



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MONITORING ENERGY METER SYSTEM BY IoT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Telecommunications) (Hons.)

by

NURUL ATIKA AFIFA BINTI ABDULLAH

B071310113

900822-12-5480

FACULTY OF ENGINEERING TECHNOLOGY

2016

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: MONITORING ENERGY METER SYSTEM BY IoT

SESI PENGAJIAN: 2016/17 Semester 2

Saya **NURUL ATIKA AFIFA BINTI ABDULLAH**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

SULIT

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)


TERHAD

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

TIDAK TERHAD

Disahkan oleh:





Alamat Tetap:

112, KAMPUNG SUNGAI BARU

MUKIM GUNONG

05150 ALOR SETAR KEDAH

Tarikh: 9/12/2016


Cop Rasmi:

WIN ADIYANSYAH INDRA
Pensyarah
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Monitoring Energy Meter System By IoT” is the results of my own research except as cited in references.

Signature : 

Name : NURUL ATIKA AFIFA BINTI ABDULLAH

Date : 9 DECEMBER 2016

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Telecommunications) (Hons.). The member of the supervisory is as follow:



WIN ADIYANSYAH INDRA
Pensyarah
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

.....
(MR. WIN ADIYANSYAH INDRA)

ABSTRACT

The proliferation of technology paves way to new kind of devices that can communicate with other devices to produce output mostly on wireless communication. Wirelessly communicating embedded devices are brought to one another in a single link over Internet called IoT (Internet of Things). This report focus to develop smart energy meter by implement the latest technology to monitor the watt and bill electric consumption that have been use at residential house more easily. The system billing for this project was based on an electricity tariff rate that is determined by Tenaga Nasional Berhad (TNB). Using sensor as device that to detect the changing pulse at energy meter before data are process and transmit to the web application, ThingSpeak through the using of microcontroller Arduino and Ethernet shield. Arduino and Erthenet Shield give more easy to program the coding and able to device connect to internet.

ABSTRAK

Kepesatan teknologi memberi ruang mudah kepada penghasilan yang membolehkan komunikasi antara mesin ke mesin yang lain menggunakan komunikasi tanpa wayar. Perhubungan tanpa wayar yang berkomunikasi di antara mesin kepada mesin yang lain dalam satu perhubungan melalui Internet dipanggil IOT (Internet Perkara). Fokus laporan untuk menambah baik tenaga meter elektrik kepada meter yang lebih berteknologi dengan mengaplikasikan teknologi terkini agar dapat membantu memantau kiraan watt dan bil penggunaan elektrik yang telah digunakan di kediaman rumah dengan lebih mudah. Sistem pengiraan bil dalam projek ini adalah berdasarkan pada kadar tarif elektrik yang ditentukan oleh Tenaga Nasional Berhad (TNB). Menggunakan sensor sebagai peranti yang mengesan perubahan kiraan watt pada meter elektik sebelum data diproses dan dihantar kepada aplikasi web, ThingSpeak melalui menggunakan peranti pengawal mikro Arduino dan Ethernet Shield . Arduino dan Erthenet Shield adalah lebih mudah untuk untuk diprogram pengkodannya dan mabolehkan disambungkan ke internet.

DEDICATIONS

To my beloved parents, family members, and friends for your supports, encouragements, understanding, and all the favour. May God bless all of you.

ACKNOWLEDGMENTS

All the praise to all mighty ALLAH, for bestowing I with courage, knowledge, health and wisdom to carry out this project. I also have to thank my supervisor, Win Adiyansyah Indra. I really appreciate their tips and guide that give me pleasant to solve this project. Without their assistance and dedicate involvement in every step throughout the process, this paper would have never been accomplished. I would like to thank you very much for your support and understanding over this past one semester. I also want to give a special thanks to my family and friends that always give moral support and positive thinking whenever I was face difficulty doing this project until I achieved my objective for this project.

