SMS-Based Electrical Energy Meter: A Hardware Design

Mohd Helmy Abd Wahab, Herdawatie Abdul Kadir, Azhar Ismail, Ayob Johari, Mohamad Farhan Mohamad Mohsin

Abstract — Besides air and water, electricity is one of the most important elements in human life nowadays. Electricity is needed to make all the electric and electronic devices working properly. In Malaysia, Tenaga Nasional Berhad (TNB) is responsible in supplying the electricity to all houses and premises. This paper describes the development of power meter reading system with integration with GSM network. The device created can help Tenaga Nasional Berhad to overcome their problems in capturing meter reading as it incurs high cost. This project concentrates on designing a system that can send meter reading from the user premises to Tenaga Nasional Berhad office via SMS. The data transmitted will be received by the database system to analyze, generate a bill and store the data. The implementation of the project involved two different components; software and hardware. Microcontroller PIC16F877A was used in this project and was programmed using Mplab software. The program and the designed circuit were simulated using Proteus software to make sure it was working properly. The prototype meter was connected to the circuit to send the data using the GSM modem. At the final stage, the complete system was integrated within its hardware and software to turn these two components into one complete system. Currently, the prototype is suitable to be apply in a rural environment due to the individual house is scattered randomly at particular region. Thus the prototype could ease the authorized to manage the electrical bill efficiently.

Keyword : *SMS, GSM Modem, microcontroller, meter reading*

INTRODUCTION

Electrical energy is one of the most important things in modern life. Electricity is required to operate all electrical and electronic appliances or machines in factory. In Malaysia, TNB responsible to supply the electrical energy to all house and premises by providing each house with kWh analog meter. The meter is used as a device to record the energy that has been used. The main purpose of this study is to improve the process of capturing the meter reading from the meter rather than the conventional method. The device can help to reduce the problem faced by TNB in which they have to send a meter reader to record the meter reading. Since the rapid growth of ICT, the use of SMS is increasing dramatically. The SMS is the fastest and the most efficient communication technology in today's world. SMS technology has been chosen due to its low in maintenance cost. This project intends to innovate the current existing meter to be associated with SMS technology through GSM network so that the meter reading can simply be sent by the meter itself without any human contact. The SMS content includes of meter ID, date, time and the total usage. These data were then recorded by the billing system for bill issuance.

Conventional method that is currently being used by the TNB is to download all the previous meter readings into a hand-held device carried by the meter reader. This can only be carried out when the meter reader could get access into the meter. The problem arises when the meter reader couldn't get access to it especially when the house owner was not in or the entrance gate was locked. The actual meter reading could not be read or recorded and it is merely an estimated value. The need of personnel to read the meter-reading sometimes contributes problem especially when involving cost. These problems could be minimized by utilizing SMS technology for each meter which automatically sends the meter reading to the nearest TNB branches. The meter reading then is used by the billing system to generate the bills.

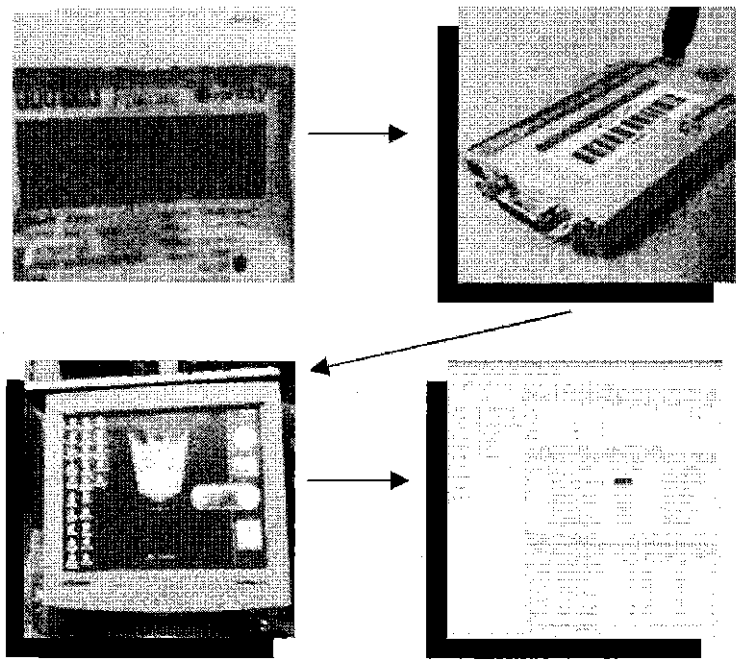

Figure 1: Block Diagram

Figure 1 shows the connection between the major parts in this project. The process starts at the meter unit where the usage value is generated by PIC16F877. The value is transmitted using GSM Modem that has been connected to the meter. Then the data is received by another modem which is placed at the TNB's office. The data are transferred to the computer, analyzed and generate the bill.

