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Cost Effective Home Energy Monitoring System

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ABSTRACT-Every management system is trying to make automatic, portable and remote control. This work presents a smart energy meter for an automatic metering and billing system. The integration of the Arduino and GSM Short Message Service (SMS) provide the meter reading system with some automatic functions The proposed energy meter system can incorporate with embedded controller and GSM modem to transmit the data like consumed energy in kWh, generated bill, security services (line Cut/On) over GSM mobile network such as data can be then fed and integrated into existing energy management systems located at power companies or organizations to provide the services among the customers without man-power. Our implemented project is able to provide all required services remotely

Keywords—SmartEnergy Meter (SEM), Arduino(microcontroller), Global System for Mobile (GSM), Short Message Service (SMS)

INTRODUCTION

It has become a trend to integrate automatic systems via wireless applications over network. Along with the advancement of technology development, research on wireless applications and remote control has become significant and popular today. An electricity meter, electric meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. A smart energy meter (SEM) is electric device having energy meter chip for electric energy consumed measurement, wireless protocol fo r data communication (such as GSM Modem) and peripheral devices for security purpose, data showing, meter controlling etc. Energy meter systems can be incorporated with embedded controllers such as GSM modem to transmit the data over the mobile network. Such data can be then fed and integrated into existing Energy Management Systems located at power companies and organizations. The problem of efficiently collecting data from a large number of distributed GSM Modems in the energy meters is still a challenging problem. GSM modem should needs the terminal to control that part. Our Embedded controller

interfaced with energy meter reading systems and GSM modem to control both. The Energy Monitoring System is appropriate for Industries, manufacturing plants, commercial buildings. The Energy Management System leads to savings in the overall cost. These savings may be come from better utilization of manpower, servicing cost, savings in the energy consumption, and non-breakdowns in the system.

ENERGY METERING SYSTEMS

Conventional System

 Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) to give energy used (in joules, kilowatt-hours etc.). The meters fall into two basic categories, electromechanical and electronic. The most common type of electricity meter is the electromechanical induction watt-hour meter. The electromechanical induction meter operates by counting the revolutions of a non-magnetic, but electrically conductive, metal disc which is made to rotate at a speed proportional to the power passing through the meter. The number of

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revolutions is thus proportional to the energy usage. There are many flaws and errors in conventional billing. Some human mistakes may also occur in manual billing . Analyzing the conventional billing some of the common observed errors and mistakes are:

• It's a time consuming procedure.

• There is always a chance of human error while taking the manual meter reading.

• There is no check and balance and verification procedure of this meter reading.

Proposed System

A smart meter works by communicating directly with wireless data protocol with your energy supplier, so the company will always have an accurate meter reading and there's no need for you to take a meter reading yourself. Smart meters can work in a variety of different ways, including using wireless mobile phone type technology to send data There are many benefits of smart energy meter such as:

• Your smart energy monitor shows you how much energy you're using in money. So you can see what you're spending by the minute. Knowing more about how much energy things use, will help you choose the way you use them.The proposed system consists of digital energy meter, an Arduino (microcontroller) and GSM modem. After switching power on the Arduino and the GSM modem, turn on the relay and connects the energy meter to load via relay. Then read the EEPROM and display the current data. Arduino checks the impulse from energy meter Ie. If impulse occur increase the data and display current data. GSM modem checks the new SMS. If there is a new SMS and read it. If the SMS is "DATA", send data to the specific number. If the SMS is "LINE CUT", turn OFF the relay, so load will disconnect. Again the SMS is "LINE OK" and then turn ON the relay so load will connect. If there is any other SMS in any other formats, then delete the SMS.

Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on our computer, used to write and upload computer code to the physical board. The Arduino [12] platfonn has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board - you can simply use a USB cable. Additionally, the

Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package[14]. The Uno is one of the more popular boards in the Arduino family and a great choice for beginners.

Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Power Supply Unit

A power supply is an electronic device that supplies electric energy to an electrical load. As all know any invention of latest technology cannot be activated without the source of power. All the electronic components starting from diode to Intel IC's only work with a DC supply usually ranging from ±5v to ±12v. We are utilizing for the same, the cheapest and commonly available energy source of 230v-50Hz and stepping down, rectifying, filtering and regulating the voltage to convert it into suitable DC voltage. In our project the required voltage is +5V & +6V to run Energy meter IC, Microcontroller and the display unit

Optocoupler

An optocoupler is a device commonly used to galvanically separate microcontroller electronics from any potentially dangerous current or voltage in its surroundings. Optocoupler usually have one, two or four light sources (LED diodes) on their input while on their output, opposite to diodes, there is the same number of elements sensitive to light (phototransistors, photo-thyristors or phototriacs). The point is that an optocoupler uses a short optical transmission path to transfer a signal between the elements of circuit, while keeping them electrically isolated. This isolation makes sense only if diodes and photosensitive elements are separately powered. In this way, the microcontroller and expensive additional electronics are completely protected from high voltage and noises which are the most common cause of destroying, damaging or unstable operation of electronic devices in practice. The most frequently used optocouplers are those with phototransistors on their outputs. When it comes to the optocouplers with internal

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base-to-pin 6 connection (there are also optocouplers without it), the base can be left unconnected.

