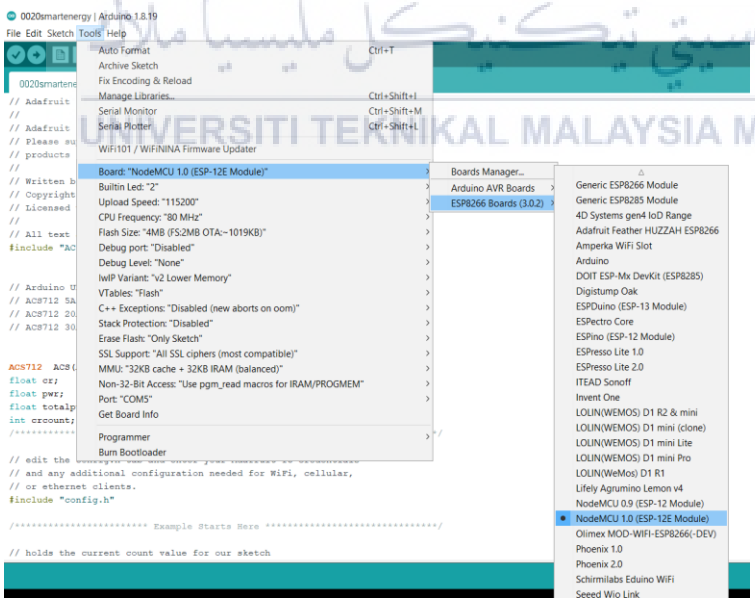
Load function (Send current, power, and total power that use)	`void loop() {`
	
	`  // process messages and keep connection alive`
	`  io.run();`
	`  currentget();`
	`  if (millis() > (lastUpdate + IO_LOOP_DELAY)) {`
	
	`  cr = cr / (crcount + 1);`
	`  pwr = cr / 1000 * 240;`
	`  totalpwr = totalpwr + pwr;`
	
	`  Serial.print("sending -> current ");`
	`  Serial.println(cr);`
	`  current->save(cr);`

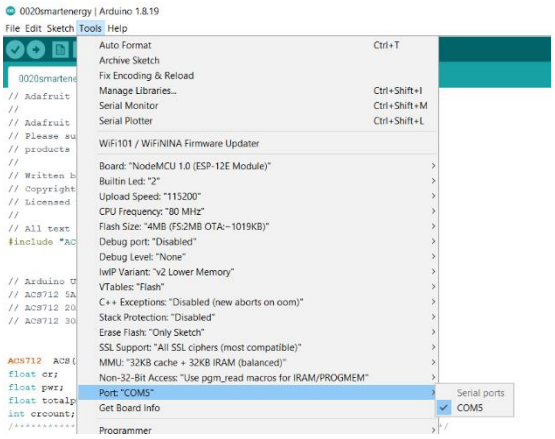
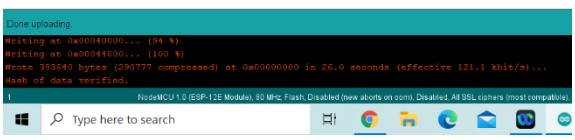
Include the ESP8266WiFi.h library to use the ESP8266 WiFi features and to let the	`// edit the config.h tab and enter your Adafruit IO credentials`
	`// and any additional configuration needed for WiFi, cellular,`
	`// or ethernet clients.`
	`#include "config.h"`