RELATED WORK

The SMS system has been widely used and gained a lot of attention from many researchers. Study indicates by [8] which developed a system that allows people to monitor and control the house appliances via SMS. The system operates via mobile phone set by sending commands in SMS form. Two types of SMS messages were used in the system. One is outgoing message from the system to the homeowner's mobile and the other is incoming SMS messages from the homeowner's mobile to the system while [6] using the SMS system to transmit a vehicle location and status with aid of GPS. However, the project developed by [4] is a system for remote control and remote monitoring the house appliances via SMS from anywhere as long as in the range of GSM network. The devices that connected to the system such as lights, can be turned on or off through SMS. The reason on why GSM system has been chosen because it has a wide coverage, wireless and mobile.

An SMS application also has been applied in education as indicated by [7]. The SMS system were used for variety of academic and administration services such as notifying the assessment result, exam dates and assigning learning task while a study done by [2] demonstrates the SMS text acceptance among college students in Malaysia. The research shows that SMS user acceptance is very high among college students. In addition, [1] also develop a system that act as a medium between students and lecturers in delivering and spreading information. The system is developed using Active Server Page (ASP), Macromedia Dreamweaver, SQL Server 2000 and also using GSM Modem with Rabbit Processor. A study [3] designs a notice board using SMS system to change the info display on the board. The main purpose of the design is to help the lecturer for example update information to their student while they are not around.

Instead of using mobile phone, PDA and web sites, the SMS data also can be received via GSM Modem [1]. In this study, modem is the main equipment to receive the data. Modem is a contraction of the Modulator and Demodulator. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves as a dial-up modem. The main difference between them; is a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

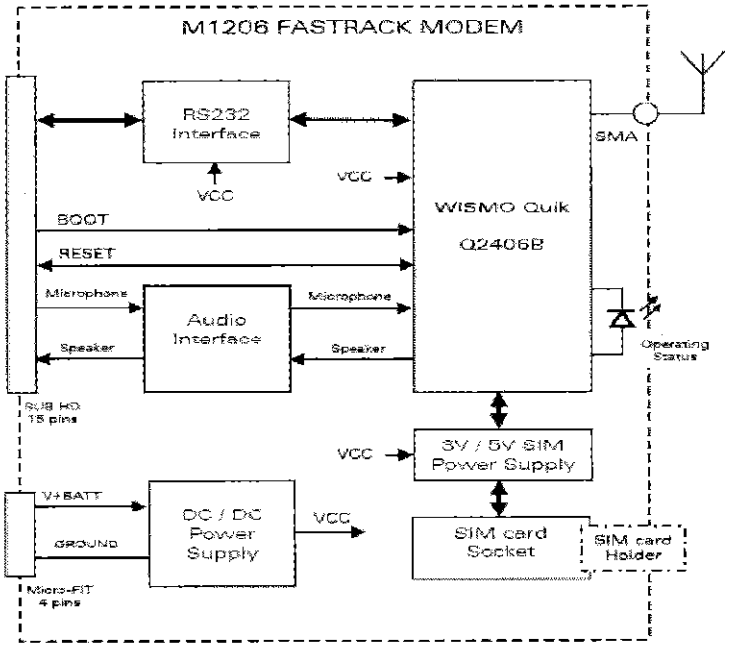

Figure 2: Architecture of GSM modem

Figure 2 illustrates the architecture of GSM Modem. WISMO Quik Q2406B acts as a power supply interface. For the RS232 interface, it is available to allow send/receive to/from the GSM modem data. Meanwhile for Audio interface, it consists of two different microphone inputs and two different speaker outputs. Finally, for SIM interfaces, there is a slot to place the identity chip of the users where the information of the users can be read from it by the modem.

In order to send and receive the SMS data, there are several softwares needed to work with GSM Modem. They are AT commands which is used with HyperTerminal to work with GSM Modem [3] and highlevel programming such as Visual Basic, C/C++ programming or Java to send and receive the AT ASCII command and read messages at the computer from the serial port where the GSM modem is attached to. GSM technology was chosen because its technology has been so popular these days and also its application is very mobile, easy to operate and does not require a lot of maintenance cost.

DESIGN AND DEVELOPMENT

The implementation of the project involved two different components; software and hardware. Microcontroller PIC16F877A was used in this project and was programmed using Mplab software. The program and the designed circuit were simulated using Proteus software to make sure it was working properly. The prototype meter was connected to the circuit to send the data using the GSM modem. At the final stage, the complete system was integrated within its hardware and software to turn these two components into one complete system. Figure 3 shows the block diagram of the project in general.