TABLE OF CONTENTS

DECLARATION	iv
APPROVAL	v
ABSTRACT	vi
ABSTRAK	vii
DEDICATIONS	viii
ACKNOWLEDGMENTS	ix
LIST OF FIGURES	xiii
LIST OF SYMBOL AND ABBEVIATIONS	xv
CHAPTER 1: INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	3
1.3 Objectives	3
1.4 Scope	3
1.5 Summary/ Conclusion	4
CHAPTER 2 : LITERATURE REVIEW	5
2.1 Previous Systems and Existing Technologies	5
2.1.1 Smart Energy Meter with Instant Billing and Payment	6
2.1.2 Experimental Study and Design of Smart Energy Meter for the Smart Grid	6
2.1.3 Implementation of Automatic Meter Reading (AMR) Using Radio Frequency (RF) Module	7
2.1.4 Remote End Energy Capturing and Monitoring Through Automatic Meter Reading	7
2.1.5 Microcontroller Based Single Phase Digital Prepaid	8
2.2 Hardware Overview of The System	9
2.2.1 Energy Meter	9
2.2.1.1 Electromachanical Meter	12

2.2.1.2	Electronic Meter	12
2.2.2	TSL257 Light to Voltage Converter	13
2.2.3	Liquid Crystal Display (LCD)	14
2.2.4	Microcontroller	14
2.2.4.1	Arduino MEGA	15
2.2.5	Ethernet Shield	15
2.3	Automatic Meter Reading (AMR)	16
2.4	Advanced Metering Infrastructure (AMI)	17
2.5	IoT (Internet of Thing)	17
2.5.1	ThingSpeak	18
 CHAPTER 3: METHODOLOGY		19
3.0	Introduction	19
3.1	Flow Chart of The Project	20
3.2	Design Methodology	22
3.2.1	Block diagram of the system	22
3.2.2	Flow Chart Process	23
3.3	Hardware Implementation	25
3.3.1	Hardware Placement	25
3.3.2	Haerdware Device Description	25
3.4	Software Implementation	27
3.4.1	Circuit Design	27
3.4.2	Programming Code	29
3.5	IoT Implementation	32
3.6	Development Model Project	34
 CHAPTER 4: RESULTS AND DISCUSSION		36
4.0	Introduction	36
4.1	Working Principle	36
4.2	Results	37
4.3	Analysis Performance	42
4.3.1	Sensor TSL257 (Light to Voltage Converter)	42
4.3.2	ThingSpeak	42

4.4	Discussion	43
4.5	Limitation	44
CHAPTER 5: CONCLUSION AND FUTURE WORK		45
5.0	Introduction	45
5.1	Conclusion	45
5.2	Future Work	45
APPENDIX		47
REFERENCES		50

LIST OF FIGURES

Figure 2.1: The LCD display shows meter reading is 0 kWh	10
Figure 2.2: The LCD display shows meter reading is 5567 kWh	10
Figure 2.3: The LCD display shows meter reading is 223 kWh	11
Figure 2.4: The LCD display shows meter reading is 67 kWh	11
Figure 2.5: Analog Meter	12
Figure 2.6: Digital Meter	12
Figure 2.7: TSL257 Sensor	13
Figure 2.8: 16 ×2 LCD	14
Figure 2.9: Arduino MEGA	15
Figure 2.10: Ethernet Shield	15
Figure 2.11: ThingSpeak	18
Figure 3.1: Flowchart project	21
Figure 3.2: Block diagram of the system project	23
Figure 3.3: Flowchart process	24
Figure 3.4: Fritzing Software	28
Figure 3.5: LCD connection circuit	28
Figure 3.6: LED and sensor connection circuit	29
Figure 3.7: IDE Software	29
Figure 3.8: Include Libraries	30
Figure 3.9: Pin declaration	30
Figure 3.10: Ethernet MAC and ThingSpeak server	31
Figure 3.11: Calculation bill	31
Figure 3.12: Counting pulse	31

Figure 3.13: Account ThingSpeak on Window	32
Figure 3.14: ThingSpeak application for android phone	32
Figure 3.15: Structure of transmitting data	33
Figure 3.16: Project model	34
Figure 3.17: Project circuit view	34
Figure 4.1: System bill in TNB	37
Figure 4.2: Bill resit	38
Figure 4.3: Testing accuracy bill	38
Figure 4.4: Hardware test stage 1	39
Figure 4.5: ThingSpeak (IoT) test stage 1	39
Figure 4.6: Hardware test stage 2	40
Figure 4.7: ThingSpeak (IoT) test stage 2	40
Figure 4.8: Hardware test stage 3	41
Figure 4.9: ThingSpeak (IoT) test stage 3	41

