GSM based Energy Meter Reading and Billing

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Abstract: *In present world almost all industrial systems are based on wireless communication, as it has many advantages. The development of a fully Automated Energy Meter which is having capabilities like remote monitoring and controlling of energy meter will lead to transparency in the energy meter reading and billing system. Automatic Meter Reading system (AMR) will continuously monitors the energy meter and sends data on to a server system of service provider through wireless communication where data will be stored as well. Later the bill details will be sent to the customer through SMS. It saves huge human labor. Global System for Mobile communication (GSM) technology is used to communicate between the service provider and the customer. This system avoids the human intervention in power management. If the customer does not pay the bill in time, the user is informed through SMS system using GSM. If still customer does not pay the bill then as per designed late consideration, one alert message will be sent then automatically the power connection is disconnected from the remote server. This developed system provides efficient monitoring of energy meter reading, power control mechanism, avoids the billing error and also reduces the cost of maintenance.*

Keywords: Global System for Mobile communication (GSM), Short Message Services (SMS), Automatic Meter Reading system (AMR), Visual Basics (VB), Liquid Crystal Display (LCD)

1. Introduction

In present scenario the human operator from the electric utility will visit the consumer's houses to take the readings from the energy meter and produces the electricity bill for that particular month manually. If in case the consumer or any of his family members are not available at home then he will keep the produced bill near the meter or he will give the bill to the neighbour, therefore there will be chances of misplacement of the bill.

If the customer forgets to pay the bill then the operator will come and cut the power. An operator going to each consumer's house and producing the bill is an effortful work and consumes a lot of time. Especially during the rainy season the work will get more difficult than other days. Therefore to reduce the effort of operator and misplacement of the bill, new technology can be incorporated that is, the GSM based Energy Meter Reading and billing application. Where the data of energy consumption is automatically collected and transferred to a central data base. Central data base server will look after the billing of the consumption, if in case any trouble or malfunction the data can also be analyzed.

Disadvantages of conventional meter reading system:
- An operator should be appointed to visit each customer's house to collect meter reading and produce the bill manually.
- There will be possibility of misplacing the bills therefore data security will be less.
- In case consumer does not pay the bill then operator should visit his home and cut the power therefore remote monitoring is not possible.
- Operational cost will be more because this system needs more man power.
- Real time meter reading is not possible.
- In apartments there will be more than one energy meter , if any one tries to tamper any of the meter then there will be

no alarm, the tampering alert feature is not there in this system.

The above disadvantages can be avoided by using GSM based Automatic meter reading. This technology mainly helps the service utility to reduce the expenditure on the workers who will have to visit the customer's place every month and reads meter to produce bill. In this project there will be a process where the energy consumption readings are automatically collected and transferred to a central server database. The collected data later used for billing and troubleshooting if any problem occurs. This data can also be used for analyzing the annual consumption of consumer.

Main advantage of this system is to reduce expenses of a service provider company on the persons who should be visiting periodically to the consumer's place for getting meter readings and produce the electricity bill.

Another important advantage is that the energy consumption billing is purely based on the real time power consumption by the consumer and not based on past or predicted power consumption. This kind of information which also can be analyzed can help both service provider and customer to have better control and use of electrical energy.

Basic idea of this system is to reduce the maintenance costs for service providing organization and creating awareness in consumers regarding their consumption of power, so that if they find anywhere they can save on payment (which also saves electrical energy) they can plan or practice to save money.

2. Wireless communication technology and mobile application development.

Main advantage of the wireless communication is security of data transmitted and speed of data transmission from transmitter end to receiver end. Nowadays most of the people have touch phones with internet facility; therefore the idea of

developing an application environment for energy meter reading and billing will help people know more about their energy consumption. The application is designed such that a common person who does not know anything about the power system can also understand the how much energy has been consumed and the structure of billing.

A. Wireless Communication Technology

Wireless communication technology transfers information between two or more points which are not connected by an electrical conductor. The term *personal communications services* (PCS) refers to a wide variety of wireless access and personal mobility services provided through small terminal, with the goal of enabling communications at any time, at any place, and in any form. Choosing an appropriate Wireless Communication System is an important task in this project work. All communication media have both merits and shortcomings as well in many aspects like short transmission distance, high transmission & communication cost, maintenance difficulty and unsafe data transmission.

Here we consider zigbee module, which is recently developed two-way wireless communication protocol system. Zigbee is designed for low power consumption and at low cost. Zigbee has been developed to meet the growing demand for capable wireless networking between numerous low-power devices.