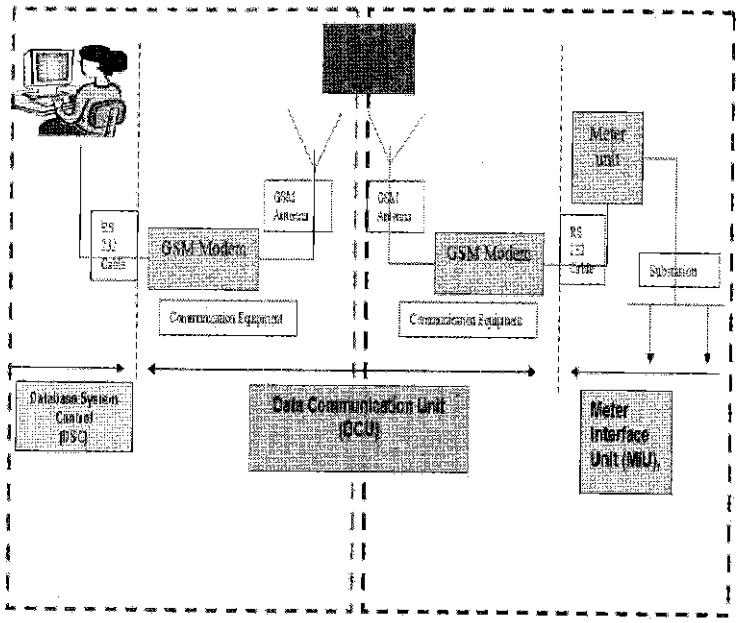

Figure 3: Architecture of the prototype

TEST

A series of tests have been conducted on the complete system to make sure the meter reading system is working properly as it has been programmed. From the test any problem and flaws of any part of the system can be easily identified and rectified.

A. Prototype System Simulation

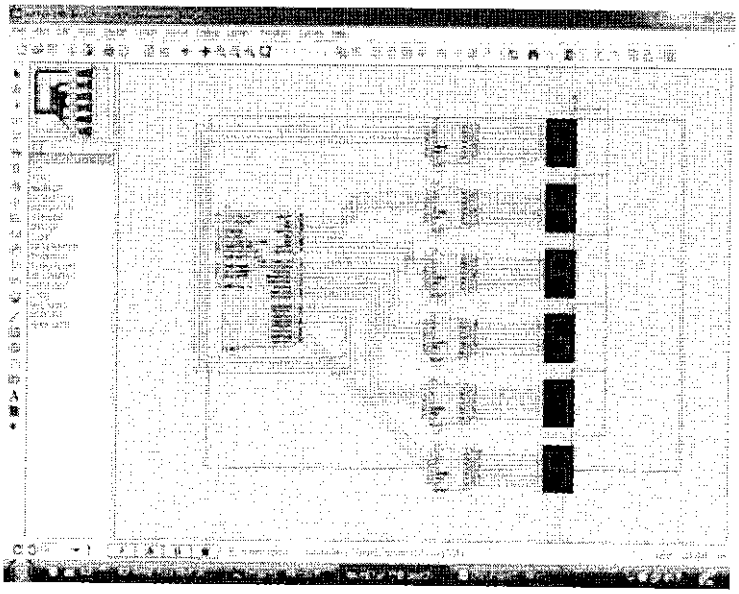

Figure 4: Circuit Simulation

Figure 4 shows the circuit simulation using Proteus software. The simulation is done to make sure the connection between each component in the circuit and the program in the PIC16F877A is correct. The hardware is built after the simulation shows the desired outputs.

B. Prototype Meter Reading

Table 1 shows the increment of meter reading test. The tests were carried out to determine the values generated by the PIC16F877A are increasing each time the switch is pressed. This test is crucial because the circuit needs to generate value that is larger than the previous value generated to make the bill calculation possible.

