

Automatic Energy Meter Reading and Load Control System Using ZIGBEE

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Abstract: - Now-a-days technology has developed to a large extent. At the same time the need for systems with automation and high security are preferred. An automatic energy meter reading (AMR) and load control system is presented in this paper. Conventional energy meter reading method for retrieving energy consumption and billing is a tedious process and cost of data logging systems is high. This requires huge labor and long working hour to achieve the reading process. Human billing are prone to reading errors and sometime in houses the electricity power meter is placed in location where it is not easily accessible, the billing will slowed down due bad weather conditions. AMR technology will automatically collects energy consumption data from energy meter and transfer that data to Electricity Board (EB) office by using wireless sensor networks (WSN). This system use LCD display to provide the meter reading, power cut, total load used and power disconnect information at customer side. This information is being sent and received by concerned energy Provider Company with the help of ZigBee network. It can also control loads with the help of relay circuit, when the demand for energy consumption goes high. This system not only reduces the labor cost but also increase energy meter reading accuracy and save huge amount of time.

Keywords— Automatic Meter Reading (AMR), LCD, ZigBee, Relay control

I. INTRODUCTION

Electricity is the major driving force behind the development of any country. With the development of country's economy and the improvement of national power, the power requirement is still ever increasing due to use of improper power management systems and the conventional energy metering system. Traditional meters, in which the pendulum rotates for a predefined times and it calculates the consumption of unit power in terms of Watts. Those meters are economical ones and installed at home and as well as in industries. Our traditional meters are non real time ones so calculation of bills is slow in process. Now a day's a computer operated meter are used but they are also non real time system operated device. In this process we require more time and human resources. And if any fault occurs then to detect it and resolve the problem is the big task, as in [1]. Now a day energy meter reader goes to every premise and takes the reading manual then issues the bill. In manually reading human error possible and not provide reliable meter reading. An energy meter is a device which is used to measures the consumption of energy of any residence or other industrial establishment. In Conventional metering system, to measure electricity consumption the energy provider company hires persons who visit each house and record the meter reading

manually. This is only a sluggish and laborious. In conventionally metering system people try to manipulate meter reading by adopting various corrupt practices such as current reversal or partial earth fault condition, bypass meter, magnetic interference etc, as in [3]. If any consumer did not pay the bill, the electricity worker needs to go to their houses to disconnect the power supply.

The wide proliferations of wireless communication propose and explore new possibilities for the next generation. Automatic meter reading (AMR) whose goal is to help collect the meter measurement automatically and possibly send commands to the meters. There are three key elements in an automatic meter reading (AMR) system. 1. consumption measurement, 2. meter reading and data transmission and, 3 Data processing and billing. Wireless method is used for processing energy meter reading digitally with the help of computer communication in a very efficient way. Basic idea behind this model is to overcome the disadvantage of conventional meter and to speed up the process. The main part of this model is ZigBee since it has main feature of low data rate so it consumes less power to operate and it is highly reliable, as in [10]. It eliminates the error of any kind of data loss during the transmission and reception of digital data.

II. LITERATURE SURVEY

In the existing methods energy meter is using Power Line Carrier Communication. It is wired system and hence the performance is less compared to wireless systems. Power line communication (PLC) has seen a lot of interest in the past few years due to the almost omnipresent nature of the power line grid. Moreover, the power line channel proves unfavorable to reliable communication due to its multipath nature, frequency selective effects, narrowband interference and presence of strong impulse and colored back-ground noises, as in [4]. The conventional energy meter has the following disadvantages: (i) Sometimes the meters are installed inside people's homes and if the consumer is not at home, the meter-reader cannot record the reading. (ii) Requires huge man power. (iii) Dissatisfaction of some customers who may consider meter-readers entrance to their homes as some sort of invasion of their privacy. This is especially applicable in villages, where during the day most men are outside of their homes earning a living and only women are at doing the housework. (iv) False billing due to human error. (v) Auto load control is not possible, as in [2]. In Bluetooth based energy meter reading system the problem comes with the range, as in [9]. With the development of wireless technology all the above mentioned problem can be overcome with the help of ZigBee communication.

III. METHODOLOGY

In this paper, we proposed a new way of communication between the EB section and the consumer using ZigBee technology for transmitting the customer's electricity consumption and bill information that is calculated using PIC microcontroller. The power fluctuations are monitored using the voltage sensor and current sensor and fed to the microcontroller which indicates it to the Electricity Board. Depending on the power generation, the household's devices are controlled automatically. With a help of LCD metering information, tariff changes and power shut is displayed at consumer site. Through email the amount to be paid is sent to every consumer.

3.1 Zigbee Technology

ZigBee is a new emerging technology used now days for short range communication network which works on a unique identification code. It is a wireless communication device which is comprised of a trans-receiver just like a

blue tooth device or a Wi-Fi network but data rate is low. It has 16 bits address so it creates 65536 nodes in a network or in other words it has 16 Channels for communication. The only difference in ZigBee is it uses unique identity method means if one ZigBee device transmits data then it is received by only that ZigBee device which is having its decoding address. While in Bluetooth or in Wi-Fi anybody can transmit or receive data. So data is prevented in ZigBee device, nobody can manipulate the data. Only authorized person or device can read data, as in [7, 10].

