

# Electricity Theft Control Using Smart Prepaid Energy Meter

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**Abstract**—The paper aims to design and develop an intelligent energy metering system that can efficiently control the amount of electricity consumed by the user. Electricity users can by specific amount of energy to use it only when they needed. This is achieved by interfacing energy meter with smart card technology. The system also alerts when the payment was not cleared. This paper features a smart card secure solution for a novel prepaid electricity system. The proposed system uses a controller in addition to a power meter providing efficient control of the amount of electricity consumed by a user. This paper aims to reduce the power bill defaulter using smart card technology. A new interactive, user friendly graphical user interface is developed using Microsoft visual studio .Net framework and C#

**Keywords**— Smart Energy Meter, GSM, Microsoft Visual studio. Net, C++, Smart card, PIC (SMS).

## I. INTRODUCTION

In India there are many sector which has attained a rapid development but only few developments are made in electricity broad sector. Traditional electromechanical meters still widely used today are prone to drift over temperature and time as a result of the analog and mechanical nature of the components in these meters. Collection of meter readings is also inefficient, because a meter reader has to physically be on-site to take the readings. This method becomes more problematic and costly. There exists chance for missing bills, absence of consumer etc. In this paper, a prepaid metering (PPM) system has been proposed. Each consumer has to install digitally designed prepaid electricity meter along with smart card in their home, office or industry. Based on the electricity utilization the credit will be deducted automatically from the smart card. When the credit goes below the threshold value, the meter gives warning icons and if credit reaches to zero the meter will automatically cut off the power supply. The consumer has to go to the vending station with the smart card and money to buy electricity. In the vending station, user can buy the credit to his smart card by paying the money. Then the consumer will insert the smart card to the meter and the meter will be recharged. In prepaid billing system, the consumer will be always conscious about the remaining credit and thus try to use electricity carefully and stop its misuse. Furthermore, in contrast with post-paid billing, the consumer can buy credit at any time in the month from the vending station. In the present proposed scheme there is no need of

manual intervention to note meter reading which avoids hassle in billing and distributions companies make money promptly which certainly helps them to generate more revenue.

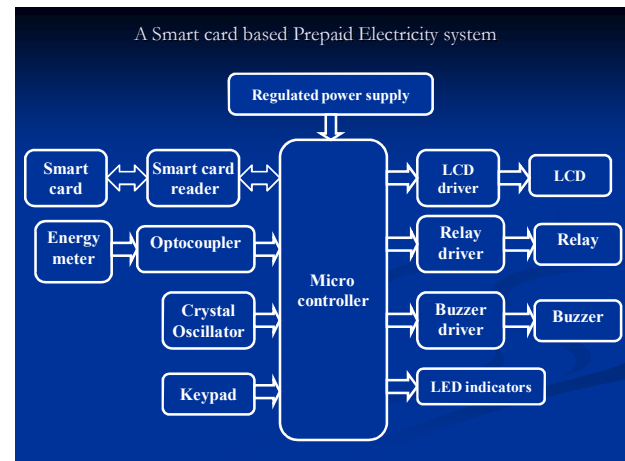


Fig.1:Block diagram

## II. LITERATURE REVIEW

The prolonged discussion clearly defines the architecture of smart metering system. The architecture proposed in this study is a multifunctional approach to read the energy meters located at the consumer sites. This report states that out of total energy generated only 55% is billed and only 41% is realized [1]. Each customer equipment provides the energy consumption to the MCIC that keeps the details of individual users. The meter tampering is easily detected by this approach. But the implementation cost is high. This paper discusses simulations and models based on data from pre-paid meters in order to determine the feasibility and method of Operation for remote check meter. The resolution of illegal consumers detected depends on the deviation of the losses and the connected time of the check meter. This report gives only the simulation result. It would be the better method for minimum amount of users. The further improvements to detect the electricity theft lead to grouping of customers by means of Support Vector Machine (SVM) [3]. This methodology insists data processing and data mining methods to detect the customers with abnormal consumption of electricity. It involves many complicated mathematical calculations that may provide erroneous results and can detect only 60% fraudulent customers. The previous methodologies are apt for the traditional power systems. Sudarshan K. Vallurup[4] proposed the Design and Assemble of Low Cost Prepaid Smart Card

