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INTELLIGENT SYSTEM FOR SINGLE PHASE ENERGY METER BILLING AND ACTION TAKING USING WIRELESS NETWORK

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Abstract— The Household energy meter data automatically reading is important in the process of power system information. It is also vital problem that power industries want to solve because the accuracy and real time of meter data copy affect the power system information level, management decisions, and cost-effective benefits. The technology of electronic metering has gone through fast advancements and there is increased demand for a reliable and efficient Automatic Meter Reading (AMR) system. The proposed system in this paper replaces the traditional meter reading method and GSM based wireless communication module included with energy meter access the usage of power consumption. Billing section contains the PC with GSM and complete monthly usage bill is generated to the users. They can monitor the meter reading often without meter reader visiting each house. .NET frame work and C# software are used in the billing section PC.

Keywords— Global System for Mobile (GSM), Automatic Meter Reading System (AMRS), Short Messaging System (SMS), .NET frame work, C#.

I. INTRODUCTION

Electrical power has become vital and integral part of the human life system. Due to the enormous dependence on the electrical power, automation should be introduced to meet the growing demand of the people and to enhance the people's life standard. Conventional meter reading by human operator is incompetent to meet the future residential development needs. So there is surge for Automatic Meter Reading (AMR) systems which collects meter readings electronically, and its application varies as industrial, commercial and utility environment. Electronic and automated utility meters are significant step towards automating the utility metering process. It offers many new features that help to reduce the cost of utilities to customers and the cost of delivering utilities to the utility provider. Now days still using electro-mechanical meters are prone to drift over temperature and time as a result of the analogue and mechanical nature of the components in these meters. A meter reader has to physically be onsite to take the readings. So this traditional meter reading of collecting data becomes more difficult and costly when readings have to be collected from immense area and often scattered rural areas.

Meter readers are unwilling to make the effort to travel to such areas and will often submit inaccurate estimations of the amount of electricity consumed by the users. Some of households at the top of high buildings and luxury housing plots, traditional meter reading method are highly difficult. There may chance to missing bills, absence of consumer etc. Even though these electro-mechanical meters were replaced with more efficient and accurate electronic energy meters these problems still persists. So here implementing a system which will provide the bill in users mobile will be more suitable in the current scenario. Here a new method of postpaid electronic energy metering is introduced in this paper which will automatically sense the used power consumption, records these reading continuously, then sends it to the billing point through the existing wireless Global System for Mobile (GSM) network. Finally after processing the collected data bill is generated using a web based system software and is send back to the customer as Short Messaging System (SMS).

II. LITERATURE SURVEY AND RELATED WORKS

The existing work In India about the meter reading techniques are analyzed and conducted a large study on different energy measuring instruments available now. In existing system either an electronic energy meter or an electromechanical meter is fixed in the premise for measuring the usage of power consumption. The measurement of units of energy meter is kWh. 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 see data to an account holder and then determine the how much amount have to pay the specific tariff in use.

For automatic meter reading so many energy meter systems built on various platforms have been proposed by different research groups all over the world. Basically there are two types of AMR systems, wire based and wireless. Power Line

Carrier (PLC) and Telephone Line Network (optical/ cable) are wire-based AMR system and several related works are available. Many metering systems have now been proposed, based on GPRS, Bluetooth, and GSM as explained in [1-2, 5-8].

Design of an Electric Energy Meter for long-distance data information transfers which based upon GPRS is proposed in [3]. These systems can't be implemented so easily because the regular use of GPRS is costly to the common people. A GSM Energy meter with instant billing facility is introduced in [1] and [4], but still the problem of missing SMS, less accuracy and performance. A more reliable and user friendly system with web portal for multiple access using C#.net frame work is created in this project which will manage the data efficiently. This is the different design compare to earlier proposed systems. The GSM channel is useful communication as sending data as SMS turns out to be a very handy tool, due to its good area coverage capability and cost effectiveness. In INDIA some of the state's electricity boards started using GSM facility and there increased demand for this method. In this energy meter project the front end is User friendly and any employee with minimum knowledge of computers can work on this software.

2.1 A look back at GSM Technology in India

Various transmission protocols in wired or wireless network manner were introduced so far to read digital electronic meters remotely at different places of India. The digital electronic watt-hour meters are microprocessor based meters which replaced electromechanical meters.

Tele watt meters were implemented to transmit data on monthly basis to a remote central office through a dedicated telephone line and two modems. A microprocessor based meter is used in this to measure the electricity consumption of multiple users in residential or business places. A master PC at the control centre was used to send commands to a remote meter, which in turn transmitted data back, using the Power Line Communication (PLC) technique. These techniques were mainly implemented in areas that had a fixed telephone network.