Main features of ZigBee are low data rate & low power consumption. The main layers which are used in communication are PHY layer and MAC layers of ZigBee. While the network may have a star, bus, mesh topology or hierarchical tree structure for routing of data between two stations. The main advantage of ZigBee is that it can create network automatically in which it can add or leave any device of a network. Now a day's power sector companies are looking for improved technologies to reduce their cost and to boost their profits, which include flexible billing dates for their customer, forecasting their bills in advance, to remind bill dates and amount of money, to inform their load schedule in advance.

3.1.1 ZigBee Parameters

The following parameters defined in the IEEE 802.15.4 standard are used,

- ❖ Working frequency is 2.4 GHZ, 868/915MHZ.
- ❖ Data rate is 250 kbps.
- ❖ System resource is 50kbytes-60 Kbytes.
- ❖ Communication range is 1.5-2 km.
- ❖ EVM cannot exceed 35%.
- ❖ Support low power consumption.
- ❖ Battery life time is 100-1000 days.
- ❖ Success metric-reliability, power cost.

3.1.2 Key Features

- ❖ Retries and Acknowledgements
- ❖ DSSS (Direct Sequence Spread Spectrum)
- ❖ Each direct sequence channel has over 65,000 unique network addresses available
- ❖ Point-to-point, point-to-multipoint and peer-to-peer topologies supported
- ❖ Self-routing, self-healing and fault-tolerant & mesh networking

3.2 Hardware Implementation

The hardware architecture and appearance of wireless AMR is as shown as Figure.1, 2. The energy consumption is being calculated using a standard calibrated energy meter. In order to prevent unauthorized connection, mismatch with the energy meter. The digital date generated from this block is then sent to PIC-based embedded system to compute power parameter. The proposed AMR system is divided into two sections i.e. consumer section and provider section. This wireless meter has two main components; one is an interface circuit and second is digital transceiver circuit. This wireless AMR can be divided into five parts. Those five parts are PIC as interface unit, LCD, wireless communication module, relay control unit, energy provider control center.

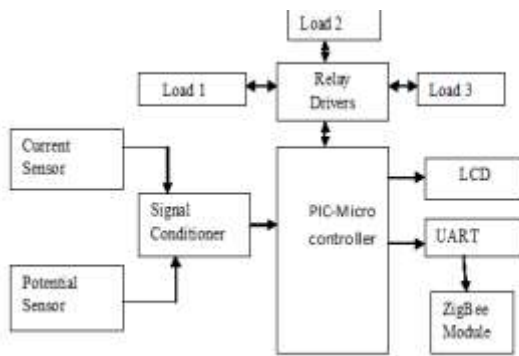


Figure.1 Functional Block Diagram –Consumer Section

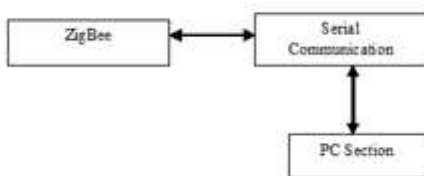


Figure.2 Functional Block Diagram- Provider Section

A) PIC as Interface Unit

PIC microcontroller (PIC16F877A) acts as interface circuit, which has Harvard architecture i.e. separate data & program memory. It has a high performance and low cost solution for network applications. The controller has peripheral features like inbuilt analog to digital controller (ADC), 1-UART, 3-Timer (Timer0, 1 & 2), and capture, compare module. Operating speed is max 20 MHz, Voltage (2- 5.5) v and has pulse width modulation. It has 5-ports named as port A, B, C, D, E. Low power and high speed

Flash/EEPROM Technology. It acts as a link between the electric meter, power line and ZigBee. The basic part of interface circuit is to observe the blinks of electric meter and counts every blink. After (e.g.) 3200 blinks it calculates power as 1 Watt and transmits those digital counts to base stations.

B) Wireless Communication Module

ZigBee is used as wireless communication module. ZigBee device collects the blinks and updates every count of blink which is coming from the electric meter through interface circuit. After processing the blinks it transmits that low rate digital data into network of ZigBee concentrator. The meter and base station may have long distance so it sends data from home to base stations via different kinds of communication network such as mesh, star, cluster etc. ZigBee Router routes the data from one device and acts as communication link between utility provider and service provider. ZigBee has major role in monitoring and efficient power utilization. It covers enough area needed for wireless communication and it works on low data rate of 20Kbps to 250Kbps with minimum power consumption.

Range Extender is used to cover long distance in a network a group of ZigBee is installed which is an intermediate terminal of a network. If a service provider wants to break the power connection for maintenance or after detecting a theft or tamper at any stage, it can switch-off the power line by a simple command from base station, as soon as the power line can be disconnected. To establish a connection again a command is given via ZigBee network to switch-on the line that enters into meter.