Energy Meter. This will reduce the energy wastage and save lot of energy for future use. Even this is an advanced technology it cannot cover the remote area. In order to check out the wide area real time investigation is needed [5]. This paper defines the spot monitoring of the energy meters to verify whether the electricity theft has happened or not. It continuously compares the determined meter reading with the traditional meter reading to avoid relaying of the values. The above mentioned methodology doesn't give the exact theft detection criteria. Better analysis of about technical and non-technical losses will provide the electricity theft measures [6]. This paper implements black tracking algorithm to determine the power deviation between the meter data and delivered power data. In this idea, the malfunctioned consumer's power supply will be turned off. The detection of exact

theft location is somewhat harder when we talk about the previous methods, to overcome the drawbacks. Ashna.K and Sudhish N.George[2] proposed GSM based automatic energy meter reading system. This method is valid for the highly equipped distribution line and is not applicable for the rural areas. To expand the coverage area GPRS based electricity stealing prevention method is proposed. Here electricity users that uses GPRS communication software will reduce the electricity losses. The above mentioned procedures only dealt with the meter readings of individual customer don't care about the neighbourhood readings. This concept may detect the electricity theft but not the exact location. In the previous proceedings, the power thefts in various ways are detected but no more provision to investigate the illegal activity.

### III. HARDWARE DETAILED DESIGN

The project consists of a microcontroller, energy meter, relay, buzzer, LCD, smart card reader, relay and LED indicators. The microcontroller's internal non-volatile memory is used to store the electricity consumed. The non-volatile memory inside the Smartcard is used to store the prepaid amount. When the recharged units become zero on power consumption, the microcontroller put off all the loads connected to it by giving an audible beep sound. User has to recharge the same Smartcard for further usage of electricity

#### A. Power supply

The microcontroller and associated circuitry requires 5V supply while the relay requires a 12 V supply. A single 12V adapter connected to the mains produce DC 12V output usable for the relay and this voltage is further passed through a positive fixed voltage regulator IC 7805 resulting in a 5V DC output usable for the microcontroller and other logic circuitry.

#### B. Microcontroller

Microcontroller is a programmable device which contains a microprocessor, memory, input-output ports etc which can be compared with the microcomputer. Microcontroller is a single chip computer. As microcontroller is a low cost programmable device. It is used in the automatic control application.

#### C. GSM modem

We have used GPRS modem SIM300 from SIMCOM limited designed for global market, SIM300 is a Tri-band

GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz SIM300 provides GPRS multi-slot class 10 capabilities and support the GPRS coding schemes CS-1, CS-2, S-3 and CS-4. With a tiny configuration of 40 mm x 33mm x 2.85 mm, SIM300 can fit almost all the pace. Requirements are in application, such as smart phone, PDA phone and other mobile device.