LIST OF SYMBOLS AND ABBREVIATIONS

LCD	=	Liquid Crystal Display
LED	=	Light Emitting Diode
IDE	=	Integrated Development Environment
PIC	=	Programmable Integrated Circuit
EEPROM	=	Electrically Erasable Programmable Read-Only Memory
AMR	=	Automatic Meter Reading
AMI	=	Advanced Metering Infrastructure
IoT		Internet of Thing
BASs	=	Building Automation Systems
RF	=	Radio Frequency
GSM	=	Global System for Mobile Communications
GPRS	=	General Packet Radio Service
TCP	=	Transmission Control Protocol
UDP	=	User Datagram Protocol
UART	=	Universal Asynchronous receiver transmitter
SPI	=	Serial Peripheral Interface
API	=	Application Program Interface
PWM	=	Pulse Width Modulation
PC	=	Personal Computer
TNB	=	Tenaga Nasional Berhad

CHAPTER 1

INTRODUCTION

In this chapter will provide brief explanation of the Monitoring Energy Meter System by IoT that only will be implement in residential house. It will covers the background, problem statement, objective, scope, project significance and summary.

1.1 Background

Nowadays electricity places a key role in the human life. Without electricity, life will be very difficult. Various scientific inventions have made this world worth living where the developments of technologies have increase day by day. They made our human lives more luxurious and comfortable. The invention of electricity is one of the greatest achievements of man.

Now the growing demands of life today make people need some alternative in way to minimize or manage their usage of electricity. According to the report New Strait Times, 21 April 2016, TNB say that the highest ever demand for electricity in Peninsular Malaysia was recorded at 17,788 megawatts (MW) just in two day. The peak of reading was increase due to the El-Nino phenomenon. TNB however said that the use of units that are not maintained properly could cause the consumption of electricity to increase. It cited that reducing the temperature, increasing fan speed and prolonged use of air conditioning units caused the spike in usage while ultimately resulting in higher bills.

So the utility management emerge as an important thing in order to ensure that the utility is not burden to the public especially to pay the rate of electricity bills.

People are trying to reduce the cost of electricity bills in several ways as they start to concern about the uncontrollable electricity usages. The regular monitoring of energy patterns can indicate areas of unnecessary consumption while the reporting of power usage can provide savings of up to 20 percent.

In modern buildings, the building automation systems (BASs) are more and more implemented. Hence in this project Monitoring Energy Meter System by IoT bring us an idea one method easy way to users monitor their own bill of electricity consumption every single day so they can be more careful during using electricity.

The system in this project will be implement with web application that is IoT(Internet of Things). The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Basically, the development of this project includes hardware and software elements in an integrated circuit in order to display monthly electricity usage. Unlike the conventional meters, this project tries to integrate an electricity cost calculator into the same device. The outputs being displayed will be electricity usage in kilowatt-hour (kWh) and amount of current usage in Malaysia Ringgit (RM).

Using microcontroller as a main brain in process data, the calculating cost of bill will be calculate based on the pricing and electricity tariffs rates provided by the national utility provider in Malaysia, which is Tenaga Nasional Berhad (TNB).

1.2 Problem Statement

As the electrical vitality utilization is relative to the use of power, the higher utilization of power prompts the higher bill costing. The uncontrolled day by day power utilization causes the month to month power bill to climb up without understanding that it surpasses the family unit spending plan. The mains issues now the using old meter reading such an electro-mechanical meter and digital meter that not provide a system that user can directly monitor their electricity usage, make them need to wait until end of month when the meter reader come to every house and manually take the reading for the billing of energy electricity consumed. This make the family unit cannot control the utilization of power on the grounds that there is no marker or estimation that can let them know the sum expense of current use. Thus, by this technology the users can monitor their billing of electricity consumption easily without referring to the utility bill.

1.3 Objectives

The objectives of this project are:

1. To develop a Monitoring Energy Meter System by IoT using Ethenet Shield.
2. To verify the accurate measurement monitoring meter reading with TNB billing system.
- 3 To investigate the performance system of project with IoT application.

