Smart Power Theft Detection and Monitoring System

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Abstract- Now-a-days electricity meter reading and billing is conducted manually by door-to-door system. This system requires large man power and is time and energy consuming. The theft of electricity is a major concern of the transmission and distribution losses in the supply of electricity. To overcome these limitations a prototype module smart energy meter reading system is proposed which includes advanced wireless technology called "ZIGBEE". In this system, time delay, errors, and theft of electricity is reduced. The ZigBee technology works at low frequency, low data rate hence it is preferred more and its cost is also less. Wireless Electric Meter is used for remote collection of unit count and sending bill on consumers meter screen. Wireless automatic meter reading technology not only saves human resources but improves the accuracy and remote access of a meter. The consumers are no more dependent on conventional power. The proposed meter calculates net bill, units consumed and theft detection is displayed on LCD screen.

I. INTRODUCTION

Conventional metering and billing system is not efficient and also has many disadvantages. It is a time consuming system due to requirement of man power. To overcome these drawbacks, a smart energy meter is used. Wireless technologies such as ZigBee, Wi-Fi, Bluetooth and GSM are used for communication. All countries are promoting renewable power generation by adopting many policies to credit consumers who are generating power by their own. Electricity theft is a serious issue in developing countries like India. Apart from the formation of laws against electricity theft, it is still a problem at alarming stage. Every year a huge amount of revenue to the utility is lost due to theft. To overcome this issue theft measures are incorporated in a smart meter. The ZigBee Digital Power Meter (ZPM) utilizes the wireless sensor network to send it power usage reading using information back to the energy provider wirelessly. This wireless system is also used to overcome the theft of electricity via bypassing the energy meter and hence it also controls revenue losses and utility of electricity authorized agency [1]. There are two types of techniques to deliver the information to the authorized agency to control the theft of electricity: Wired techniques and wireless techniques. Wired techniques include electrical cables, coaxial cables, and optical fibres. Wireless techniques include ZigBee technique, GSM technique, WI-FI, Infrared, Wi-max, Bluetooth etc. [2]. ZigBee is used mainly in data exchange between low power electronic devices within a limited range. There can be as many as 65000 wireless communication modules in a ZigBee network, which is very similar to telecommunication. There are lot of problems related with the wired techniques such as installation problem, complexity and cost also matters in case of long distance. Hence ZigBee is more convenient to use as wireless technology. ZigBee Module: ZigBee is the standard-based wireless technology designed to address the needs of low cost, low power wireless sensor and control networks. ZigBee is easy to implement, needs little power to operate and is also less expensive. ZigBee uses 2.4GHz radio frequency to deliver a variety of reliable standards. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other Wireless Personal Area Network (WPAN's) such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life and secure networking. It is a network protocol supported by ZigBee Alliance that uses the transport services of IEEE 802.15.4 network specification. ZigBee standards are maintained by a group of ZigBee Alliance.

Chipcon, BM Group, Ember, Free scale, Honeywell, Mitsubishi, Motorola, Philips and Samsung are nine companies in ZigBee Alliance called promoters.

Application and security layer specification are defined by ZigBee Alliance itself.

Types of methods:

(a) GSM Technology: In GSM based technology, GSM module is used in order to overcome the limitations of distance between transmitter and receiver occurred in other techniques. Here Automatic Meter Reading (AMR) technology has proved effective in which data reading is done automatically but sending and receiving data simultaneously is not performed in GSM technique.

(b) Microcontroller based system: In microcontroller based system the energy consumption units are displayed in the form of four digits on display screen and further the information is stored in EEPROM memory. Once the supply is restored the meter restarts again with previous stored value. The only drawback of microcontroller based system is that of distance limitation since there is no use of communication networks such as GSM or ZigBee.

(c) Arduino Based system: The Arduino based system consists of simple energy meter and a GSM modem. This system is a combination of arduino and a GSM modem where smart meters send accurate and regular information of total energy consumed by consumer. This system works well only if network strength is strong for proper working of GSM modem. In case of network issues it cannot receive signals which may cause errors in calculation.

(d) ZigBee technology: The wireless technique using ZIGBEE technology is used to overcome or reduce the theft of electricity. This controls the revenue losses and therefore bypassing of the energy meter can be avoided. This system consists of mainly a ZigBee module, energy meter and microcontroller. In this technique the theft of electricity is detected and hence stealing of electricity which is done by bypassing the energy meter can be avoided due to which large amount of energy can be conserved.[4] Hence as compared to all above methods ZigBee technology is more effective as it provides error free, accurate information of energy consumption.

