



**Faculty of Electrical and Electronic Engineering Technology**



**DEVELOPMENT OF INTERNET OF THINGS-BASED SMART  
ELECTRICITY HOME MONITORING SYSTEM USING ARDUINO**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DOMINIC LAADE**

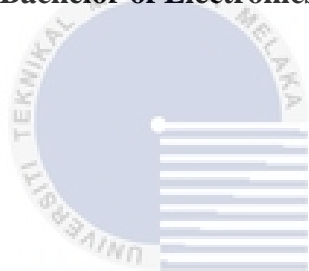
**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours**

**2022**

**DEVELOPMENT OF INTERNET OF THINGS-BASED SMART ELECTRICITY  
HOME MONITORING SYSTEM USING ARDUINO**

**DOMINIC LAADE**

**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**

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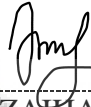
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## APPROVAL

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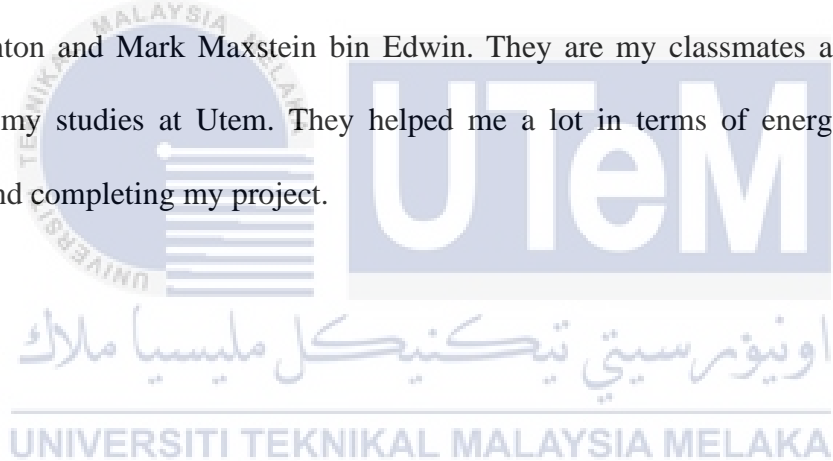
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## DEDICATION

I dedicate this thesis mainly to my supervisor, Ts. Zaihasraf Bin Zakaria who has helped me a lot to solve many questions about theory and simulations that I run on Universiti Teknikal Malaysia Melaka. I also want to remember my father who has helped me financially and emotionally to make this project a success. He never gave up giving me words of encouragement to me besides my mother no less great giving me advice. They are the people who give me the most encouragement. To my beloved father, may you find peace and happiness in Heaven. Finally, I dedicate this to my friends Addrian Thanasugang anak Douglas Anton and Mark Maxstein bin Edwin. They are my classmates and roommates throughout my studies at Utem. They helped me a lot in terms of energy and time in preparing and completing my project.



## ABSTRACT

In recent years, the very rapid development of technology around the world has brought us to an era where the use of electricity is indeed very much needed by the whole society. Electricity seems to have become one of the basic needs in the life of society like water where it is very necessary in all things. As we have seen in industry, electrically powered machines help humans to do jobs that are beyond human capabilities such as the use of conveyors that move heavy goods from one place to another. Similarly, the same concept is applied in our homes, most of our home appliances in the house on average use electrical energy to function such as lights, fans, air conditioner units, ovens, refrigerators, and many more. As a result, our dependence on electricity and its complex production methods has resulted in the value of electricity consumption increasing every year. If we do not practice the concept of energy saving at home, we will definitely pay very expensive bills every month. Therefore, smart electricity home monitoring system will help us in saving electricity consumption at home by utilizing Internet of Things (IoT) technology that can reduce manual monitoring and control. We can track and control every use of electrical goods that are in our homes by simply using a cell phone. For examples, when we go to work early in the morning and forget to turn off the garage lights, instead of going back home we can actually turn them off using only a cell phone. In a nutshell, this project focuses on producing a tool that can show daily usage rates so that we can monitor early on without waiting for a billing statement from a power distributor that will come out at the end of the month only.

