ADJUSTABLE POWER MONITORING SYSTEM (APMS) FOR DAILY USAGE

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Supervisor's Name : SITI AMANIAH BINTI MOHD CHACHULI

Date : .....

For my beloved family, friends and lecturers for helping and supporting me during my studies

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ABSTRACT

With the increasing the new tariff for electricity nowadays, people try to find a method to minimize their electricity consumption. But, this can only be achieved if they understand the pattern of their electricity consumption. A new device that can help user in gaining understanding about electricity consumption need to be developed. Therefore, this project has been conducted in order to increase the awareness of electricity usage among the residential consumers. This project consist of microcontroller, current sensor, LCD panel and switches. The current sensor will be clamped at the live cable in the main distribution board to sense the current flow. Then, the target value will be compared with actual usage of electricity. If the actual usage is exceeding the target value, a notification LED will turn on. The advanced power meter was designed with the ability to read the overall power usage in a house or at individual appliance and display the electric bill. This meter is suitable for the residential buildings as the current sensor used can measure RMS current up to 100A and power up to 240 kW. From the experiment conducted, the average highest error is 9.05% and the lowest average error made is 3.72%. Both error is less then 10%. Thus, the design power meter is reliable and robust to use.

ABSTRAK

Dengan peningkatan kadar baharu tarif elektrik, pengguna mencari jalan alternative untuk mengurangkan kadar penggunaan tenaga elektrik mereka. Tetapi, ini hanya boleh dicapai jika pengguna memahami pola penggunaan tenaga elektrik mereka. Satu alat yang boleh membantu pengguna memahami pola penggunaan tenaga elektrik harus dicipta. Oleh itu, projek ini dijalankan bagi tujuan meningkatkan kesedaran tentang penggunaan tenaga elektrik dalam kalangan pengguna di kawasan-kawasan kediaman. Projek ini mengandungi mikroprosessor, pengesan arus, paparan LCD dan suis. Pengesan arus akan dipasang pada kabel hidup di dalam kotak agihan untuk mengesan arus yang melalui kabel tersebut. Tahap penggunaan tenaga elektrik yang dijangka oleh pengguna akan dibandingkan dengan penggunaan tenaga elektrik yang sebenar. Jika penggunaan tenaga elektrik melebihi tahap penggunaan yang dijangka, peringatan akan diberikan dalam bentuk nyalaan lampu LED. Meter kuasa maju ini telah direka dan dihasilkan dengan kebolehan membaca keseluruhan penggunaan tenaga elektrik dalam sebuah rumah dan memaparkan jumlah kos bagi penggunaan elektrik tersebut. Meter ini sesuai untuk pengguna yang tinggal di kawasan kediaman memandangkan pengesan arus yang digunakan mampu mengesan nilai arus sehingga 100A dan kuasa hingga 240 kW. Daripada ujikaji yang dijalankan, purata peratusan ralat yang tertinggi adalah 9.05% dan purata peratusan ralat yang paling rendah adalah 3.72%. Kedua-dua ralat adalah di bawah 10%. Oleh itu, meter yang dicipta amt diyakini untuk digunakan.

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LIST OF AMBREVIATIONS

UTeM	Universiti Teknikal Malaysia Melaka
TNB	Tenaga Nasional Berhad
PLC	Power line communication
PPCOM	PLC Power-Controlled Outlet Module

Chapter I

INTRODUCTION

1.1 Introduction

Currently, much user are focused in how to reduce electricity consumption. Increasing in consumption of electricity is neither economical nor environmentally sustainable. Additionally, there is a growing consensus that environmental and economical sustainability are inextricably linked [1]. As the cost of electricity and power increases, we must find the solution to help reducing or at least optimize our energy use.

While household appliances are increasingly more energy efficient, a household has a plethora of personal electronic devices (gadgets) for each member of the dwelling. The typical end-result is a monthly electric bill that leaves the question of where all the kilowatt-hours has gone [2]. This is because user does not know the individual usage of household appliance and the only they know is the total amount of what they need to pay.

With recent technology, we will develop a device that will help consumer to monitor their usage of electricity in daily life. This work offers a simple solution to the growing power needs by raising the awareness of homeowners regarding how much individual household devices are consuming electricity [2]. With the aim to reduce the energy usage of the domestic devices, this project will produce a smart power meter which can display not only the total power, but also the electricity bill, so that the consumers can be more alert about the amount of energy being used in term of Ringgit Malaysia [4].

In the next section, we will have a view on problem statement, objective of project, scope of work, significant of study and how the thesis is organize.

1.2 Problem statement

Nowadays, awareness of saving energy has been quite high due to the efforts taken by the government and the authorities in reaching the public. These phenomena had created a new path of business opportunity for tools and devices related to monitoring and saving energy.