II. SYSTEM ARCHITECTURE

2.1 Consumer Side

This side of module consists of energy meter, microcontroller, LCD display, voltage sensors, ZigBee Module and power supply unit. The microcontroller continuously monitors the energy meter reading and stealing of electricity. The theft is detected when consumer tempers the meter by bypassing it. The fuses at either side of meter are directly connected through a conducting wire hence the meter will be completely bypassed that actuates voltage sensors. This theft signal is displayed on LCD display on consumer side and transmitted to Electricity Board (EB) side via ZigBee Transmitter. The LCD display indicates the energy consumption in terms of unit consumed, power down, theft detection, monthly bill in INR.

2.2 Electricity Board Side

The Electricity Board (EB) side can also be called as management side. It includes ZigBee module and Personal Computer System. This end displays units consumed, theft status, and power status (ON/OFF), current bill according to units consumed. Monthly bill status will be send with help of “Send Bill” button, Power Switched to off for any theft detection with help of “Cut Off” button and the power supply can be restored back with “Restore Supply” button. This communication takes place wirelessly via ZigBee module.

The system operation is illustrated in the flow chart above which shows that how to prevent the theft of electricity. Firstly it add/removes the load from system and then checks meter reading units. Microcontroller continuously monitors the system; if there is any theft then ZigBee modem sends message to management side and displays on screen that theft is detected. After theft is detected then POWER is cut off by management side. Once power supply is cut off the consumer is asked to pay the penalty. If there is no electricity theft then LCD displays OK message.

Block diagram of consumer module

III.RESULT AND DISCUSSION

3.1 System Star

When we install our system in to electric meters in domestic houses system show the status about whether it is properly install or not. If the system is properly installed then LCD displays "ALL OK" status and also displays previously send bill amount. And on the management side's GUI shows the "OK" status, which indicates that system is properly installed.

3.2 Theft Detected

If the user tries to tamper the meter by bypassing it, means that he is trying to steal the electricity which is illegal. As soon as he does this the voltage sensors at the meter are actuated and send a "THEFT DETECT" message to management side via ZigBee. The following figure shows the theft detected situation.

3.3 Loading the System

Once the 'ALL OK' message is displayed on the LCD display, it is then very much safe to load your system. Since its purpose is domestic, the load can be of any type. Any number of loads can be made to run and accordingly the meter will display the consumed units.

3.4 Bill Sending

If management center wants to send the bill amount to user at the end of each month, the EB sends the message to the particular consumer and that message is displayed on the LCD display.

3.5 Power Cut-off from Management Side

Since the stealing of electricity is illegal, the management side has been given the provision to cut-off the power of that user. The GUI at management side has a "Cut Off" button, which when clicked by an authorized person cuts off the electricity supply of that particular user in case of either theft detection or bill payment is overdue.

3.6 Billing Message Displayed at Consumer Side

The total unit consumed in one month by the consumer is calculated by the current unit rate at the management side and sends the message to that particular user that is displayed on users LCD display.

3.7 Restore Power Supply

The power is restored back to the user in either case when that user has successfully paid his overdue electricity bill or for the theft detection he has paid the penalty for the illegal use of electricity by stealing it.

Fig 3.1 System start status

Fig 3.2 Theft Detected

Fig 3.3 Restore Power supply

Fig 3.4 Bill message at consumer side

Fig 3.5 Restore power supply

Fig 3.6 Theft Detected

IV. CONCLUSION

The proposed system is wireless smart energy meter using ZigBee. This system reduces the work of the office person to a great extent. It also reduces the difficulty faced by the people when readings are taken manually. It simplifies the work of the electricity board in tripping the supply to a particular customer in case bill is not paid. It also helps the customer in knowing about the due date for the payment of bill. Mainly the electricity is being stolen via bypassing the energy meter therefore this wireless system is utilized to overcome this type of the theft of the electricity and is very beneficial for the authorized agency to control its revenue loss as all of us know that the cost of fuel is increasing day by day.

V.FUTURE SCOPE

(a) Notification via SMS or Email of billing or any information related to power management system (such as load shedding time table , power shut down) provided by electricity authority .

(b) Project work can be extended for net metering required for smart grid technology.

(c) The similar system can be used in water management and LPG gas management system in domestic housing society.

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