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Centralized Electricity Billing and Monitoring System with Power Theft Control

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Abstract: Every management system is trying to make automatic, portable and remote control. In recent years many engineers and companies have been working on Automatic Meter Reading (AMR), and different media, such as radio, telephone lines, and power lines, have been used for this purpose. Energy theft and faulty meter readings are the common problem in countries like India where consumers of energy are increasing consistently as the population increases. Utilities in electricity system are destroying the amounts of revenue each year due to energy theft and erroneous meter readings. It is quite impossible to check and solve out theft and to maintain accuracy of billing by going every customer's door to door. In this paper, a new embedded technology based approach for automated energy meter reading system is proposed which enables the meter readings to be updated onto the centralized server on a regular interval basis and sends bills to customers each month. This approach is also concerned about detecting and controlling the energy meter from power theft and solves it by remotely by disconnecting the service (line) of a particular consumer. The meter readings are sent to nearby located central station using RF link and from there a computed bill is sent to consumers mobile using GSM and also displayed at consumer premises through RF Paging. An acknowledgement for the transmitted unit of energy is recorded using RF signals continuously and if there is constant delay occuring in acknowledgments, it automatically signifies as power theft and temporarily disconnects the service for that customer. It also provides the facility of electricity tamper detection. The wireless controlling of meter reading system is mainly done using arduino and GSM module.
***Keywords**: Smart Energy Meter (SEM), Arduino (microcontroller), Global System for Mobile (GSM), Radio Frequency Module(RF), automatic meter reading (AMR)*

I. INTRODUCTION

India is advancing towards the path of the digital smart country. Now most of the populations in India are the smart users, they use online methods of shopping, billing and payments. With the increasing necessity for modern equipments and a lavish lifestyle of the people, the demand for electricity has increased. This has also been a great issue in the society. With the rapid developments in the Wireless communication technology by the use of integrated circuits, it has become a trend to integrate automatic systems via wireless applications over network. Along with the advancement of technology development, research on wireless applications and remote control has become significant and popular today. An electricity meter, electric meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. And in such a scenario power being the main support to daily life, the tampering and losses in power is in turn a greater loss to the national economy when all the losses are added together. The traditional manual Meter Reading is not suitable for longer operating purposes required human intervention thereby increasing their efforts and also material resources. These techniques also require huge manpower. A smart energy meter (SEM) is electric device having energy meter chip for electric energy consumed measurement. When developing a technology that might replace one which has been in use for more than thirty years, not only the key issue needs to be addressed, but added functionality and solutions to other obstacles presented by the previous technology need to be addressed, for example the elimination of physical address (on site) meter reading and forcibly reducing the national load during critical load times. The engineering challenge is to develop a product that can serve as an "in line" replacement for the meters currently in use, while already implementing some (if not all) of the new technology proposed above. This entails that the meter under development has to work under the old circumstances and perform all the previous functions (be backwards compatible) but also be able to relay the information in a new way and perform additional functions, without the need of replacing all the meters on the electrical grid simultaneously or the need for extensive new infrastructure. The prototype proposed is for simple and low cost wireless control of the electric meter and calculating electric bill for the customer including a notification to the customer whenever necessary using wireless GSM technology. It involves development of an advanced energy meter to ease the work of users as well as Electricity Board officers and thereby reducing human efforts to a greater extent. As the Energy Management System leads to savings in the

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overall cost. These savings may come from better utilization of manpower, servicing cost, savings in the energy consumption, and non-breakdowns in the system. Factually at present, the metering and billing system of our country is totally conventional and it is very much slowed, faulty and corrupted so our proposed smart energy meter is highly deserved for national implementation.

II. ENERGY METERING SYSTEM

A. Conventional System

Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) to give energy used (in joules, kilowatt-hours etc.). The meters fall into two basic categories, electromechanical and electronic. The most common type of electricity meter is the electromechanical induction watt-hour meter. The electromechanical induction meter operates by counting the revolutions of a non-magnetic, but electrically conductive, metal disc which is made to rotate at a speed proportional to the power passing through the meter. The number of revolutions is thus proportional to the energy usage.