Affective from 1 January 2014, new tariff rates is set by Malaysian electricity provider which is Tenaga Nasional Berhad (TNB) for domestic customer. Table 1.1 shows the new tariff that has been set [3]. According to The Star online, the electricity tariff will be increased by an average of about 14.89% for Peninsular Malaysia, and by about 17% for Sabah and Labuan [5] when the new tariff is used. The new tariff set is slightly higher price than the previous year price which is in 2013. This mean, user need to pay more for their electricity bill even when they used the same amount of electricity. Other than that, user should put a limit at their usage of electricity in order to minimize their monthly electricity bill. For limiting and monitor the usage of electricity, a new home based power monitoring system should be developed. Thus, this project is proposed. With development of the project, consumer can monitor the power consumed at any time. Additionally, this power meter also will display the total price for the power consumed. Therefore, consumer can easily understand the pattern of electricity usage and at the same time encourage them to reduce the electricity usage.

Table 1.1 : New tariff for electricity [3]

TARIFF CATEGORY (for domestic usage)	UNIT	CURRENT RATE (1 JAN 2014)
For the first 200 kWh (1-200 kWh) per month	sen/kWh	21.80
For the first 200 kWh (201-300 kWh) per month	sen/kWh	33.40
For the first 200 kWh (301-600 kWh) per month	sen/kWh	51.60
For the first 200 kWh (601-900 kWh) per month	sen/kWh	54.60
For the first 200 kWh (901 kWh onwards) per month	sen/kWh	57.10
The minimum monthly charge is RM 3.00		

1.3 Objective of Project

The objectives of this project are as follows:

1. To develop a power meter for monitoring electricity for daily usage.
2. To analyse the overall performance of the project in term of efficiency and accuracy.

1.4 Scope of Work

This project is in limited scope as follows:

1. Arduino Uno will be used in this project.
2. Only single phase system will be monitored in this project.
3. The unit of power used for this project is kWh.
4. Acceptable percentage error in this project is 10%.

1.6 Significant of Study

This project should be able to help user at home by minimizing their electricity usage by setting a limit for their everyday usage of power. Most residential consumer only received feedback on their energy use in the form of monthly bill. The utility in Malaysia only give one monthly reading for electricity use, which does not encourage consumers to examine their electricity usage pattern. With increasing in electricity tariff nowadays, this project can be applied as one of the solution for rising awareness in minimizing the usage of electricity. Also, with the increasing concept of smart home and automation, this project can be implemented to give an additional feature on smart home concept. User can monitor their everyday usage of electricity by referring to LCD panel and LEDs on power meter. If the electricity usage in a day is exceeding the limiting usage, the LED will light on. Thus, the user will know the status of electricity usage of their home.

1.7 Thesis Organization

This report consists of five chapters. The overall summary for each chapter are as follows.

Chapter 1 discuss briefly about the introduction of the project, which consists of project objective, problem statement, scope of work, significant of study and thesis organization.

Chapter 2 is about the review of the previous work which had been done by other researcher that may have some similarities. It include the study of power line communication concept, client server concept, current and voltage sensor concept, energy metering IC and previous design of power meter.

Chapter 3 explains the methodology of this project. This chapter consists of flowchart, software development and hardware development.

Chapter 4 discuss about the experiment results from the prototype. Accuracy analysis will be carried out in this chapter.

Chapter 5 presents overall conclusion of the project. Some recommendations to improve this project is also highlighted so that it can be applied in the future.

Chapter II

LITERATURE REVIEW

This chapter explains about the previous research on energy measurement. A brief explanation about the perspective and methods used in the previous research is presented in this chapter. A few types of power meter also presented in this chapter.

2.1 Previous Research on Energy Measurement

With the increasing of electricity bill, a lot of methods were introduced in order to minimize the usage of electricity and consequently reduce the electricity bill. One of the most practice method is the introduction of energy saver device such as Power Tune Power Saver[10]. This device is used to reduce the current used in electrical

appliances. However, this method will only save some amount of electricity bill, not rising awareness towards consumers on how important to save electricity usage. In order to raise the awareness of pattern of energy usage, consumer need to know how much the energy that have been used by them every day. One of the method is by measuring the usage of electricity. In the next section, we will discuss the methods that have been used by other researchers to monitor the energy usage.

2.1.1 Power Line Communication Concept

Power Line Communication (PLC) is a communication technology that able to transmit data over existing power cables. This method used same power cables to power up an electronic device and to control/retrieve data from it in a half-duplex manner. PLC applied same concept in communication technology whereby a sender modulates the data to be sent, injects it onto medium, and the receiver de-modulates the data to read it. The major advantage of PLC is no extra cable is required since it used existed wiring. Other than that, all line- powered devices in PLC also can be controlled or monitored [6].