B. Mobile Application Development

The term Mobile application development denotes the act or process by which application software is developed for hand held devices such as mobile phones. These applications can be pre-installed on phones during manufacturing platforms, or delivered as web applications using server-side or client-side processing (e.g. JavaScript) to provide an "application-like" experience within a Web browser. Application software developers also have to consider a lengthy array of screen sizes, hardware specifications and configurations because of intense competition in mobile software and changes within each of the platforms.

The project is mainly divided into two parts,
- Personal purpose application for an individual's mobile.
- General purpose web application which increases security in case of apartments.

3. Developed Hardware Design Description

This developed energy meter reading and billing system gives a solution to visualization of power units consumed. The consumer meter is connected to zigbee transmitter module & microcontroller with LCD display. The central processing authority will have PC and zigbee receiver module. Data transmission takes place from consumer to central utility & controlling commands will execute from utility to consumer.
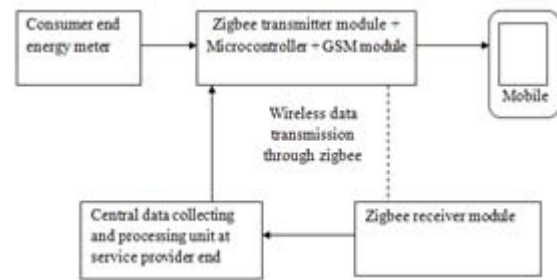

Figure 1: Overview of developed meter reading and billing system

Transmitter Module – The regulated power supply of 5V DC is given to all blocks as shown in Fig.2. The functionality of power supply is to drive the energy meter. The transmitter module contains following parts.

A. Data transmitter section

1) Energy Meter - The electric power is supplied to load through energy meter. The power variations in energy meter are in accordance with the connected load. The energy meter is integrated with electric load and produced analog signal can be converted in to digital signal and that digital signal in the form of light pulses.

2) Signal Conditioning - Light pulses from the energy meter are given to the microcontroller via opto coupler. Thus after signal conditioning the microcontroller receives the interrupt signal from opto coupler unit.

3) Microcontroller - Automatic Meter Reading unit continuously monitors and records energy meter reading. This can be accomplished by using microcontroller in the system. We have used PIC16F877A microcontrollers for realizing the project. They have low power, high speed flash/EEPROM CMOS technology with up to 8K bytes of flash program memory. The PIC16F877A is self programmable under software control. For serial communication it has USART with 9-bit address detection. It has two 8-bit timers and one 16-bit timer.

4) Relay: Relay control unit is interfaced with the energy meter and microcontroller. Depending on the information received from the remote station, the relay driver can control the Relay unit to disconnect or resume the power connection.

5) Liquid Crystal Display: Liquid crystal display is interfaced to microcontroller and is used to display the meter reading, power status etc.
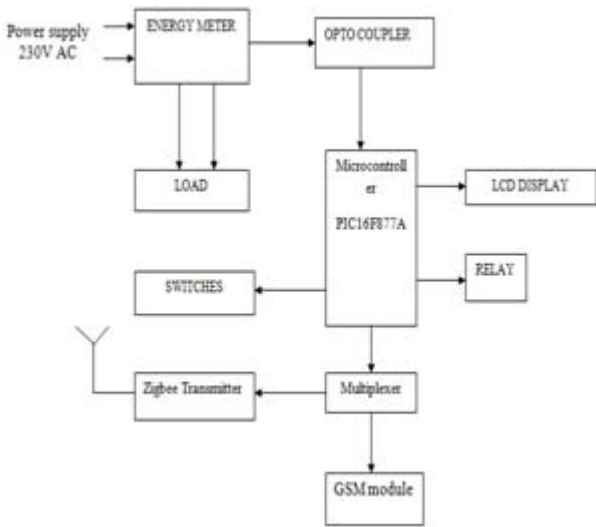
Figure 2: Energy meter reading transmitter block diagram

B. Data receiving section

Zigbee receiver module received the data from the zigbee transmitter module through wireless communication. Depending on the information received from the zigbee receiver module, control unit decide the power connection status i.e. disconnect or resume the power connection. The controlling can be done by tripping, i.e. power connection is switched automatically without visiting consumer's premises.

i. GSM modem

To implement AMR system we used GSM modem and which is helpful for the wireless communication with the control unit. Using Serial communication protocol we communicate with the GSM modem. It supports the AT command sets. As GSM modem supports the AT command set, AT command is sent to the modem and modem returned with an OK signal in the same baud rate of 9600baud. Also we have used Subscriber Identification Module (SIM) in the modem through which we can send various SMS to consumers.

