Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED REAL-TIME ENERGY MONITORING SYSTEM USING ARDUINO

SHARVIN RAJ A/L RAJA LINGAM

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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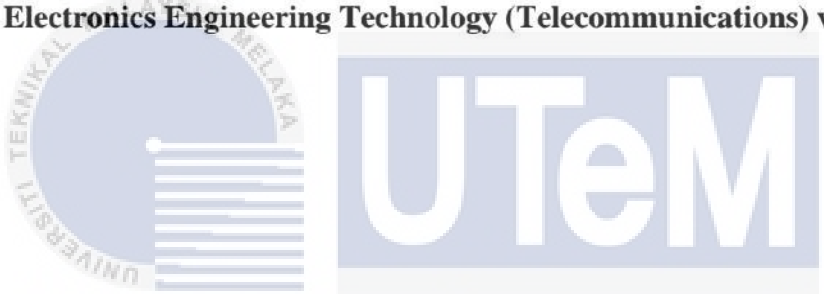
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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I declare that this project report entitled "Development of IOT Based Real-Time Energy Monitoring System Using Arduino" 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 Electronics Engineering Technology (Telecommunications) with Honours.

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Date : 16/01/2023

DEDICATION

To my family and friends, I dedicate this project report. My parents, Mrs. Sivasundari A/P Rubanathan and Mr. Raja Lingam A/L Rajeswaran, in particular, deserve special recognition for teaching me that even if a task first seems hard, it can be finished if it is carried out one step at a time. Additionally, I dedicate this work to my friends and the locals who have supported me in finishing the project. I will always be appreciative of the help and advice offered. Additionally, I want to express my thanks to my PSM Supervisor, Dr. AKM Zakir Hossain, for providing me with advice on how to effectively complete my final year project.

ABSTRACT

The rapid expansion of residential homes around the globe has greatly increased the demand for energy. The energy consumption by the houses impacts cost, availability, and performance. Thus, real-time energy monitoring would aid the homeowners in gaining a deeper understanding of the energy requirements and other relevant metrics that can be used to optimize the performance. In recent years, connecting sensors that gather and transmit real-time data to an Internet of Things monitoring dashboard has gained appeal. This project was to develop an IoT system which connect sensors that its main function is to monitor energy consumption and other parameters that can be measured to identify anomalies and prevent untimely breakdowns. The energy utilization metrics aid homeowners in determining the total consumption of a facility and approaches to enhance the overall efficiency for greater cost savings.

ABSTRAK

Pertumbuhan pesat perumahan di seluruh dunia telah menyumbang dengan ketara kepada permintaan yang lebih tinggi untuk bekalan tenaga. Tenaga yang digunakan oleh rumah-rumah menyumbang kepada kos, ketersediaan dan prestasi. Oleh itu, pemantauan tenaga masa nyata akan membantu pasukan pemilik rumah lebih memahami keperluan tenaga dan parameter lain yang berkaitan yang boleh membantu mereka mengoptimumkan prestasi rumah mereka. Menyambung penderia yang mengumpul dan menghantar maklumat masa nyata ke papan pemuka IoT pemantauan telah mendapat popularity sejak beberapa tahun kebelakangan ini. Projek ini bercadang untuk membina sistem IoT yang menghubungkan penderia terbenam yang memantau penggunaan tenaga dan faktor lain yang berkaitan yang boleh dianalisis untuk mengesan penyelewengan dan mengelakkan penghentian yang tidak diingini pada peringkat awal. Parameter penggunaan tenaga secara khusus menyokong pemilik rumah untuk menentukan penggunaan keseluruhan keseluruhan kemudahan dan cara untuk mengoptimumkan kecekapan keseluruhan untuk penjimatan kos yang lebih baik.

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I want to sincerely thank my friends and classmates for their encouragement and support while I conducted the research for my bachelor's degree thesis. Last but not least, I want to thank my seniors, juniors, and fellow students who willingly assisted me by providing the crucial data. I wish to thank Ts. Abdul Halim Bin Dahalan and Ts. Effendy Onn Bin Siam for acting as my assessors.

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LIST OF SYMBOLS

A	-	Ampere
GND	-	Ground
I	-	Current
I/O	-	Input & Output
J	-	Joule
KTOE	-	Kilotonne of Oil Equivalent
V	-	Voltage
VCC	-	Input for Arduino
W	-	Watt

