INTELLIGENT ENERGY METER WITH POWER THEFT DETECTION

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Abstract

The data collection of energy distribution for billing and monitoring of the distribution system are very important part in the research of energy visualization and analysis. In the conventional method, a meter reader who authorized by the Electricity department visited the customer's house and note down the consumed energy units and calculates the usage charge. In this method problems may arise due to errors caused by meter reader and it is time consuming also. Automation of electricity billing system is the solution to this problem. This paper proposes a method to automate the electric billing system. It can be achieved by incorporating a microcontroller with energy meter and interface it through Global System for Mobile Communications (GSM) module. This system enables Kerala State Electricity Board (KSEB) to collect the bill automatically without utilizing the man power. The data collected at the customer premises is shared to the KSEB office through web/GSM. A database at the KSEB office stores all the details and will be accessible to the officials and customers on demand. When the energy consumption exceeds a particular value the heavy loads will automatically disconnected and alert the consumers. Electricity theft is a social evil that has to be completely eliminated. This paper suggests a method for effective energy management and power theft detection on distribution lines also. In the proposed system if there is any tapering between the distribution post and the actual customer, power theft detected message will be sent to KSEB office.

Keywords: Electricity theft; GSM module; Energy management system; database

I. INTRODUCTION

Energy management and monitoring has a significant role for the proper utilization and better energy management. In existing system the meter readers has to visit every home to take the consumed units and cost. This billing process may arise several problems such as errors caused by the meter reader while writing the reading. A single digit error can entirely change the cost of the consumed units. Next problem is absence of the consumer in the house when the meter reader comes to take the reading. This will bear fine to the consumer. Due to the bad weather conditions this task is difficult for the reader. This billing process will be time consuming. Nowa days Kerala state faces a shortage of electricity. To manage this shortage government borrowing electricity from other states and this will bear a huge amount as debt around 200 crores. Illegal power usage is termed as electricity theft [1] [2].

This paper proposed a method to automate the billing process, effective energy management and power theft detection on distribution lines. This system enables KSEB office to collect the bill and power theft detection data automatically without utilizing the man power. The data collected at the customer premises is shared to KSEB office through web and GSM. A Liquid crystal display (LCD) will show the live readings at customer premises. The data is sent to the customer via GSM also. When the energy consumption exceeds a particular limit the heavy loads will automatically tripped off and alert the users through short message service (SMS) and through indicator. If there is any tampering done in the post then power theft detected message will send through KSEB office via a GSM. The intelligent energy meter contains energy meters, GSM modem, microcontrollers and a relay circuit. This proposed system is highly deserved for national implementation.

This paper enhances and supports the concept of digital India and thus making the country digitally empowered in the field of technology.

The remaining part of the paper is organized as follows. In section II, it describes the literature survey. In section III, provides the information about the system architecture. In section IV, the hardware implementation of the proposed system is explained. Section V describes the methodology of the system implemented. In section VI the results and discussion has been presented. In section VII provides the conclusion of the paper.

II. LITERATURE SURVEY

Energy consumption is increasing rapidly in the state of Kerala. As per the survey conducted during the period of November 2016 to December 2016, a total number of 40 houses in the local areas of Manvettam, Mallappaly, Pathanapuram and Puthur. The people are not satisfied with the present existing meter billing system. The meter readers have to visit every home to take the meter readings. Many of the times the door locked and could not get the bill. In the absence of the consumers they locked the door and gates due to security reasons. So, they didn't get the electricity bill properly and also get fined. They are also complaining against the errors caused by the meter readers while writing the reading. A single digit error can entirely change the cost and consumed units. People need to know their consumed units and the corresponding cost at any time. The storage of the electricity bill is also hectic. Most of the people demanded to limit their usage to a particular value. Above that particular value the heavy loads should be tripped off automatically and the alert the users.

Nowadays, the state Kerala is facing an electricity shortage crisis. So the conservation of energy is inevitable. According to the discussion with the KSEB officials of Pallom and Kaduthuruthy subdivisions, they arises the problem of power theft on distribution lines. Illegal power usage in customers, namely electricity theft is classified as a non-technical loss of power distribution systems. There is no method to find the power theft in the present system. About 2.8 crores of revenue is wasting every year due to power theft. (Newspaper report "power theft cases on the rise" ,The Hindu news on 24 May 2016)

Based on these survey results, the proposed method is trying to optimize the problems faced by the consumers and KSEB officials. This paper proposed a method to automate the billing process, better energy management and power theft on distribution lines. This system enables KSEB to collect the billing and theft detection data without utilizing man power. When the energy consumption exceeds the threshold value the heavy loads will be automatically disconnected.

