Implementation of Intelligent Energy Meter

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Abstract – The electrical energy plays an major role in day to day life. as we know a person from electricity board (EB) department takes readings in meter by meter throughout the area. According to that the electric bill to be calculated, and they are handover the readings to the EB department as well as the customer. Because of that manual reading some interruption are takes place like overbilling amount, meter reading is not accurate. Today's world moves to an automotive mode. The possible solutions for that kind of problem are a wireless meter. In this project of intelligent energy meter (IEM) also a wireless meter uses IoT with prepaid mode. It is a fixed range meter. According to the utilities requirements the meter range will fixed. The Energy consumptions by the electrical loads in units are measured and those values are updated to cloud with real and reactive power. The energy consumed by the individual loads also being updated. Those parameters are send to the customer as well as the service provider (EB) by message through GSM and also by the HTML page. The Automatic connection and disconnections are made through HTML page. The main objective of the project is to monitor and control the status of energy consumption.

Index Terms – Iintelligent Energy Meter-IEM, Electricity Board (EB), Liquid Crystal Display -LCD.

1. INTRODUCTION

In this case of available meter system, every month consumer receive a bill from the electricity board which consists of the consumption of the electricity according to that the payment takes place [1]. When a bill is surprisingly higher in a certain month a problem may occurred. Regularly EB department receives queries regarding the same issue where in people say that despite their electricity usage being the same as the previous month. Their electricity bills have spiked, a very important reason for this lies with the electricity meters [2].

This project mainly deals with intelligent energy meter, which utilizes the features of embedded system is combination of hardware and software inorder to implement desired functionality. This paper discusses comparison of Arduino and other controllers, and the application of GSM and Wi-Fi modems to introduce 'intelligent' concept. With the use of GSM modem the consumer as well as service provider will get the used energy reading. The consumers will even get notification in the form text through GSM when they are about to reach their thresh hold value and each interval of 5 units that they harvest. Also with the help of Wi-Fi modem the consumer can monitor his consumed reading. This can be achieved by the use of Arduino unit that continuously monitor and records the energy meter reading in its non-volatile memory location [3], [4].

The HTML web page in this project consists of two logins; one is for utilities to monitor about their energy consumption. From that they can receives the unit of energy consumption and also all the parameters that are available in the conventional meter. The energy consumed by the individual appliances also being receive the another login for the service provider to receive all those things and also for the connection and disconnection purposes. The connection and disconnection process is being in automatic way as well as by the manual way through the web page [5], [6].

2. RELATED WORK

2.1 Energy Meter

The Watthour meter or energy meter is an instrument which measures the amount of electrical energy used by the consumers. The utilities install these instruments at every place like homes, industries, organizations to charge the electricity consumption by loads such as lights, fans and other appliances. From those meters we can see some digits on it, those numbers tells you how many units of electricity have consumed so far and the bill is entirely depends on the readings. Basic unit of power is watts. One thousand watts is one kilowatt. Use one kilowatt in one hour, it is considered as one unit of energy consumed. These meters measure the instantaneous voltage and currents; calculate its product and gives instantaneous power. This power is integrated over a period which gives the energy utilized over that time period [7], [8].

2.2 Electromechanical Induction Type Energy Meter

It consists of rotating aluminum disc mounted on a spindle between two electro magnets. The speed of rotation of disc is proportional to the power and this power is integrated by the use of counter mechanism and gear trains. It comprises of two silicon steel laminated electromagnets i.e., series and shunt magnets. The series magnet carries a coil which is of few turns of thick wire connected in series with line whereas shunt magnet carries coil with many turns of thin wire connected across the supply [9]. The braking magnet is a permanent magnet which applies the force opposite to normal disc

rotation to move that disc at balanced position and to stop the disc while power is off. The series magnet produces the flux which is proportional to the current flowing and shunt magnet produces the flux proportional to the voltage [10]. These two fluxes lag by 90 degrees due to inductive nature. The interaction of these two fields produces eddy current in the disk, exerting a force, which is proportional to product of instantaneous voltage, current and phase angle between them. The vertical spindle or shaft of the aluminum disc is connected to gear arrangement which records a number, which proportional to the number of revolutions of the disc. This gear arrangement sets the number in a series of dials and indicates energy consumed over a time. This type of meter is simple in construction and accuracy is somewhat less due to creeping and other external fields. A major problem with these types of meters is their easy prone to tampering, leading to a requirement of an electrical energy monitoring system. These are very commonly used in domestic and industrial applications [11], [12].