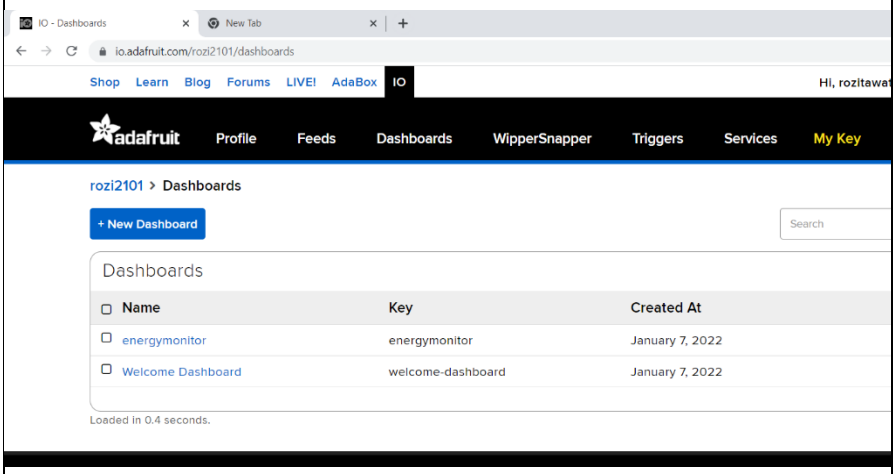
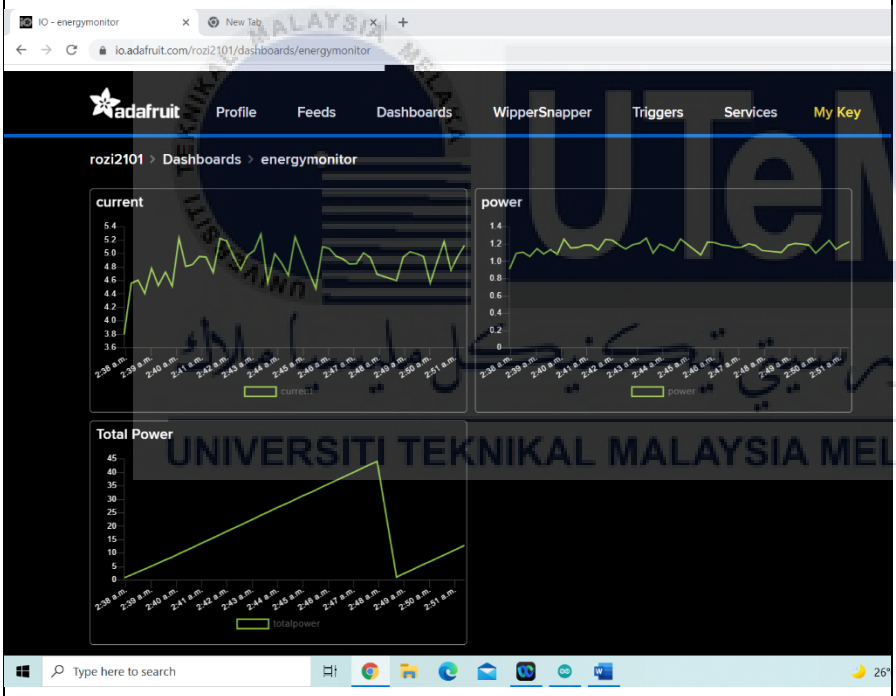
NodeMCU communicate with a WiFi connection.	
Initialize the WiFi connection by declaring the Wifi credentials that will be connected to the NodeMCU ESP8266.	`#define WIFI_SSID "qaicaneen"` `#define WIFI_PASS "pasaipa?"`

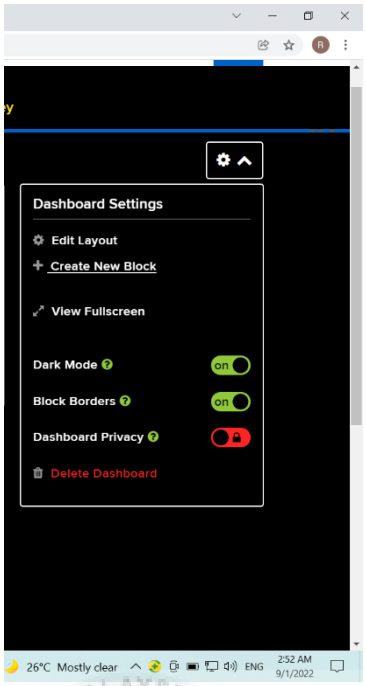
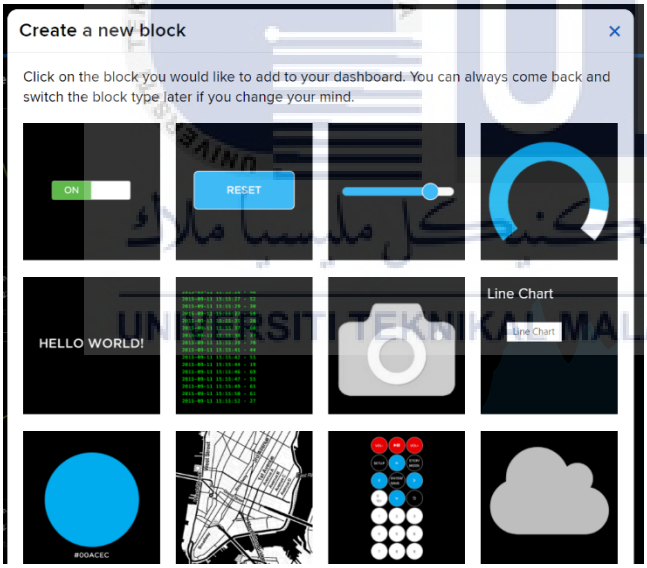
Table 4.3.3.1 Configuration of Node MCU ESP8266