The paper is concerned with the automation of the electric billing system. The electricity bill sends to KSEB office through GSM module. An LCD display is connected with microcontroller to show the consumed units and cost. Bill records are digitized. When the energy consumption is more than the threshold value the heavy loads in the home circuit will automatically tripped off using relays. This method provides an indication system to aware the user about the over energy consumption than the threshold value and sends a SMS to consumers.

III. SYSTEM ARCHITECTURE

The system architecture of intelligent energy meter is shown in figure1. It consists of arduino uno, energy meter, optocoupler, relay, LCD display and GSM modem.
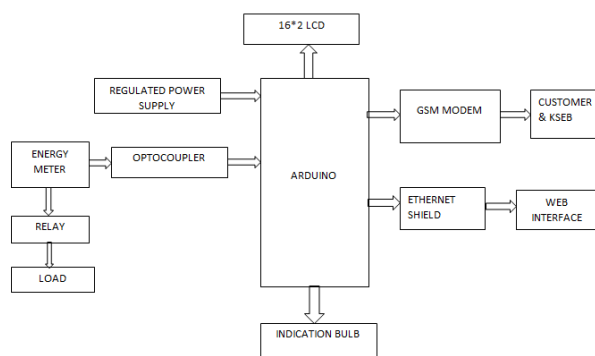

Fig.1: Block diagram of intelligent energy meter

A. Arduino Uno

Arduino is a flexible programmable hardware platform. The arduino software development environment is easily available in internet. It is a microcontroller board based on the ATmega328P. It has fourteen digital input/output pins, six analog inputs, a sixteen megahertz quartz crystal, a Universal serial bus

(USB) connection, a power jack, an In-circuit Serial Programming (ICSP) header and a reset button.

Arduino is a physical programmable circuit board (PCB) and a piece of software called Arduino Integrated Development Environment (IDE) that runs on computer, used to write and upload computer code to the board. The Arduino IDE uses a simplified version of C, making it easier to learn to program. Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package. The Arduino Uno is one of the most popular boards in the Arduino family and a great choice for beginners [2].

B. Energy Meter

An energy meter is a device that measures the amount of electrical energy supplied to or produced by a home or building. The most commonly used energy meter is kilowatt hour meter. Instantaneous power is calculated by taking the product of the instantaneous current and voltage. This instantaneous power is then integrated against time to give energy used by the consumers. The meters are classified into two basic categories, electromechanical and electronic. The energy consumption is calculated by using the output pulses of energy meter. The load is said to consume 1 unit of electricity when the internal counter of microcontroller counts upto 3200 pulses.

C. Optocoupler

It is an electronic device which is designed to provide electrical isolation coupling between its input and output. Optocouplers eliminate the effects of electrical noise caused by crosstalk, power irregularities and electrical interferences. The main purpose of an optocoupler is to prevent rapidly changing voltages or high voltages on the circuit [4].

D. Relay

A relay is an electrically operated switch. Relays are basic components in a majority of types of electrical and electronic device. It is also used in power engineering. An overload relay that uses a heating element to detect overloads. Electro-mechanical relay is a high speed device which is insensitive to pulse and high-frequency interference and surge voltage. It exhibits a robust behaviour in overload modes and has a satisfactory reset ratio. [4].

E. LCD display

A 16*2 LCD display contains two lines and there are 16 characters per line. Each character is displayed by 5x7 pixel matrix. This LCD consists of two registers, namely, Command and Data. The command register saves the command instructions that are given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clears its screen, sets the cursor position, controls display etc. The data register saves the data to be displayed on the LCD [2].

F. GSM Modem

GSM Modem has the capability to send and receive SMS to and from the system. The communication with the system takes place through RS232 serial port. It needs AT commands for communicating with the microcontroller. This GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. GSM technology provides the benefit that the system is accessible in remote areas [1].

