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Electricity Bill Generation using AMR Technology

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Abstract - *Electricity is one of the significant technological innovations of humans. It has now become an essential thing just like food, clothes, air and shelter for us in all walks of our life for various personal comforts for entertainment, for various industrial & agricultural functionaries. A smart meter is an electronic device that records utilization of power and communicates the statistics to the electricity supplier for monitoring and billing. However, all those systems resulted in high power consumption and overpriced. Hence there is a need of system which estimates the electricity consumption, generate bills and sends appropriate alerts.*

Key Words: **AMR, Smart meter, Lora module, Energy meter (Pzem004t), kilowatt-hour (kWh), LCD, GSM.**

1. INTRODUCTION

Electricity is an important part of present-day technology and without current, most of the items that we use daily simply couldn't work, and would certainly not been designed. Nearly all the machines at houses, businesses, and industries are running by virtue of current. An electricity meter is a device that estimates the amount of electrical energy utilized by users. The Electricity board uses energy meters installed at consumer's premises for bill generation. They are generally calibrated in billing units, the globally used one is kilowatt-hour (kWh).

Smart meters do well beyond the fundamental functions of a general energy meter. Predominantly, the differentiating feature of a smart meter is to subsidize 2-way transmission with utility providers. This is the idea that leads to the invention of different types of smart systems. These meters provide support for energy consumption analysis and its notification. A conventional programmed meter perusing tracks your power utilization, against which your utility company applies a normal cost for the past month in order to decide your charge. In any case, power costs change all through the day, spiking in periods of high request, and falling drastically amid periods of low demand--like amid the night.

As power markets have gotten to be deregulated, companies have looked for superior ways of estimating the power they give, in arrange to charge buyers for the power that they utilize, when they utilize it. Moreover, since shrewd meters can be perused remotely, power companies see them as a way to spare cash in working and labor costs. Whereas smart meters don't in themselves constitute a "smart framework," they shape a necessary portion of one.

As such, smart meters can assist you to save cash each month in the event that you're able to expend amid off-peak periods (or alternately, conclusion up costing you more).

Advanced metering infrastructure (AMI) applies smart control and communication technologies to automate metering functions that have been typically accomplished through manually intensive operations, including electricity meter readings, service connection and disconnection, tamper and theft detection, fault and outage identification, and voltage monitoring. Based on advanced technologies, Advanced metering infrastructure enables applications to offer new rate options that impetus customers to reduce high demand and energy consumption. The term Automatic Meter Reading (AMR) is a type of technology that helps to collect the meter reading data automatically and possibly send requests and commands to the energy meters. Automatic meter reading technology can be implemented for a different metering purpose like gas, water to know accurate energy consumption data. The proposed system will enable the meters to update the measurement data onto the web server automatically on a regular basis and generates bills to customers each month. There are different ways to pay bills, customers can pay bills of postpaid meters and can recharge the prepaid meters by sending a message to the service provider. The meter reading information is sent to a nearby located central station (gateway) using RF link and from there to a web server using GSM.

The proposed system replaces the conventional method of meter reading and enables service providers to access the energy meters remotely.

1.1 How electricity reach homes?

1. In power stations, big spinning turbines are powered by coal, wind, or natural gas to generate electricity. 2. The current is transmitted by transformers, which boosts voltage so that flow can be accelerated to more distant. 3. The electric power is then transferred by transmission wires held up by large towers, which stretch across long distances. 4. The electricity from transmission lines arrives at a substation, then the voltage is lowered and sent on smaller lines. 5. Through distribution lines, the current is transmitted to smaller transformers, where the voltage is reduced and sent to houses and is safe to use. 6. The electricity provided for residences passes through a meter, which estimates the amount of current use.

1.2 Automatic meter reading (AMR)

Automatic meter reading technology collects information about consumption, status, and diagnostic from electric meter devices and transfers that data to a database for bill generation, troubleshooting, and analysis. This technology predominantly saves the electricity department the expense of periodic trips to each location to record meter reading for the generation of bills. Bills are generated based on real-time consumption in preference to predicted consumption or estimation based on the past. This felicitous information combined with analysis will help both customers and utility providers to have better control over the consumption and electric energy production. Generally, Automatic meter reading devices electronically records meter reading and matches that with the customer's account. As technologies are advanced more information can be recorded, stored, transmitted to the main system, and remotely metering devices are also controlled. The other information that can be added is leak detection, low battery, tampering, reverse flow. Various Automatic meter reading devices record data in intervals and tabulate meter events.