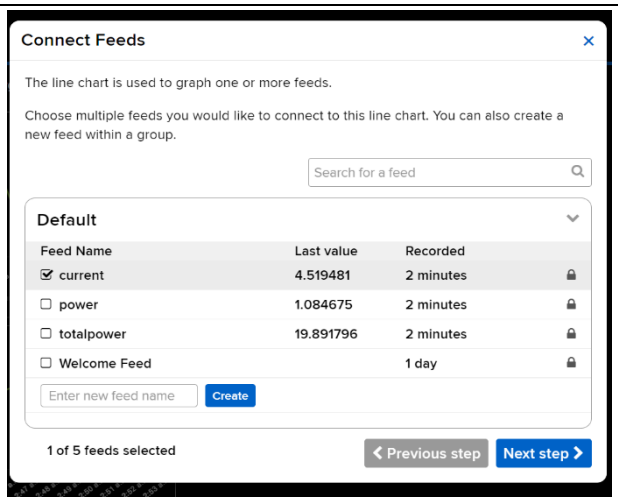
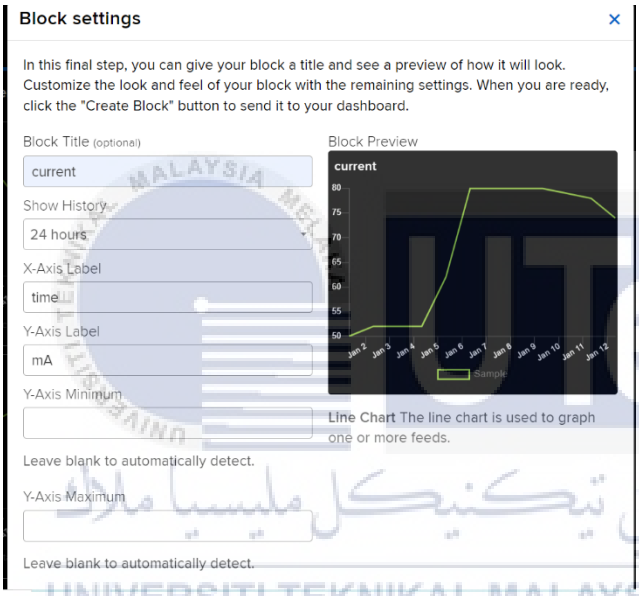
4.4 Result and Analysis

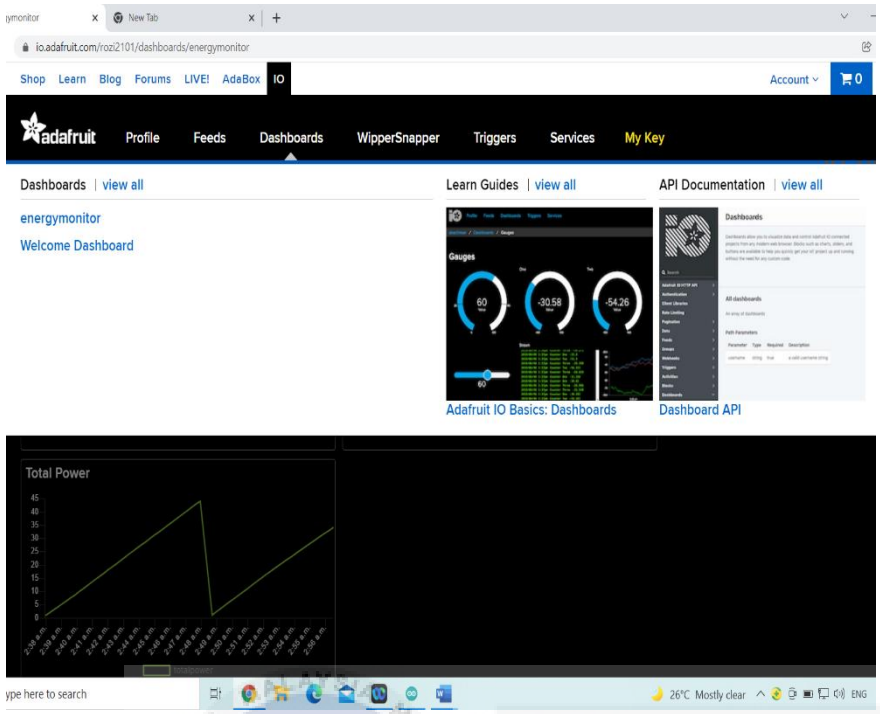
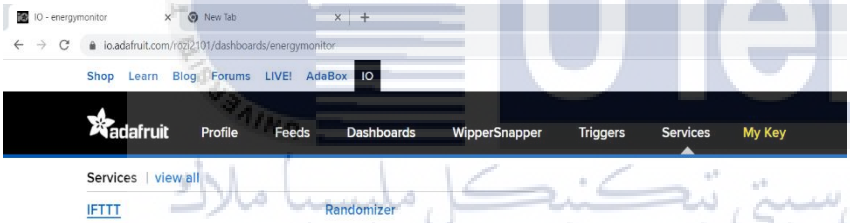
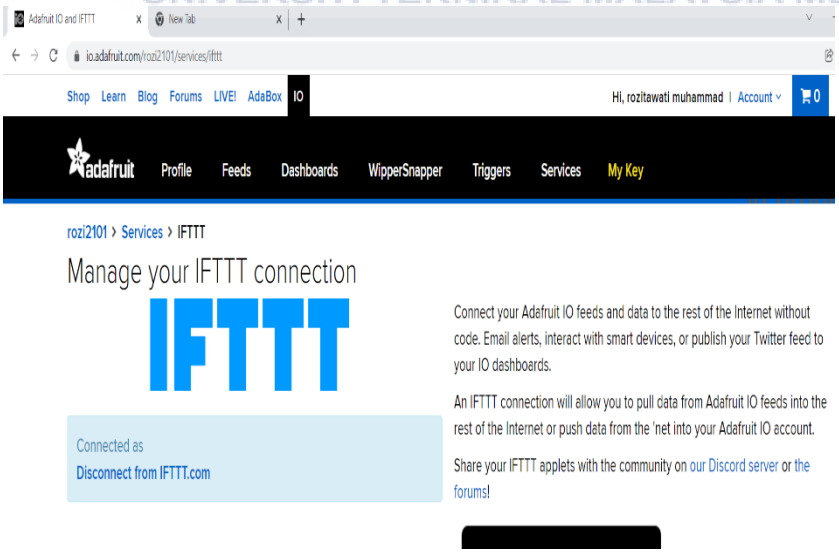
	Step 1: In the Arduino interface go to Tools – Board:"NodeMCU 1.0(ESP-12E Module)" – ESP8266 BOARDS(3.0.2) – NodeMCU 1.0(ESP-12E Module)