LIST OF ABBREVIATIONS

AC	-	Alternating current
ADC	-	Analog to Digital conversion
APP	-	Application
CT	-	Current transformer
DAQ	-	Data acquisition board
DC	-	Direct current
EEPROM	-	Electrically Erasable Programmable Read-only Memory
GPRS	-	General packet radio services
GSM	-	Global system for mobile
IHD	-	In home display
IOT	-	Internet of things
kWh	-	Kilowatt-hour
LCD	-	Liquid crystal display
OS	-	Operating system
PC	-	Personal computer
RAM	-	Random access memory
RM	-	Ringgit Malaysia
ROM	-	Read only memory
RTC	-	Real time clock
RX/TX	-	Receiver/Transmitter
SDM	-	Single Phase Din rail Mounting
SMS	-	Short message service
TNB	-	Tenaga Nasional Berhad
TTL	-	Transistor-transistor logic
TOU	-	Time of use
USB	-	Universal serial bus
WI-FI	-	Wireless Fidelity

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Electrical energy is essential to the world economy, and between 2005 and 2011, per capita consumption increased by 14.3%.[1].Energy consumption keeps on expanding as an ever-increasing number of social orders industrialized, to such a degree, to the point that in innovative development nations, for example, the USA. Due to a constant rise in the number of domestic electrical appliances over the last two decades, private power consumption in the United States has climbed by 49% despite advances in energy efficiency. [2]. Domestic users, such as residential customers, are often unaware of their energy consumption, and as a result, power theft can occur. Bills are frequently created based on assumptions, and users of digital energy meters dosen't know the amount to pay for the usage due to the lack of tariff computation. To address the issue, a IOT based energy monitoring system was created to track and notify energy consumption in household equipment. The IOT based real-time energy monitoring system using Arduino allow the consumer to view their electric bill via LCD and cloud server.

The main objective of the system's development is to build an IoT-based system that is integrated into an energy monitoring system and connects embedded sensors that measure energy usage and other crucial parameters that can be analysed to detect anomalies and prevent unwelcome stoppages at an early stage using the most effective technique. The TTL to RS485 converter and the Arduino Mega 2560 are both connected in the same way. The sensor (SDM120CT MV) senses the load current (A) and power (W) that is clipped through

the life cable using split-core and sends it to the TTL to RS485 converter, which then sends it to the Arduino Mega 2560. The Arduino IDE was used to collect the single-phase analyzer SDM120CT MV data, and the ESP01 (ESP8266wifi module), which was connected to Wi-Fi, was used to access the Blynk Application.

The single-phase analyzer will be able to detect current, power, and kilowatt-hour use. The Arduino Mega 2560 with ESP-01 module will be used to create an IoT platform where the user can keep track of the energy being used using the Blynk application even when they are not present to make an efficient approach for the consumer to monitor their energy consumption. The main controller will make use of these modules to send all the data to the cloud storage server. Customers will be able to see their energy meter data online at any time and from any location thanks to the system's design. When the power is shut off, or if energy consumption increases excessively rapidly, the user will notice that there is a technical problem with the electricity use or the home electrical cabling and will proceed to investigate it. This enables the user to easily determine which system is having problems.

As a result, it assists the user in managing their utilization to save electricity. Because it is impossible to prepare a budget without knowing how much electricity is used, this system would be able to assist the user in planning their budget and manage their electricity for the following month. Aside from that, this technique might prevent others from stealing power. Focusing on how to use, store, and preserve energy will be a smart technique for the user.

1.2 Problem Statement

When the use of energy grew widespread, an energy meter was invented for both household and industrial use. The basic function of the energy meter is to monitor energy consumption, show it in Kilowatt/Hour, and calculate the monthly electric bill that the

consumer must pay at the end of the month. When the energy meter is widely employed proportionally to the expansion of energy, a slew of issues arises [3]. Because this project is being implemented in Malaysia, consumers may find it challenging to decipher Tenaga Nasional Berhad's electrical bills and use (TNB). As consumers, we frequently use electricity without realizing the limit; additionally, during the festive season, electricity usage will increase, and combined with other expenses, a high electricity bill will be a significant hardship for consumers. The rapid growth of technology, as well as the constant increase in human requirements, has flooded our environment with new electrical and electronic devices. There is no effective consumer alerting system or monitoring gadget that allows consumers to track their daily energy consumption. These factors contribute to one of the world's most pressing issues: excessive energy use. The daily creation of enormous amounts of energy contributes to pollution, which causes the ozone hole, which, in turn, contributes to the greenhouse effect, which causes ice to liquefy, resulting in rising ocean levels and the extinction of rare species of wildlife. As a result, the consumer must act to reduce these negative consequences. Consumers would prefer not to stop using energy sources that make our lives more comfortable, or to make it easier to replace older appliances with new, higher-efficiency ones [4], but they can make greener decisions by leveraging innovation. This can be accomplished by attempting to cut down on energy usage. A system capable of displaying and notifying energy usage in financial terms to assist consumers in realizing the need of lowering energy usage. As a result, users can keep track of their monthly electricity usage to see exactly how much they used. Using the IOT based real-time energy monitoring system using Arduino, consumers may monitor current, power consumption in kilowatt-hours, and RM value according to the TNB tariff on the LCD and cloud server. Additionally, once the stated limit has been achieved, consumers will receive an alert on their phone detailing their

energy consumption. The microcontroller Arduino Mega technology used in this product allows customers to plan their budget and save electricity.

