Implementation of Automatic Meter Reading System Using Wireless Sensor Network

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Abstract: **Because of disadvantages of traditional meter reading such as errors in reading, inaccuracy, external conditions affecting readings, delayed work we have implemented meter reading system based on latest ZigBee technology. In this model we have designed and implemented wireless sensor network for measuring utilities such as electricity, water. The system is designed using electric meter, flow sensor for measuring utilities, ARM controller LPC2138 as core processor, and ZigBee module in close communication with GSM for distant communication. This system performs tasks such as taking meter reading, distribution of bills, sending notice, cutting and reconnection of flow automatically. This model can lead to great deal of costs saving in water, electricity metering.**

Index Terms: **Arm7, GSM, Wireless Sensor Network, ZigBee**

I INTRODUCTION

The traditional metering systems has many disadvantages as manual reading has shortcomings such as errors in taking reading, inaccuracy, external conditions affecting readings ,delayed work .These techniques also requires huge manpower. Automatic meter reading system is one way to avoid these shortcomings.

There are three key elements in an automatic meter reading (AMR) system: consumption measurement, meter reading, transmission of measured data, and data processing and billing. An AMR system has to be Cost-effective i.e. costs of implementation, maintenance should be reduced while providing robust and reliable performance. And one very important thing is the relationship between the customer and the supplier must be considered [5].

The emerging field of wireless sensor networks combines sensing, computation, and communication into a single tiny device. The development of Wireless Sensor Networks (WSNs) resulted due to Continuous advancements in sensing, computing and communication technologies together with the necessity of monitoring physical phenomena. These wireless sensor networks senses physical environment with sensors and takes suitable control action based on its observations and accordingly perform operations. Thus this technology can be proved to be effective in meter reading systems. In This way meter reading system can be made automatic and this will also eliminate shortcomings of traditional meter reading system. The costs involved in manual reading of the meter are eliminated and the consumption of goods becomes more transparent.

A WSN Structure

A wireless data collecting system consists of flexible combinations of sensors, controller, and wireless communication devices. The WSN is formed by using "nodes". Each such sensor node is typically made up of several parts: a sensor for sensing the physical environment, a radio transceiver with an antenna for transmitting data wirelessly, a microcontroller for processing the data, an electronic circuit for interfacing with the sensors and an energy source. A WSN is formed by densely deployed sensor nodes in an application area. There can be from a few to several hundreds or even thousands of nodes and each node is connected to one or several sensors

For sensor network applications, key design requirements revolve around long battery life, low cost, small footprint, and mesh networking to support communication between large numbers of devices in an interoperable and multi-application environment.

The development of wireless communication technology in recent years resulted in evolution of for low cost equipment of wireless networking technology, called ZigBee. It is a short range, low-complexity, low cost, low power consumption, low data rate two-way wireless communication technology with high network capacity, short time delay, safety .

There are numerous applications that are ideal for the redundant, self-configuring and self-healing capabilities of ZigBee wireless mesh networks. Key ones include

• Energy Management and Efficiency—To provide greater information and control of energy usage, provide customers with better service and more choice, better manage resources, and help to reduce environmental impact.

• Home Automation—it provides more flexible management of lighting, heating and cooling, security, and home entertainment systems from anywhere in the home.

• Building Automation—it provides centralize management of lighting, heating, cooling and security for whole building.

• Industrial Automation—to extend existing manufacturing and process control systems reliability. [6]

II. Literature Survey

Babak Aghaei [1] presents a model for processes which are related to user of water, electricity and gas by using wireless sensor network in Iran. In this paper the amount of economy and optimization occurred in offices in Malekan those by proposed model are given. Li Quan-Xi1, Li Gang2 [2] propose household metering system design

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based on Zigbee and GPRS technologies, using PIC18LF4620 as the core processor and CC2430 chip as close communication function, using SIM300 chip as communication function in distance.

Md. Wasi-ur-Rahman, Mohammad Tanvir Rahman, Tareq Hasan Khan and S.M. Lutful Kabira[3] proposed technique for remotely reading electricity meter readings using Short Message Service (SMS) has been illustrated. Existing Global System for Mobile communications (GSM) networks have been used for sending and receiving SMS.

Dr. Mohd Yunus B Nayan1, Aryo Handoko Primicanta2 [4] propose hybrid Automated Metering Reading (AMR) system which is a combination of ZigBee and GSM technology. In this propose system ZigBee module is attached to the electric meter by using interface board and the data collector will be connected to the central computer by using GSM.

Gordan Štruklec1, Vedran Bilas2[5] propose a wireless automatic water-meter reading system founded on ZigBee technology . The wireless automatic water-meter reading system presented here uses ZigBee networking to avoid difficulties and problems inherent to other meter reading techniques

In all above models either single parameter is used for developing AMR i.e. electricity and water or give general idea about designing of AMR. Designed model gives detailed design of AMR which will measure electricity and water and for each house and will forward recorded data to central station and will also send sms to user using gsm communication, regarding due dates ,bills etc.