Here introducing a new approach of using an energy measurement technique that encompasses the GSM network as a mean of transmitting energy data is more pertinent. The GSM network gives most coverage in developed and developing countries. This method is also effective in rural areas, which are not thickly populated, and in which, most people do not have access to a fixed telephone network. We need to focus more on this method as it can be implemented very easily and effectively in India and other countries.

Fig 1: Traditional Electromechanical meter Vs Electronic meter

III. GSM METER ARCHITECTURE

When developing a technology that might replace one which has been in use for more than forty years, not only the key issue needs to be addressed, but added functionality and solutions to other hindrance presented by the earlier technology need to be addressed. Even existing meter readers have to accept the quality and effectiveness of the proposed system.

The engineering defiance is to develop a invention that can serve as wireless network replacement for the metering and billing system presently in use. This stress that the meter under development has to work under the old circumstances and perform all the earlier functions, but also be able to relay the information in a new way and perform extra functions, without the need of replacing all meters on the electrical network at the same time.

In this paper the developed automatic meter reading system consists of three main parts: a digital GSM power meter installed in every individual consumer unit, transmission facility (SMS gateway), and billing server at the energy provider side. The detail concept of the proposed system overview is shown in Fig. 2.

Electricity billing is automatic in the proposed system. We can reduced human effort for onsite meter reading, consumer can directly know the details of the power consumption billing.

IV. DETAILED DESIGN

The internal block diagram of the energy meter is constructed using the microchip single phase dedicated energy metering IC MCP3905A, 8-bit PIC Microcontroller PIC16F877A and a display. A 10A class I single phase meter is designed with embedded GSM modem. This utilizes the existing GSM network to send its energy usage value as SMS to the energy provider wirelessly. Electrically Erasable Programmable Read

Only Memory (EEPROM) is non-volatile memory which is storing the message details every time. Real Time Clock (RTC) module is integrated in the meter to have time stamped recording of usage details. The detailed design blocks are shown in Fig. 3.

In the billing section, the GSM modem will receive the messages from home section and software will calculate the total power consumption of each user. The discussion of the hardware design and software web portal design explained.

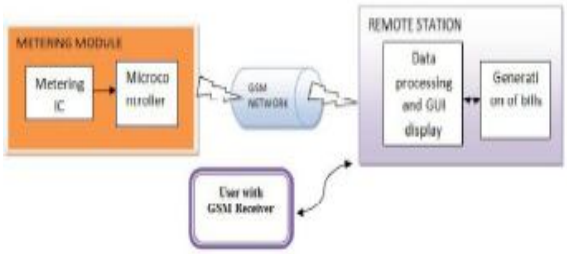


Fig 2: Overview of proposed structure

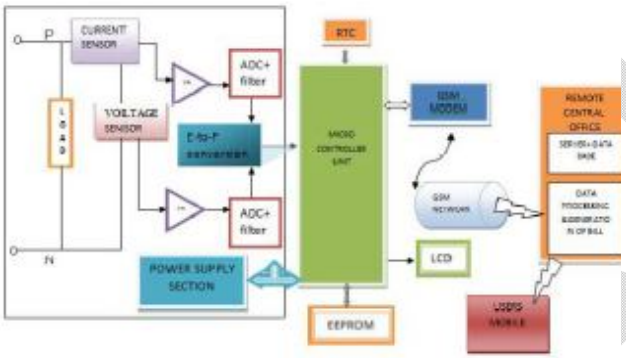
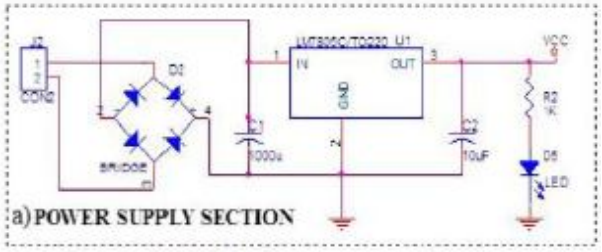


Fig 3: Detailed design blocks

V. HARDWARE DETAILED DESIGN

The proposed system implementing the two wire power supply is connected to the energy metering IC through the analog front end of the MCP3905 energy meter evaluation board which provides typical active power information via a pulse output which may be then used to be processed by a Micro Controller Unit (MCU). The GSM modem is interfaced to the micro controller via a MAX 232 convertor as in Fig.4 (b). User GSM modem transmits power consumption details to the billing section modem.