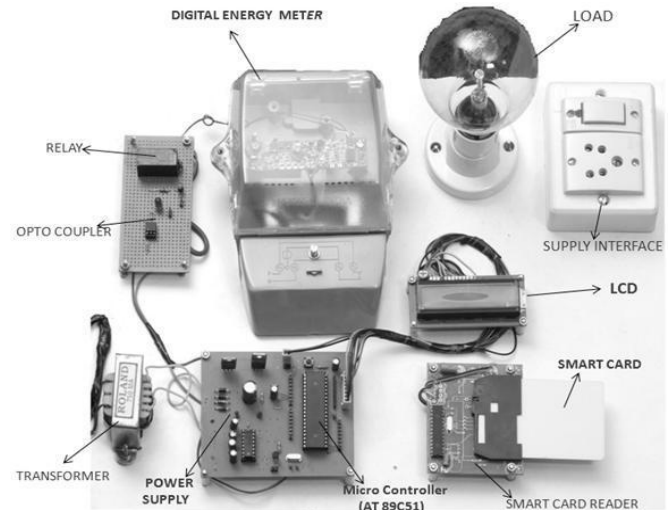


Fig.2: hardware implementation

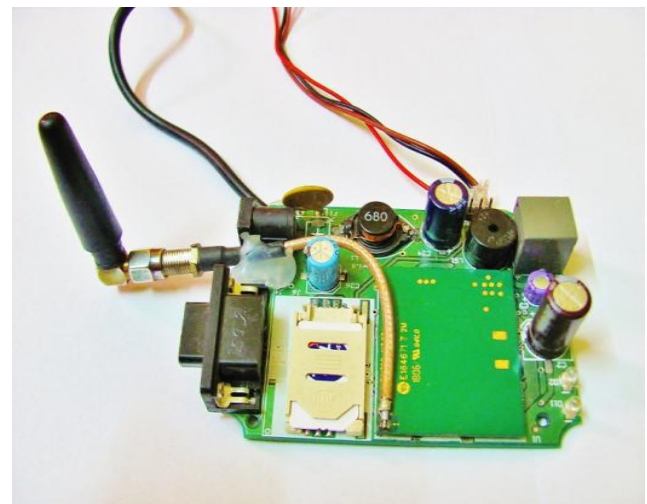


Fig. 3: Real view of GSM modem

#### D. smart energy meter

Smart meters go a step further than simple AMR (automatic meter reading). They offer additional functionality including a real-time or near real-time reads, power outage notification, and power quality monitoring. They allow price setting agencies to introduce different prices for consumption based on the time of day and the season.

#### E. Liquid crystal display

LCDs are preferred as display devices compared to LED because of lower power consumption, flexibility in display content and compact structure suitable for embedding in the hardware unit. LCDs work on the principle of change in orientation of the liquid crystals due to incident light.

**F. Smart Card**

A smart card, chip card, or integrated circuit card (ICC), is any pocket-sized card with embedded integrated circuits. The smart card is a plastic card about the size of a credit card, with an embedded microchip that can be loaded with data, used for telephone calling, electronic cash payments, and other applications, and then periodically refreshed for additional use.

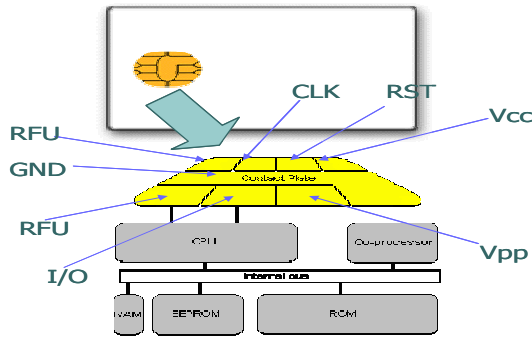


Fig.4: Picture of smart card

**G. Electromagnetic relay**

Relay board consists of three SPDT relay and a relay driver ULN 2803. ULN 2803 is a unipolar relay driver IC with maximum output voltage 50V and output current 500mA. It contains eight Darlington pair transistors, each having a peak rating of 600mA and can withstand 50V in off-state. Outputs may be paralleled for higher current capability.

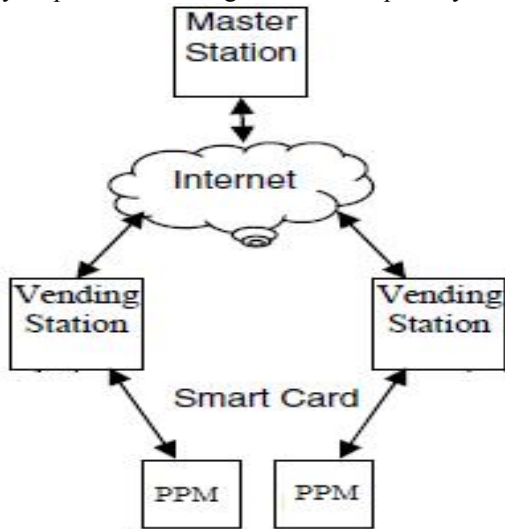


Fig.5 Architecture of the Prepaid Metering System

**IV. SOFTWARE DETAILED DESIGN**

**A. Microcontroller software design**

All software used for the PIC16F877 in the control circuitry was developed in Microelectronic's Micro PRO 4.15 IDE. The meter PIC MCU is programmed via the In-System Programming (ISP) interface. Picket 2 v 2.61 is used for programming the target PIC. GSM modem is controlled by using AT command for all kinds of operations. The algorithm for meter were developed by considering all the required

outputs. The brain of the meter is this developed firmware. It can be modified and updated any time, even in the field. The firmware is written in embedded C.



