



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON ENERGY METER USING ARDUINO FOR HOUSEHOLD APPLICATIONS

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honor's.

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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 Electrical Engineering Technology (Industrial Automation & Robotics) (Hons). The member of the supervisory is as follow:

.....
(En.Mustafa Bin Manap)

ABSTRAK

Pembuatan Meter Elektrik menggunakan Arduino Uno adalah untuk menganalisis dan mengukur penggunaan elektrik dari barang-barang yang berasaskan elektrik di rumah. Lebih-lebih lagi projek ini membolehkan pengguna untuk mendapat bacaan penggunaan elektrik dengan lebih jelas lagi pada bila-bila masa sahaja dan dapat pengguna untuk berjimat apabila menggunakan elektrik serta memberikan peluang untuk pelan bajet mengikut jumlah penggunaan elektrik. Sistem ini mengaplikasikan teknik pembacaan arus iatu tanpa memotong wayar arus dan dapat mengelakkan kecederaan atau litar pintas. Projek ini adalah gabungan elektronik dan aplikasi. Pada bahagian elektronik sebuah peranti yang akan digunakan adalah Arduino Uno dan clamping current sensor, manakala untuk bahagian aplikasi pula Arduino IDE akan digunakan. Clamping current sensor akan di pasang pada wayar hidup iatu live wire untuk mengesan arus yang lalu dan menghantar signal analog kepada Arduino UNO. Arduino UNO akan memproses isyarat tersebut dan menukarnya kepada isyarat yang boleh di baca menggunakan peranti LCD I2C. Arduino Uno akan melakukan pengiraan, di mana pengiraan tersebut berdasarkan panduan TNB. Akhirnya bahagian elektronik akan di pasang di dalam acuan plastic dan dapat mengukur jumlah penggunaan malah dapat memberi pengguna penggunaan elektrik masa ke semasa.

ABSTRACT

The development of Energy Meter using Arduino is to study and measure the usage of electricity on household applications. Moreover giving user a clear view of the consumption whenever they wish to view and could help users to save electricity or plan their budget based on the usage. This system applies current sensing technique without the need to cut the wire open and brings no harm to users. This project is a combination of electronic and software. For the electronic part, an Arduino Uno board and clamping current sensor are used, while for the software part Arduino IDE were used. The clamping current sensor is used to measure current by clamping it to live wire to measure the flowing current and sends the analogue signals to Arduino Uno. The processor will process the signal and changes it into a signal where could be readable for us using LCD I2C. The processor does some algorithm which the tariff calculation and kWh calculation based on TNB datasheet. At the end the electronic parts were assembled in a moulded plastic container and could measure current and gives users a clear picture of their usage.

DEDICATION

I dedicate this project report to my parents and friends. A special thanks to my father Mr. Muthukumar a/l Subramaniam and my mother Mrs. Sundra Bujang who both taught me that even when the task seems impossible at first it can be accomplished if it is done one step at a time.

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LIST OF SYMBOLS

V	- Voltage
I	- Current
W	- Watt's
I/O	- Input & Output
Hz	- Hertz
B	- Magnetic field
GND	- Ground
J	- Joule
AC	- Alternating current
mA	- Mili Ampere
Vcc	- Input for Arduino
kWh	-kilowatt-hour
A	-Ampere
\$	-Ringgit Malaysia or pricing

LIST OF ABBREVIATIONS

RCCB	-	Residual Current Circuit Breaker
LCD	-	Liquid Crystal display
TNB	-	Tenaga Nasional Berhad
RM	-	Ringgit Malaysia
GSM	-	Global System for Mobile
SMS	-	Short message service
IoT	-	Internet of Things
GPRS	-	General packet Radio Service
IHD	-	In Home Domestic show
TOU	-	Time of use
ED	-	Electrical diagram
RAM	-	Random Access Memory
SoCs	-	System on Chips
BOM	-	Bill of Material
SRAM	-	Static Random Access Memory
USB	-	Universal serial bus
PC	-	Personal Computer
KWh	-	Kilowatt-hour
IC	-	Integrated Circuit
CT	-	Current Transformer
DIY	-	Do It Yourself
RMS	-	Root Mean Square
PWM	-	Pulse with Modulation
ICSP	-	In-System Programing
IoT	-	Internet of Things
GSM	-	Cell-phone network
SMS	-	Short Message Service