Table 1: Increment of Meter Reading Test

No. of experiment	No. of switch	Meter Reading (KWh)	Increment of reading
1	0	000000	-
2	1	324562	√
3	2	549574	√
4	3	672133	√
5	4	823837	√

Electrical Power Usage (KWh) = Latest Meter Reading – Previous Meter Reading

C. SMS Circuit

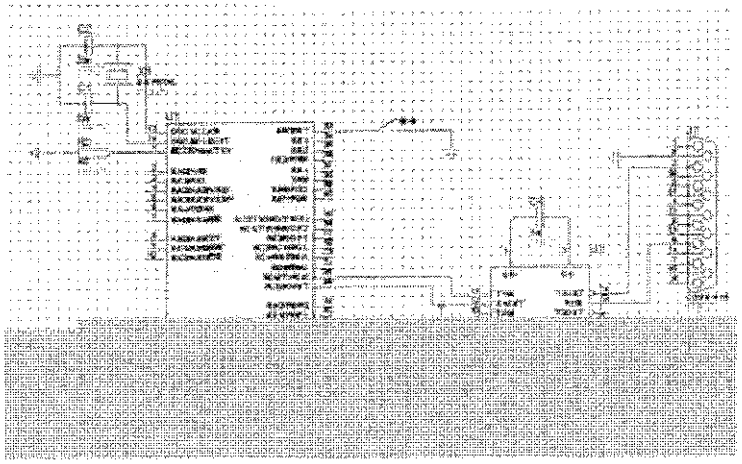

Figure 5: SMS Circuit

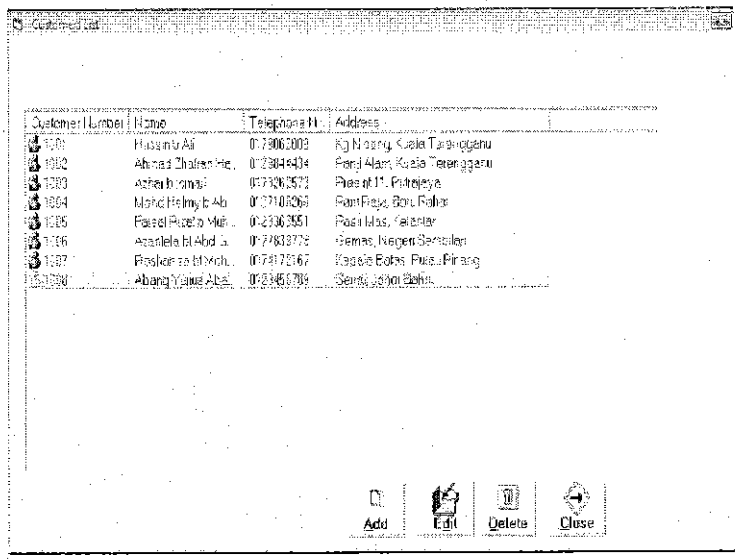

Figure 6: Integrated Customer billing system

Figure 5 shows the schematic diagram of the connection between the circuit and cable connector (RS232). This circuit was tested to make sure its ability to send the data through the GSM modem. From the test it was found that the complete system worked as expected. Some minor problems were identified and managed to be rectified and solved. As illustrated in Figure 6, customer billing system located at the server manages the SMS sent to calculate the amount based on the meter reading. The current meter reading minus with previous meter reading to produce the total usage. Figure 7 illustrates the amount generated from the system.

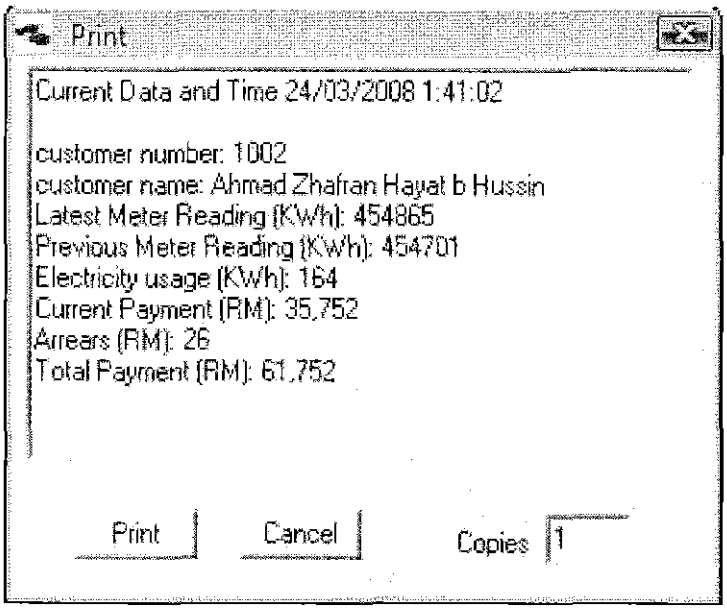

Figure 7: Bill generated from the system

CONCLUSION

As an overall, the implementation of the project was a success. However a few recommendation need to be taken into account when developing this project in future, they are; back-up power supply to continuously supply power to the house, memory device that can store the power usage (KWh) in case of power failure, and an LCD display instead of 7-segments display which can display more information than the 7-segments.

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