DESIGN AND IMPLEMENTATION OF AUTOMATIC ENERGY METER USING INTERNET OF THINGS (IoT)

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Abstract : The traditional method of billing process for electric power consumed by residence, commercial complex and industries requires man power and has shortcomings such as external conditions affecting readings and duration of time required to reach the premises where meter are placed. Developing automatic energy meter reading system is one approach to avoid these shortcomings. The objective of our work is to overcome the disadvantages traditional billing process by developing an energy meter reading system combined with billing process. This paper presents a simple energy meter reading system associated with web interface. In addition the consumer will also be informed about the billing through messaging service. With proper authentication, consumer can access their power consumption details. A working prototype of the system was build to demonstrate the automatic meter reading, billing and notification of the electricity consumption through the use of IOT System.

IndexTerms - Automatic energy meter reading system, GSM, Aruidno, ESP8266.

1. Introduction

In the present day scenario electric power consumption billing process is done by employee from electricity office visiting every meter installed premises. Traditional electro-mechanical meter (figure 1) are bound to undergo wear and tear with passage of time. Also its accuracy deteriorates due to the various factors such as humidity and dust which affects the operating accuracy of the meter. Also these types of meters are prone to tampering, leading to a requirement of an electrical energy monitoring system. In the last two decades energy meters have gone through many improvements with respect to design and functionality with electro-mechanical meter being replaced by electronic meters (figure 2). New features are incorporated in the electronic meters and these are of accurate, high procession and reliable types of measuring instruments as compared to conventional mechanical meters. Traditional electricity meters have no ability to detect or deal with tampering because they only measure energy based on the voltage and current flowing between the inlet and outlet terminals. In such meters, tampering has become very easy and its detection is difficult.

Fig 1 Electro-mechanical meter

Fig 2 Electronic meter

But consumers/electricity meter owners are not satisfied with the services rendered by the electricity authority for various reasons. Major reasons are meter installed premises may be locked and bills might be lost. Also due to weather conditions manual billing process might get slowed downed when readings have to be from rural areas. Hence an Automatic Electricity Bill system can be used which offers an efficient method for meter reading, processing and calculation of bill. Though electronic meters are used in place of conventional meters chance for missing bills, absence of consumer type of problems still persists. With the rapid development in Information Communication technology development of wireless meter reading systems are gaining popularity. An energy meter reading system associated with web interface is presented in this paper which automatically senses the consumed power, records the readings and sends it to the database for billing purpose.

This paper is organized as follows. In section II we present literature review.

2. LITERATURE SURVEY

Systems built using different technologies by various researchers were reviewed prior to the design and prototype development of the system.

Alessio Filippi et.al [1] have proposed a methodology for energy monitoring. They provide solution for energy monitoring by measuring the energy consumption of each appliance when in use. These individual appliances power consumption gives us the idea of its performance. Also Power disaggregation problem is posed in multi user environment. Two linear detection algorithms are applied to find which loads are active in the network. These in turn helps in finding individual power consumption. Experimental setup and simulations are conducted by the authors to evaluate the performance of algorithms. When we view these types of systems from consumer perspective, consumers are not benefitted since power consumed by the householder is the sum of its individual loads when in use. Also it needs extra embedded system in the residence which do not yield any use to consumer.

AltafHamedShajahan et.al[2] presented an approach to monitor energy consumption at the device level. They have proposed a smart plug which actually does the energy monitoring by real time updating of the energy consumption at the load level. Non-invasive type of current sensing technique is used. The user interface is developed to control the load. Information about the active load is sent from the smart plug using audino micro controller which uses the Ethernet connection. Major drawback of this system is extra hardware utility at each plug point. As the plug point increases the hardware setup also increases. Configuration and reinstalling is also difficult due to hardware setup at each plug point.

Authors Lidia Poceroa et.al[3] worked towards improving the energy consumption of buildings. Buildings were selected because it consumes more energy than a residence use in a day. Widely used approach to reduce energy consumption is by using energy-efficient infrastructure and materials. The proposed approach focuses on promotion of energy consumption awareness and behavioural change on people living or working inside buildings. Educational building is considered because promoting sustainable behaviour at school leads to same behaviour at home For energy consumption and environmental monitoring they have used open source IoT infrastructure, aiming specifically for educational buildings. Use of Open Source approach provides a fundamental that can be reused, modified and extended. This type of awareness can be combined with power consumption details so that one will be aware of benefits of energy utilization.