## ***ABSTRAK***

Sejak kebelakangan ini, perkembangan teknologi yang pesat di seluruh dunia membawa kita ke era dimana penggunaan tenaga elektrik sememangnya sangat diperlukan oleh seluruh masyarakat. Tenaga elektrik ini ibarat sudah menjadi salah satu keperluan asas dalam kehidupan masyarakat layaknya seperti air dimana ianya sangat diperlukan dalam segala hal. Seperti yang kita lihat dalam industri, mesin yang dihidupkan oleh elektrik membantu manusia untuk melakukan pekerjaan yang di luar kemampuan manusia seperti penggunaan konveyor yang memindahkan barang berat dari suatu tempat ke yang lain. Begitu juga konsep yang sama diterapkan di rumah kita, kebanyakan peralatan rumah kita di rumah rata-rata menggunakan tenaga elektrik untuk berfungsi seperti lampu, kipas, penghawa dingin, ketuhar, peti sejuk dan lain-lain lagi. Hasilnya, kebergantungan kita terhadap tenaga elektrik ini serta cara penghasilannya yang rumit mengakibatkan nilai harga penggunaan elektrik semakin meningkat setiap tahun. Jika kita tidak mengamalkan konsep jimat tenaga di rumah sudah pasti kita akan membayar bil yang sangat mahal setiap bulan. Oleh itu, sistem pemantauan rumah elektrik pintar akan membantu kita dalam penjimatan penggunaan elektrik di rumah dengan memanfaatkan teknologi Internet of Thing (IoT) yang dapat mengurangkan pemantauan dan pengawalan secara manual. Kita boleh mengesan dan mengawal setiap penggunaan barang elektrik yang berada di rumah kita dengan hanya menggunakan telefon bimbit. Secara ringkasnya, projek ini fokus dalam menghasilkan sebuah alat yang dapat menunjukkan kadar penggunaan harian supaya kita dapat memantau dengan awal tanpa menunggu penyata bil dari pihak pengedar kuasa elektrik yang akan keluar pada hujung bulan sahaja.



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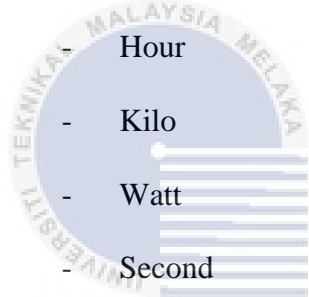
## LIST OF SYMBOLS

×	-	Multiplication sign
Ω	-	Ohm
%	-	Pencent



## LIST OF ABBREVIATIONS

V	-	Voltage
I	-	Current
P	-	Power
E	-	Energy
t	-	Time
A	-	Ampere
s	-	Second
h	-	Hour
k	-	Kilo
W	-	Watt
s	-	Second
kWh	-	KiloWatt hour



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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

The existing utility system only provides feedback at the end of the month in the form of a bill or the recent energy meter in Malaysia, which displays power consumption over a period of time. This bill or unit on the meter, as the case may be, is usually from the electricity supplier such as Tenaga Nasional Berhad (TNB). A consumer has no way to track their power usage on a more immediate basis. To that effect, a smart home energy monitoring and automation system is therefore developed to provide a clear picture of a home's energy usage. The information obtainable from the proposed device can be used by the user to optimize their energy usage. In addition, it also helps user to control some home appliance usage by turning on and off home appliances based on their electricity consumption cost through a mobile app to reduce electricity consumption and minimize energy waste.

### 1.2 Problem Statement

In our country Malaysia, each state has electricity prices and tariffs for domestic consumers that are different from each other. For example, prices and tariffs in Sarawak are relatively cheaper compared to Sabah and the states in the Peninsula Malaysia because the rate of electricity generation in Sarawak is higher than demand. This situation poses a great challenge in analyzing the usage rate that will be processed by the device later.