2.3 Digital Electronic Energy Meters

The digital signal processor or high performance microprocessors are used in digital electric meters, similar to the analog meters, voltage and current transducers are connected to a high resolution ADC. The ADC is used to convert analog signals to digital samples. The voltage and current samples are multiplied and integrated by digital circuits to measure the energy consumed. The microprocessor also calculates phase angle between voltage and current, so that it also measures and indicates reactive power [13]. It is programmed in such a way that it calculates energy according to the tariff and other parameters like power factor, maximum demand, etc. and stores all these values in a non volatile memory EEPROM. It contains real time clock (RTC) for calculating time for power integration, maximum demand calculations and also date and time stamps for particular parameters. Furthermore it interconnects with liquid crystal display (LCD), communication devices and other meter outputs. Battery is provided for RTC and other significant peripherals for backup power [14], [15].

2.4 Smart Energy Meters

It is an advanced metering technology involving placing intelligent meters to read, process and feedback the data to customers [16]. It measures energy consumption, remotely switches the supply to customers and remotely controls the maximum electricity consumption. The smart metering system uses the advanced metering infrastructure system technology for better performance. These are capable of communicating in both directions. They can transmit the data to the utilities like energy consumption, parameter values, alarms, etc and also can receive information from utilities such as automatic meter reading system, reconnect/disconnect instructions, upgrading of meter software's and other important messages. These meters reduce the need to visit while taking or reading monthly bill. The modems are used in these smart meters to facilitate the communication systems, such as telephone, wireless, fiber cable, power line communications [17], [18]. Another advantage of smart metering is complete avoidance of tampering of energy meter where there is scope of using power in an illegal way.

3. INTELLIGENT ENERGY METER

The iintelligent energy meter is a wireless meter uses IoT. It is a fixed range meter. According to the utilities requirements the meter range will be fixed. The Energy consumptions by the electrical loads in units are measured and those values are updated to cloud with real and reactive power [19]. The energy consumed by the individual loads also being updated. Those parameters are sending to the customer as well as the service provider by message through GSM and also by the HTML page. The Automatic connection and disconnections are made through HTML page. The main objective of this project is to monitor and control the status of energy consumption. The ccombination of hardware and software are used to implement desired functionality [20]. This paper discusses comparison of Arduino and other controllers, and the application of GSM and Wi-Fi modems to introduce 'intelligent' concept. With the use of GSM modem the consumer as well as service provider will get the used energy reading the consumers will even get notification in the form text through GSM when they are about to reach their threshold value and each interval of 5 units, that they harvest. Also with the help of Wi-Fi modem the consumer can monitor his consumed reading. This can be achieved by the use of Arduino unit that continuously monitor and records the energy meter reading in its non-volatile memory location [21], [22]. The Fig.1 shows the layout of the proposed systems and Fig.2 shows the block diagram of proposed system.

