Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF IOT BASED ON ENERGY MONITORING SYSTEM FOR INDUSTRIAL APPLICATION

SAYED ASRAF BIN SAYED ALWI

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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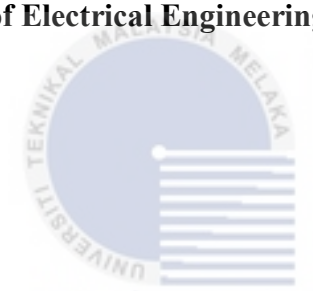
DEVELOPMENT OF IOT BASED ON ENERGY MONITORING SYSTEM FOR INDUSTRIAL APPLICATION

SAYED ASRAF BIN SAYED ALWI

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours



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I declare that this project report entitled "Development of IoT Based on Energy Monitoring System for Industrial Application" 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.

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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 Electrical Engineering Technology with Honours.

Signature : 

Supervisor Name : Ts.Dr. MOHD HATTA BIN JOPRI

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Co-Supervisor :

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Date :

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DEDICATION

I dedicate to my beloved mother, Nazelina Binti Ahmad, and father, Sayed Alwi Bin Yunus for supporting me throw out my degree's journey.

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ABSTRACT

The management of energy resource is a significant global issue. The practises in energy conservation reduce the impacts of energy production on the environment. Consequently, the monitoring of electricity use is an essential process which reduces energy use and CO2 emissions immediately. The lack of metres in both energy-intensive and non-energy-intensive industries is seen as one of the most significant barriers to increasing energy efficiency. The benefit of sub-metering is that it can enhance the efficiency of power usage while simultaneously lowering operating costs. Indirectly, it can encourage companies to invest more in energy efficiency programmes, which can help both the environment and the operation's costs. The traditional technique of measuring energy data such as RMS voltage, RMS current, Power and Power usage for energy monitoring requires manually handing over the source. It can sometimes be a disaster unless carefully handled and supervised by the professional. In addition, to improve data quality and efficiency for analysis, the energy monitoring system must be able to gather a lot of data and monitor in real time. To avoid a problem and acquire reliable data, the system must be able to read rms voltage, rms current, real power and power factor in real-time. This project will involve in coding, design and implementation. Creating a real-time industrial energy monitoring system would give improved insight into the industry's energy and power quality data. In industry leading to financial advantages, this will lead to reduced equipment downtime. So, some technique and approach will be used in this project to accomplish the project by the due date. Lastly, at the end of this project, the RMS voltage, RMS current, power and power usage will be generating.

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ABSTRAK

Pengurusan sumber tenaga adalah isu global yang penting. Amalan dalam penjimatan tenaga mengurangkan kesan pengeluaran tenaga terhadap alam sekitar. Oleh itu, pemantauan penggunaan elektrik adalah proses penting yang dapat mengurangkan penggunaan tenaga dan pelepasan CO2 dengan segera. Kekurangan meter di kedua-dua industri intensif tenaga dan bukan tenaga dilihat sebagai salah satu penghalang yang paling penting untuk meningkatkan kecekapan tenaga. Manfaat sub-metering adalah bahawa ia dapat meningkatkan kecekapan penggunaan kuasa sekaligus menurunkan kos operasi. Secara tidak langsung, ia dapat mendorong syarikat untuk melabur lebih banyak dalam program kecekapan tenaga, yang dapat membantu persekitaran dan kos operasi. Teknik tradisional untuk mengukur data tenaga seperti voltan RMS, arus RMS, daya sebenar, kuasa nyata dan faktor kuasa untuk pemantauan tenaga memerlukan penyerahan sumber secara manual. Di samping itu, untuk meningkatkan kualiti dan kecekapan data untuk analisis, sistem pemantauan tenaga mesti dapat mengumpulkan banyak data dan memantau secara masa nyata. Untuk mengelakkan masalah dan memperoleh data yang boleh dipercayai, sistem mesti dapat membaca voltan rms, arus rms, kuasa dan faktor kuasa sebenar dalam masa nyata. Projek ini akan melibatkan pengekodan, reka bentuk dan pelaksanaan. Membuat sistem pemantauan tenaga industri masa nyata akan memberikan gambaran yang lebih baik mengenai data kualiti tenaga dan tenaga industri. Oleh itu, beberapa teknik dan pendekatan akan digunakan dalam projek ini untuk menyelesaikan projek pada tarikh akhir. Akhir sekali, pada akhir projek ini, voltan RMS, arus RMS, kuasa dan tenaga akan dijana.

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First and foremost, I would like to express my gratitude to my supervisor, Ts.Dr. Mohd Hatta Bin Jopri for their precious guidance, words of wisdom and patient throughout this project.