### 1.3 Project Objective

The main aim of this project is to design and construct a cost effective and efficient energy monitoring which provides a feature that can provide a lot of information on the use of electricity so that users are more aware of the electricity consumption. To achieve this goal, the project focuses on the following objectives as follows:

- a) To design a centralized system that can control and manage the electrical load appliances at home by using smartphone
- b) To develop a system that can monitor the consumption of electricity anytime and anywhere with the access of internet.
- c) To design a system that can help to minimize energy waste at home.

### 1.4 Scope of Project

This project aims to develop and study a smart home energy monitoring and automation system. The power monitoring system consists of a data acquisition device, a user interface to be viewed on a smartphone. Home automation, on the other hand consists of a centralized control system that can be used to control and turn off all connected home appliances. Power and energy consumption data will be collected from distribution boards at home and the project is used as data acquisition hardware. The project requires specific software and programs to design a comprehensive graphical user interface and to build an organized data center. The scope of the project also covers wireless communication, as data obtained from project devices will be sent wirelessly to a smartphone to be viewed and also managed. Furthermore, the project requires planning, design, problem solving and problem solving to achieve its objectives.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In general, the rate of electricity consumption in the home actually depends on many factors such as from the electrical device itself that consumes a lot of electricity to operate to even including our own negligence factors. In line with the rapid development of technology, the concept and also the interest in smart home technology and Internet of Thing (IoT) has created a wide opportunity to conduct a comprehensive literature review on electricity home monitoring. In this chapter will discuss the studies of smart home technology concept in terms of monitoring and management of electricity, main motives and applications as well as other relevant information.

#### 2.2 Internet of Thing (IoT)

Internet of Things (IoT) technology is a current internet connection for connection and communication between different devices. This equipment is very helpful and simplifies human life because it can control a system that is connected remotely which is also leads to energy management where we can control our appliance at home. Previously, there are several studies that have been done related to home automation systems where the paper presents the design and implementation of a prototype of a centralized control system using Wi-Fi technology as a network infrastructure.

Several projects have been done using the concept of the Internet of Things such as IoT based home automation system over the cloud written by Shahzeb Hussain [1]. This project focuses on controlling every home appliance that is connected to the system using

only a smartphone. Among the features that are introduced is the ability of the system to warn and alert users if they forget to turn off the switch when not at home. If there is a weak internet connection around, the system will automatically find and connect the connection with the stronger internet. The whole system is indeed 100% dependent on the internet to communicate with users as shown in figure 2.1.

