Implementation of IOT based Electricity Controlled Prepaid Energy Meter Monitoring and Bill Payment System

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***Abstract*—Energy fuels the growth and development of any country and as such effective monitoring, measurement, billing and access control is not proper. As the advancement of technology and dependencies over the electrical appliances increases, the usage and requirement of electricity is also increases rapidly and the utilities are facing difficulties in collecting electric bill. The main aim of this paper is to make a system which will help in reducing the usage of electricity and which helps in bring transparency between the Electricity Board and the customers. This meter needs to be recharged similar to a mobile phone, payment for recharge can be done on app and can monitor the amount deduction, energy consumption, frequency, voltage and power fluctuation. User can also stop flow of electricity from remote location if the electricity is not in use. The energy measurement and billing system is automated. IOT based system that is capable of detecting power theft and identified can be sent to EB and customer.**

***Index Terms*—IOT, Energy Meter, Ethernet Shield, Android App, Wamp Server.**

I. Introduction

In developing countries , the idea of prepaid entering scheme is introduced[1]. This concept is based on Pay first use later one. From the consumers point of perception, the idea is attractive because there is no Fear of disconnection and reconnection for some reason. The amount remaining in the meter gradually decreases. In the present billing system the EB are unable to keep track of the demand of consumers. The consumer is facing problems like receiving due bills for bills that have already been paid as well as poor reliability of electricity supply and quality even if bills are paid regularly. The solutions for all these problems is to keep track of the consumers for accurate billing, monitoring, controlling and theft detection . These are all the features to be taken into account for designing an efficient energy billing system. This paper Implementation of IOT based electricity controlled prepaid energy monitoring billpayment system addresses the problems faced by both the consumers and the Electricity Board. It mainly deals with energy meter, which utilizes the features of embedded systems i.e. combination of hardware and software in order to implement desired functionality. The paper discusses comparison of Arduino and other controllers, and the application of GSM and Wi-Fi modems to introduce Smart concept. With the use of GSM modem the consumer as well as service provider will get the used energy reading with the respective amount, Consumers will even get notification in the form text through GSM when they are about to reach their threshold value, that they have set. Also with the help of Wi-Fi modem the consumer can monitor his consumed reading and can set the threshold value through webpage. This system enables the electricity department to read the meter readings monthly without a person visiting each house. This can be achieved by the use of Arduino unit that continuously monitor and records the energy meter reading in its permanent (non-volatile) memory location. This system continuously records the reading and the live meter reading can be displayed on Android Application to the consumer on request. This system also can be used to connect and disconnect the power supply of the house when needed.

II. LITERATURE SURVEY

Birendrakumar Sahani.al[1] are made a practical model of IoT Based Smart Energy Meter. The proposed model is used to calculate the energy consumption of the household, and even make the energy unit reading to be handy. It reduces the wastage of energy and bring awareness among all.

Mayur Rawte.al[2] are developed a system to solve many problems such as over usage of electricity, large amount of manpower transparency of usage and wastage of money and resources etc.This technology allows verified customers to check status of electricity usage by using Device identification number and password in real time. This can be done from web application using Internet.

Nazmat Toyin.al[3] are designed the system to resort to a local server and database, upon resumption of internet connection, all information are synchronized with the web server. The billing is handled locally by the web server and has not been interfaced with any online payment platform agencies.

Mst. Shahnaj Parvin.al[4] are explained the framework and how it will be beneficial in detecting an unauthorized use of electricity. The relative advantages of the proposed system

over conventional systems have also been outlined in the paper.

Azfar Tufail.al [5] provide some enhancement in the conventional Metering system by smart metering. The term Smart Meter is an advanced energy meter that measures consumption of electrical energy providing additional information compared to a conventional energy meter.

Omijeh.al[6], introduced a tamper detect feature for a GSM solution for prepaid energy meter, however this work didnt provide an interactive interface for real-monitoring, access control as well as a robust database.