2. BLOCK DIAGRAM OF DESIGNED SYSTEM

The block diagram has two sections, the above part is on the consumer side for transmitting meter information, and the below part is for collecting information. This system includes Ac power supply, an electric bulb as load, Energy meter (PZEM004T), two Arduino UNO microcontrollers, LCD, LoRa transmitter, LoRa receiver, and a server. Between AC supply and energy meter bulb is connected as load. The energy meter measures the electricity used by each bulb. Arduino UNO collects this data and displays it on LCD. The information collected by Arduino UNO from the transmitter side is sent to the receiver side Arduino UNO using the LoRa transmitter and receiver. From the receiver side microcontroller data is sent to a server that generates bills for customers according to the customer's ID.

In this system, the electric meter is not employed as an element, preferably its working is implemented using other components. The components used to setup electric meter working are AC power supply, a bulb, AC energy meter (PZEM004T). For displaying the meter reading Arduino UNO and LCD are used. AC supply is applied to the bulb and the current used by the bulb is calculated by the PZEM004T module. In the PZEM004T module, there is no display function, therefore LCD is employed with Arduino UNO. The PZEM004T module measures current, active power, power factor, AC voltage, active energy, active power. TTL interface is used for reading data in the PZEM004T module.

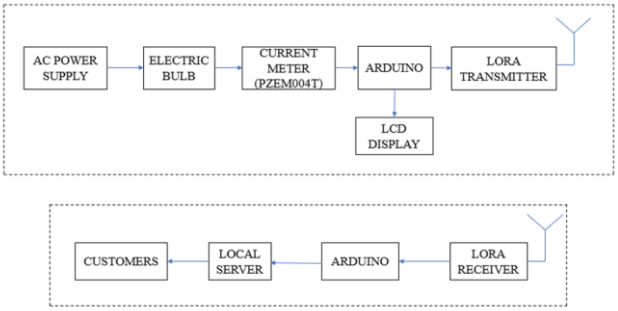

Fig -1: Block Diagram of AMR System

3. METHODOLOGY

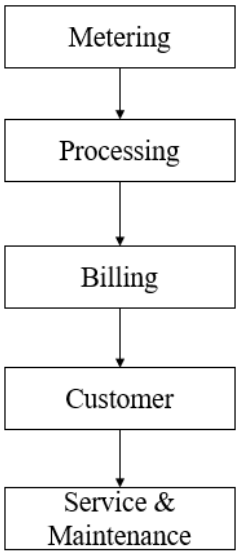

Fig -1: Methodology of the system.

1. Metering: Meter identification, storing of the user profile, and commands. 2. Processing: Data is read from meter and transferred to AMR. 3. Billing: Bills are generated according to the parameters set by the operator. 4.Customer: Customers receive SMS, email alerts about electricity usage. 5. Service & Maintenance: Electricity supply board monitors the bill generation and solve the complaints of the customers.

4. IMPLEMENTATION

In the designed system, the energy meter setup is made manually by connecting ac supply to the bulb and bulb to the pzem004t energy module. This power module measures the current consumed by the bulb (an electric device) and it sends that information to Arduino UNO. The Arduino UNO collects energy utilization data and displays it on LCD and the serial monitor. In this electric meter setup, the reading is displayed in volts, amps, power, and the cost of current consumed.

In the transmitter section, the electricity used by an electric device is recorded and displayed using LCD. Lora Transmitter is used to send recorded data to the Lora receiver in the receiver section. All the tasks in this module are performed by programming the integration of all the components with Arduino UNO using Arduino IDE. The programming part of the transmitter section consists of a global declaration of variables and constants, Serial Peripheral Interface (SPI), LoRa libraries, pzem004tv3 libraries. SPI for serial communication between Arduino and other components. LoRa libraries are included in the program to send collected data from Arduino in the transmitter side to Lora in the receiver section using LoRa radios. Pzem004tv3 library is included in the program to monitor and measure the current, voltage, power, and frequency of the bulb. After adding all the libraries, the initialization is done by declaring input and output pins and by setting the baud rate.