Fig.6:GSM Meter after casing and sample results on display.

**B. Billing software**

A web oriented GUI designed especially for e-billing, manages all received SMS readings, updates the database regularly, computes the monthly bill amount, and notify the consumer his bill details through SMS. It also publishes the bill in the designed web portal and consumer can log for getting the usage details any time. Printed postal mails can also be

provided for respective consumer. Authority can log for bill preparation and analysis of any collected data. Information portal helps to assist the smart meter to log consumption data to the database. Microsoft Visual Studio 2008 IDE is used to develop the web portal. Data base used is Microsoft SQL Server2005.

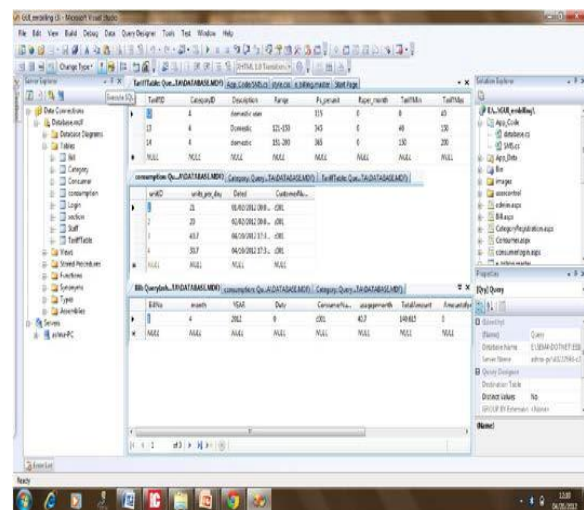


Fig.7:Database details.

Microsoft Visual Studio .NET 2008 provide an integrated development environment (IDE) for maximizing developer productivity with the .NET framework. It is used to develop



console and graphical user interface applications along with Windows Forms applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET framework, .NET Compact framework and Microsoft Silverlight. In this application sourcecode is written in C#. The .NET version of C# is an improved version with more features and additions. The developed site can be checked by running locally on any PC using ASP.net development server local host. Designed home page of the web portal is shown in Fig.12. It can be hosted to the server for practical use, once hosted the user can access it from anywhere through internet.

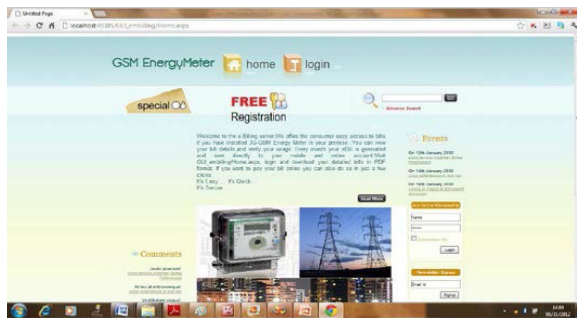


Fig.8:Home page

Users are categorized as administrator, staff and consumer. Any user can log using the user login option available in the web site as shown below in Fig.13. Administrator can perform category registration, section addition, tariff updates, staff registration and message setting. After the initial login the administrator can connect the GSM modem to the web portal through serial port / USB. Initially required hardware configurations have to done for the modem setup. Then by selecting the corresponding port administrator can connect it to the system for accepting SMS from meter.

