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Automated Wireless Meter Reading System for Monitoring and Controlling Power Consumption

O. Homa Kesav, B. Abdul Rahim

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.

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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. SYSTEM ARCHITECTURE

The high level block diagram of the wireless meter reading system is shown in the Figure.1.The Power Supply section supplies all other components with required Power.

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The ARM7 LPC2148 microcontroller module takes the data from the energy meter and performs the necessary control operations like breaking the circuit through Relay control unit and the required information to the mobile phone via the communication module [2] GSM. The MAX-232 which was inbuilt in the ARM7 is used as a serial communication interface for the GSM modem for transmitting the data from

the controller to the mobile phone. In the Load bank section a 60W incandescent bulb is used as a load for the purpose of energy consumption of the user.

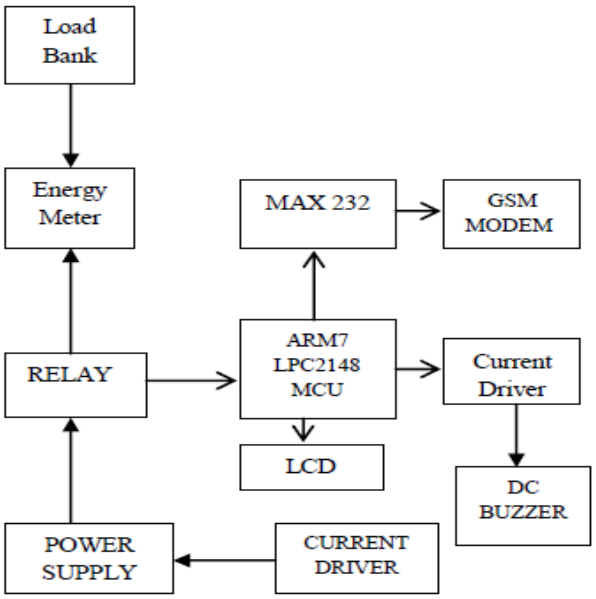

Figure 1. Wireless Meter Reading System

The user can obtain the status of the energy consumption and the billed amount by sending the corresponding commands [10] from the mobile phone to the GSM modem. Then it sends the commands to the microcontroller section and the required information is sent to the user mobile through the GSM modem. If the consumer fails to pay the billed amount in time, the disconnection and reconnection can be done by sending their corresponding commands to the controller. Whenever a request is obtained by the user to the controller and the data has been sent the DC buzzer gives a beep sound as an indication that a request has obtained and sends the data to the user.

III. SYSTEM HARDWARE

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

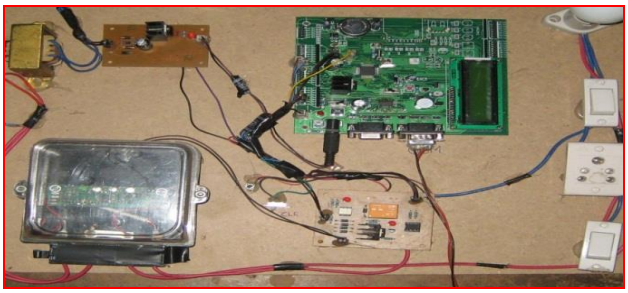

Figure 2. System hardware

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

A. ARM7 (LPC 2148) Microcontroller

ARM stands for Advanced RISC Machines. It is a 32 bit processor core used for high end applications.

The LPC2148 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high speed flash memory ranging from 32KB to 512KB.

ARM (Advanced RISC Machine)

- T – The Thumb 16 bit instruction set
- D – On chip debug support
- M – Enhanced Multiplier
- I – Embedded ICE hardware
- S- Synthesizable

A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate [4]. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. The LPC 2148 microcontroller is shown in figure.3.

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 [5], 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

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[11] based on the load. These outputs are interfaced with the LPC2148.One of the feature 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 [6] 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 [7]. 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. SIMCOM 300 GSM modem

Specifications:

- Tri-Band GSM/GPRS 900/1800/1900 MHz
- Supply voltage range is 3.4V to 4.5V
- Low power consumption
- Operating temperature is -20°C to +60°C
- Serial interface and debug interface
- LCD interface
- Keypad interface
- Antenna connector and antenna pad

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. IMPLEMENTATION AND RESULTS

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.

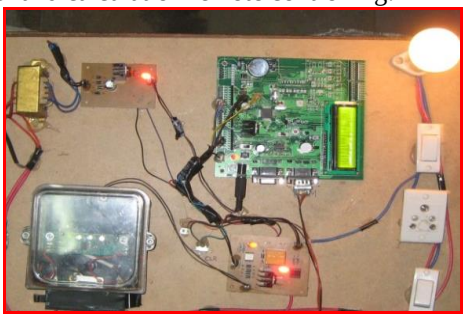

Fig 6. Wireless meter reading system PCB when the load is ON and the interfacing of Energy meter, ARM7 (LPC 2148) Microcontroller modules.

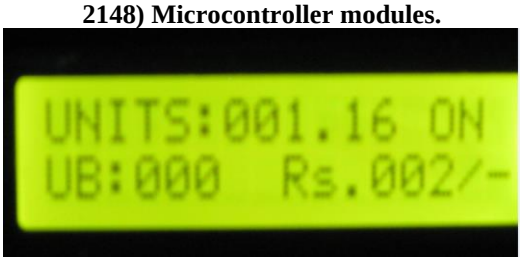

Fig 7. LCD showing the energy consumption values, billed amount and status of the system is also displayed when system is ON.

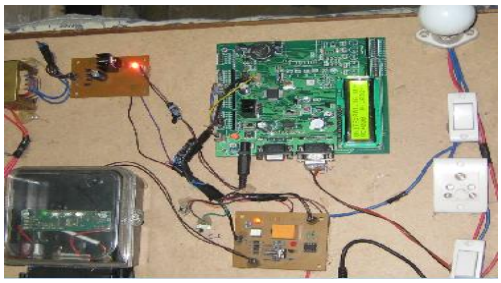

Fig 8. Wireless meter reading PCB when the Load is OFF and the interfacing of Energy meter, ARM7 (LPC 2148) Microcontroller modules.

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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.

Total energy consumed= (Wattage X No. of hours used per day) ÷ 1000

= Kilowatt hours (Kwh)

Table 1: Energy consumption of the Load

Load	No of hours used	Kilowatt hours (Kwh)
60W incandescent bulb	19	1.16
60W incandescent bulb	1	0.06

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.

V. 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.

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AUTHOR PROFILE

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