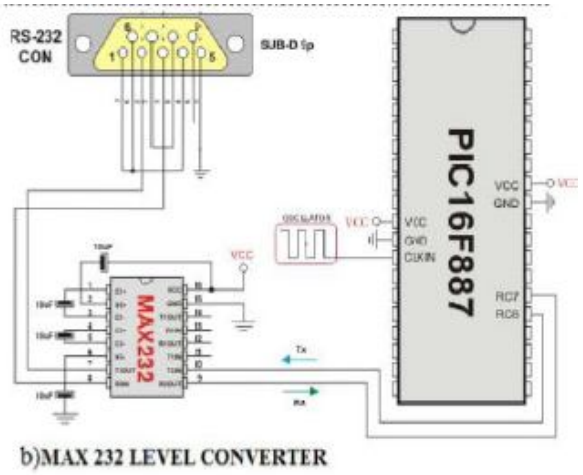


Fig 4: (a) Power supply (b) MAX 232 interfacing.

5.1 Power Supply

The microcontroller and additional devices get power supply from AC to DC adapter or from direct ac lines through voltage regulator. The adapter output voltage will be 12V DC non-regulated. The 7805 voltage regulators are used to convert 12V to 5V DC. Circuit details of the power supply are shown in Fig.4 (a).

5.2 Real Time Clock

RTC is used to maintain the real time and date in off line processing. RTC counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap-year compensation valid up to 2100.The RTC selected here is DS1307. This RTC is low cost, easy to solder, and can run for years on a very small coin cell (3V CMOS battery) which runs continuously even in power failure.

5.3 External EEPROM Memory

EEPROM memory is belonging to the family of Atmel 24C256. This memory device is used to store the data for off line process. That is it stores the amount of unit the user consumed while transferring each message.

5.4 Implementation Details

Energy metering IC Output pulses are counted using the default timer of PIC MCU. The signal from meter through

Octocoupler is normally high (5V) and the high to low transition of this voltage wave indicates the occurrence of a pulse. The counting of low pulse is an ineffective method as unfit grounding issues may even be counted as a pulse by the device. So the produced pulse is reversed before applying to the counter. A Transistor Transistor Logic (TTL) compatible inverter circuit is used for this purpose.

The microcontroller is programmed to read data from the energy metering IC each and every second. When microcontroller reads the Power consumption, it is stored and current reading is incremented in its software. In this design meter is calibrated such that for 1 unit of energy (kWh) consumption, it generates 3200 pulses in LED. (It can be calibrated for a meter constant of 1000 imp/kWh or 100 imp / kWh or 32000 imp / kWh etc as per the requirement).

$$\text{Energy per count, Epc} = (I_{max} \text{ X } V_{rms})/3200$$

Where I_{max} is the maximum load current and V_{rms} is the RMS voltage.

$$\text{Energy per LED pulse, } E_{pp} = 1000 \text{ X } 3600/M_{pr}$$

Where M_{pr} is the pulse rate of the meter in impulse/kWh.

Transmitter prototype is practical set up developed with using the energy meter circuitry as shown in Fig.5. The 16x2 LCD display is used for the status indication and it is placed top of the microprocessor shown in Fig.6.

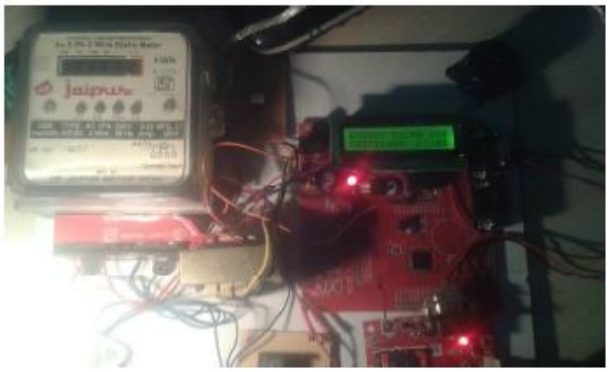


Fig 5: Transmitter Prototype

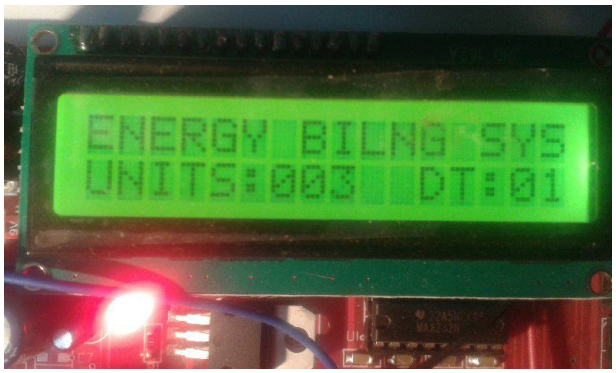


Fig 6: GSM meter sample result on display

VI. SOFTWARE DETAILED DESIGN

6.1 Microcontroller software design

Most of the all softwares are used for the PIC16F877 in the control circuitry was developed in Mikroelektronika's MikroC PRO 4.15 IDE. Through the In-System Programming (ISP) interface, the meter PIC MCU is programmed. GSM modem is controlled by using AT command for all kinds of operations. The algorithm for meter was developed by considering all the required outputs. The brain of the energy meter is this developed firmware. It can be modified and updated any time, even in the field. The Firmware is written in embedded C.