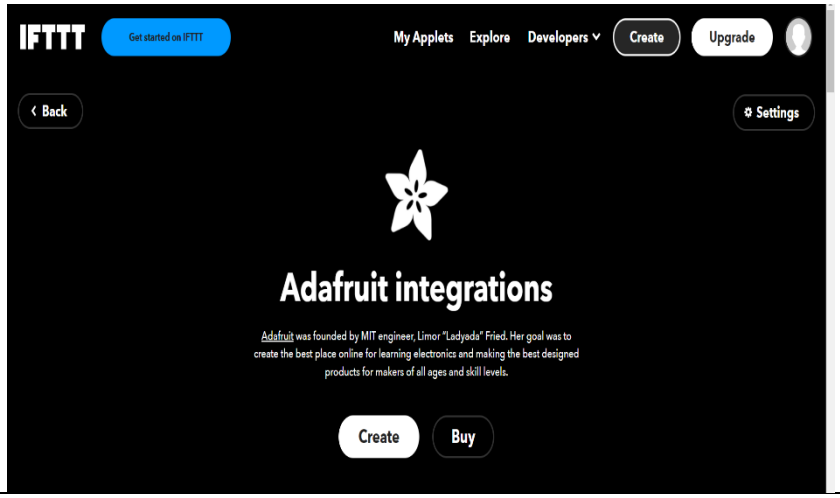
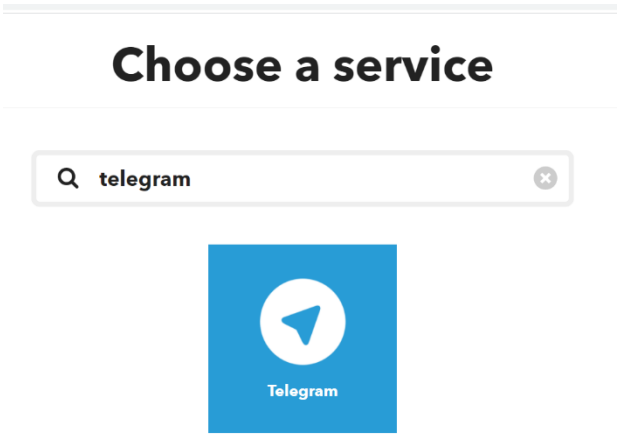
	Step 2: In the same interface click Tools – Port Com5 – COM5.
	Step 3: Click upload to finish the process
	Step 4: Wait until 100% to finish the process and go to the next step.
	Step 5: Finish the process (100%).

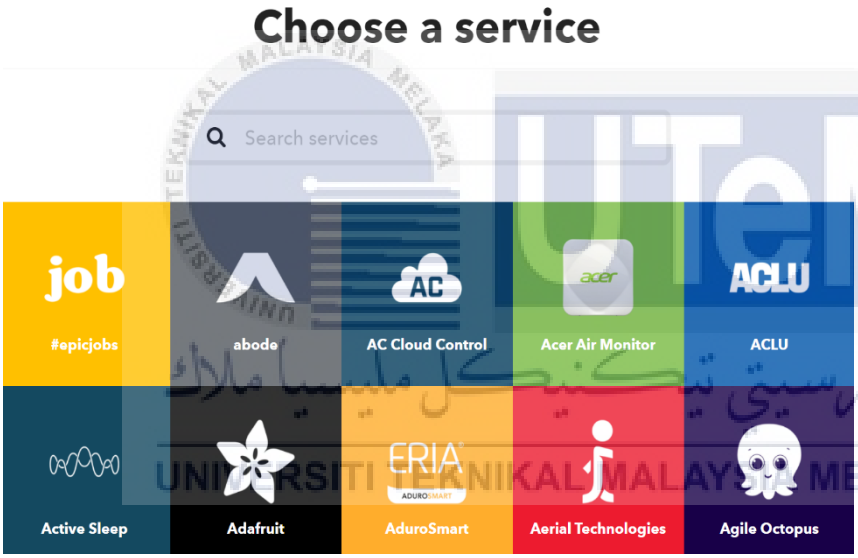
	Step 6: After finishing the upload, go to adafruit for the next step. In adafruit, we can create a new dashboard. In this picture rename the dashboard such as energy monitor.
	Step 7: After clicking the dashboard, we can see there is an analysis for the energy meter which is contain current, power, and total power that is used.