Laurent Lefèvre et.al[4] have proposed energy consumption techniques in cloud system. Cloud systems involves lot of distributed networks moving over networks and high computations. Efficient usage of electricity plays a major role. In this paper they collect energy consumption information, divide and distribute the jobs based on the energy consumption report collected. Finally they develop energy consumption system or dynamic adjustments of task based on opportunities to decrease the amount of energy consumption.

3. SYSTEM ARCHITECTURE OF AEM

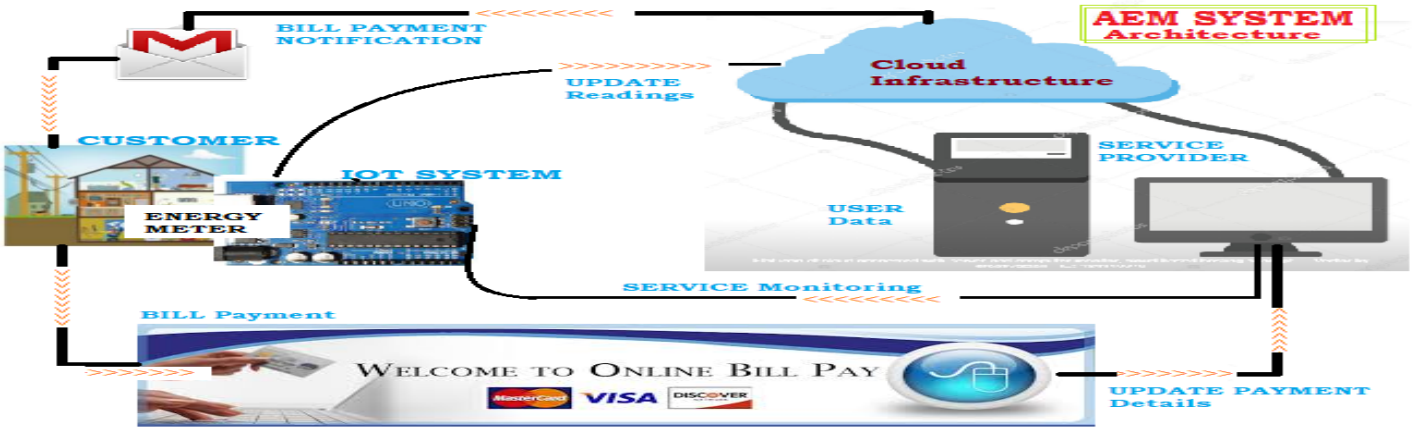

Fig 3 System Architecture of AEM

In our system, the ESP8266 module is the central processing unit of the system and responsible for communication between IoT Module and web server for the Electricity Billing management system. There are two main parts in system design. (i) ESP8266 with Wi-Fi module and (ii) web server for Electricity Billing management system. In our proposed system, the digital meter consists of Arduino Leonardo Pro Micro - 5V/16MHz which is the main function for calculating the Electricity Consumption. The current sensor of the meter is capable to operate with the max of 30 Ampere, and it is designed in such a way that it can be easily configured with micro controllers. This current sensor instrument is low cost solutions for AC current sensing.

The system is designed to develop an Accurate Electricity Billing and Management System. it contributes a convenient solution for problems in an existing system, such as the manual readings errors, travel expenses for meter readers, waste of papers. The system interacts with the cloud to update energy consumption and units consumed automatically. The System allows customers to view electricity usage along with bill. Proposed system offer merits to both service provider and power consumers. To the Service provider, the issues from meter readers such as time delays, wrong and infrequent meter reading that can be avoided. The system uses the Automatic Energy Meter[AEM] as an attempt for building electrical power efficient system for new cities. The sensing unit comprises of the voltage transformer and the current sensor that are connected to the main supply. The

voltage transformer uses 240v to 6v step down transformer. Current sensor was a SCT-013-000 non-intrusive sensor, clipped over a single wire either live or neutral, to sense the passing current.

Cloud infrastructure is used to manage huge amount of customer data. It keeps track of old and current details of the power consumption. Producers and consumers are allowed to view their power consumption and other details that allow online payment for electricity usage. System automatically disconnects the electricity supply for the no payment of bills and automatic re-connection. Service providers can disconnect the electricity supply and they can reconnect after successful payment manually. This is established via RELAY unit used in the proposed system. In our system some of the features are Reduction of expenses, increasing income and improving customer service.