IV. METHODOLOGY

A. Intelligent energy meter

Intelligent energy meter is concerned with the automation of the electric billing system. Accurate reading is possible by using a programmed microcontroller. The energy meter is interfaced with the microcontroller using an interfacing device / Opto-coupler. The pulses from the energy meter are detected by an Optocoupler and it converts the pulses to electrical signals acting as clock pulses for the microcontroller. In actual system 1unit =3200 pulses but here in this paper considering 1 unit= 10pulses for convenience. Based on these pulses ardunio will automatically generate consumed unit and cost. An LCD display is connected with microcontroller to show the consumed units and cost. At the end of each month the data containing the consumed units and cost is shared to a database provided by the service provider, which is kept at KSEB office through web and to the customer through GSM. The interfacing of the energy meter with internet and GSM can be achieved by using Ethernet shield on arduino board [1] [4]. All the web interfaced data are received and stored in a database at the premises of service provider, which can be created by MySQL. When the energy consumption is more than the threshold value the heavy loads in the

home circuit will automatically tripped off using relays. It also provides an indication/alarm system to aware the user about the over energy consumption than the threshold value.

WampServer version 2.5 software is used for webserver and data base creation. WampServer refers to a software stack for the Microsoft Windows operating system, created by Romain Bourdon and consisting of the Apache web server, Open SSL for SSL support, MySQL database and PHP programming language.

WampServer is a Windows web development environment. It allows to create web applications with Apache2, PHP and a MySQL database. Alongside, PhpMyAdmin allows user to manage easily their databases.

WAMP stands for "Windows, Apache, MySQL, and PHP." WAMP is a variation of LAMP for Windows systems and is often installed as a software bundle for Apache, MySQL, and PHP. PHP is an open source scripting language offering a solid and widely used development platform.

WAMP includes MySQL and PHP, which used for creating dynamic websites. MySQL understands Structured Query Language (SQL), the standard language of choice for all modern database systems. MySQL includes an SQL server, client programs for accessing the server, administrative tools and a programming interface for writing the programs. It is a high speed data base. It is a high performance, multithreaded, multi-user around client server architecture. MySQL is easy to tune and optimize for the most demanding applications. MySQL became widely popular because of its speed and simplicity. It is a high-performance but relatively simple database system and is much complex to set up and administer than larger systems [5].

B. Power theft detection

Two separate digital energy meters can be used for power theft detection, one meter is installed at customer side and the other is installed at a pole based system. Customer side energy meter measures the power consumed by load over a period. Pole based meter is capable to measure the power distribution over each line connected to that pole. Now the microcontroller in the pole based meter has two readings: one is total power distributed by the pole itself and another is power consumed by the customer. In normal case these two readings will be same and

which indicates there is no power theft. If there is tapping done by any unauthorized person on the line over a certain period there will be a difference between the above two meter readings. Microcontroller placed in the pole meter will compare these two values obtained from the two meters and if the measured power on pole is more than the power send by customer side meter then power theft happened on the line. This theft signal generated on pole system can be transmitted to substation/KSEB office by power line communication technique or by wireless technique whichever is suitable and economical. Wireless communication is done by using a Bluetooth module. HM-10 is a Bluetooth V4.0 Bluetooth low energy (BLE) version. It has a working frequency of 2.4GHz ISM band. Transmission version can be used to transmit data between two Bluetooth devices. Tolerance should be provided for losses of line. Figure 2 shows the power theft detection arrangement [3] [4] [5].
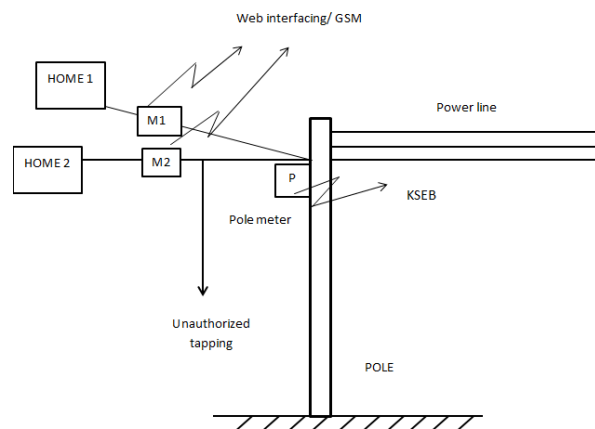

Fig.2: Method for power theft detection

V. HARDWARE IMPLEMENTATION

The power supply is the basic unit in every electrical and electronics projects circuit, which is used for providing the required power to the microcontroller and other components in the circuit. Generally, this power supply block consists of step-down transformer, center tapped rectifier, and IC 7805 voltage regulator. Microcontroller in the Arduino requires 5V power supply. The microcontroller block can be considered as the main block of the entire circuit. It is programmed to control all the components to perform the desired operation. Here, in this proposed system Arduino uno is used and programmed using Arduino software. The

energy meter is interfaced with the arduino using an interfacing device called Optocoupler [3].

