

Implementation Of Energy Monitoring And Control Device Based On IoT

Aniket Savaratkar^{#1}, Chinmay Sawant^{#2}, Kunal Patil^{#3}, Shuham Patil^{#4}

B.E. Electronics and Telecommunication Engineering

Shivajirao S. Jondhle College of Engineering & Technology, Mumbai University

Mumbai, India

Assistant Professor Harsh Jondhle

Abstract:-The use of wireless automation in almost all the fields of power, gas and water generation, distribution and billing has come of age. Here with the inclusion of wireless communication with the automation may lead to paradigm change in the current trend. The design presents a new methodology for avoiding the high construction and maintenance costs in the existing meter reading technology. Apart the use of wireless meter reading with network technologies has become need of the day. The designed system avoids the human intervention in Power Management. The Consumer has to pay the bill in time, if couldn't, the power connection may be disconnected automatically from the remote server. It displays the corresponding billing information on LCD and data is sent to the server through the GSM Module. The ARM7 based hardware system consists of a processor core board and the peripheral board. The entire programming for microcontroller operation is based on Embedded C Language. This system provides efficient meter reading, avoiding the billing error and reduces the maintenance cost. This paper also addresses advantages of implementing the GSM communication module and design detail and discusses the advanced security of the data communications.

Keywords:-Wireless meter reading, GSM, ARM7 (LPC 2148) Microcontroller.

I. INTRODUCTION

With the rapid developments in the Wireless communication technology by the use of microcontrollers, there are many improvements in automating various industrial aspects for reducing manual efforts. The traditional manual Meter Reading was not suitable for longer operating purposes as it spends much human and material resource. It brings additional problems in calculation of readings and billing manually. Now-a-days the number of Electricity consumers is increasing in great extent. It became a hard task in handling and maintaining the power as per the growing requirements. Presently maintenance of the power is also an important task as the human operator goes to the consumer's house and produces the bill as per the meter reading. If the consumer is not available, the billing process will be pending and human operator again needs to revisit. Going to each and every consumer's house and generating the bill is a laborious task and requires lot of time. It becomes very difficult especially in rainy season. If any consumer did not pay the bill, the operator needs to go to their houses to disconnect the power supply. These processes are time consuming and difficult to handle. Moreover, the manual operator cannot find the Un-authorized connections or malpractices carried out by the consumer to reduce or stop the meter reading/power supply. The human error can open an opportunity for corruption done by the human meter reader. So the problem which arises in the billing

system can become inaccurate and inefficient. The availability of wireless communication media has made the exchange of information fast, secured and accurate. The digital implementation caused the rapid utilization of devices such as computers and telecommunication devices. Communication media like the internet, GSM networks, etc exists everywhere. Wireless meter reading puts more control into the hands of both utilities and consumers by giving them more detailed information about power consumption [1]. This allows utilities to better regulate supply. So, remote wireless meter reading system and management kinds of network technologies has become a trend now. In the work presented here, a technique has been developed to read electricity meter readings from a remote server automatically using the existing GSM networks [3] for cellular phones. This technique can be applied for gas or water meters as well. The meters send the meter readings like kilo-watt-hour (kWh), voltage, current, bill, etc. by SMS to a central server. The central server then stores the information in database for analysis and sends the bill to the customer mobile phone. The SMS based data collection can be done very quickly and efficiently. Data can be collected after any desired time interval such as hourly, daily, weekly, or monthly basis. As there is no human intervention in the entire process, there is no chance of human error and corruption. In the extremely bad weather conditions like heavy snow, rain, storm, etc the system will not hamper on collecting data as long as GSM networks are stable. The development cost of the SMS based remote meter will be higher than conventional meter but the electric supplier revenue will increase in the successive months because it will eliminate the possibility of corruption done by the customer or as of a reader. Remote meter can be used in residential apartments and especially in industrial consumers where bulk energy is consumed.