III METHODS

A System Architecture

We designed model which is concerned with main household utilities that are water, electricity distribution network. In this designed system, meters used for recording amount of family's consumption. In this system we have designed two nodes .As we know wireless sensor network consists of nodes, one house containing these meters can be considered as one node. Data i.e. consumption of one house is transferred to next house by using wireless sensor network. In this model main office is considered as central node of a network.
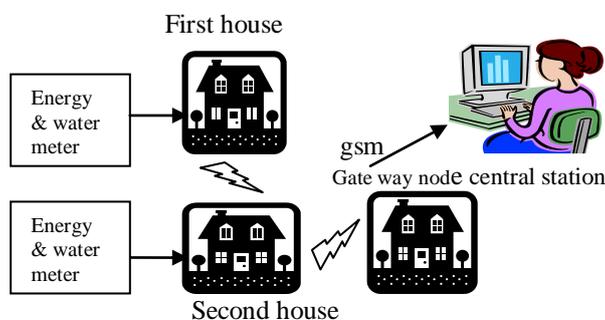

Fig 1.System Architecture

As shown in figure above, this model works such as one house sends its data to next house i.e. one node sends its data to neighboring node. This node then sends its data along with data of previous house to further node and process continues. Data gathered from every node is

collected in data collecting module through ZigBee network. Finally all data is sent to central office via gsm communication for billing and further analysis [1]. GSM module is also used to broadcast messages of bills of individual houses, due dates for payments, confirmation of bill payments etc.

B HARDWARE BLOCK DIAGRAM

User meter reading module consists of three parts, intelligent instrument data acquisition module, data storage and data transfer module of ZigBee [2]

The LPC2138 controller is low power, low cost, high speed device. The LPC21438 microcontrollers are based on a 32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support. It has embedded high speed flash memory 512 kB. For critical code size applications, it provides the alternative 16-bit Thumb mode which reduces code by more than 30 % with minimal performance penalty. This controller also supports serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, SSP to I2Cs and on chip SRAM of 32 kB. These features make these devices very well suited for communication gateways and protocol converters, and also in applications like soft modems, voice recognition and low end imaging. It also provides 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edges or level sensitive. [8]

LCD display is connected to microcontroller for continuously displaying values of water, electricity consumed. Microcontroller is also connected to the relay driver and relay which cuts and resumes supply if bill payment is not done. This makes system automatic

The wireless communication among devices is achieved using XBee modules. The XBee OEM RF Modules designed to meet IEEE 802.15.4 standards and supporting the unique needs of low-cost, low-power wireless sensor networks are used for RF transmission. The modules require minimal power and provide reliable delivery of data between devices. This module has specifications of Indoor/Urban range up to 100' (30 m) ,Outdoor line-of-sight: up to 300' (100 m),Transmit Power: 1 mW (0 dBm) and Receiver sensitivity: -92 dBm[7]
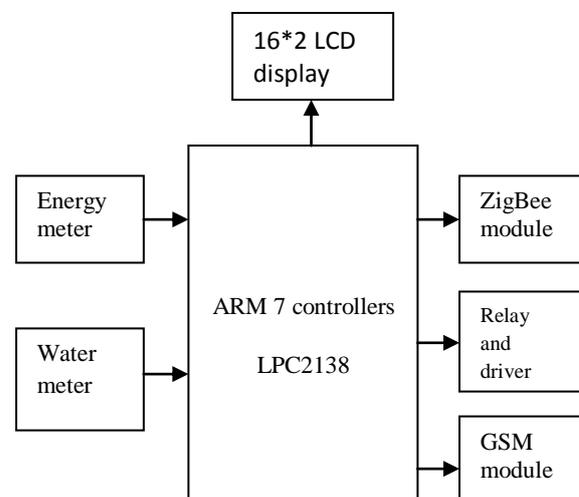

Fig 2.Hardware Block Diagram

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IV EXPERIMENT RESULTS

In this section, we demonstrated the experimental results of the proposed system. The monitoring and management interface of the wireless automatic meter reading system in this research is shown in Fig. 4. It is coded with the Visual Basic Program language developed by Microsoft. At this central station, it receives multifunction electric meter data, and water meter data i.e. energy and water consumption. During experiment two houses were selected and the load was connected to demonstrate the working of model. An electric meter, measures amount of energy consumed by one house, while water meter measures amount of water consumed and transfers this measured data to next house using XBee .This data is then send to PC via RS 232 communication format. The fig 3.shows the designed model used for experiment.
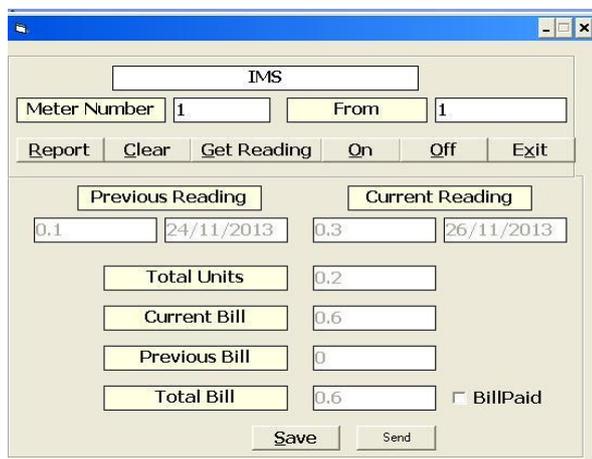

Fig 3. Node Designed For Experiment

Fig4: Monitoring and management of wireless automatic meter reading system at central station

V CONCLUSION

Automatic meter reading system model presented in this paper uses WSNs for main household utilities which are related to user of water and electricity. This process includes taking meter reading, distribution of bills and sending notice about due dates via sms, cutting and reconnection of flow. By study of WSN this automatic meter reading system was designed by using XBee as communication medium. Use of XBee in WSN makes this system low cost, less power consuming, secure and reliable. This system can not only reduce the shortcomings of traditional metering system but will also reduce manpower required.

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