Electronic meters display the energy used on an LCD or LED display, and some can also transmit readings to remote places. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as instantaneous and maximum rate

of usage demands, voltages, power factor and reactive power used etc. They can also support time-of-day billing, for example, recording the amount of energy used during on-peak and off-peak hours. There are many flaws and errors in conventional billing. Some human mistakes may also occur in manual billing. Analysing the conventional billing some of the common observed errors and mistakes are: It's a time consuming procedure, There is always a chance of human error while taking the manual meter reading, There is no check and balance and verification procedure of this meter reading,

There is always a chance of theft and corruption. Extra human power is required, Consumer is not updated of his usage, Consumer may not get the bill slip within due date.

B. Smart Energy Meter

Smart electricity billing system is a technique which is cost efficient and can reduce problems associated with billing and also reduces deployment of manpower for taking meter readings. Smart electricity billing system has many advantages both from suppliers as well as consumer's point which are, No bill production , No bill distribution , No further actions such as disconnections , Customer responsible for disconnection , Load and demand side management ,Limit load, Load based , Time based , Pay to suit your income status, Daily, weekly, monthly budgeting, Show true cost of consumption, Reduce consumption when income is tight–make money, No billing errors

III.LITERATURE REVIEW

In paper [1] a smart energy meter is analyzed where the whole system works in IOT platform which allows remote access of the device and the data is stored in cloud. It is mainly concerned about remote monitoring and billing and does not provide power theft control measure. Instead, proposed system can automatically detect and control power theft. In paper [2] proposes a smart energy meter where the communication of gathered information is mainly depends on GSM connectivity. It is difficult to install in remote areas. In our system with the implementation of RF module provides wide area coverage, it can offer service for urban and remote areas also. Paper [3] Is concerned about developing a smart energy meter system for prepaid energy meters and postpaid energy meter. The monthly bill is displayed to consumer through sms which is sometimes risky as there is coverage problems arise in remote locations. The proposed system provides solution by remotely generating and displaying the bill through RF Paging at both central server and consumer side i.e., smart energy meter and also to registered number via GSM. Paper [4] shows the implementation of an AMR system which uses arm 7 microcontroller for processing and GSM for communication. This system is uneconomic for real time implementation as the cost of arm and gsm is costly. In Paper [5], an automatic energy metering system discussed where NRI-ACDCS software is used in central computer of service provider for AMR Configuration and Data Collection using SMS. This system is mainly concerned about fetching information remotely. it also uses GSM modem at both consumer and service provider for communication which is cost ineffective with growing consumer population. Instead the proposed system provides automatic theft detection and also computation of gathered information and uses GSM at central server only for remote billing display purpose. In Paper [6] smart energy meter Arduino and GSM are used for processing and communication of billing information. it is mainly concerned about billing processing, communication and remote controlling of service and does not provide effective measure for power theft. The model not only perform remote billing but also gives automatic power theft detection and

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controlling capability to the centralized server. Paper [7] AMR system uses ZigBee technology for communicating billing information to central system. this system lacks power theft control and detection application and as zig bee is costlier to implement even though it provides secure communication. Instead, the proposed system implements GSM for bill displaying and RF paging for remote billing which is cost effective and provide additional power theft control application.

IV. METHODOLOGY OF PROPOSED SYSTEM

The system model consists of two different units: home communicable unit, central controlling unit. The working of each unit is described in detail below.

A. Home Communicable Unit(user/customer)

This unit consists of power supply, 89C51 microcontroller, LCD segment and RF module, relay and switch. The energy consumption is continuously monitored using microcontroller and the meter readings are shown on the LCD screen. The readings are sent to the centrally located unit through RF link only after reception of activation signal from Central Controlling Unit. It also continuously acknowledges for received units of power to central server using RF link. We use switch to acknowledging the received power. If there is continuously delay for the acknowledgement, the server automatically detects it as tampering and temporarily disconnects the service for that particular consumer. The computed bill for unit of consumption is also displayed in the LCD screen on getting information from central server.