CHAPTER 1

INTRODUCTION

1.0 Background

Efficient power consumption and savings became a major issue recently and the need for power is increasing day by day. Domestic user such as residential customers is not aware of their consumption means to save it, and also sometimes power stealing could happen because of this. According to studies energy consumption is increasing year after year and if there is no action taken to prevent by 2030 energy consumption will be double same with 1980 level and will increase by 2006 (Barbato et al.). Energy cannot be conserved if residential and industrial area is still using electromechanical meter. Generally bills are often prepared by assuming and if it's a digital energy meter users are unlikely to know the amount of usage because the lack in tariff calculation. Meters that can show or display the amount in the term users could understand would bring a difference in saving energy. Smart energy meters with display that shows the amount of usage will be a game changing plan in conserving the energy consumption. In this situation smart energy meter using Arduino would give awareness towards the usage of electricity. This instrument is able to display the amount of usage in RM. This smart energy meter is only applicable for domestic house use only and it can be attached to an RCCB to check the amount of electricity of a certain device or machines. It helps the user to realize the amount of certain household applications and manage the usage of it to save electricity.

Microcontroller will read the amount of electricity consumed by the user. In this project Digital energy meter will be used to and microcontroller Arduino Uno will be used to count the unit from the current sensor and display the amount of

usage using LCD display. It will also display the current power, voltage and current. There will be also a reset button to initialize new count for the instrument.

The development and implementation of this project will bring awareness to domestic residential users. It will be an eye-opener to everyone on how to use, conserve and preserve electricity. This instrument would able to help users to plan their budget on coming month because without knowing the amount of electricity been used it will be hard for certain users to plan their budget. Other than that, this power metering system could prevent power thief by other user.

1.1 Problem statement

Energy meter has been introduced for residential and industrial section when usage of energy became wide. The energy meter main function is to detect energy and display it in Kilowatt/Hour for energy meter inspector to sum up bills. Energy meter is widely used in the world, when it is widely used proportionally along the growth of energy a lot of problems occur (K et al.). Because this project implements in Malaysia, Tenaga Nasional Berhad (TNB) sends bills which we can never figure out the amount of usage. As a user we always use electricity without knowing the limit, moreover when it comes to festive season electricity usage will rise up and along all expenses high electricity bill would be a big burden for users. Besides that, power stealing happens everywhere rapidly (Islam and Bhuiyan). With this device, users could plan their budget and conserve electricity using microcontroller Arduino Uno technology.

1.2 Objective.

The objectives of this project are:

1. To create and develop a smart energy meter using Arduino Uno for household applications and displays the usage in RM.
2. To compare and study smart energy meter reading with TNB energy meter reading and displays the value.
3. To prevent excessive usage of electricity and by informing users a clear view of how much electricity they are using.

1.3 Scope.

The scope of this project is mainly introducing smart advance technology to residential houses for monitoring their usage. Arduino Uno shall be used in this project for monitoring and calculating their usage. This project focuses on single phase residential areas only.

1.4 Summary / conclusion

This chapter has covered the background of the project, problem statement, objectives and scope of the project. The background of this project is about smart energy meter for monitoring. This project is designed to improve recent energy meter to a better one that can help users to conserve and use electricity wisely in their daily life. The objectives had been explained briefly and the scope discuss the hardware and software that been used in this particular project. Statement explains how this project could monitor particular household applications usages.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter introduces and shows the research done by other researcher that have relevant study case like mine that is smart energy meter monitoring system. In the same time, different studies related to smart energy meter will be discussed and determined. Literature which is similar and been investigated will be stated based on types of energy meter, such as wireless based and also using different communication platform. Methods and information from the previous papers will be compared and evaluated to produce good methodology to complete this paper.

2.2 Related Works

Various technologies have been developed to measure and monitor energy consumptions. For monitoring the usage, user usually refers to the energy meter reading which is in kWh where most of the users cannot understand what is stated. At present most of the houses in Malaysia uses electro – mechanical watt meter and the reading is not automated. User usually doesn't know the amount of the usage because it is not stated in Ringgit Malaysia (RM).

Next generation meter is also electro – mechanical but it is in digital state and it is better because the previous meter was in analogue state. With this digital meter user can note down the consumption of energy precisely, track down voltage and currents.

Then comes a digital meter equipped with global system for mobile which is known as GSM. This system is wireless and could send user SMS to inform the usage or uses to monitor the usage of energy. The latest technology for energy meter

is using IoT to be known as internet of things. This system replaces GSM and the energy data reading could be achieved online and monitoring could be done anytime and anywhere using online (Sahani et al.).