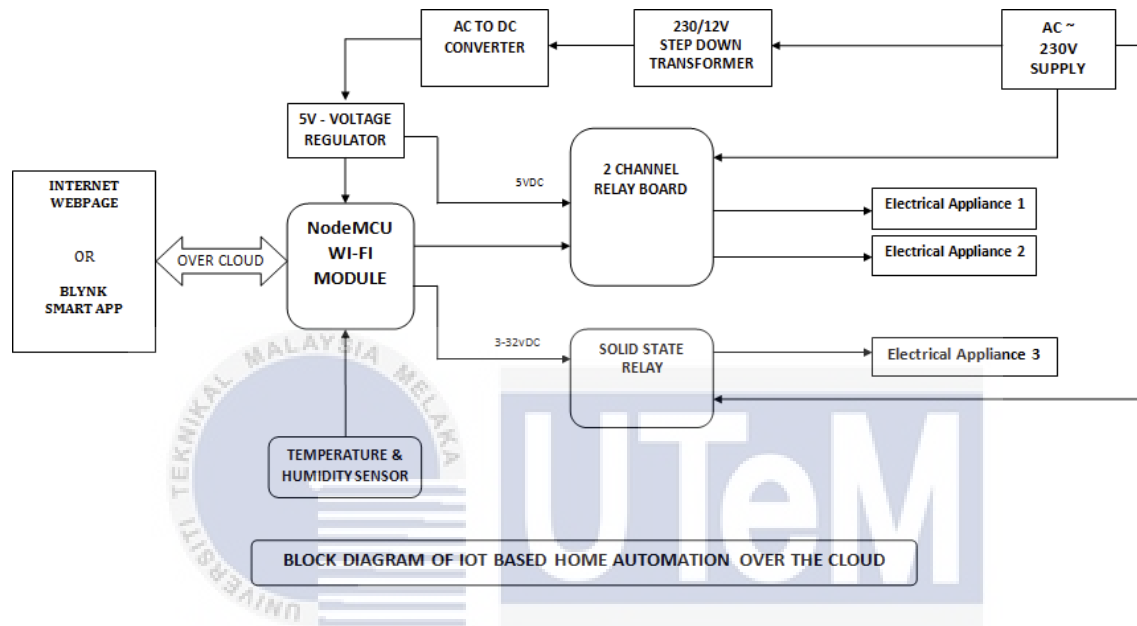


Figure 2.1 System Block Diagram of Based Home Automation Over The Cloud

The next research is entitled Internet of Things-Based Smart Electricity Monitoring and Control System Using Data Usage conducted by Mohammad Kamrul Hasan, Musse Mohamud Ahmed, Bishwajeet Pandey, Hardik Gohel, Shayla Islam, and Izzul Fitrie Khalid[2]. This research focuses on helping consumers save electricity consumption by using the concept of IoT where a centralized system that will connect to a smartphone via an internet connection as shown in Figure 2.2. With this, users can control every electrical appliance in the house using only a smartphone. In addition to controlling, users can also check the rate of electricity consumption at home using this system.

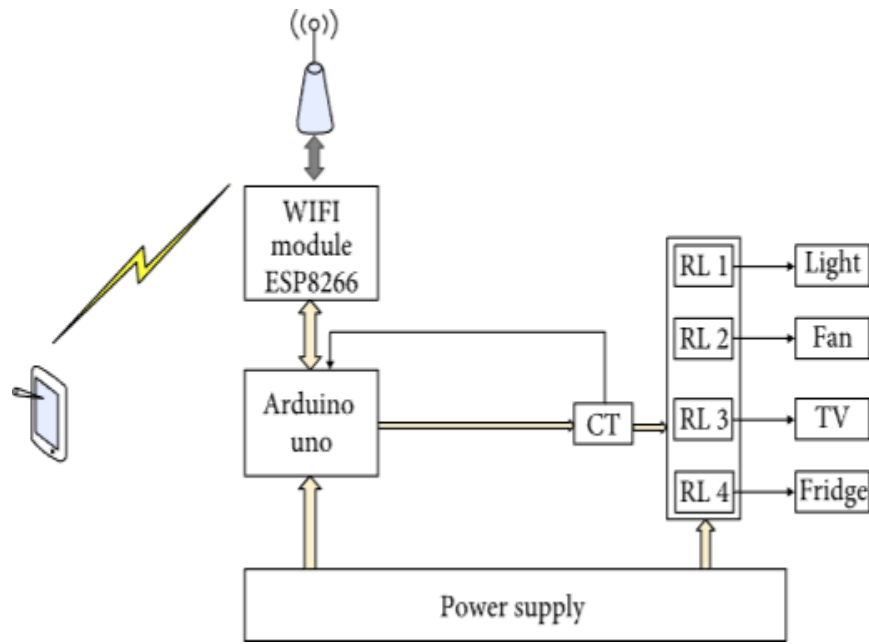


Figure 2.2 System Block Diagram of IoT-Based Control

### 2.3 Energy Monitoring

In general, although electricity suppliers place a meter in each of our homes, only a few know how to use the meter to monitor and control electricity consumption. This is because this process involves manual calculations using data obtained from the meter so that we can value the current electricity consumption rate. So, the existence of a suitable technology is a solution that can help every consumer control, manage and record their home electricity consumption, so that they can be aware and act earlier to apply the concept of saving electricity.

Research on the development of energy monitoring systems using WiFi technology and the Internet of Things (IoT) was conducted by Mohamed Hadi Habaebi, Qazi Mamoon Ashraf, Amir Alif Bin Azman, and Md. Rafiqul Islam[3]. In this research, a study on technological communication devices used in Home Energy Monitoring System (HEMS) applications was conducted to monitor energy consumption in deep sleep mode. The results

of the study showed an increase of 0.3W in each cycle and an average power dissipation of less than 0.1W/s by referring figure 2.2 and figure 2.3.