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My highest appreciation goes to my parents, Nazelina Binti Ahmad and Sayed Alwi Bin Yunus for their love and prayer during the period of my study.

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LIST OF SYMBOLS

V	-	Voltage
σ	-	Standard Deviation
x	-	Mean

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LIST OF ABBREVIATIONS

V	-	Voltage
I	-	Current
P	-	Power

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CHAPTER 1

INTRODUCTION

1.1 Background

Electrical energy is a number 1 priority now for the world and also be a backbone for the global with per capita consumption increasing by 14.3% from 2005 to 2011 [1]. The main field that dominated the global electricity consumption is come from manufacturing industry by 42.3% of the world electricity consumption [2]. Base on the increasing trend for demand of the electricity, the price also increases. Energy price spikes have compelled companies to regard energy as a resource that must be prepare and controlled for their plants as a variable input. To reduces the energy consumption for industries, the industries need to be more efficient in their operation. Energy-efficient management offer a range of benefits including cost reductions, enforcement of environmental laws and adaptation of green goods to market demand [3]. ISO 50001 state that energy monitoring and analysis is the key that need to be improve so that energy efficiency increases [4]. One of the expert name's Hu et al say that the efficiency of many machines was below 30% only [5].

The lack of meters in both energy intensive and non-energy intensive sectors is consider one of the key obstacles to improving energy efficiency. With sub-metering also, the benefit is it can increase the efficiency of the electric consumption and also can reduce the cost of operation [6]. Indirectly, it can motivate the industries to be more invested into energy efficiency program which can benefit for environment and also costing of the operation.

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Lastly, one of the problems in energy conservation arises from diversity of energy use across system is each with its own set of energy consumption characteristics. The combination of energy management and production management is the secret to energy quality improvement [7].

1.2 Problem Statement

The old method to measure the energy data such as RMS Voltage, RMS current and energy usage for energy monitoring is required the human to manually hands on to the source. It sometime can be a disaster when not handle it with properly and supervise from the expert. According to the Timothy Thiele, the current over 200mA can damage the internal organ of human and will led to died [8]. Usually, the current for household that supply to switch carrier 15 to 20 ampere [8]. Besides, to optimize the accuracy and efficiency of the data for analysis, the energy monitoring system must be able acquire a lot of data and monitoring in real time [9]. In order to avoid a problem happened and getting accurate data, the energy monitoring system based on IoT must be develop so that all the real time data for energy analyzer can be monitor by using smartphone or computer only.

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1.3 Project Objective

a) To develop real time energy monitoring system based on IoT.

b) To analyses electrical parameters such as RMS Voltage, RMS Current, Power and Energy usage for real time energy monitoring.

c) To validate the accuracy and precision of the proposed system at field testing.

d)

1.4 Scope of Project

The scope of the project is specified as follows to avoid any confusion about the project owing to various limits and constraints:

a) Acquire RMS voltage, RMS current, Real Power, and Power Usage and upload to ThingSpeak.

b) Collecting data for Voltage and Current using Voltage sensor (ZMPT101b) and Current sensor (SCT013).

c) Coding the Arduino Uno to obtain Voltage, Current, Power and Power Usage.

d) Coding the ESP8266 to upload Voltage, Current, Power and Power Usage to ThingSpeak.

e) Implement the project for 230V, 50Hz Single Phase.

f)

g)

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1.5 Research Methodology Project