II. LITERATURE REVIEW

A survey of the already existing literature on energy meters show that a lot of developments have been reported in implementation of meters which record and display the domestic power consumption. presents the implementation of an energy meter which is based on non-invasive current sensing. Non-invasive current sensing has the advantage that it can be placed at any point where the power is to be measured. The energy consumption details in this case are displayed on a smart phone. ENC28J60 Ethernet module was used to send data over the internet. S.H Ju et.al have devised an automatic meter reading device (AMR) based on powerline communication (PLCC). PLCC involves sending data over the electrical wiring cables. This possibility requires appropriate modification in the domestic wiring of house. Moreover, it uses

invasive technique to sense the current from the mains. The disadvantage with this kind of a system is that the user cannot measure the power consumed by an individual device. Explains the implementation of a wireless automatic meter reading system (WAMRS) which incorporates the widely used GSM/GPRS network. The system includes a microcontroller, which periodically transmits power consumption values calculated from the sensed voltage and current values via an existing GSM/GPRS network, to a master station. The main disadvantage of this technology is distance factor. A strong GPRS or GSM network coverage at long distances may not be available whereas the other disadvantage might be speed of operation. Considering the inputs provided from various literatures, this paper proposes a portable energy meter using non-invasive technique for sensing the current using a split core current transformer. The internet connectivity is established through Wi-Fi module ESP8266. Real-time acquisition of energy and its remote monitoring can be implemented by adopting the concept of IoT.

III. FUNCTIONAL UNITS

The basic hardware components used in the Project are shown below in figure.2



Fig2. System hardware

- A. ARM7- LPC2148 Microcontroller
- B. Energy meter
- C. GSM Modem
- D. Relay control unit
- E. Power Supply

A. ARM7 (LPC 2148) Microcontroller

A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty.



Figure 3. LPC 2148 Microcontroller

Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 KB up to 40 KB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

B. Energy meter

Energy meter module is composed of ADE7757 which is energy metering IC with integrated oscillator and load and which produces the analog signal can be converted into digital signal and that digital signal in the form of pulses and ADE7757 outputs average real power information based on the load. These outputs are interfaced with the LPC2148. One of the features in ADE7757 to enhance the capability of this work is having a power supply monitoring circuit on the VDD supply pin of the ADE7757. Due to this, proper device operation is achieved at power up and power down modes. High degree of immunity to false triggering from noisy supplies is attained due to built-in hysteresis and filtering operations in power supply monitor of the ADE7757.

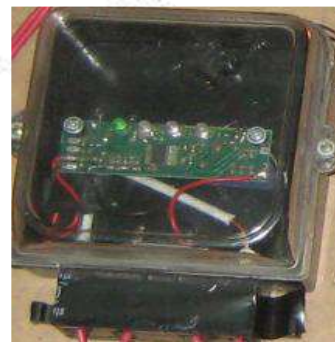


Fig 4. ADE 7757 Energy meter

Depending on the data received from the energy meter Module, it sends information of the user meter to remote place through wireless communication module. In addition to that, the same information is sent to the user through LCD.

C. GSM Modem

The Communication Module consists of GSM Modem. It is used to transfer the data of the user meter from LPC2148 controller to remote station by GSM wireless module. The serial communication with the modem is full duplex 8 bits, no parity, 1 stop bit and at 115200 bauds. We have used Subscriber Identification Module (SIM) in the modem.



Fig 5. GSM modem

D. Relay Control Unit

Relay control unit is used to shutting off the electric power supply when the due date is over. Whenever the user pays the bill the electric power supply is resumed by the relay module. The relay is driven by the LPC2148 controller.

The user can monitor power consumption details on LCD. Controller of the Wireless meter reading system [8] is a 32bit ARM7 CPU (LPC2148). The system communicates with the remote station through communication module.

Depending on the information received from the remote station, the LPC2148 can control the Relay module to shut off or resume the electric power supply.