1.4 Scope

The scope of this project is to introduce advanced technology with the IoT to residential house for monitoring their energy meter reading. The modern technology that will be implement are by using Arduino and Ethernet Shield, where the system

will be only implement to single phase digital meter reading that not provide Advanced Metering Infrastructure, AMI system which is Smart Meter reading. In this project bill usage electricity can be calculated and display at LCD and the same way through web application. Creating an web as a medium two-way communication between user (smart phone) and device make an easy access monitoring the bill of electricity consumption. Those to run the project successfully, the microcontroller use for this project is Arduino Mega as a brain control whole process and Ethernet Shield as to allow communication device with the internet.

1.5 Summary / Conclusion

Chapter 1 is roughly describes about the background of project, problem statement, objectives and scope of the project. This chapter is a basic guideline of this project. The idea to design this project is to improve recently meter energy by upgrade to be an instrument that can help people in their daily life. Next chapter is Literature Review which is provided the review from previous research that related to this project.

CHAPTER 2

LITERATURE REVIEW

In order to make this project successful, some studies and researching has been done. The information and studies for this project was collected from many sources such as books, articles, journals and internet. All this information was used in this project as a guide to make sure this project can be done in the time given. All the studies and information collected was based on major component and topic that related to this project.

2.1 Previous Systems and Existing Technologies

There are a lots of system that had been created to measure and monitor the electric consumption and billing used by residential outside there using the latest technology nowadays. Basically we will know the amount of bill electric consumption at the end of month, because the meter board billing will come to every house and take the meter reading end of month and then give bill to the customer, and that was the only method to user know their bill. At present most of the house in Malaysia uses the traditional electro-mechanical meters, this meter in analog meter reading.

Now just a decade later, electronic meters were introduced which has replaced the analog into digital system, but the function still same as electro-mechanical meter were it just upgrading the system from analog to digital view. Over the last decade, major electricity meter manufacturers have introduced solid state models and discontinued electromechanical production.

The improvement of technology have create a several kind of energy meter reading with using new and latest technology for system one or two way communication, like Automatic Meter Reading with the help of using ZigBee technology, GSM technology and Radio Frequency wireless system where it give a solution to customer or provider in way to monitor and collect data of energy consumption.

2.1.1 Smart Energy Meter with Instant Billing and Payment

According to (Ravi et al. 2015) in this project mainly focuses on the measurement of energy consumption and providing data for billing and a system for payment. Present a simple design for Automatic Energy Meter reading with payment facility with the help of ZigBee communication technology. By this technology communication was at faster rate without any data loss and it provides high security in serial communication. In this system the energy is measured in units and the data is fed to a remote computer server where a software solution is provided to generate bill for energy consumption and the data is send back by using same communication method, the consumer can pay the bill at home by using a keypad system.

2.1.2 Experimental Study and Design of Smart Energy Meter for the Smart Grid

This paper introduces the advancement of a GSM and ZigBee based keen meter. This meter can gauge the vitality and send the data to the administration supplier, who can store this data and inform the purchaser through SMS messages or through the web. The combination of automatic reading and two-way communication are the reason why the meter is called smart and they are also the difference between the traditional energy meter and the smart meter. The authors composed and built up a straightforward smart meter model that utilizations both GSM and ZigBee. The meter

exploits the broad utilization of the GSM system with its SMS ability and the simple to utilize ZigBee system to send and gather the vitality utilization information. Zigbee is utilized to speak with different devices. Moreover, this paper additionally clarifies how the information can be gathered by the administration supplier and circulated to the customers .

2.1.3 Implementation of Automatic Meter Reading (AMR) Using Radio Frequency (RF) Module

According to (Ali et al. 2012) AMR by utilizing radio recurrence (RF) is the remote accumulation of utilization information from clients' utility meters utilizing radio recurrence advances. This framework gives electric utility administration organization (TNB) the chance to increment operational effectiveness, enhance client administrations, lessen information accumulation costs and rapidly assemble basic data that gives knowledge to organization leaders. The current computerized electric in the showcasing is updated by adding RF module to give remote correspondence abilities. In the meantime, the beneficiary module unit interfaced specifically to a PC/tablet to show all essential points of interest.