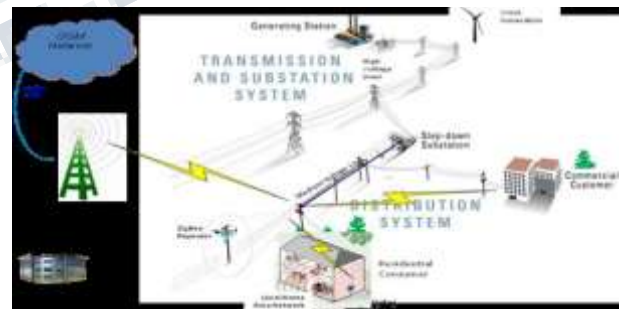


Figure.3 Model of Wireless AMR

C) Relay Control Unit

The relay control is a vital part in Wireless AMR system. It provides the useful functionality of remotely switching the power ON/OFF to the user. It consists of a protective relay, breaker control circuit & line breaker.

D) LCD

LCD display is provided at consumer site. The basic idea behind this part is to provide simple communication setup at consumer site. It passes the information about electric bill, load shedding time. Instead of LCD display GSM can be used to provide info about the amount they have to pay through SMS.

E) Energy Provider Control Center

This control center has a PC as control server with needed programs and storage to read and collect power parameters from AES via communication network. It stores information about all energy consumers in its data base.

3.3 Automatic Load Control

Automatic load is a new feature which has been added in this system. It is used to make or break a circuit connection. When the communication network is of error free in this case a power line is connected to meter and energy is consumed by appliances. But if someone fails to pay the bills as per meter reading before due date then base system generates a signal to turn off the meter and shut down the power system of that particular person by using his serial no or ID. There is another situation in which any customer tries to manipulate the meter reading or tries to steal the electricity then tamper sensor generates a signal to base station and after receiving a tamper signal an authorized person again shuts down the meter or power cable. When a customer pays the bills then at base station a automatic signal is generated by data software all due are cleared and start the power.

Automatic load control comes as an important issues when the demand for electric energy usage goes high .Especially during summer season demand for energy goes high so the energy provider cut the power for more than two hours, which put customer to difficult situations, particularly for rural people who has no secondary mean of electric supply (e.g. generator, UPS, etc). In this paper, we propose a solution to overcome power cut problem. Here, we control load at each house with the help of relay circuit by measuring current with the help of current and potential transformer.

IV. SOFTWARE IMPLEMENTATION

Figures 4, 5 and 6 give the flowchart for software implementation. The system software is implemented by C language in the Keil software along with flash magic also editing, compiling and debugging can be accomplished using the above mentioned software's

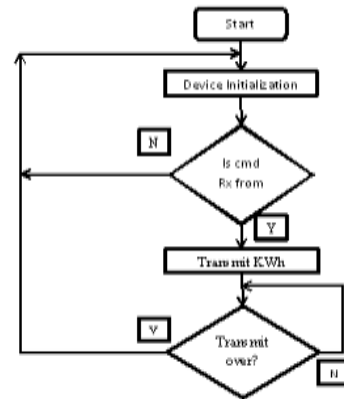


Figure 4 Meter side flowchart

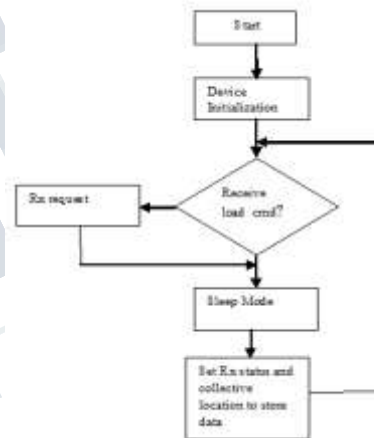
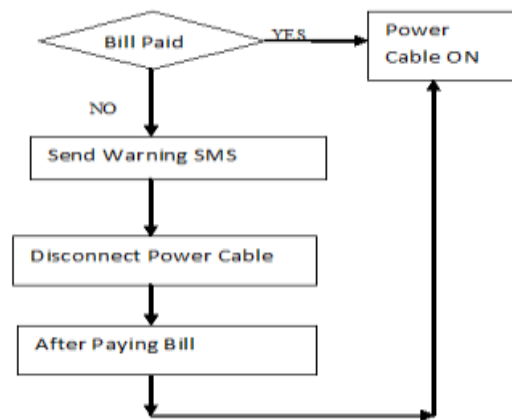


Figure.5 Server Side Flow



Figures.6 Auto Load Control

V. CONCLUSION

Through detailed study and analysis a ZigBee based wireless meter is introduced in this paper which replaces the conventional meter. This model eliminates the difficulties present in older system like saving of money and labor resources. The data is secured using unique serial no or ID technique. This wireless meter have additional feature like connects and disconnects the power line from meter. One of the advance technique is used in this system are auto load control and tamper detection. In addition an LCD display is used for intimating consumer about power shut down schedule, about their monthly bills, or to inform area supervisor in case of emergency with a buzzer sound. In future the system can be implemented using algorithm for better results and for more accuracy

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