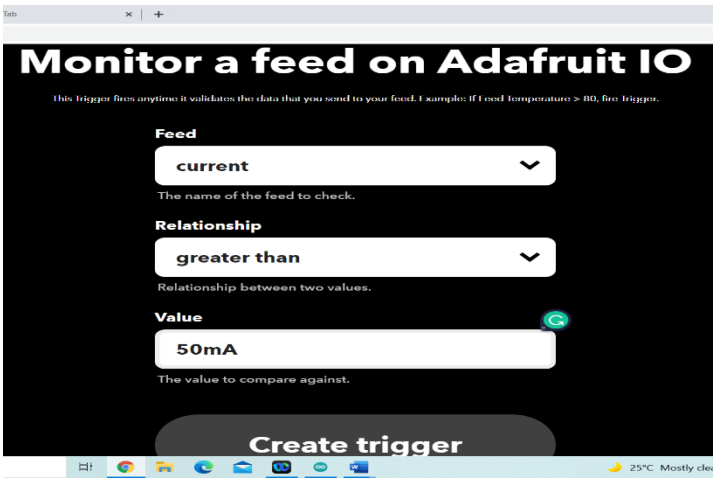
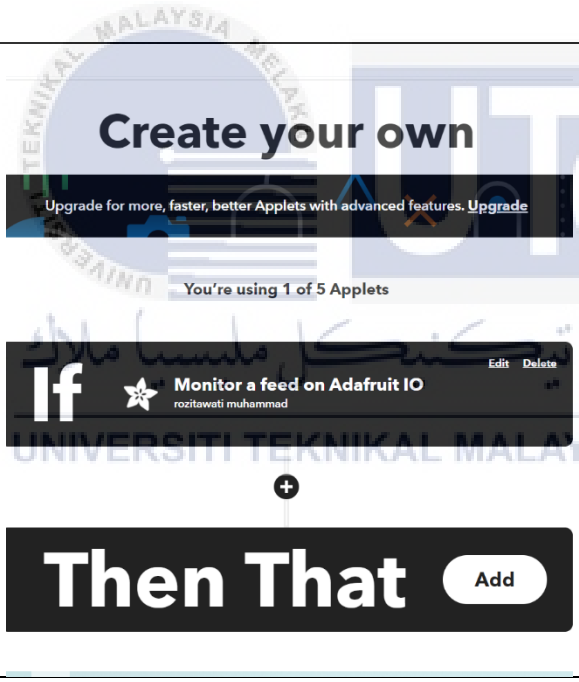
	Step 8: In the dashboard setting we can create a new block.
	Step 9: Click on the block you would like to add to your dashboard. I choose a line chart and go to the next step.

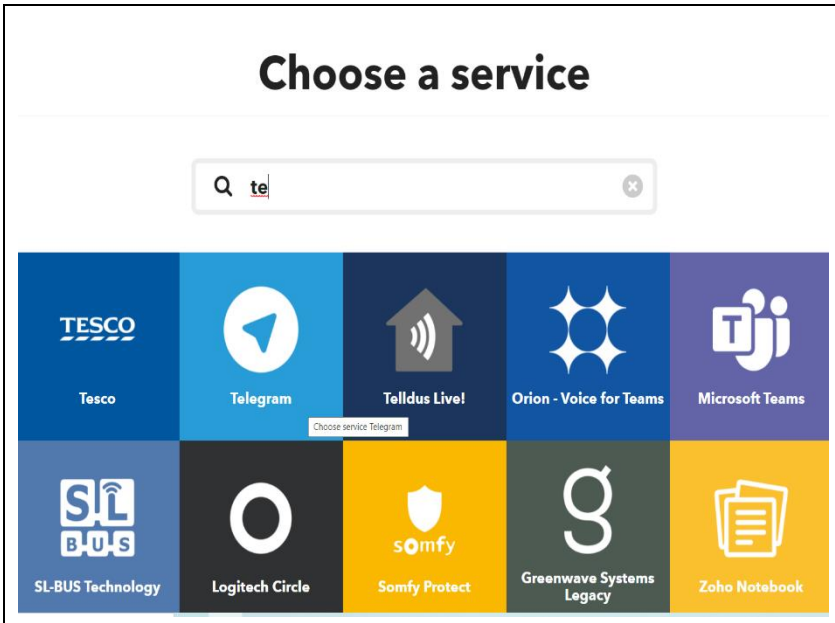
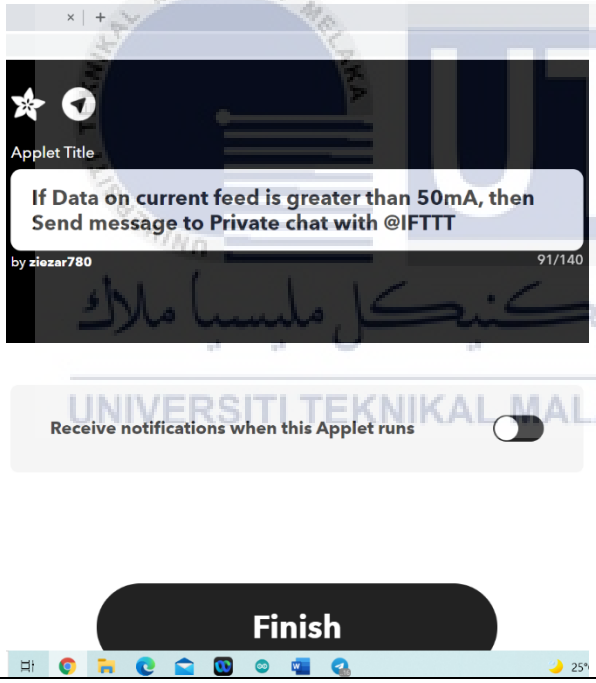
	Step 10: After choosing the block, tick at the feed name then go to the next step.
	Step 11: In block settings, write down block title, X-Axis Label, and Y-Axis Label