6.2 Billing software design

In billing section, PC requires the sharpdevelop4.4 set up and install the .NET frame work software. Run the front end and designed home page of the web portal is shown in fig 7. It is designed especially for billing, manages all received SMS readings, updates the database regularly, and notifies the consumer his bill details through SMS. Authority can log for bill preparation and analysis of any collected data.

Visual Studio .NET 2008 provide an integrated development environment (IDE) for maximizing developer productivity with the .NET framework. It is used to develop comfort and graphical user interface applications along with Windows Forms applications, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile and .NET framework. In this application source code is written in C#. The .NET version of C# is an improved version with more features and additions.

VII. RESULTS

Energy meter is able to send the usage value at a predefined time with using GSM modem and the status is displayed on

LCD shown in fig 6. The billing section homepage is shown in fig 7 and the generated bill in the fig 8.

After completion of a month, billing section receives the SMS from users home section and user receive the SMS from home section. The SMS on the user mobile is shown in the fig 9. Users will be able to pay electricity bill in billing section office and generated bill is shown in fig 8.

Fig 7: Billing section homepage

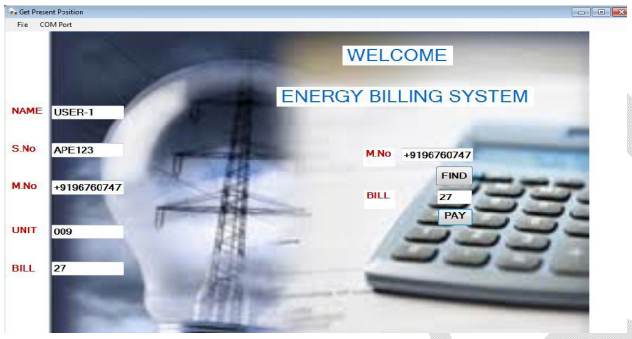


Fig 8: Generated bill in billing section

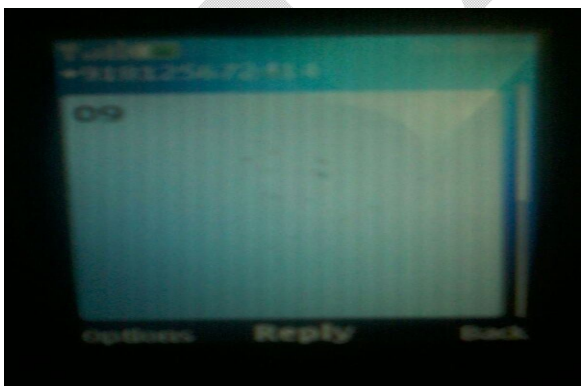


Fig 9: Generated bill to user

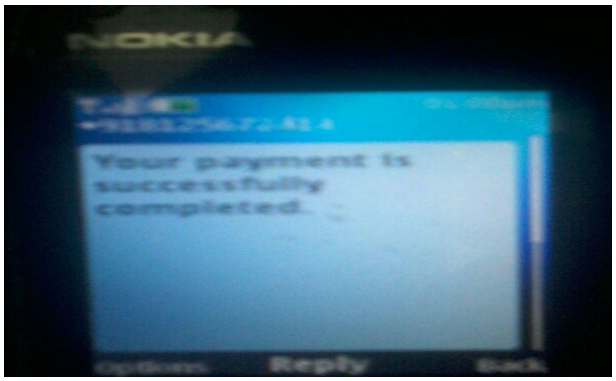


Fig 10: Payment acknowledgement to user

After completion of payment in the billing section office user can get SMS as like 'payment is successfully completed'.

VIII. CONCLUSION

Different electronic energy meters have been developed and are still being developed. The use of GSM modem in this particular system provides several advantages over methods that have been earlier used. The implications of being able to transmit readings more often are that energy utilities will be able to generate timely bills, better understand energy demand patterns, manage meter failures more powerfully and manage deception better. The designed energy meter system is highly effective in the sense it is able to eliminate the drawback of serial communication. i.e., even though it lacks acknowledgement of the sent SMS it is not affecting system performance. If a SMS is missing then also as the system is accepting the cumulative value next time which includes the lost content and while preparing bill the system is accepting the maximum consumption value. These implementations make the designed energy meter system unique and effective compared to the earlier proposals.

The proposed energy meter system also poses much less of a safety risk since human interaction has been reduced. The generated bill is available as SMS at the time of generation to the users .The system can be modified by using newest SPI metering ICs which will provide more parameters. By using the Microchip three phase IC MCP3909 the same idea can be extended to three phase systems also. The designed system is paperless. Power factor improvement options can be added in future. By adding an initialization message option at the time of installation the meter time can be updated from the server.

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