The 230V AC power supply is given to operate the loads. Primarily, we need to register the authorized mobile number with the wireless electricity consumption meter. This, registered mobile number can monitor the wireless energy meter system. In this wireless energy meter, SIM in the GSM modem sent the message showing the cost of the consumed energy units to KSEB office at the end of every month. An LCD module is used to display the current usage and units consumed. After usage of each unit the amount and total units will be incremented. This lets the consumer to know about his exact electricity units consumed and cost directly from the energy meter so that there is no chance of bill tampering. The wireless energy meter reduces the man power for electricity billing to each and every home or office.

When the energy consumption exceeds a threshold value, the heavy loads will be automatically disconnected using relay. The same will alert the users by indicating an indication bulb and a message will sent to the users.

If there is any tapping done on the distribution lines, immediately a message which consists of the details of location is sent to the electricity office [3].

VI. RESULTS AND DISCUSSIONS

At the end of each month the electricity bill sent to the KSEB and customer through GSM module. A registered SIM number is provided in the GSM module. The figure 3 and figure 4 shows the automatic electricity bill as SMS to the KSEB and customer respectively with the experimental set up.

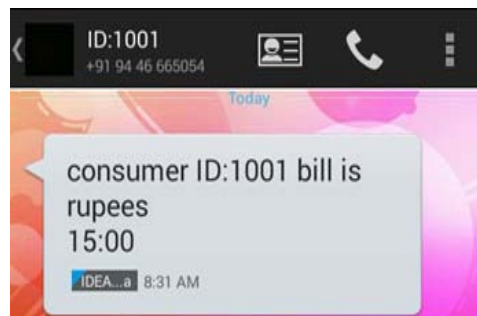
Fig.3: Automatic electricity bill to KSEB

Fig.4: Automatic electricity bill to customer

A database is created in the KSEB office which records the bill details of each home. All the web interfaced data are received and stored in a database at the premises of service provider, which can be created by MySQL. Figure 5 shows the database created in the experimental set up of the method proposed.

Fig.5: Database creation of Bill

When the energy consumption is more than the threshold value the heavy loads in the home circuit will automatically tripped off using relays. A message sent to the the user to aware about the over energy consumption than the threshold value. Figure 6 shows the message of over energy consumption with experimental set up.
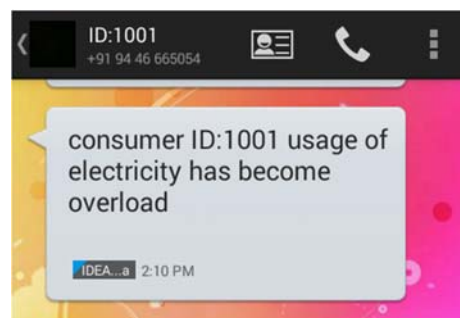

Fig.6: Over energy consumption message

If there is any tapping done on the distribution lines, immediately a message sent to the electricity office. Figure 7 shows the theft detected message with experimental set up.
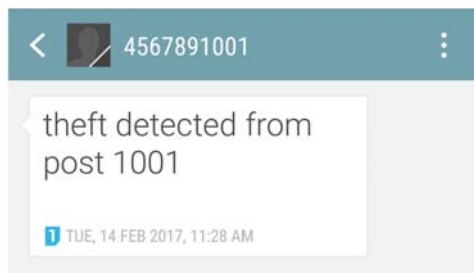

Fig.7: Theft detection message

VII. CONCLUSION

Intelligent energy meter is easy to install and beneficial for both energy provider and consumer. Using this meter can reduce the manual efforts to take the readings from the energy meter which is cost effective. This system also helps the users to be aware of their energy consumption. The information is transmitted to the electricity board office using GSM modem on GSM network and through web creation of data base. It can also limit the energy usage by indicating the over energy usage. The proposed system avoids electricity theft to large extent and makes the energy meter tamper proof. This meter increases the revenue of the Government by detecting the unauthorized tampering in the power lines.

The proposed method can be expanded for automatic power cutting if the bill is not paid.

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