4. IoT System

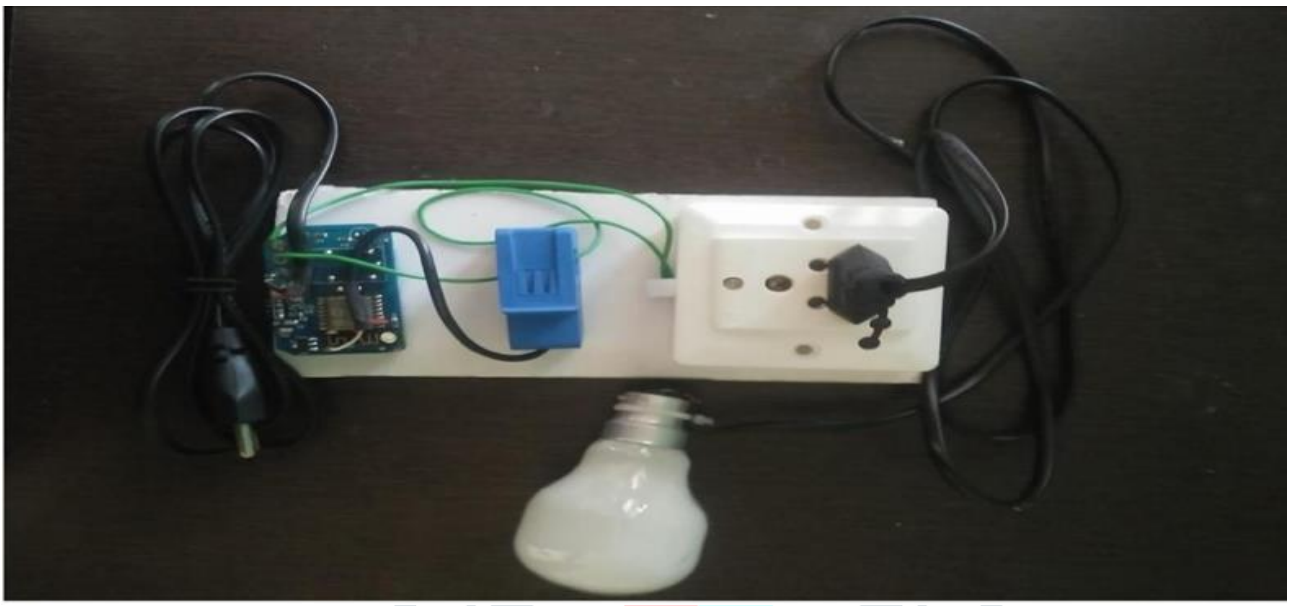

Fig 4 IoT MODULE

Fig 4 IoT Module shows the IoT Module, the relay and ESP82666 is embedded together on a PCB board is a micro controller to which the load and current sensor are connected. In this model the current sensor is tapped in between the load and micro controller so as to let the current sensor to read the Electricity Consumption. Data is directly transferred and the ESP module takes the data and sends it to the cloud server.

- **Relay and ESP8266**

Relay is an electromagnetic switch, used to switch ON and OFF current. Means we can switch ON the relay which allows current to flow to Consumer and Switch OFF Disconnects the connection to consumer.. Commonly used Relay is Single Pole Double Throw (SPDT) Relay.

ESP8266 module is of low cost and comes pre-programmed with an AT command set firmware. ESP 8266 is integrated with the sensors and other application through its GPIOs.