2.1.4 Remote End Energy Capturing and Monitoring Through Automatic Meter Reading

(A.Priyanka, Dr. T. Gowri Manohar & N. Damodar, 2015) in this paper automatic meter reading (AMR) is used for capturing the electrical energy meter data from the meters located at remote end. AMR system is the modern system used to read meter data from server end and to facilitate to generate different kinds of reports including billing. Automatic Meter Reading System is a sophisticated system which allows companies to collect the readings without visiting the site. AMR include various technology for data collection such as power line communication, Zig-bee, Radio Frequency (RF Method)

and GSM/GPRS network but GPRS network is best among this technology. This paper will discuss only GPRS based AMR system. Automatic meter reading system helps the customer and energy service provider to access the accurate and updated data from the energy meter. AMR System can send energy consumption in hourly, monthly or on request. This data is sent to central system for billing and troubleshooting. These data are stored into the database server for processing and recording. By using this technique can reduce the losses, labour cost, collection time, energy theft, avoids late payment.

2.1.5 Microcontroller Based Single Phase Digital Prepaid Energy Meter for Improved Metering and Billing System

According to (Haque et al. 2011) this paper presents a single phase digital prepaid energy meter based on two microcontrollers and a single phase energy meter IC. This digital prepaid energy meter does not have any rotating parts. The energy consumption is calculated using the output pulses of the energy meter chip and the internal counter of microcontroller (ATmega32). A microcontroller (ATtiny13) is used as a smart card and the numbers of units recharged by the consumers are written in it. A relay system has been used which either isolates or establishes the connection between the electrical load and energy meter through the supply mains depending upon the units present in the smart card. Energy consumption (kWh), maximum demand (kW), total unit recharged (kWh) and rest of the units (kWh) are stored in the ATmega32 to ensure the accurate measurement even in the event of an electrical power outage that can be easily read from a 20×4 LCD. As soon as the supply is restored, energy meter restarts with the stored values. A single phase prepaid energy meter prototype has been implemented to provide measurement up to 40A load current and 230V line to neutral voltage. Necessary program for microcontrollers are written in c-language and compiled by Win-AVR libc compiler.

2.2 Hardware Overview of the System

The hardware overview is an analysis of the component that should be considered in the design of monitoring energy meter system by IoT which the usage of single phase energy meter, Arduino , Ethernet Shield, LCD display, sensor and other components.

2.2.1 Energy Meter

A power meter, electric meter, electrical meter, or vitality meter is a device that measures the measure of electric vitality supplied to a private or business building. The most widely recognized unit of estimation made by a meter is the kilowatt hour, which is equivalent to the measure of vitality utilized by a heap of one kilowatt in one hour.

The electricity energy meters fall into two basic categories, which are electromechanical and electronic meter. Electromechanical meter is an analog type meter that operates by counting the revolutions of a non-magnetic metal disc which is made to rotate at a speed proportional to the power passing through the meter, while the electronic meter is a digital type meter that operates the input of loads, voltage, current and instantaneous time to a digital signal processing system and convert the energy to the pulse signal form.

In Malaysia, the energy provider is Tenaga National Berhad (TNB). The most of TNB's vitality meters are electronic meters. Electronic meters are identifiable through the LCD show boards. Whilst electromechanical meters are still being used, TNB is steadily eliminating them through substitution programs. All TNB vitality meters introduced at the premises have been adjusted and tried in understanding to Malaysian Standards ISO/IEC 17025: 2005. (TNB, 2016).

According to (TNB web page, 2016) in Malaysia, there are four companies that was assigned by electrical energy provider to provide energy meter for household use. They are Smart Meter Technologies Sdn Bhd (SMT), Malaysian Intelligence Meters Sdn Bhd (MIM), Krizik Malaysia Sdn Bhd (KMSB) and MISA Sdn Bhd (MISA). These four companies are responsible to produce a digital meter with energy calculation that based on the TNB tariff rates. Meters Shown below are the 4 most common single phase electronic energy meters used in TNB.

- a) Smart Meters (Smart Meters Technologies Sdn Bhd), Model:Phoenix Series 2



Figure 2.1: The LCD display shows meter reading is 0 kWh

- b) Meter energy produce by MIM (Malaysian Intelligence Meters Sdn Bhd) with Model: G3



Figure 2.2: The LCD display shows meter reading is 5567 kWh