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Design and Implementation of Smart Energy Meter

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ABSTRACT : The main concept of this project is to design and implement the smart energy meter system in houses and in many public places. Here this system has functionality of both prepaid and post paid system inbuilt in it. This system has a GSM that is used in sending the sms to the owner of house or any place where he gets the e bill of his electricity consumption. Here the bank account of the person is linked to his current billing system. Therefore the bill will be deducted from his account and he gets two sms about the amount. one from his bank and another from current billing system. This paper presents a smart energy meter for an automatic metering and billing system. In this meter energy utilized and the corresponding amount will be displayed on the LCD continuously and communicated to the controlling base station. The feedback from the user helps in identifying the usages between authorized and unauthorized users which helps in controlling the power theft. Communication between user/household and substation is done using Zigbee. GSM network is used for sending SMS to the local authorities regarding theft cases. This meter can work as either prepaid or post-paid meter. The proposed system replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. Also they can monitor the meter readings regularly without the person visiting each house.

KEYWORD: Smart Energy Meter (SEM), Zigbee, GSM

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 unauthorized 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. There are two types of networks, they are wired and wireless. Wired networks require lot of setup and maintenance cost. In wireless networks there are many technologies. In this project we implemented using Zigbee technology because of its effective communication, self-

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healing networks, low power consumption, zero traffic and they can handle over 60000 devices and more over Zigbee communication installation require no special permissions in most of the places. It uses unlicensed 2.4GHz ISM band which is available worldwide. Zigbee has range between 10 m to 2 km and it works well with networks such as Wi-Fi, Ethernet and GPRS and also provides scalable networking solution which makes it suitable to be used in controlling and monitoring applications. And we selected other communication network to be GSM to send SMS to local authorities in case of theft, because GSM has a built in transport layer encryption, which is supported by most network providers.

In the existing work, we just had a current billing system and we used to pay the bill by logging into the bank account. Hence there were several glitches occurring in the internet system. hence we came with new idea of proposed system to eradicate these difficulties.

A. Block Diagram of Proposed System

The proposed system has two sections mainly, one is Home Section and another one is Electrical Base Station (EB). Communication between these two sections is done through wireless network. This system monitors the load, monitoring means calculating the power consumed exactly by the user at a given time. Energy utilized and the corresponding amount will displayed on LCD continuously and communicated to the controlling base station. The feedback from the user helps in identifying and controlling the power theft. An SMS containing monthly bill along with the due date is sent to the respective meter owner using GSM module which is present in the EB section. This module also helps in alerting the authorized people through an SMS during the power theft.

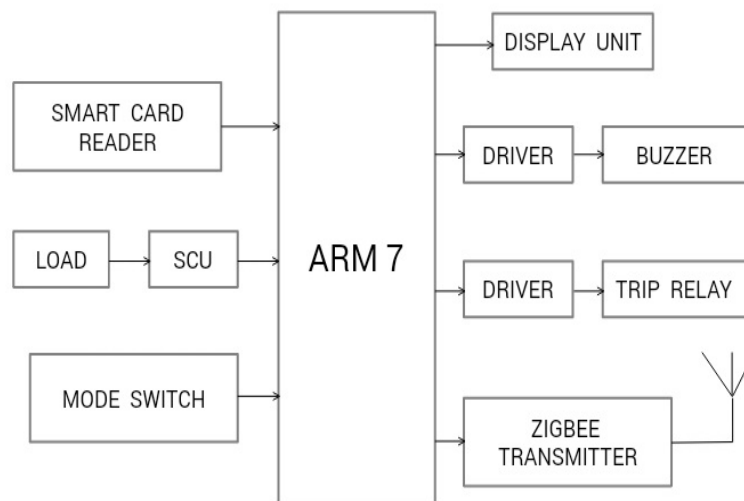


Fig. 1 Block Diagram of User's House Module

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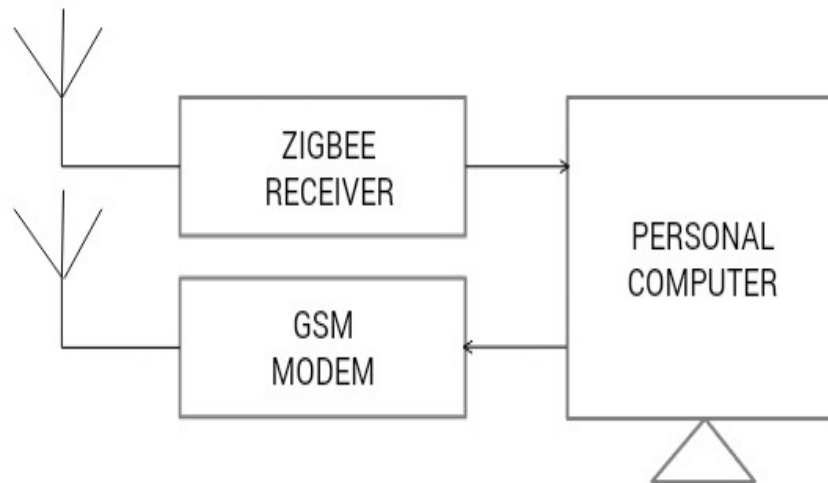