SYSTEM ARCHITECTURE OF SMART ENERGY METER

THE SYSTEM ARCHITECTURE OF ARDUINO AND GSM BASED SMART ENERGY METER IS SHOWN IN THE FIG. 1. THE ENERGY CONSUMPTION IS BEING CALCULATED USING THE ENERGY METER IC AND ARDUINO. IN ORDER TO PREVENT A TAMPERING, DETECTION PROGRAM IS PRESENT IN THE ARDUINO. ARDUINO AND GSM BASED SMART ENERGY METER CAN BE DIVIDED INTO SEVERAL PARTS AS ENERGY METER IC, LCD, ARDUINO, GSM MODEM , RELAY, OPTOCOUPLER, CONTROL UNIT, DISPLAY UNIT AND POWER SUPPLY UNIT ETC.   THE HARDWARE DESCRIPTION OF DIFFERENT PARTS IS SEPARATELY INTRODUCED AS FOLLOWS:
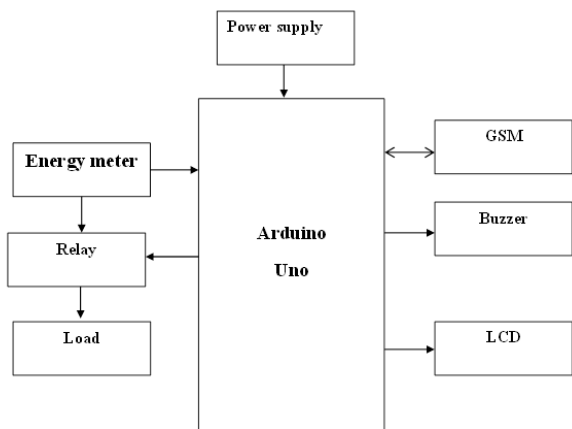
FIG 1. BLOCK DIAGRAM OF THE PROPOSED SMART ENERGY METERING SYSTEM.

ENERGY METER

The energy meter is an electrical measuring device, which is used to record Electrical Energy Consumed over a specified period of time in terms of units. The

most common type of meter measures kilowatt hours. When used in electricity retailing, the utilities record the values measured by these meters to generate an invoice for the electricity. The most common unit of measurement on the electricity meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour.

Fig 2.The complete circuit diagram of the proposed smart energy meter

VI.   HARDWARE IMPLEMENTATION

According to the simulation connection, we have connected all the circuit parameters and parts of the project in a project board as shown in Fig. 3.

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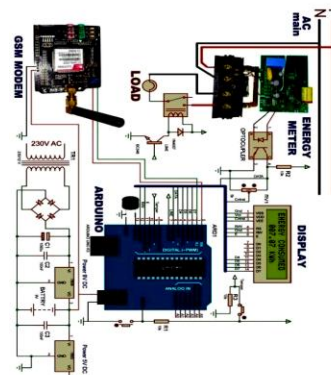
VII. CONCLUSION AND FUTURE WORK

Arduino and GSM based Smart Energy Meter for advanced metering and billing system is built which is able to read and send data via wireless protocol using GSM technology through GSM modem, capable of manage the meter as well as the line connection. However this project needs more modification for more reliable and higher degree of satisfaction and safety. For GSM module the network coverage of the SIM used is one of the important facts. The network strength should strong so that the GSM module can work well. One of the most important facts for this project is high cost of the component so that the overall cost of this project is high. Due to educational purpose and for research the equipment is provided with all pin connection, features and all possible events. As a result the manufacture cost is high. But when we implement this project commercially the cost may reduce by two or three times or more than the demo project. In commercial production for this project all the necessary component should provide only necessary pin connection and features. As a result overall cost may reduce more. In spite of being high cost at first time that mean when buy or install the overall cost of the system will reduce for this meter. The human labor that is taking data from energy meter in present day has to pay a good amount of salary for every month. Comparing this case Smart Energy Meter saves enough money for every month. In case of line cutting present system is very complex, time consuming and need much labor. Labor come to the pole from where the line taken, ride on the ladder and cut the line through pliers. This process is dangerous and risk of high voltage and high current electric shock. In case of line reconnect have to follow same procedure. For this system also need labor cost. But a Smart Energy Meter can easily do these tasks only by sending SMS. So a Smart Energy Meter saves money, labor and time. This project is very important for modem time. If this project is implementing commercially it will be benefited us in many ways. If we can implement this project in our country, Bangladesh will go ahead one step. Here we used one GSM modem for one meter but in future work of this project one GSM modem may use for more than one which make it more cost effective.

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