III. CURRENT SCENARIO AND PROBLEM DESCRIPTION

Distribution and maintenance of electricity is owned by local state electricity board. Electricity usage of a user is calculated by calculating KWH electricity used over the period of a month. This reading is stored locally on the meter. A worker from the electricity board takes this reading by visiting door to door and manually notes it. This data is then forwarded to the head electricity board for evaluation, after evaluation bill is generated on the basis of the readings taken on monthly basis. These generated bills are again sent door to door by members of workforce. Then the recipients pay their bills by their favourable payment option. This process consumes a lot of time and human efforts and bill is totally dependent on the reading of the workers. So, whatever reading for a customer the worker takes, customer needs to pay for it and because of the post-paid method of payment for the electricity many users use electricity in very inefficient manner and sometimes they dont even pay for months. This results in loss to the electricity board and loss of electrical energy as well.

IV. PROPOSED METHOD

Smart Meters by continuously monitoring and sending feedback of data to the customers. We will have a Android Application which is connected to the electric meter. At the time of installation of the device, staff will generate a unique identification number for device. Staff will then embedded this number into the device and will also create a user account for the customer containing customer name, email, mobile number and address. The newly created device and user will be linked together. After successful installation of device and verification of the user details, customer will be provided with a password for checking status of their device with the help of email provided by the customer. Now the device is ready to be used. User needs to recharge this device from a web app designed for this device in order to continue supply of electricity. If the balance of this device becomes zero, this will stop the supply of the electricity after 24 hours, within that 24-hour user will get notification regarding balance status of the meter after a definite interval until he pays bill.

Electricity usage of customer will be sent to the server after a set time interval. Customer will then be able to log into their account from the web app and will be able to check their real

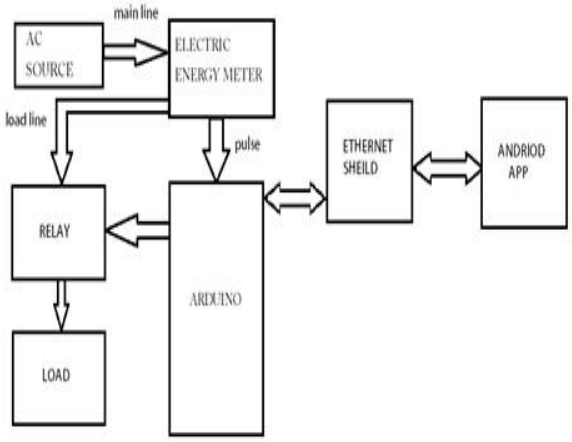

Fig. 1. Arduino based prepaid energy meter

time electricity usage. This system aims to bring transparency of billing and usage between the customer and the electricity board. Customer will use less amount of electricity because of the prepaid nature of the billing system. Because of the psychological fact that if we pay for a resource before actually using it, we end up using less amount of resource as compared to post-paid method of payment. As a result, all the customer bill accounts will be cleared at the time.

V. SYSTEM ARCHITECTURE

The main architecture of an Internet Based Prepaid Energy Meter can be classified into two main subsystems, Hardware and Software control interface[4].

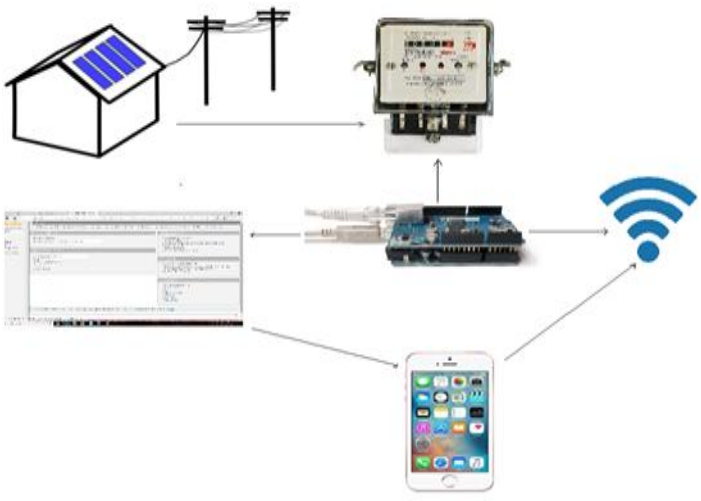

Fig. 2. Architecture of an Internet Based Prepaid Energy Meter

A. Hardware Subsystem IoT is the main method of communication between energy meter and the android application . The reading information from the energy meter

in real time is uploaded to a central database via IOT . An electricity meter, electric meter, electrical meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) to give energy used (in joules, kilowatt-hours etc.). Meters for smaller services (such as small residential customers) can be connected directly in-line between source and customer. For larger loads, more than about 200 ampere of load, current transformers are used, so that the meter can be located other than in line with the service conductors. The meters fall into two basic categories, electromechanical and electronic.

The Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

SIM800 is a complete Quad-band GSM/GPRS solution in a SMT type which can be embedded in the customer applications.SIM800 support Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 24*24*3mm, it can fit into slim and compact demands of customer design. Featuring Bluetooth and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

We are using Ethernet shield to transfer a data from Arduino to local Server. To use the shield, mount it on top of an Arduino board (e.g. the Uno). To upload sketches to the board, connect it to your computer with a USB cable as you normally would. Once the sketch has been uploaded, you can disconnect the board from your computer and power it with an external power supply. Connect the shield to your computer or a network hub or router using a standard ethernet cable (CAT5 or CAT6 with RJ45 connectors). Connecting to a computer may require the use of a cross-over cable.

A Relay is an electrically operated as switch. Current flowing through the coil of the Relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so Relays have two switch positions and they are double throw switches.

B. Software Subsystem

Web Server interface design is having following items.

1) Admin: This module is the main part in the system architecture. It provides user-name and password to the EB office and customers. It gives the access to EB office to add and manage their information. Also, on real time basis it allows client to access the information of electricity bill.
2) Client: Client needs to install android application on mobile. The client can login to view the bill details through the application. Also he can pay bill or add balance in case of prepaid payment system.
3) Database: The database used in this system is PHP database. It is used for storing users information like , Meter ID , login ID , Address etc.

VI. EQUATIONS AND MATHEMATICAL CALCULATION

Usually different meters have different readings[2].

Some have,

3200 blinks = 1 unit

In our case 3200 blinks of LED is 1 unit. But for practical purpose,

Assumption we made in our system

7 blinks = 1 unit of power consumption.

Let, X = number of blinks of LED

Y = number of units of electricity.

Z = cost of consumption.

Basically,

No. of units (Y) = (X/3200)

But in our case,

Y = (X/7)

Assume that 1 unit cost = 7rs.

Z = Y * 7rs

For Threshold,

Assumed threshold set value will be =5 units for practical.

If units reach,

Threshold value 1 unit = 5-1 = 4 units,

Notification will be send to consumer through android application, if consumer doesnt response and go on using electricity above threshold value then meter will automatically get OFF. Again to turn it ON consumer has to visit android app again to increase threshold value by recharging.

UNIT:

Normally, basic unit of electricity is Kilowatt hour (KWh).

1kWh = 1000 watt for 1 hour.

Example,

Ten 100watt bulbs used for 1 hour gives 1kWh.

VII. WORKING MODEL

Working of this device is based on the technologies like prepaid meter and Internet of things. As shown in Fig 3 this meter will be connected to Arduino. This will be connected to Arduino to local host via LAN cable using Ethernet shield. Every Meter will have a unique identification number, at the time of installation of this device, staff of the electricity provider will assign this device identity to user of the that meter. This device needs to be recharged with some amount of money through the Android application of this device.

This device will measure the electricity units on the blinking pulse rate of the LED of the meter and only allow the electricity to pass through if balance of that device is not zero. This device will be connected to a local server through