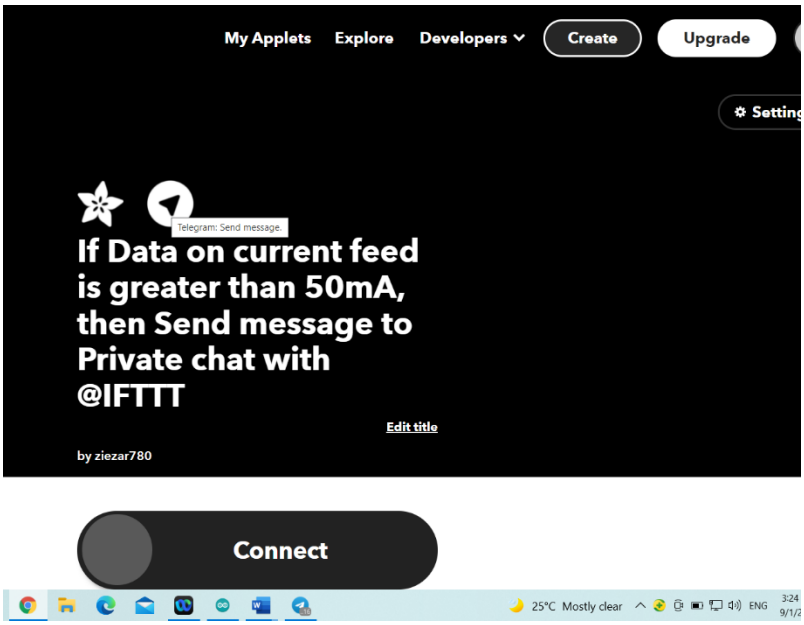
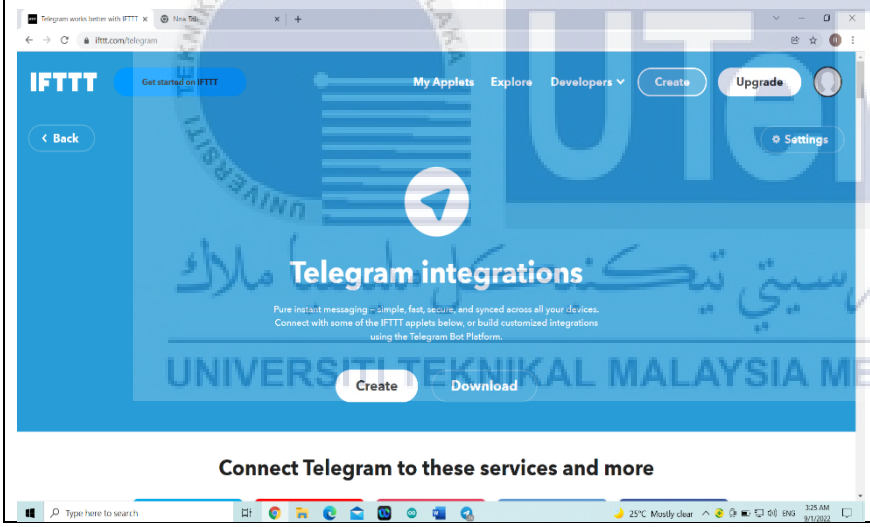
	Step 12: After finishing in block settings, we can see the display on the dashboards.
	Step 13: Click the services and select IFTTT
	Step 14: In this part, we must manage our IFTTT connection

	Step 15: In Adafruit integrations click create.
	Step 16: Create your applets. Click if this and add.
	Step 17: Choose the service. The service that we use is a telegram.

	Step 18: In telegram display, click new message with key phrase to @IFTTT
	Step 19: Choose the Adafruit.

	Step 20: In the monitor, a feed on Adafruit IO, choose feed, relationship, and value. After that click trigger.
	Step 21: Click than that for the next process.

	Step 22: Choose a service that is telegram.
	Step 23: In the applet title, we can put the title which represents the message.