Lien et *al.* proposed a system for monitoring power based on power line communication. They introduced a no-new-wire embedded system to monitor and control power at home. This system used Power Line Communication (PLC) technology and hence, electrical appliance at home can be controlled and monitored through domestic power line. This system consists of three parts which are PPCOM (PLC Power-Controlled Outlet Module), embedded home server and remote control. Any electric home appliance plugged into the socket of a PPCOM can be controlled and monitored without making any additional setting. By combining PLC and Ethernet technologies, PPCOM can be connected to the embedded home server without any new additional wire lines. Thus the user can manage electric home appliances and remotely monitor the power consumption status of the electric home appliances by means of the remote Web browser. The remote Web browser with a GUI allows the user to easily control/monitor the power status of electric home appliances. Figure 2.1 shows the overall block diagram of the proposed system [6]

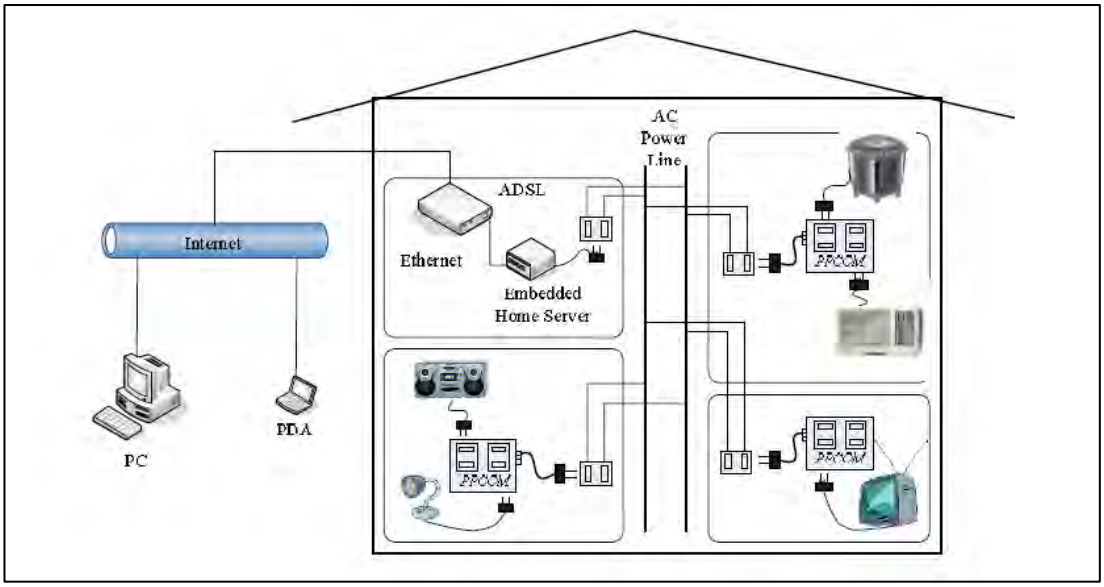

Figure 2.1: Overall block diagram of the system

Figure 2.1 shows an overview of the embedded system which consists of three parts: the PPCOM (PLC Power-Controlled Outlet Module), the embedded home server and the remote control. Any electric home appliance plugged into the socket of a PPCOM can be controlled and monitored without making any additional setting. The PLC and the asymmetric Digital Subscriber Line (ADSL) which has been selected for a wide area network have also been selected for the home network. By combining PLC and Ethernet technologies, PPCOM can connect to the embedded home server without any new additional wire lines.

De Guia et *al*. presented a system that able to monitor and consolidate information regarding the energy consumption of individual appliance. The system can measure instantaneous wattage and volt-ampere and it also able to monitor power consumption within one percent. The system consists of one or more power monitoring devices and a server to store the data that has been recorded by the power monitoring devices. This method will involves monitoring and recording the energy consumption of one or more household appliances, the storage and display of the information in an organized manner and finally, the transmission from the power monitoring device to the server, which will involve power line communication

technology. The operation of the proposed system is started with monitoring the energy consumption. This can be achieved by placing the monitor between the appliance and the power outlet. Then, data is sent through the power lines as soon as the server broadcasts a request, or being manually requested by the homeowner. Once the server has received the information, it will organize the information and display the data in its web-based interface for the homeowner to view. To verify the accuracy of the power analyzer module, several household light-bulbs were tested, mixing full length fluorescents, CFLs and LED types [2]. The test yielded a 100% success rate, which is expected since there are no other factors affecting the data that is sent.