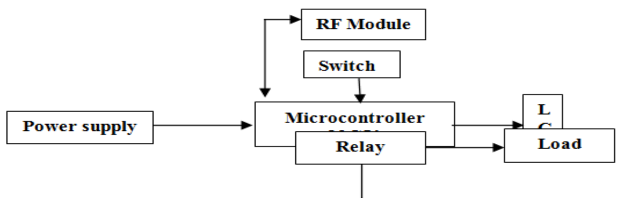

Fig1. Home Communicable Unit

B. Central Controlling Unit(centralised office)

This unit consists of an Arduino and 89c51 microcontroller, RF module, power supply, LCD segment and a GSM module. The meter readings sent from all the home communicable units of the same premise on getting activation signal from this unit, gets collected here through RF links. As the monitoring of unit of consumption is time consuming using existing energy meter. We generate pulse of input signal using Monostable Multivibrator and transmit it as one unit of power and monitor this as unit of power consumption through RF link by receiving the acknowledgment by using same switching procedure at consumer side. The billing for the unit of power consumption per customer is computed using Arduino and displayed in the LCD screen. The computed bill is simultaneously transmitted through GSM via SMS for authorized consumer mobile and also to the respective registered smart energy meter for displaying the same in the LCD screen of consumer unit using RF Paging by pressing the monthly bill switch. This central server unit also continuously monitors the acknowledgment for transmitted unit of power per consumer using 89c51 Microcontroller and this provides central server, automatic power theft detection and controlling capability by remotely disconnecting the service for the registered meter when tempering is detected.

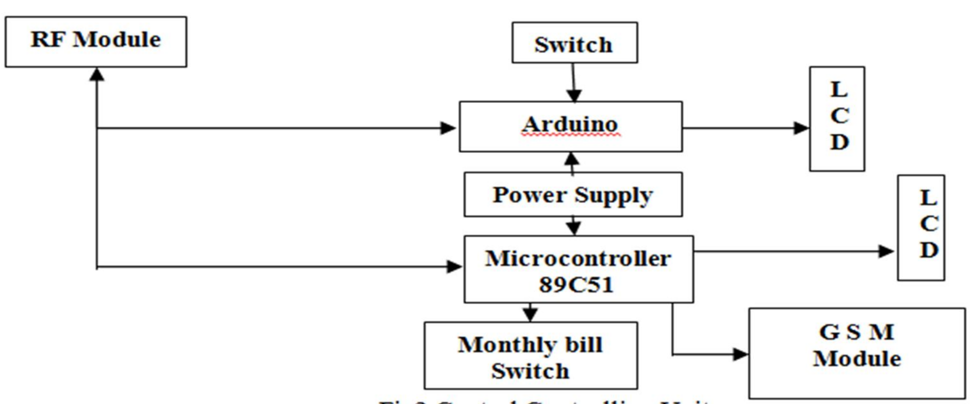

Fig2.Central Controlling Unit

C. Software requirements for centralised electricity billing system with power theft control.

The system software is implemented by C language. The developed code is edited, compiled and debugging by Keil Micro vision and the code has been dumped by using flash magic software.

D. Conventional system drawbacks in comparison with the Benefits of the proposed system.

From the consumer's perspective, smart meters are offering a number of potential benefits; for example, consumers are able to estimate bills from the collected information and thus manage their energy consumptions to reduce their electric bills. From the utility's perspective, they can use the information collected from smart meters to realize real-time pricing, by which the companies can limit the maximum electricity consumption and tries to encourage users to reduce their demands in the periods of peak load. System operator can terminate or re-connect electricity supply to any customer with proper mechanism remotely in order to optimize the power flows Tampering in conventional system maybe by the customer to reduce the bill rate or by an outsider to theft the power, this is overcome in present smart system, Safe storage of consumption of power by the customer. Smart automated process instead of manual work, accurate information from the network load to optimize maintenance and investments, customized rates and billing dates, Streamlined high bill investigations, automatic outage information and faster recovery, better and faster customer service, automatic power theft control.

V. CONCLUSIONS

Per capita power consumption is rapidly increasing with increase in population and improved technologies. When the user is concerned about the electricity bill and power consumption, there are high chances for reducing per capita consumption. As the world is leading towards technology advancement. This paper is the combined hardware advantage for both utility and the customer. So, the proposed embedded system which works on wireless communication is highly efficient because every process from taking meter readings to sending it to the service provider, generating bills, sending bills to the customer via SMS and power theft control. Everything is automated, and it is manual labour free which minimizes the errors up to very extinct and also protects the consumer equipment. By this method it is possible to solve the problem of manual process of energy measurement and billing system and this technology signifies towards solution. From this, we hope this proposed idea can make a great change in assessment of electricity bill and can give the benefit to the government by reducing the manpower and time consumption and the reduction of cost.

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