IV. RESEARCH METHODOLOGY

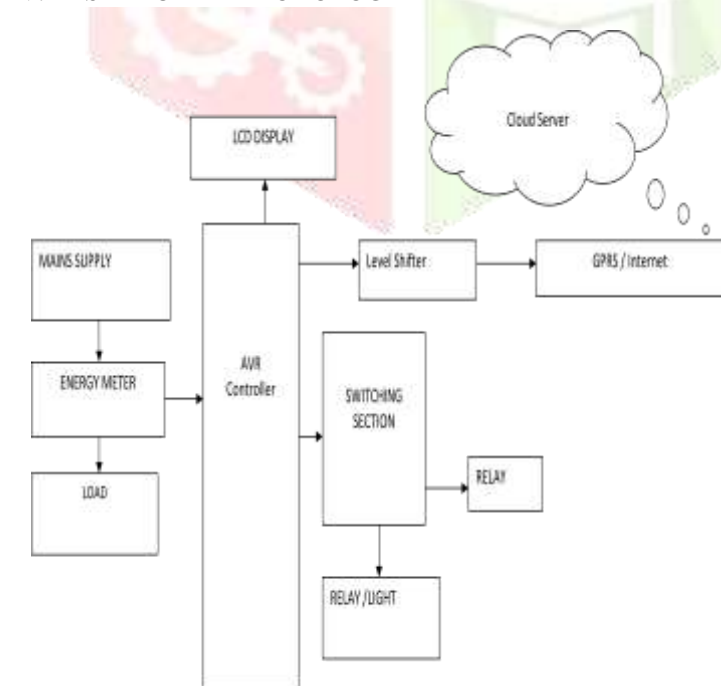


Fig 5. Wireless meter reading system

V. DESIGN AND DEVELOPMENT

A. Hardware Design and Working

The proposed system is tested in the place of conventional power meter and achieved good results. Figures 6 to 11 shows the actual photographs of the proposed system. LPC2148 is interfaced with GSM module, Energy meter Module, the Relay Control Unit. For demonstration purpose, 60Watt bulb is used as load to examine our system. The bulb is connected to load and the Energy meter (ADE7757), which is used to measure the average real power information. The test is performed and power consumption [9] is observed. During this period the bulb glows continuously which is shown in Fig 6. After the due date, the LPC2148 controller turned off the bulb through the relay, which proves the accuracy of our system in terms of the power and calculation remote controlling.



Fig 6. Wireless meter reading system PCB when the load is ON and the interfacing of Energy meter, ARM7 (LPC 2148) Microcontroller modules.

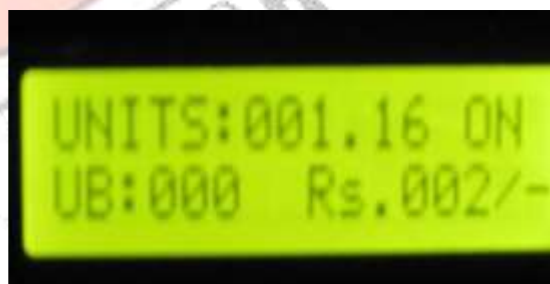


Fig 7. LCD showing the energy consumption values, billed amount and status of the system is also displayed when system is ON.

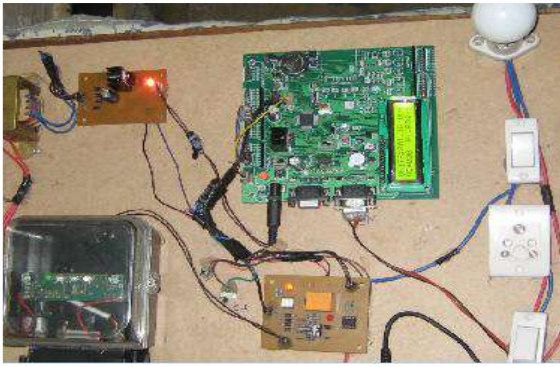


Fig 8. Wireless meter reading PCB when the Load is OFF and the interfacing of Energy meter, ARM7 (LPC 2148) Microcontroller modules. Automated Wireless Meter Reading System for Monitoring



Fig.9: By sending the command “#DCONNT” through the mobile phone the GSM modem receives the command and the load will be disconnected and an reply message will be sent to the mobile phone regarding the current status of the system.



Fig.10: LCD showing the power consumption values and the billed amount and status of the system is also displayed when it is OFF.



Fig.11: By sending the command “#CCONNT” through the mobile phone the GSM modem receives the command and the load will be disconnected and an reply message will be sent to the mobile phone regarding the current status of the system.