Fig. 2 Block Diagram of Base Station Module Working:

The proposed system mainly operates in two modes:

1. Prepaid Mode
2. Post-paid Mode

C. System Hardware

The basic hardware components used in the Project are listed below:

1. ARM7- LPC2148 Microcontroller
2. Smart Card
3. LCD
4. Signal Conditioning Unit (SCU)
5. Buzzer
6. Relay Control unit
7. Zigbee
8. GSM
9. Mode Switch

ARM7- LPC2148 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



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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. 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.

8. GSM: The Communication Module consists of GSM Modem. It is used to transfer the data from remote station to local operator 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. Its specifications are:

- 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

6. 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.

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D. Implementation

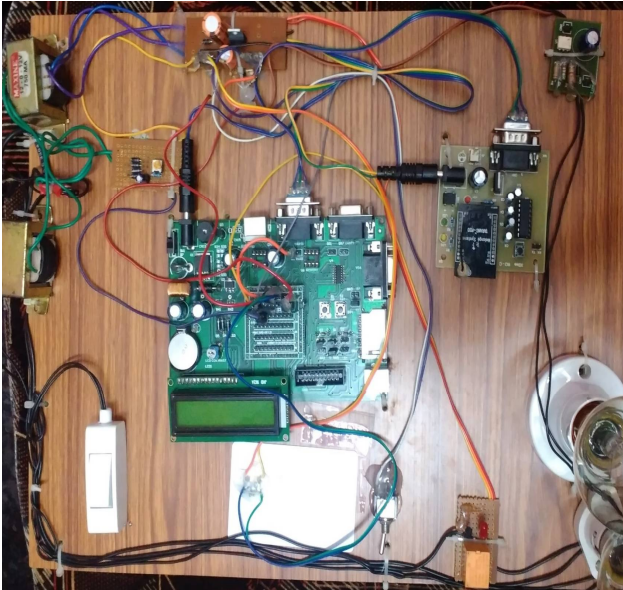


Fig. 3 Module at User's House

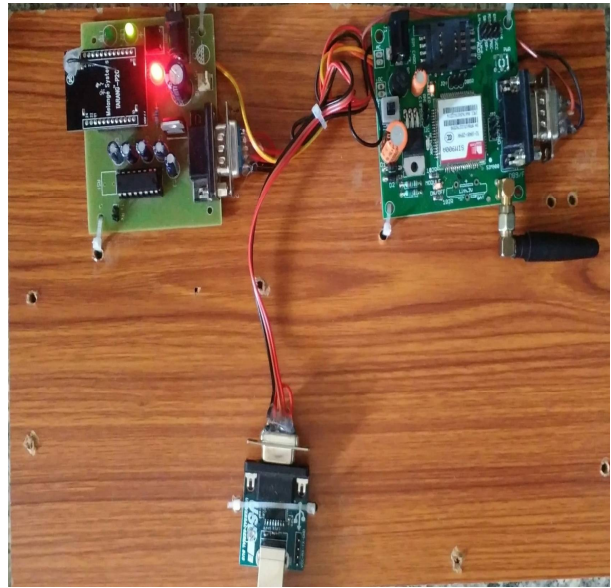


Fig. 4 Module at Base Station

E. Results

The following are the results of my project in transmitting section.