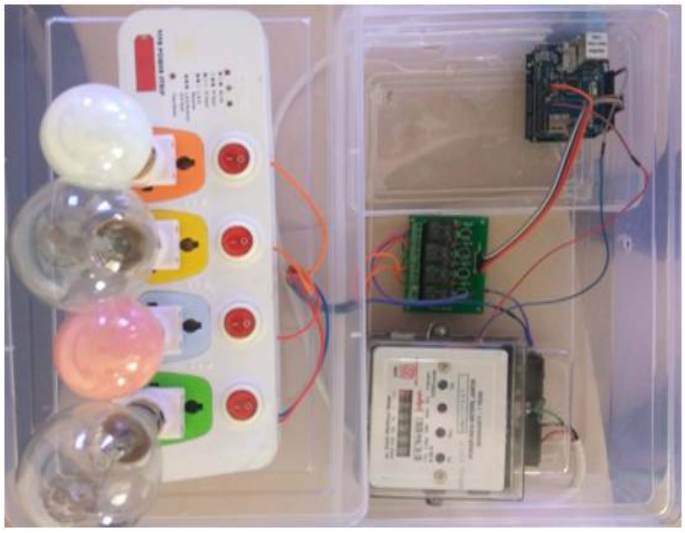

Fig. 3. Working Model of Prepaid Energy Meter

Ethernet shield. Arduino will be programmed such that it will send usage to the local server. Local Server will store all the incoming messages in database. This device will be connected to the electric meter via a circuit that will connect a GPIO pin of this device to the kwh pulse LED. Usage of electricity will be calculated on the basis of the KWH PULSE LED blinking. Each 1000 times a LED blinks 1 unit of electricity will be added to the usage and cost of that 1 unit will be deducted from the device, which will be updated onto the server in real time with the help of Arduino via LAN cable using Ethernet shield. In order to have successfully transition of data a working internet connectivity is required via Local Server. If no internet connection is available at the time of operation data will be stored locally and will transmit the data whenever internet connection will be available.

When we power up the system then it reads checks the available balance with the predefined value and take action according to them, like if available balance is greater than 5 rupees then Arduino turns ON the electricity of home or office by using relay. And if balance is less than 5 rupees then Arduino sends a notification to user phone regarding low balance alert and requesting to recharge soon. And if balance is less than 5 rupees then Arduino turns OFF the electricity connection of home and sends a notification to users phone for Light Cut alert and requesting to recharge soon. Energy meter monitoring is completely done by Android application. The following specification are developed for Android Application to control and monitoring the meter.

- Once meter ID is entered, present status of the meter should be displayed.
- Consumer can recharge his meter using mobile or online banking facility or credit in his mobile.
- Consumer may disconnect the meter on his own during a long vacation when he does not want to use elecricity.
- Consumer may be able to lodge complaint, if any.

VIII. IMPLEMENTATION AND RESULTS

The customer has to to login with the provided vidyuth app . In here for authentication after every login the costomer will get the OTP to authorize himself. After that the costomer will get login to the application, In here he has to enter his meter id after entering he gets the information of current status of the meter , name,address,phone number in fig 4 and fig 5. The fig 6 shows that the costumer turn on and off application individually remotely through internet.

Fig. 4. Vidyuth app login page

Fig. 5. Vidyuth app consumer details page

IX. CONCLUSION

In these days of energy stytem, designing strategies which helps in effectively controlling energy consumption and avoiding energy wastage is very important. This is a Ardunio uno based design and implementation of energy meter using IoT.

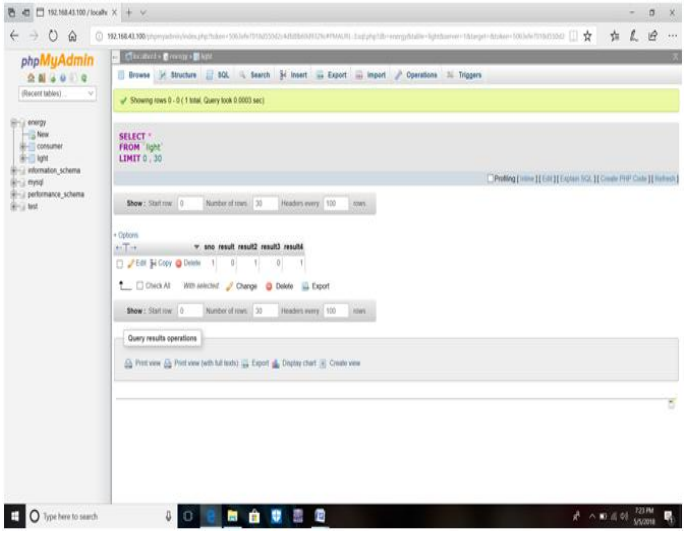

Fig. 6. Customers web page

Here energy consumption is calculated by counting calibration pulses from energy meter. In this system, electricity controlled prepaid energy monitoring billpayment system electricity controlled prepaid energy monitoring billpayment system is designed to continuously monitor the meter reading to be handy and transfer the data to a central server which can be accessed from anywhere on the remote place at any time by android app. Disconnection of electric service from remote place is done through our designed android application.

X. Future Scope

In the present system,IOT energy meter consumption is accessed using internet and it will help consumers to avoid unwanted use of electricity.In future the following objectives can be achieved to save the power.

- We can make a system which can send SMS to the concerned meter man of that area when theft detected at consumer end.
- We can send the GPS location of the meter to the Electricity board when theft detected.

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