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Smart Grid and Power Theft Detection Using WSN

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***Abstract*— Now-a-days, the most important problem faced by most of the countries in the world is scarcity of energy resources. Smart grid technology is one of the recent developments in the area of electric power systems that aid the use of non-conventional sources of energy in parallel with the conventional sources of energy. The control and monitoring is essential for its effective and efficient functioning. A power sensing module is designed and developed to calculate the power for any kind of loads our project basically makes an attempt to cut forth the power theft by developing a node wireless sensor and establishing a wireless communication between the node sensor and the based power station for informing about the power theft if any. Besides this the project also makes an attempt to established a prioritize power authentication in order to have an uncut power supply to those places which requires power supply with higher priority even when there is load-shedding (power cut) in the suburb region.**

***Keywords*— Smart grid, Wireless Sensor Network, Power theft, ZigBee**

I. INTRODUCTION

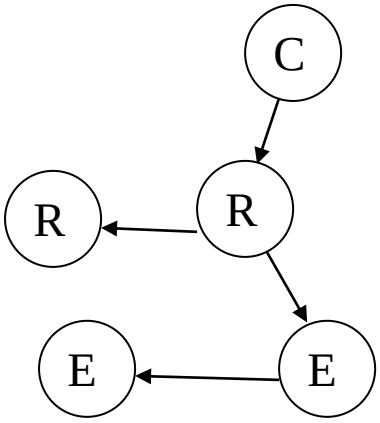
Electrical energy is one of the major boom to the development of lifestyle of human beings as a whole. However along with the efficient use of this electrical energy the other major problem that most of the countries in the world face is the power theft. In today's world we can see that there is great need of efficient and intelligent use of the energy resources available with us.

Improvements in power electronics technologies and utilization of renewable energy sources for power generation have given rise to the use of distributed generation and create concept of smart grids to overcome rapid increase in the demands for electricity and depletion of conventional energy. Monitoring of power system parameters sources like current, voltage and power at distribution level is of crucial importance for efficient functioning of smart grid. Smart grids enable increased demand response and energy efficiency, integration of variable renewable energy resources. Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market stakeholders to operate all parts of the system as efficiently as possible, minimizing costs and environmental impacts while maximizing system, resilience and reliability. The smart grid technology enables information technology as a root to penetrate into existing today's electrical distribution system through information technology by using wireless sensor network. Smart Grid utility system encapsulates the net metering system for facilitating consumers to optimally utilize the power consumption efficiently. The urgency of an integrated smart grid monitoring system use wireless sensors network for advancements in metering of the electrical meters to provide more efficiency, reliability and options to consumer. Monitoring of the power system essentially has two main modules: the sensor module for sensing the different parameters like power, current and voltage and communication module. Wireless sensor networking have been recognized as a promising technology that can enhance various aspects of today's electric power systems, including delivery, generation, and utilization, making them a vital component of the next generation electric power systems, smart grids. ZigBee based wireless sensor networking is proven to be more reliable, efficient and effective way for smart grid technology.

II. POWER MONITORING MODULE USING WSN TECHNOLOGY

The characteristics of the system to be monitored such as current, power and voltage ratings have to be well defined for the proper design of the hardware platform.

A. Setting up of Wireless Sensor Networks



ZigBee protocol works on the standard IEEE 802.14.5.The above diagram is used to show the three point network. 'C' denotes Coordinator – 1 required in every network In charge of setting up the network Can never sleep. 'R' denotes Router – multiple may exist Can relay signals from other routers/EPs Can never sleep. 'E' denotes End Point – multiple may exist Can not relay signals Can sleep to save power.ZigBee support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other.

There are three ZigBee modules used. One of them is the main module named as 'Master; module which is used to control other two ZigBee modules. At the control room the module will be having the controller with power supply for it and a ZigBee module in order to have wireless communication with the each wireless node sensor fitted outside the home. A provision would be made at the control room in order to count the units of electricity that would be transmitted with the help of controller.

B .Power Theft Detection mechanism

The units of electricity that should be received at each wireless node sensor would be fed into it including the proper calculation of losses that would occur during the transmission process. If suppose now 50units of electricity is transmitted by the control room and expected units of electricity at a home at around 60m is 49units but it is observed that the units of power received is 30units than it would be concluded that a power theft has occur in this case and a buzzer will blow on fitted at the wireless node sensor outside the house and along with that a wireless communication would be done by the node sensor with the control room regarding the same so that the control room would come to know about this power theft.