Data is collected with zigbee module and then it is transferred to central computer using GSM communication modem. The software is developed in Visualbasic4.0 to display the developed billing procedure.LCD display is also provided which display power consumption details.
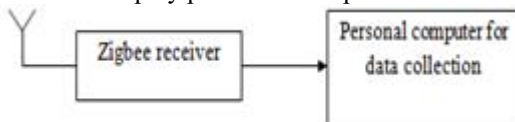

Figure 3: Data receiver block diagram

4. Software Details

For developing this project VB 4.0 is used for serial communication programming in Visual Studio 2015 environment. C# language with .Net 4.5.2 framework is used for developing mobile application and web application. Developed GUI for serial communication is shown in Fig. 4.

Figure 4: Developed Graphic User Interface

5. Results of the Developed Project

In the presented idea the complete process of energy meter reading and billing and bill calculation, notification of due date, meter disconnection or reconnection can be automated efficiently with better performance and less manpower. As already mentioned this project has two applications one is general purpose web application in order to increase security. Fig. 5 shows the designed log in page for this first web application.
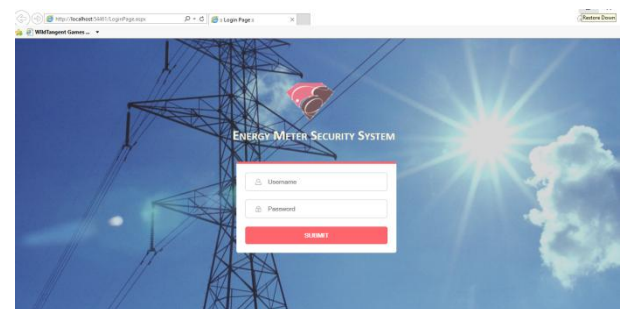

Figure 5: Log in page designed for web application

Fig. 6 shows the details which can be viewed after log in by the security person. Here he will be able to see meter ID, customer name, customer contact number, flat number and tamper status of the meter.

Figure 6: Log in details for web application

Fig. 7 shows the alert message if the meter gets tampered. Here an option is given to edit the status, once the cause for tampering is cleared then security person can edit this option and restore the tamper status to "False" in web application.
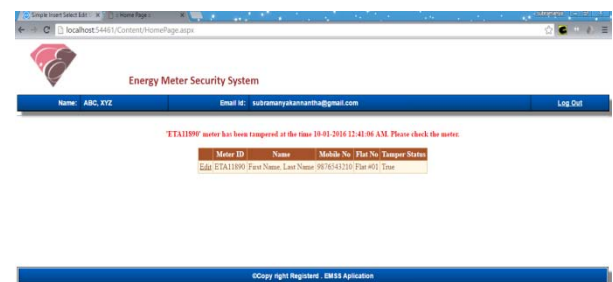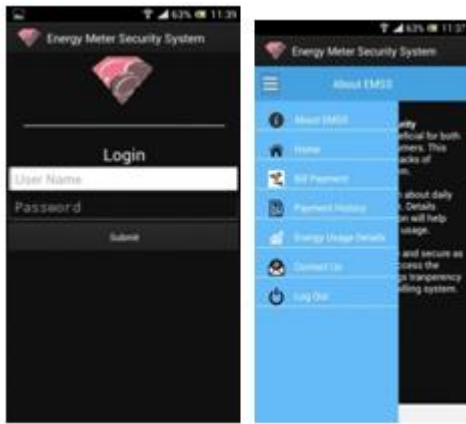

**Figure 7:** Alert notification in case of tamper.

Second part of the project is mobile application for personal reference which will have options like bill payment, payment history and usage details. We have named this application as EMSS app that is Energy Meter Security System application. Following figures from 8 to 12 shows developed mobile application.