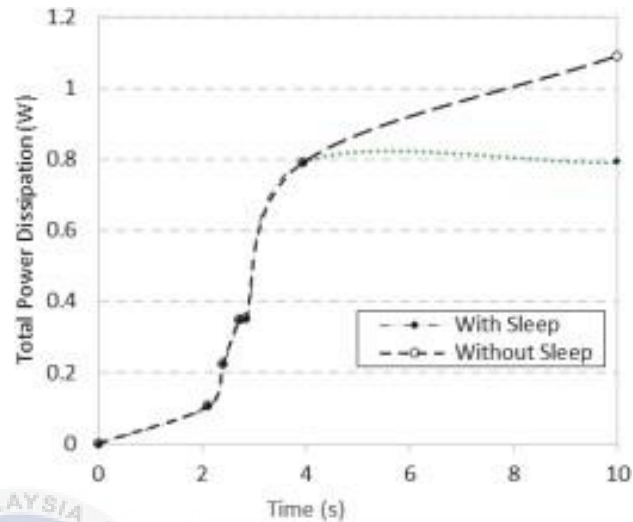


Figure 2.3 Comparison of power consumption with and without sleep

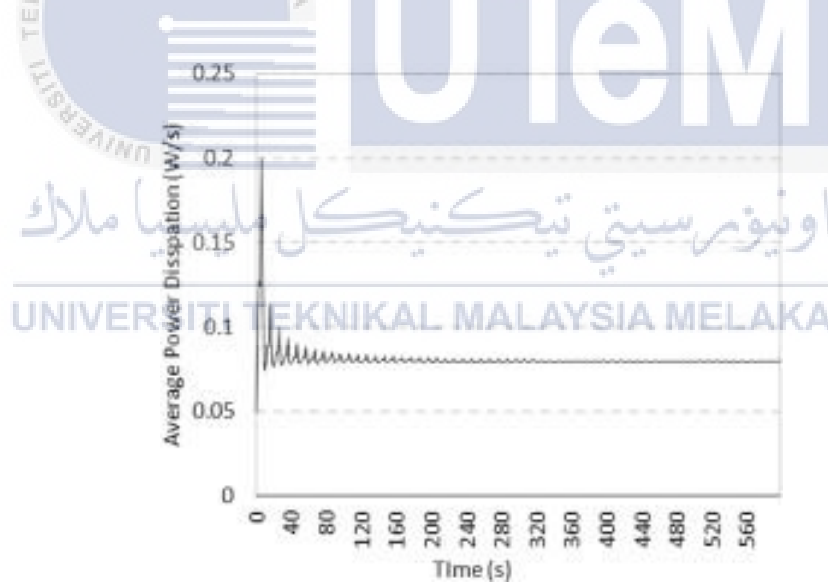


Figure 2.4 Average power dissipation over a period of one hour

After that, M G Hiremath, V Pujari and B Gadgay conducted a development system to look at the energy power consumption of some household appliances as well as actions to highlight energy saving[4]. Their energy monitors device development using Arduino and ESP8266 technology. Energy measurements are carried out on the assumption that each

voltage for each device is 230Vrms. In my opinion, the determination of voltage values using only assumptions is a shortcoming of the study conducted by them.