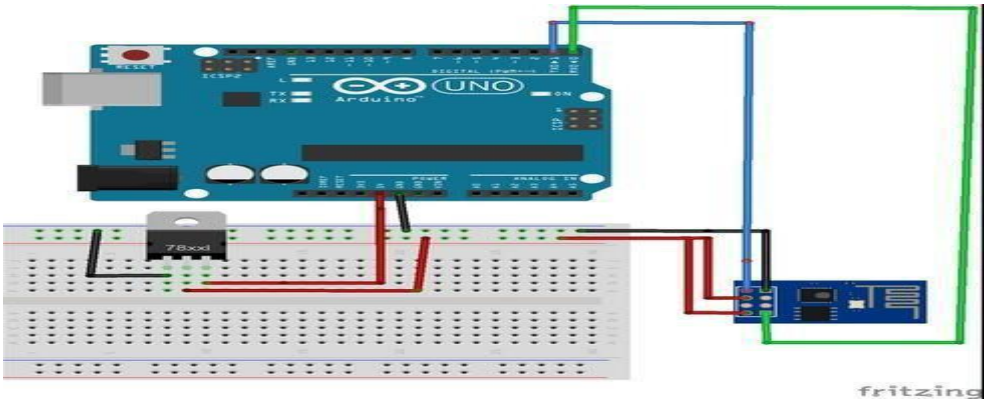

Fig 5 Arduino UNO With Relay and ESP 8266

5. SYSTEM MODULES

5.1 UI Module Of Service Provider and Consumer

Fig 6 UI Module Of Service Provider and Consumer

The **Fig 6** made Maintenance of the AEM easy and simple to the Service provider as well as to the consumers. New connection is requested by customer admin have permission to "Add Customer" and also maintain and track the details in the database for further service.

5.2 Energy Meter Module

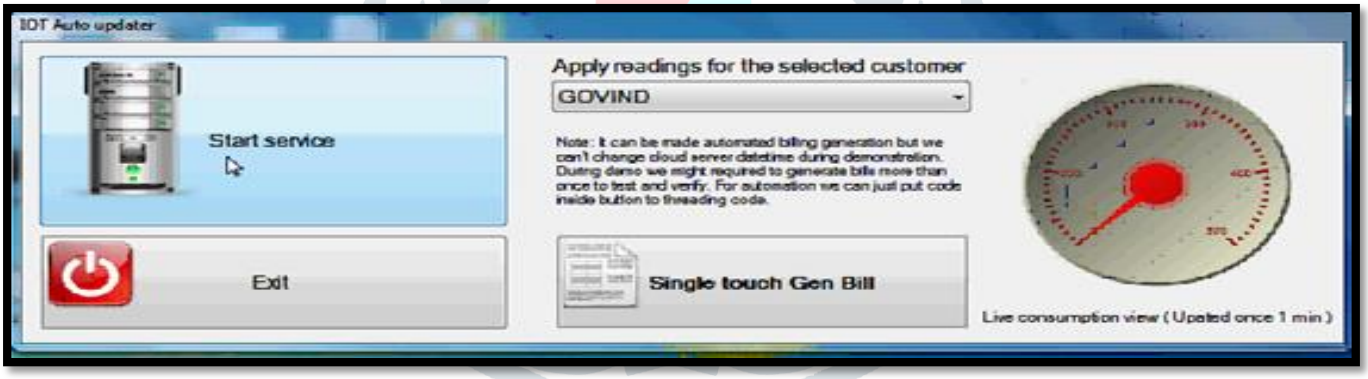

Fig:7 Energy Meter of AEM

Fig.7 Energy Meter of AEM, Energy meter is the soul module of the AEM. We can view the live consumption of the electricity by customer via energy meter. Single touch Generate bill option is used to generate the bill and generated bill will be sent through mail. Consumer request for disconnection or non payment of the bill service providers are allowed to stop the service manually by using stop service.

6. RESULTS AND ANALYSIS

Electricity Bill	
Meterno	M123
Name	Govind
Connection type	domestic
Units consumed	0.0030465
Amount to pay	0.0097488

Table: 1 Electricity Bill

Table 1 is the sample of electricity bill send to customer after the bill generation it has details of electricity bill for domestic connection with meter number, with the name of the consumer, type of connection,consumption of electricity and amount that we need to pay with due date.

7. CONCLUSION AND FUTURE ENHANCEMENT

The proposed system can overcome and improve the challenges of energy efficiency and manageability. The parameters of energy meter can be read correctly and reliably, such as load profile, demand value, and the total energy consumption. The utility saves money by increased speed of reading, has lower liability from entering private property, and has less chance of missing reads because of being locked out from meter access. The benefits of this metering are clear and proven. Automated meter reading provides accurate meter reading and no more estimates, eliminates the need of the human resource, improves billing method, less cost of deployment and also transparency of cost to read metering. This application also helps the user for better payment mode by sending mails informing the bill generated and also acknowledges via notification for the paid bill.

Future Enhancements

The future works will include the performance improvement in terms of tamper detections and outage notifications.

- In addition to Email, messages can be sent to the customer via SMS
- Database can be uploaded in cloud for distributed access to customers and can act as a backup.
- Better encryption techniques can be used for bill payment.

8. REFERENCES

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