In the receiver section, the data packets received by the LoRa receiver are sent to Arduino. The Arduino processes the data and displays it on the serial monitor. Along with the current consumption, the cost is also displayed. The energy used and its cost are sent to customers using the GSM module. The Arduino is interfaced with GSM to send the bill as SMS to consumers.

5. RESULTS

The Arduino IDE is used to upload programs to Arduino UNO and display the results in the serial monitor. The meter reading is displayed both on serial monitor and LCD. In the serial monitor, the meter reading is shown in different forms like current, energy, power, frequency, power factor, and voltage and price of electricity consumed.

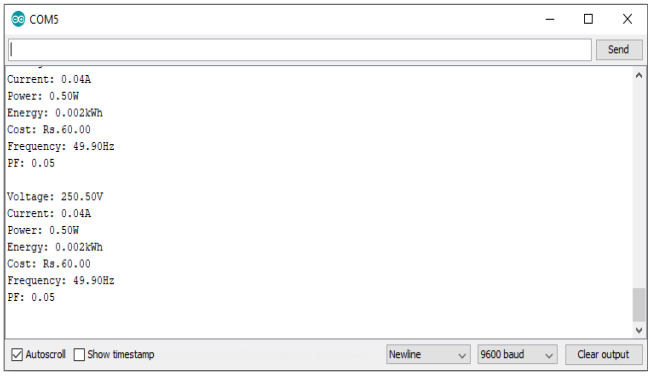

Fig -2: Screenshot of electric meter reading in serial monitor of Arduino IDE

The output presented on LCD is electric power consumption values in volts, amps, and watts and the cost of energy being used. The bill is calculated by considering the minimum cost per kWh. Figure 2 shows the screenshot of output in the serial monitor. The meter reading and cost are displayed on LCD is shown in figure 3.

Fig -3: Current consumption information is displayed on LCD

This module displays an accurate bill to customers. Using the LoRa module, the electricity department can monitor energy usage remotely. The output on LCD can be customized depending on the requirement that is the energy consumption values can also be displayed in power, frequency, and power factor.

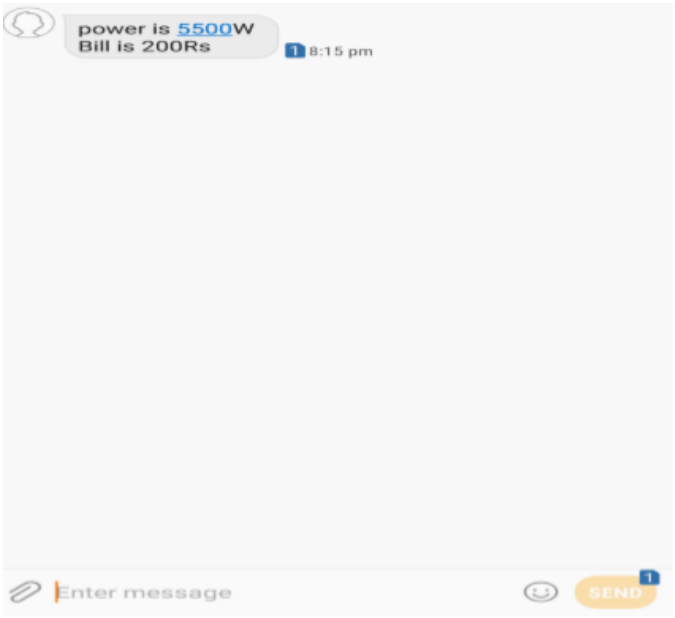

Fig -4: Screenshot of SMS received by customer

6. CONCLUSIONS

This paper presents an overview of the solution proposed to address the issue of the electric meter reading and bill generation. The solution involves the use of an energy meter module (PZEM004T) which records the current consumption, LoRa transceiver module for data transmission, the data is collected by LoRa receiver module and GSM is used to send the generated bill to the customers via SMS. The system is designed to collect real-time data via Energy meter (PZEM004T). The collected data is transmitted via LoRa. The purpose and motivation behind the design of the system are to reduce human errors, more power consumption problems in smart meters, and labor costs.

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