Fig. 5 Meter in Prepaid Mode



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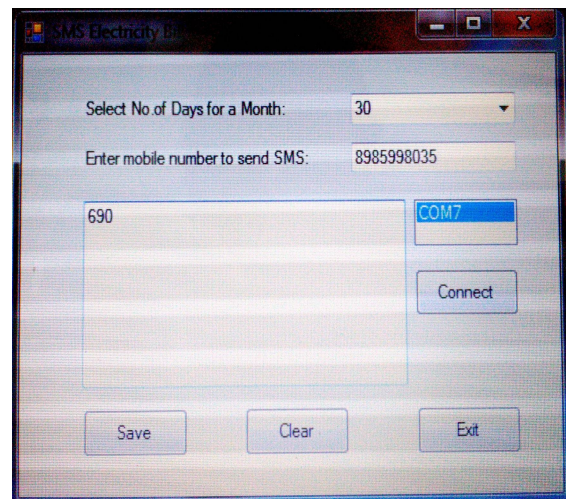
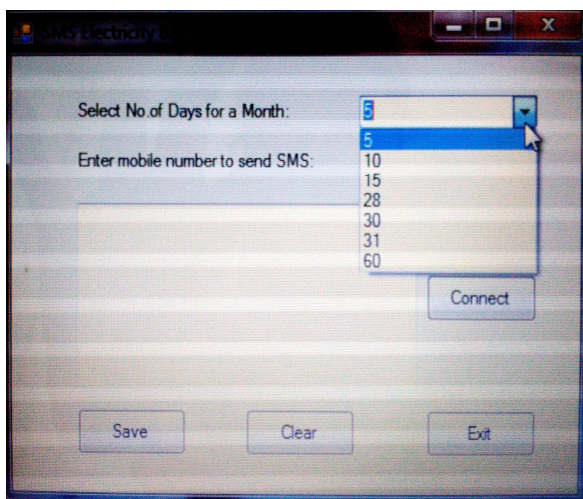
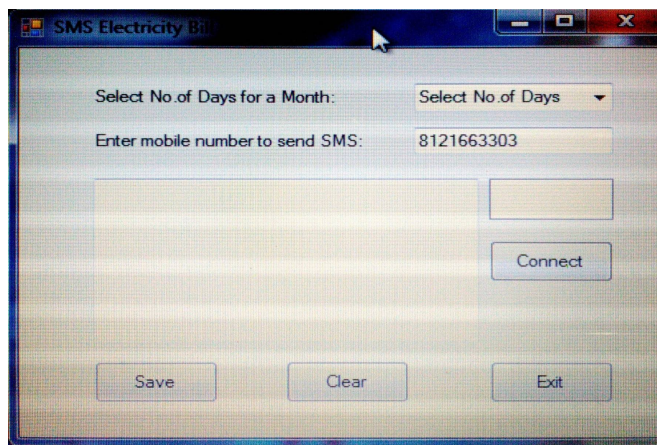
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The receiving section base station module is connected to a Personal Computer (PC)/Laptop .In my project a system file (application) is being created in PC and if we open it a window is displayed as shown in the figure below.

As shown below we can select for how many days the bill should be generated and sent to the consumer. Also we can specify to which mobile number the SMS alert has to be sent. We have to specify the local operator number in order to alert him regarding power theft cases.

The SMS alerts are received in the following way when I tested my project.



The available networks are displayed when it is connected.

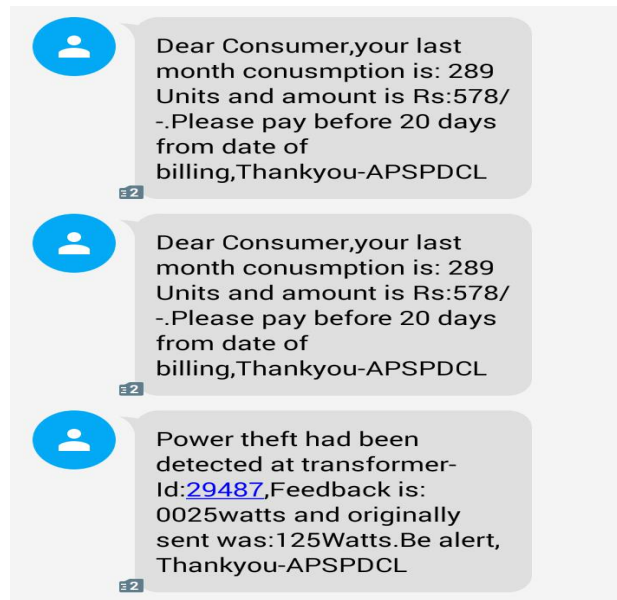


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F. Advantages

The following are the advantages of the proposed System:

1. Less manpower
2. No need to chase payments
3. Power theft detection.
4. Bill sending to the consumer with due date.
5. The meter can act as either prepaid or postpaid meter.
6. Minimize the power consumption.

II. LITERATURE SURVEY

For this work existing meter reading techniques in India are analysed and conducted an extensive study on different energy measuring instruments available now. In existing system either an electronic energy meter or an electro-mechanical meter is fixed in the premise for measuring the usage. The meters currently in use are only capable of recording kWh units. The kWh units used then still have to be recorded by meter readers monthly, on foot. The recorded data need to be processed by a meter reading company. For processing the meter reading, company needs to firstly link each recorded power usage datum to an account holder and then determine the amount owed by means of the specific tariff in use.

The major disadvantage of a post-paid system is that there is no control of usage from the consumer's side. There is a lot of wastage of power. Since the supply of power is limited, as a responsible citizen, there is a need to use electricity in a improved and efficient way. There are clear domino effect from many countries everywhere a prepaid system has reduced the usage (wastage) by a great quantity. Additional advantage of the prepaid system is that the human errors made reading meters and processing bills can be reduced to a great amount. Wireless meter can be used in residential apartments and especially in industrial consumers where bulk energy is consumed [1]. Advance in technology have made exchange of information in very high-speed, protected and truthful. Advance in wireless technology caused rapid change in field of telecommunication system. Communication system like internet and GSM are available in India. This paper presents a system which can act as either prepaid or post-paid meter.



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III. CONCLUSION

The progress in technology about electrical distribution network is a non-stop process. 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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BIOGRAPHY



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