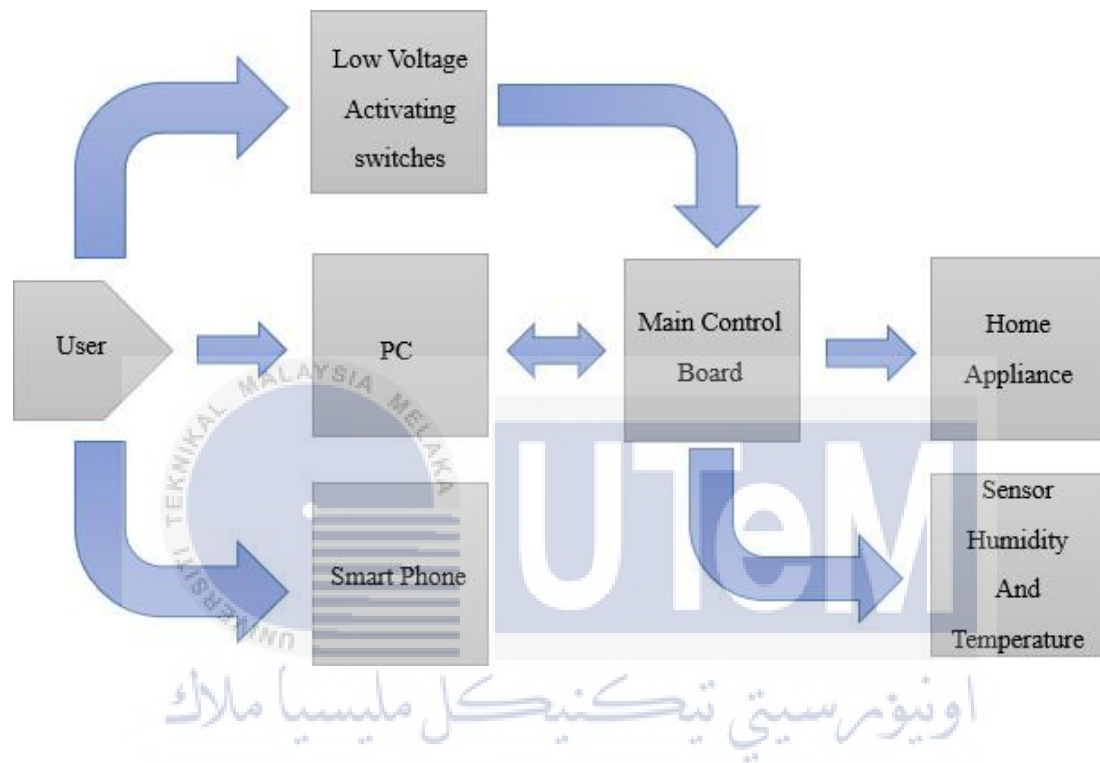
While the development of applications for intelligent energy measurement and research, the use and combination of arduino and GSM SMS (Short Message Service) communication has been carried out by Padmojethi et al[5]. The results obtained show the effectiveness of reporting and reduce energy costs, but will indirectly result in communication costs that are not examined in this study. The development of control and automation technology is now so advanced, in line with the development of wireless technology facilitates the management of electricity in the home.

## **2.4 Energy Management**

Among the main factors in energy management at home is of course the efficiency of the device, but the most important thing is the user skills and knowledge in managing energy. When talking about the efficiency of appliances, the authors observe that the average energy efficiency of appliances is below the best level because there are appliances that still use old and less efficient technology. Although strict standards have been implemented for the purpose of increasing efficiency, our role as consumers is still a key role in saving electricity. As discussed in the previous, their awareness of the use of electricity as well as the corresponding energy can raise awareness about the appropriate equipment and is very helpful to improve their control over the use of electricity. Therefore, the presence of a technology with the concept of centralized control allows us to control and manage electricity in our homes.

Research on home appliance control using smartphones conducted by Sachhin Kishor Khadke which aims to control home appliances remotely [6]. Users can access and

control all home appliances anytime and anywhere unlike we have to go back home only to turn off the corridor lights for forgetting. This app uses wireless radio frequencies to control and monitor every home appliance. This paper actually focuses fully on lighting control in our homes. Figure 2.5 shows an overview of this system.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA Figure 2.5 Full System Architecture

Next is a study entitled Smart Home Automated Control System Using Android Application and Microcontroller conducted by Mohamed Abd El-Latif Mowad, Ahmed Fathy, and Ahmed Hafez [7]. Based on the title written, the purpose of this home automation and remote monitoring is to control the indoor environment such as humidity, temperature, fault detectors and management using a smartphone. The system design is based on a microcontroller (Arduino Uno), sensors and even wireless Internet connection used for remote control.