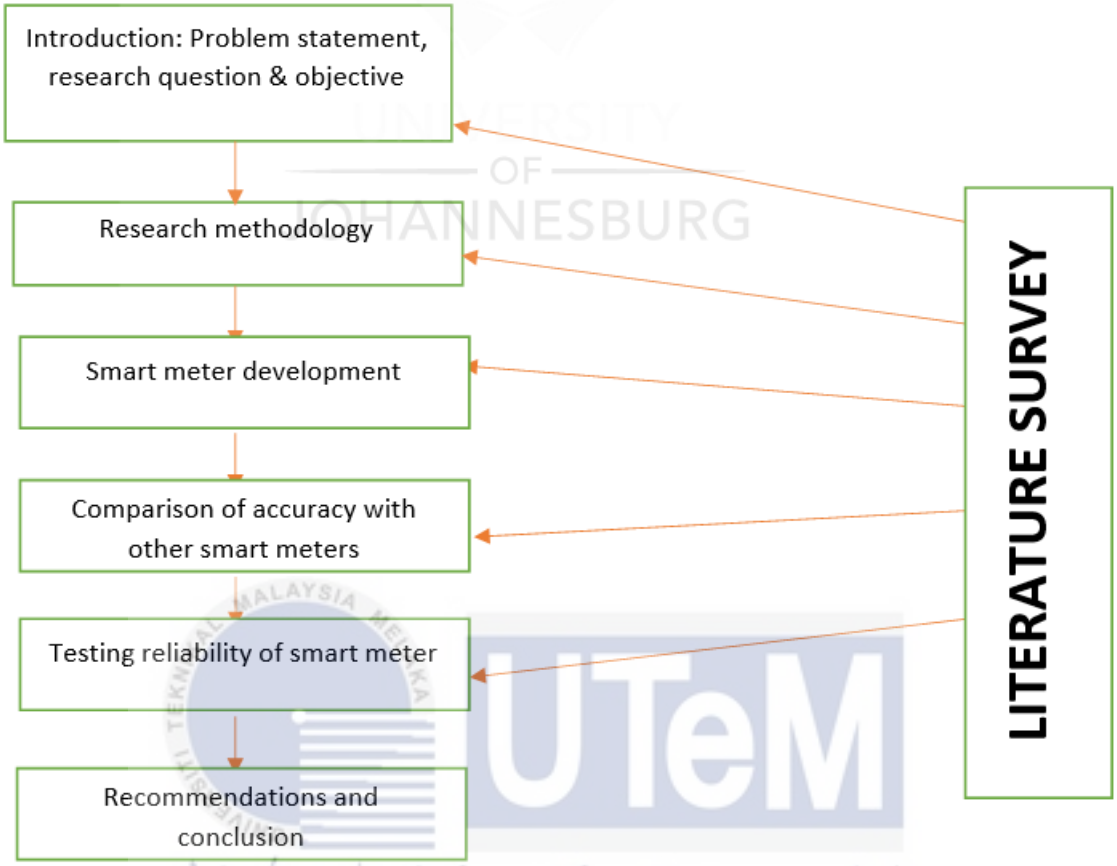

Figure 1.1 Scematic overview of the research design

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In 1974, Paraskevakos was awarded a U.S patent for the first smart meters. In 1977, he launched Metretek Inc which developed and produce the first smart meters. Since this system was developed pre-internet, Metretek utilized the IBM series 1 mini-computer. This idea was expanded into industries to develop one system that can monitoring the energy consumption for their companies. There were a lot of reason why the energy monitoring was so important to the industries especially focusing in energy prices, environmental regulation and customer awareness on environmentally benign product.

Base on Garetti and Taisch, they suggested that there is an absence of the required level of control in energy usage [10]. So, from this opinion have led to research about the method in estimate the energy consumption patterns [11]. The forecasting model use in estimating energy is classified by two categories [12]. First is based on driving factor and second is based on historical data. However, this estimating energy was lack and give inaccurate data for analysis because the time interval is too large. So, to prevent this problem, some modification in reducing the time interval have to be made so that the error between time interval can be reduce and the output data also can be accurate.

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2.2 Why Energy is So Important?

Electricity pricing can encourage people to consume less energy. The customer must be provided with a better understanding of when and where the electricity is consuming, this will be the benefit for smart energy monitoring system [13]. The energy usage data can

improve the facility and reduce the wasted energy consumption. The used of energy monitoring system can help residential and industrial customer for better understanding of their energy usage and help them in planning their budget for energy usage [14].

2.3 Type Of Energy Meter

Energy meter come in a variety of design, from a simple energy meter to advanced energy meter that come with power quality monitoring feature and remoted power control capabilities. Below are 3 type example of Energy meter:

2.3.1 Utility Energy Meter

Normally, utility energy meter is installed at residential, commercial and industrial electric system for invoicing. Now, these devices are provided with build-in communication system that allow it to transfer the data to the central monitoring system. This communication system consists of Power Line Communications (PLC) and MODBUS over IP adapters [15]. The most advance of utility energy meter is designed by Quadlogic that can measure advanced metrics which include power factor per phase, Total Harmonic Distortion (THD), voltage transient and current transients [16].

Figure 2.1 Utility Energy Meter

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2.3.2 Analog Meter

This meter is functioning by using the principle of the electro-mechanic induction. The reading of this meter is followed by making the electrically conductive metal disc rotate at a speed of power flowing through meter. Usually, this type of meter not provided with build-in communication technology that able it to transfer data to central monitoring system. The reading for energy consumption also not so accurate as a utility energy meters [17].

Figure 2.2 Analog Meter

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2.3.3 Power Quality Meter

Power Quality Meters measure a single phase and 3 phase powers in kWh and its featuring with technology that able to measure harmonic distortions, power quality metrics and also record user define events [18]. The power quality meters also provide with protection mechanisms that allow it to avoid from voltage, current and frequency imbalances [19].