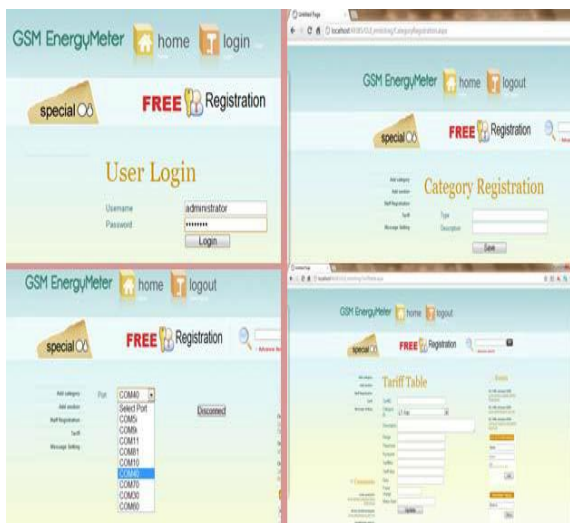


Fig.9:User login, Category registration, Port setting, Tariff table updating.

Once it is connected it will remain as connected for the whole system and continues receiving SMS till the administrator disconnects it using the disconnect option. Different staff members under the administrator are registered using the member registration option provided to the administrator. These operations are demonstrated in Fig. 13. The registered staffs are assigned to a particular section and they are registering the consumers under them. Registered staff member can login and add any number of consumers under his section. Also he is responsible for preparing the bills of consumers under him. By simple selection of consumer name and month, automatic bill generation occurs by auto processing of the background data.

## V.RESULTS

Designed meter is able to send the usage value at a predefined time and the status is displayed in LCD for the next 5 minutes after sending, as shown above in Fig. 10.

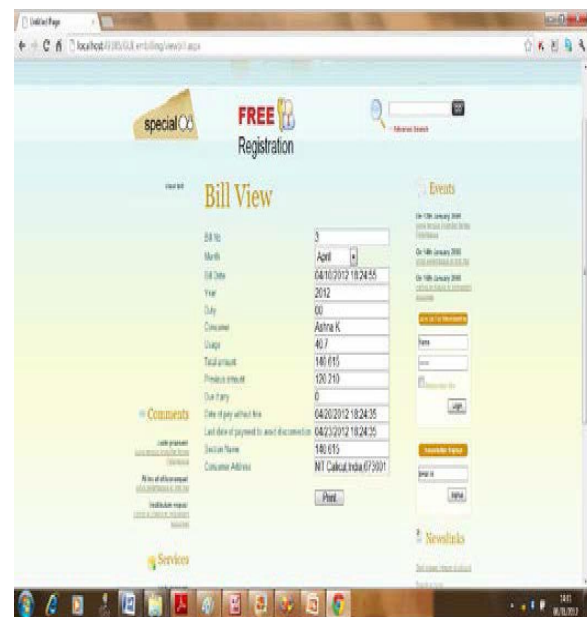
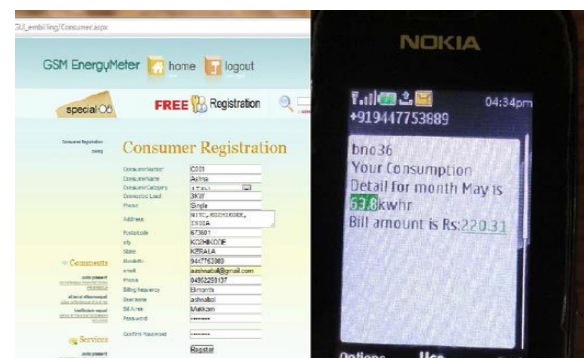


Fig.10:Generated Bill.

Example of the prepared bill by a staff member is shown in Fig.14.Consumer can login to view this bill. By selecting a particular month he can view his usage history any time.



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Fig.11:Consumer registration example and SMS reception  
in that consumer's phone.

The consolidated bill prepared sent to the users mobile, for a particular month of usage, for a particular consumer is depicted in Fig.15. Prepared Bill is successfully sent back to the registered consumer at the time of bill generation itself. Backend database details and HTML source code details can be accessed anytime by the administrator.

## VI. CONCLUSION

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the paper has been successfully designed and tested.

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