2.1.2 Client Server Concept

Client Server concept is a two way communication between the provider of data, which is the server and the receiver of the data which is the client. This system requires client to request a data from server. When someone need a data, they will request to the server. After the data is acquired, the server will reply to the client.

Chobot et *al*. proposed a system that can help users to have a better understanding about their electricity usage patterns and consequently adapt their behaviour to reduce their energy consumption and cost. This system has two major functions which are energy measurement module and remote power on/off control module. Figure 2.2 and 2.3 show the block diagram for both the measurement node module and remote power on/off control module [7].

Figure 2.2 shows the measurement nodes have two-way communication with the central server. Each measurement node in the network is connected. At first, it will read the energy use of one AC appliance, and wirelessly reports the readings to the central server for processing.

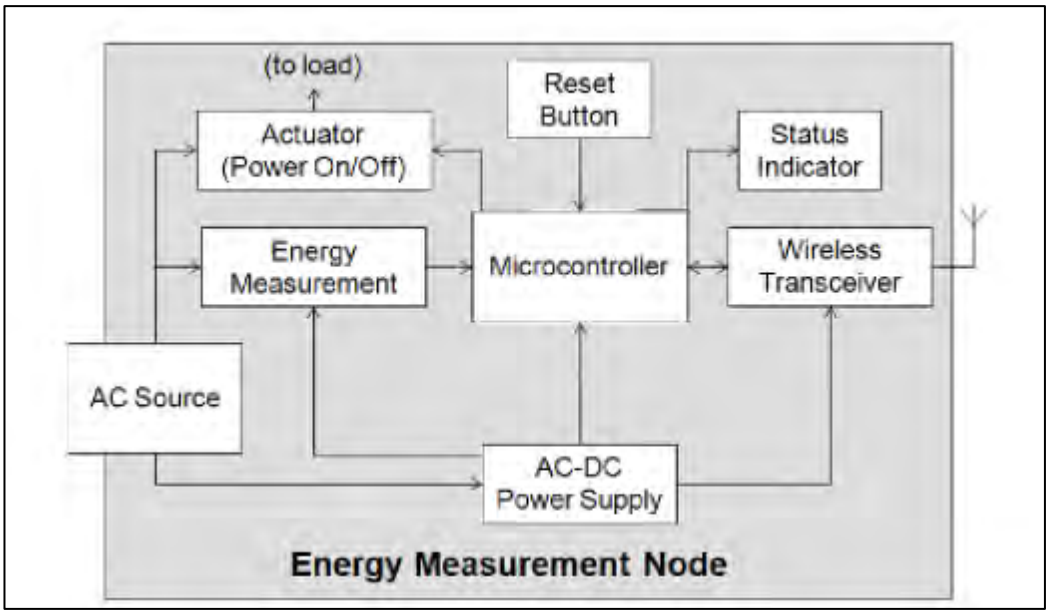

Figure 2.2: Block diagram of measurement node module [7]

Figure 2.3 shows the server displays the readings from these nodes through a user visual interface in real time. The remote power on/off control module is integrated with an actuator into each measurement node that will automatically turn on and turn off the power supply to the products.

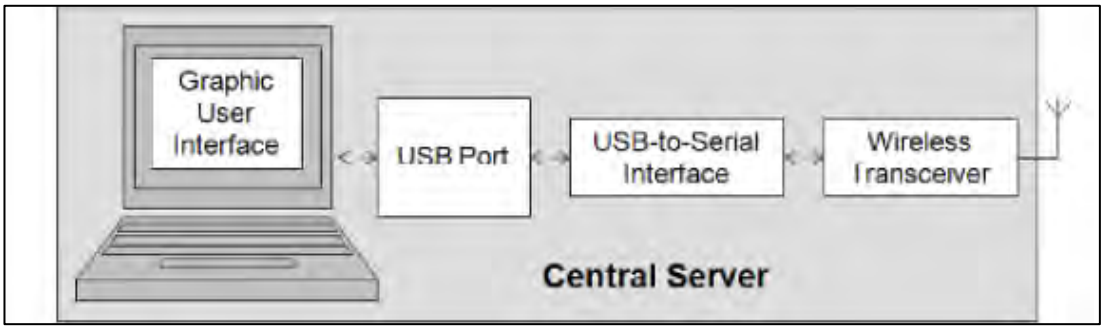

Figure 2.3: Block diagram of central server module [7]

Irid et *al*. also presented a system for measuring power with the aid of Bluetooth communication. He state that, the meter reader carrying a device such as mobile phone or laptop, then sends a signal "demand reading" via Bluetooth to the system connected to the all meters in the building. After that, the systems load all the customers data and emits them to the meter reader. This shows the efficiency of the