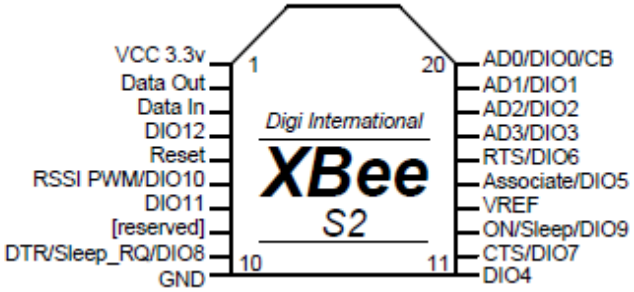
C .Priotorized Authentication

The other important part of the project is to make a prioritize authentication of power in order to provide an uncut power supply to the institutions like hospitals and places that requires 24*7 even when there is load shedding going on in the suburb region.

III. BLOCK DIAGRAM

A. Block diagram description

1) ZigBee:



The Operating Voltage for the ZigBee is: 2.1 – 3.6V.The operating Current for ZigBee is 40mA.at
3.3V. Describing about the range, the indoor range is 50 meters whereas the line of sight range is 120 meter. There are 11 digital I/O pins and there are 4 analog I/O pins. RF data rate is 250kbps whereas
Throughput speed is 35kbps.Operating range of the Temperature is -40 to 85C.

2) ACS709 current sensor IC:

The ACS709 consists of a precision linear Hall sensor integrated circuit with a copper conduction path located near the surface of the silicon die. Applied current flows through the copper conduction path, and the analog output voltage from the Hall sensor IC linearly tracks the magnetic field generated by the applied current. The accuracy of the ACS709

is maximized with this patented packaging configuration because the Hall element is situated in extremely close proximity to the current to be measured.
The operating range of the voltage is 3 to 5.5 V. Over current Fault signal typically responds to an over current condition in < 2 μs. The Integrated shield greatly reduces capacitive coupling from current conductor to die due to high dV/dt, and prevents offset drift in high-side applications.

3) The ATmega16 IC:

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. The AVR core combines a rich instruction set with 32 general purpose working registers. The ATmega16 provides the following features: 16K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, The JTAG (IEEE std. 1149.1 Compliant) Interface.

IV. SMART GRID CHALLENGES

1) Financial Resources
The business case for a self-healing grid is good, particularly if it includes societal benefits. But regulators will require extensive proof before authorizing major investments based heavily on societal benefits.

2) Government Support:

The industry may not have the financial capacity to fund new technologies without the aid of government programs to provide incentives to invest.

3*) Speed of Technology Development:*

The solar shingle, the basement fuel cell, and the chimney wind generator were predicted 50 years ago as an integral part of the home of the future. This modest historical progress will need to accelerate.

4) Cooperation

The challenge for 3,000 diverse utilities will be the cooperation needed to install critical circuit ties and freely exchange information to implement smart grid concepts.

V. ADVANTAGES

The advantages are:

- A smart grid automatically detects and responds to routine problems and quickly recovers if they occur, minimizing downtime and financial loss.
- We can detect the location from where the power is being stolen before which was not possible.
- A smart grid enables us to build less new infrastructure, transmit more power through existing systems, and thereby spend less to operate and maintain the grid.
- It Improves Resilience to Disruption and Being Self-Healing.
- Reducing greenhouse gas emissions.
- It expands Deployment of Renewable and Distributed Energy Sources.
- Improves Power Reliability and Quality.

VI.FUTURE SCOPE

The project can be implemented in remote areas. In INDIA, Future enhancements can be incorporated to suit the system for three phase electric distribution system. The research can be done on evaluating the performance of a larger network topology with multiple devices.

VII. RESULT

Power theft can be calculated by using the below formula:

Unit Difference= collected data-measured data

Where the collected data is observed at Master ZigBee and measured data is transmitted by slave ZigBee nodes. If there is some difference in unit data, we can say that power theft has occurred.

VIII.CONCLUSION

This paper is aimed at reducing the revenue losses and heavy power that occur due to power theft by the customers. From this design, we can observe the power theft and informed to the MSEB office. Also, an automatic circuit breaker is integrated to the unit so as to remotely cut off the power supply to the house or consumer who tries to indulge in power theft. The ability of the proposed system to inform or send data digitally to a remote station using wireless sensor networking adds a large amount of possibilities to the way the power supply is controlled by the MSEB office. The proposed system provides the solution for some of the main problems faced by the existing Indian grid system, such as power theft, transmission line fault, wastage of energy.

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