	Step 24: Click connect
	Step 25: Connect telegram to the IFTTT

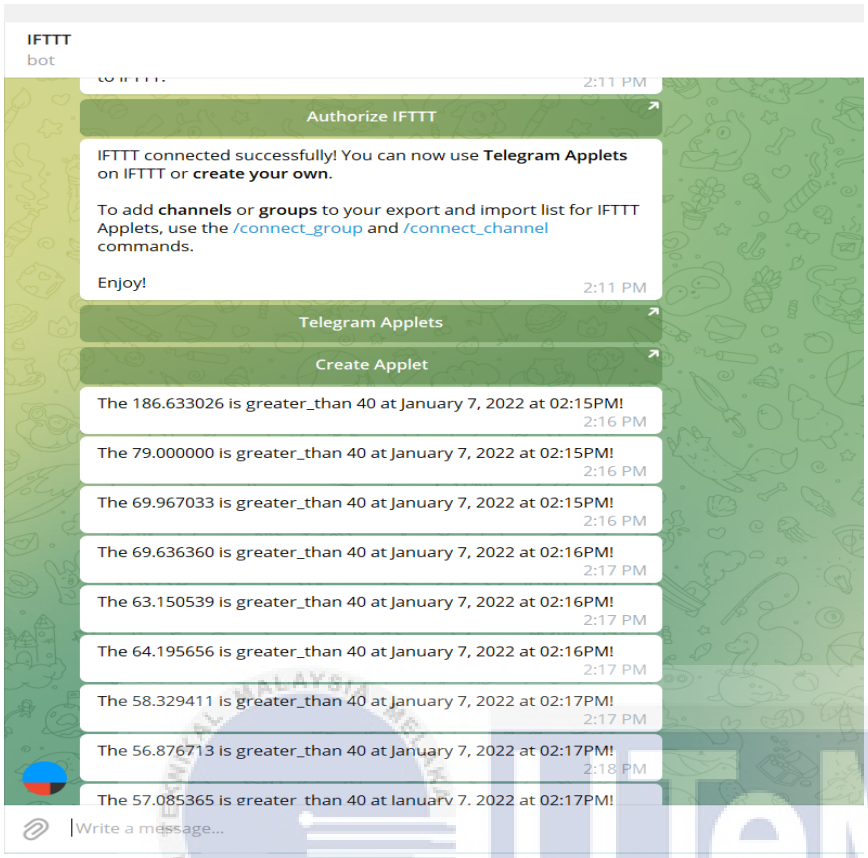
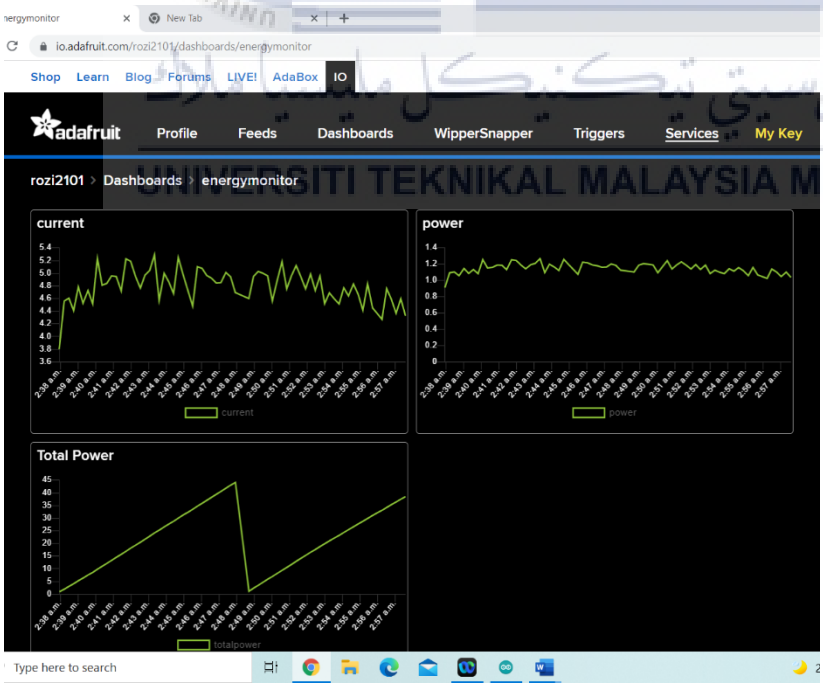
	Step 26: Telegram Applets on IFTTT.
	- There are analysis from the Ada fruit.io - In this analysis we can measure current, power and total power.

Table 4.4.1 Result and Analysis

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This chapter offers a project summary that outlines how the project objectives were met and what information was used to implement and test the project. In this chapter, the project contribution will be described to show how we measure current, power and total power consumption in the household using microcontrollers and IoT. The project's limitations and future work are also discussed in this chapter to increase the project's reliability, efficiency, and effectiveness.

5.2 Project Summarization

This project is about the development of current consumption that integrates the Node MCU ESP8266 microcontroller board and the Current Sensor ACS712. The project consists of Arduino software that can show current consumption that is used in ha households. The project is also connected to the Telegram app. So, users can measure how many current consumptions that they use every day in the household.

The first objective of the project, which is the development of monitoring power consumption in the household is achieved. This objective is achieved by designing a smart electricity energy meter using a microcontroller, current sensor ACS712, Arduino, Ada fruit, and Telegram app that can measure current, power, and total power. The second objective is to produce energy-saving electrical devices that users need. This objective has been achieved because users can monitor current, power, and total using Ada fruit. Ada fruit.io is used in real-time and display all of the data that customer need. Ada fruit.io can connect the

projects to web services like Telegram, Twitter, RSS feeds, weather forecasting, and so on. The third objective is to analyze the power consumption to adjust the usage and help in lowering the electricity bill. Consumers can track their usage of current, power, and overall power over time. If their monthly expenses are rising, they can save money by turning off the light when they are not using it.