1.3 Project Objective

The major objectives of the PSM lead after considering the above problem statement are:

i. To design an IOT based real-time energy monitoring system

ii. To fabricate the prototype of the proposed IOT based real-time energy monitoring system

iii. To benchmark the results with the current trends

1.4 Scope of Project

The goal of this project is to provide smart, contemporary technology that will enable homeowners to track their home's energy use through IoT at any time and from any location. The microcontroller in this project, an Arduino Mega 2560, captures data, displays it in the Blynk application, and computes energy usage using code from the Arduino IDE. In this demonstration project, a single-phase analyzer will be tested and the focus (SDM 120CT MV). The TTL to R485 functions as both the essential TTL converter components and minimizes the amount of wire needed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

From the conventional mechanical energy meter to the contemporary technology depending on GSM and GPRS, the electrical energy meter has evolved as technology has progressed. This section focuses mostly on the background, facts, and theory, past study, and link between the researcher's methodologies. In addition, this section will provide the relevant research papers, journals, publications, and other sources. The focus of the literature review shall pertain to the principles of an energy-efficient electrical system, and all obtained data will be summarized in the conclusion. Before beginning examination work, the literature study entails perusing the works of others to obtain crucial facts and knowledge, as well as similar projects completed by others. The sources include the prior dissertation, research papers, journals, publications, and the Internet. This chapter contains a compilation and discussion of all pertinent subjects. The trend of energy use is visible and explicable.

2.2 The History of Electricity

Around the start of the 20th century, Malaysia first experienced electricity. The first indications of energy generation were found in a small mining hamlet close to Rawang, Selangor. To power their mines, two businessmen named Thamboosamy Pillai and Loke Yew built an electrical generator in 1894. They pioneered the use of electric pumps in mining in Malaya, and their success cleared the path for the growth of electricity in Malaysia. In 1895, electricity was initially introduced to Kuala Lumpur's train stations, and in the same year, Rawang gained its own supply for street lighting. The Spam Hydroelectric Power Plant,

built by the Raub Australian Gold Mining Company in 1900 close to Raub, was Malaysia's first power plant.

Up until the middle of the 1920s, the majority of power plants used a range of fuels, such as low-grade coal, local wood, charcoal, significant oil, and waterpower. The increasing need for energy necessitated extensive planning, major investment from outside sources, and the acquisition of foreign technical expertise. As a result, on September 1, 1949, the Central Electricity Board (CEB) was established. Three of the key projects being evaluated by the Electricity Department in April 1946 were the Connaught Bridge power plant, the Cameron Highlands Hydroelectric Project, and the creation of a National Grid. The CEB bought 34 power plants with a total capacity of 39.88 megawatts, including a steam power station in Bangsar with a capacity of 26.5 megawatts and a hydroelectric power plant in Ulu Langat with a capacity of two megawatts. 28 MW is produced by a number of diesel generators with a total capacity of 11.1 MW. Amazingly, CEB purchased transmission and distribution networks worth around $30 million, employing 2,466 people, and having 45,495 customers. Personal generators are no longer necessary since everyone now has access to the same amount of energy. We heartily thank the government for recognizing the sector's importance to the development of the economy and society of the nation.

2.3 Electrical Energy

2.3.1 Energy Usage

As an ever-increasing number of social orders become industrialized, energy consumption continues to rise to such a degree that in countries with creative development. An example is the United States. Despite improvements in energy efficiency, private electricity use in the United States has increased by 49 percent over the last two decades due to a steady increase in the number of home electrical equipment[5]. As the contribution of

technology increases, people get more enthusiastic about using the latest electric and electronic products.

Consistent innovation of new local machines and other non-straight loads resulted in a significant increase of receptive and contortion control in the system, resulting in a variety of adverse effects, including transformer heating, conductor heating, and transformer losses, among others[6]. Nevertheless, industrial sectors continue to be the largest consumers of energy[7]. Without understanding energy usage, consumers continue to use household equipment with excessive energy consumption. This has brought the global energy situation to a critical crossroads. Currently, energy has been the most important factor in the continuous development of human society. Retrieved from the website of Malaysia's Ministry of Energy, Green Technology, and Water, illustrates that the primary energy supply increased by 2.9% compared to the previous year's level which is from 95,909 ktoe in 2018 to 98,681 ktoe in 2019. Except for coal, which showed a negative growth of 5.5 percent, other fuels increased in growth. This was because to fewer coal imports in 2019, notably in Peninsular Malaysia, compared to the previous year. From 1990 to 2019, the energy usage increased by 2370 ktoe for the residential sector. Figure 2-1 below shows the consumption of electricity by sectors in Malaysia from 1990 to 2019[8].