2.2.1 Design and Implementation of remotely located Energy Meter & mobile billing system through GSM.

Electricity is one of the most important features to build a modern country or a highly standard industry. In Bangladesh perspective, infrastructure field is not expanded like other country, insufficient and not well managed. In January 2014 installed electricity generation capacity was 10289 MW which is considered as three-fourth is available. There is technical and non-technical loss which is bad for the energy industry sector. In non-technical loss meter tampering, unapproved bills and so on, because of these problems 5%-7% (Islam and Bhuiyan) of power losses of total power generated Residential area meter billing system is not well stable because of irregular inspection of the meter data and most of the bills are prepared by assuming. Because of this customer suffers inconsistent billing though they use approximately same energy every month. Because of these growing problems the network meter-reading management is developed. The system will be automated meter reading, network technology, and by modern management ideas where they could manage, adjust, and predict their energy usage. To overcome this problem digital energy usage has been implemented but it is not enough to solve the problems mentioned earlier. Modification will be needed to ensure energy monitoring and digital billing to be established. The traditional energy meter is inspected by human and likely to have errors. Inspector will prepare bills based on assumption and it will be hard for residential and industrial. Some of the reasons are holidaying or admitted at hospital, the usage of energy can't be the same because they assume the bill. Electromechanical meter has many disadvantages such as lack of accuracy, can be modified to give false reading, electricity theft and many more, plus its lack of configuration (2016) (Dahringer). The current

system we are discussing can be remotely controlled by the authority to prevent such problems. It can also monitor meter reading regularly without the person going to the house or premise. In this paper a GSM 900 and Arduino Mega 2560 is been used to remotely monitor the usage of the energy by the authorities, monitoring can be worked using programming languages. Programming languages also executes logical functions, data storage, sending bills to the customer number and unsubscribe unpaid customers.

2.2.2 Arduino-based smart metering meter.

A smart meter is a digital device that informs consumptions of strength in ordinary periods and makes that record to be had to its stakeholders by way of a community interface (Klemenjak et al.). A smart meter could help to provide urgent comments on one's energy consumptions, significantly lessens the attempt to analyse the meter cost, will increase the grid's nation awareness supports the development of time-based totally strength tariff and likely helps getting short admission for switching on or off the strength flow. Except for tools used for power billing by using software agencies, smart meters can also turn out to be relevant aspect in the future. Self-sustaining electricity structures, such as clever micro-grid with nearby power manufacturing that wishes to be monitored and coordinated, so that it will assist these apps. There are requirement for a meter unit that could monitor measurements position which includes voltage, contemporary, active and reactive electricity. The electricity consumption of the meeting device itself has to be low with a view to keep strength consumptions and offer reasonable run-time with batteries. The smart meter is an open hardware which is designed with a connector interface compatible to the Arduino Uno platform, for that reason establishing the opportunities for smart meters with flexible hardware and computation capabilities. The metering platform features a current transformer which lets in a non-intrusive installation of the present day dimension unit. The advised design can switch load, offers a variable sampling frequency and gives dimension statistics which includes

active energy, reactive and real power. Outcomes indicate that measurement accuracy and resolutions of the proposed metering platform are sufficient for a range of various applications and loads.

2.2.3 Measurement of Power and Energy using Arduino.

Energy is an essential electrical quantity and the whole thing in our global today relies upon on having the power to hold them running. It is obligatory for an electricity engineer to recognize how much the amount of energy a plant generates and the amount of usage by users. This estimation helps in preventing electricity thieving and instantly reduces the transmission losses (Srividya Devi P et al.). Measurement of electrical power can be executed to measure electrical parameters of system. In the prevailing strength software installation, customers are offered with recording tools or software to record their bill data. Similarity usage bill can be convoluted in how they present the utilized data, and a purchase could not be able to convert changes of their strength usage from the bill. An opportunity to educate clients on electricity utilization is loss due to the realities. The aim of creating more awareness about energy intake might be optimize and discount in electricity utilization by the user. This would reduce their electricity costs, in addition to preserve power this paper bargains for the estimation using Arduino. The interest for control needs to be expanded according to growth of the world. Energy problem could be described through the energy reduction in a particular house. After many problems in power usage, it leads to accurate and economic power measurement. Collected data could optimize and make sure user use power wisely.