The conclusion of this project is to develop a smart electricity energy meter that uses a Node MCU microcontroller and current sensor ACS712 to measure current, power and power consumption. A message will be displayed by telegram if consumer use of an electrical appliance exceeds its capacity. This project achieves all of the goals outlined in Chapter 1. Hopefully, this project will assist all users and academics who are working with microcontrollers and sensor technology.

REFERENCES

[1] Yi-Tui Chen, *Article the Factors Affecting Electricity Consumption and the Consumption Characteristics in the Residential Sector* - A case example of Taiwan

[2] Peng Jiang, [a] Yee Van Fan,[b] and Jiří Jaromír Klemeš[b,*] *Impacts of COVID-19 on energy demand and consumption: Challenges, lessons, and emerging opportunities*

[3] Md.Sadequr Rahman Bhuiyan, *Design and implementation of remotely located energy meter monitoring with load control and mobile billing system through GSM*, February 2017

[4] Hossain, Md.Rakib, Habib, Md. Ahsan, Setu, Sadia Afrin, Smart IoT Based Energy Saver Home Automation System by Measuring Relative Distance and Power Consumption,2019

[5] Korakot Luechaphonthara, IoT based application for monitoring electricity power consumption in home appliances, December 2019

[6] Article Hourly energy profile determination technique from monthly energy bills, 14 August 2020

[7] The issue, No. 16 (2017): Occupant behavior and energy consumption in dwellings, Published 23.1.2017

[8] Journal of Engineering Science and Technology Vol. 12, No. 5 (2017) 1280 - 1294 © School of Engineering, Taylor's University, AWARENESS ON ENERGY MANAGEMENT IN RESIDENTIAL BUILDINGS.

[9] Article HEMS-IoT: A Big Data and Machine Learning-Based Smart Home System for Energy Saving; Published: 2 March 2020

[10] Short Paper—The Application of Wireless Communication in IOT for Saving Electrical Energy, iJIM – Vol. 14, No. 1, 2020

[11] Patrizio Primiceri and Paolo Visconti Department of Innovation Engineering, University of Salento, Street for Monteroni, Lecce, Italy SOLAR-POWERED LED-BASED LIGHTING FACILITIES, VOL. 12, NO. 1, JANUARY 2017

[12] Ilze Laicane*, Dagnija Blumberga, Andra Blumberga, Marika Rosa, Evaluation of Household electricity savings. Analysis of household electricity demand profile and user activities

APPENDICES

SOURCE CODE FOR ARDUINO IDE

```
// All text above must be included in any redistribution.
#include "ACS712.h"


// Arduino UNO has 5.0 volt with a max ADC value of 1023 steps
// ACS712 5A  uses 185 mV per A
// ACS712 20A uses 100 mV per A
// ACS712 30A uses  66 mV per A


ACS712  ACS(A0, 3.3, 1023, 100);
float cr;
float pwr;
float totalpwr;
int crcount;
/************************** Configuration
************************************/

// edit the config.h tab and enter your Adafruit IO credentials
// and any additional configuration needed for WiFi, cellular,
// or ethernet clients.
#include "config.h"

/************************ Example Starts Here
*******************************/

// holds the current count value for our sketch
int count = 0;
// holds the boolean (true/false) state of the light
bool is_on = false;

// track time of last published messages and limit feed->save events to once
// every IO_LOOP_DELAY milliseconds
#define IO_LOOP_DELAY 15000
unsigned long lastUpdate;

AdafruitIO_Feed *current = io.feed("current");
AdafruitIO_Feed *power = io.feed("power");
AdafruitIO_Feed *totalpower = io.feed("totalpower");

void setup() {

  // start the serial connection
  Serial.begin(115200);
```

```
  // wait for serial monitor to open
  while (! Serial);

  Serial.print("Connecting to Adafruit IO");

  // connect to io.adafruit.com
  io.connect();


  // wait for a connection
  while (io.status() < AIO_CONNECTED) {
    Serial.print(".");
    delay(500);
  }

  // we are connected
  Serial.println();
  Serial.println(io.statusText());

  ACS.autoMidPoint();
}

void loop() {

  // process messages and keep connection alive
  io.run();
  currentget();
  if (millis() > (lastUpdate + IO_LOOP_DELAY)) {

    cr = cr / (crcount + 1);
    pwr = cr / 1000 * 240;
    totalpwr = totalpwr + pwr;

    Serial.print("sending -> current ");
    Serial.println(cr);
    current->save(cr);

    Serial.print("sending -> power ");
    Serial.println(pwr);
    power->save(pwr);

    Serial.print("sending -> totalpower ");
    Serial.println(totalpwr);
    totalpower->save(totalpwr);

    lastUpdate = millis();
    cr = 0;
    crcount = 0;
```

```
  }

}
void currentget() {
  int mA = ACS.mA_AC();
  if (mA != 0) {
    cr = cr + mA;
    crcount += 1;
    Serial.print("mA: ");
    Serial.print(mA);
  }



}
```