Figure 8: Login page and Menu page of Mobile application
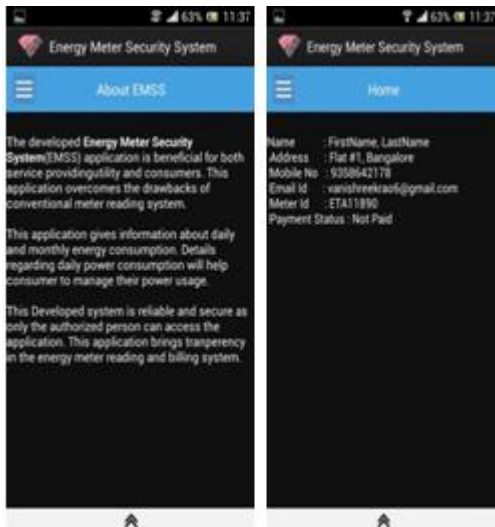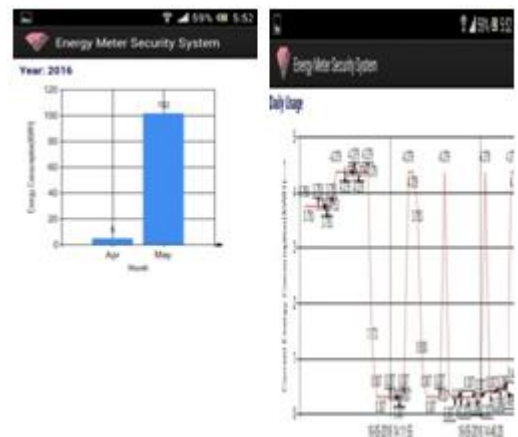

Figure 9: About EMSS details and Home page of mobile application.
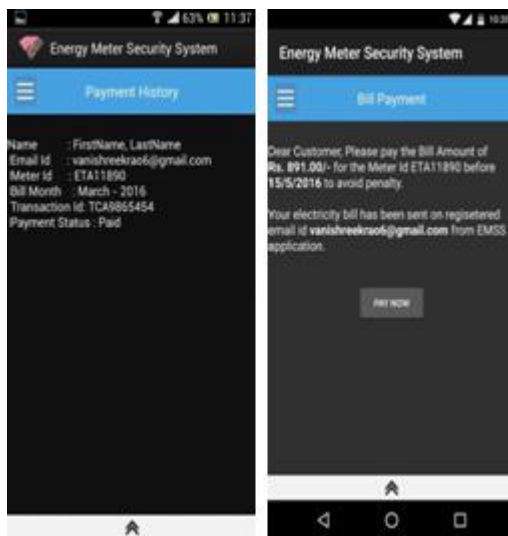
Figure 10: Payment history and Bill payment details of mobile application


Figure 11: Energy usage and Monthly usage details in mobile application.

**Figure 12:** Yearly energy usage and Daily usage details in mobile application.

Fig 13 shows the bill sent to the consumer through email with statement of power usage details. Fig 14 shows the statement which will sent along with the mail and Fig 15 shows the mail sent to consumer during penalty due to non payment of bill.
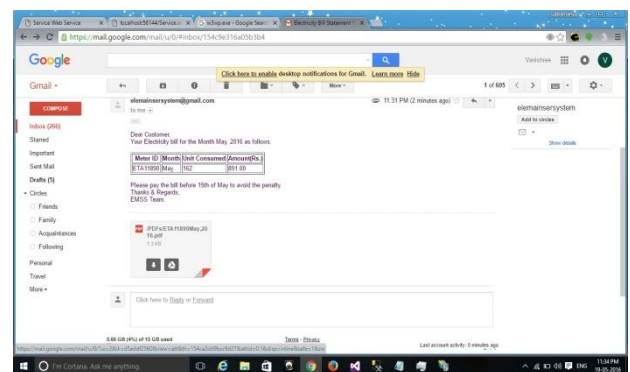
Figure 13: Monthly bill sent to consumer through Email

Figure 14: Bill statement attached with the Email
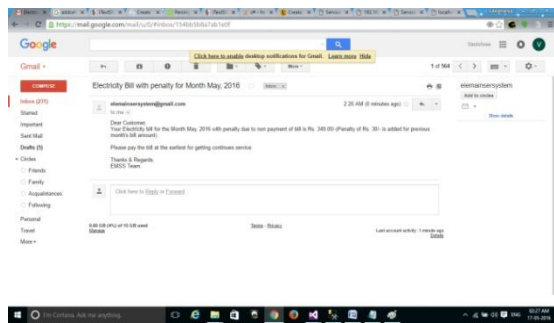
Figure 15: Bill with penalty due to late payment

6. Conclusion

The developed GSM based energy meter reading and billing is beneficial for both energy service providing utility and consumers. This system overcomes drawbacks of conventional meter reading system and provides additional services such as power cut alert and tampering alert.

Developed system also gives information about daily, monthly and yearly power usage. Details regarding daily power consumption will help consumer to manage their power usage. This developed system is reliable and secure as only authorized person can access the system.

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