Energy consumption calculation:

The total energy consumed is given as shown in the below formula.

$$\begin{aligned} \text{Total energy consumed} &= (\text{Wattage} \times \text{No. of hours used per day}) \div 1000 \\ &= \text{Kilowatt hours (Kwh)} \end{aligned}$$

From the above table we can say that if the load is disconnected immediately after the due date then there will not be any loss of energy consumption, but it is not possible through the manual operating systems. This can be achieved by using the wireless meter reading system which automatically disconnects the load when the user has not paid the bill in the specified time. So by using the proposed system all the problems of manual system are eliminated by using the wireless meter reading system.

C. Application

- It is ideally suitable for large and medium size commercial and industrial applications.
- It fully incorporates the requirements of the smart grid market and distributed the generation trend.
- Its plug and play communication module supports RF/GPRS/3G/LTE communications facilities.
- The meter offers the accuracy class which provides more accurate billing data that improves the revenue management for the customers.

D. Advantages

- Benefits for consumer and the environment.
- Helps to reduce power outages and tripping of electrical system.
- Helps to consumer to economize to receive lower energy bills.
- It support bi-directional and uni-directional measurements.
- Reactive energy measurement.
- Plug-and-play modularized design for GPRS/3G/LTE up-link.

E. result

The meter was tested against the different loads to determine both it's accuracy and it's adaptability to varying loads

The measurements were taken on the same day, in 1 minute intervals, each of 15 minute duration i.e. for each load the power consumption values were transmitted from the meter each minute, and the readings were recorded for 15 min.

These tests were also performed on different days for determining the correlation of the results

VI. CONCLUSION

In the present work wireless meter reading system is designed to continuously monitor the meter reading and to shut down the power supply remotely whenever the consumer fails to pay the bill. It avoids the human intervention, provides efficient meter reading, avoid the billing error and reduce the maintenance cost. It displays the corresponding information on LCD for user notification.

REFERENCE

- [1] Li Xiaoguang Hu, "Design of an ARM-Based Power Meter Having WIFI Wireless Communication Module" IEEE 2009.
- [2] B. S. Koay, et al, "Design and implementation of Bluetooth energy meter", Proceedings of the Joint Conference of the Fourth International Conference on Information, vol. 3, pp.1474-1477, Dec. 2003.
- [3] Petri Oksa, Mikael Soini, "Considerations of Using Power Line Communication in the AMR System", 2006 IEEE International Symposium on 26-29, pp.208-211, Mar. 2006
- [4] S. Battermann and H. Garbe, "Influence of PLC transmission on the sensitivity of a short-wave receiving station," IEEE Power Line Communications and Its Applications, pp.224-227, Apr. 2005.
- [5] Chih-Hung Wu, et al, "Design of a Wireless ARM Based Automatic Meter Reading and Control System", Power Engineering Society General Meeting, 2004. IEEE 6-10, Vol.1, pp.957-962, June 2004
- [6] Yu Qin, "The Research and Application of ARM and GPRS Technology in Remote Meter Reading Terminal Equipment", A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Engineering, 2007
- [7] Honestar Electronics Co., Ltd, "Single-phase bidirectional Power/Energy IC-CS5460A", Jan.2003.
- [8] L. Shiwei, et al, "Design of an automatic meter reading system," Proceedings of the 1996 IEEE IECON 22nd International Conference on Industrial Electronics, pp.631-636, Aug. 1996
- [9] Liting Cao, Jingwen Tian and Dahang Zhang, "Networked Remote Meter-Reading System Based on Wireless Communication Technology" in International Conference on Information Acquisition, 2006 IEEE.
- [10] Liting Cao, Wei Jiang, Zhaoli Zhang "Automatic Meter Reading System Based on Wireless Mesh Networks and SOPC Technology" in International Conference on Intelligent Networks and Intelligent Systems, 2009 IEEE.
- [11] P. Zerfos, X. Meng, S. Wong, V. Samanta, and S. Lu, "A study of the short message service of a nationwide cellular network," in ACM SIGCOMM Internet Measurement Conf., Oct. 2006.