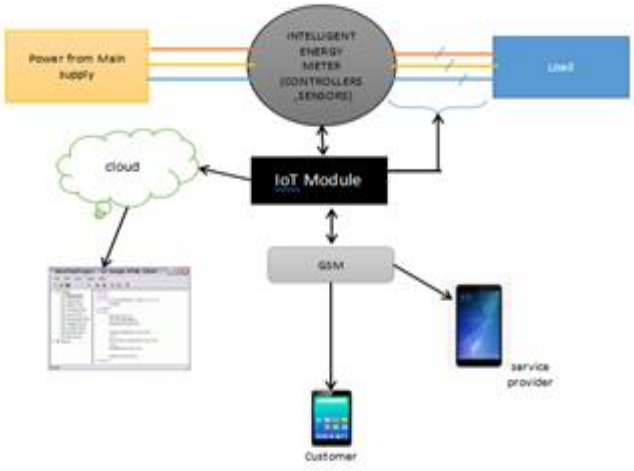

Fig. 1: Layout of the Proposed Systems

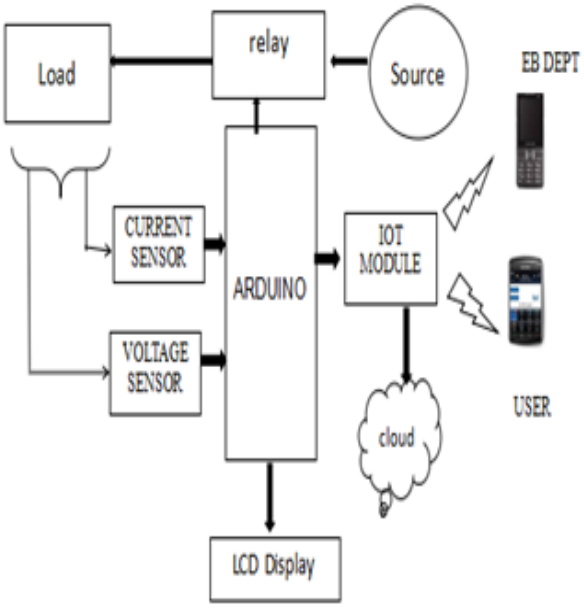

Fig. 2: Block Diagram of Proposed System

3.1 Major Components Used:

Arduino uno:

A microcontroller board based on the atmega328p (datasheet). 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 [23].

Voltage sensor:

A device that converts voltage measured between two points of an electrical circuit into a physical signal proportional to the voltage [24].

Current sensors:

A current sensor (CT1270) is a device that detects electric current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be analog voltage or current or even digital output [25].

IoT module:

IOT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the internet [26].

Load:

Domestic energy consumption is the total amount of energy used in a house for household work. The amount of energy used per household varies widely depending on the standard of living of the country, the climate, and the age and type of residence [27] - [29]. The Fig. 3 shows configuration of proposed system and Fig. 4 shows the output from proteus software.

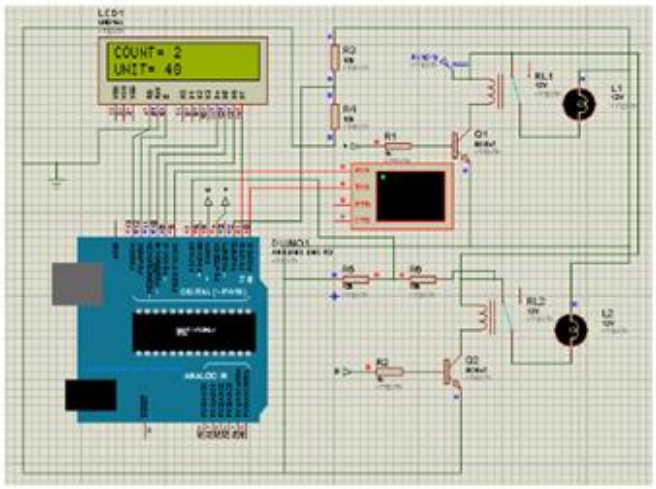

Fig. 3: Configuration of Proposed System

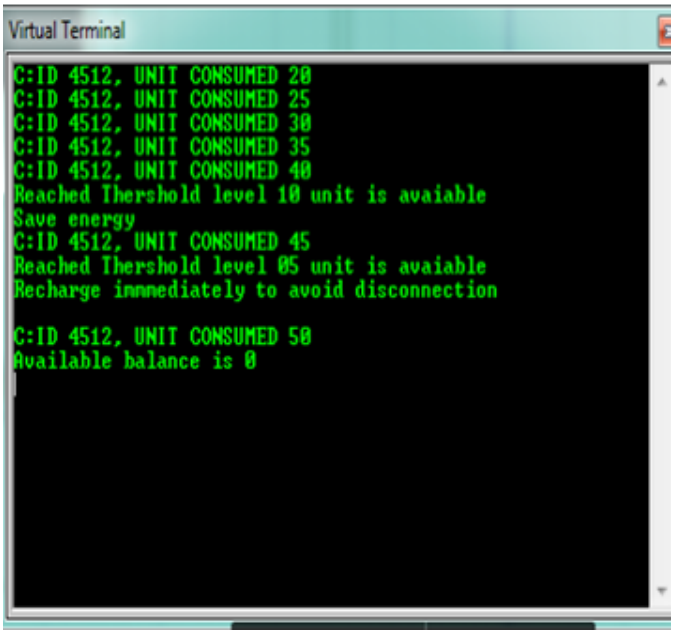

Fig. 4: Output from Proteus Software

3.2. Methodology of Proposed System:

- When the several of the household appliances are consume energy, the energy meter reads the reading continuously and this consumed load can be seen on meter.
- This project is designed for single phase 230V, 50Hz supply. As already said it is a fixed range meter. Range of our current system is 50 units (as per customers' requirements).
- It is a prepaid mode meter. The customer need to pay the electricity bill for a period with respect to their meter's

configurations. If they use 50units the meter then they needs to pay the amount for those 50 units in advance. Then they got the meter turned ON, otherwise the meter will be in OFF position.

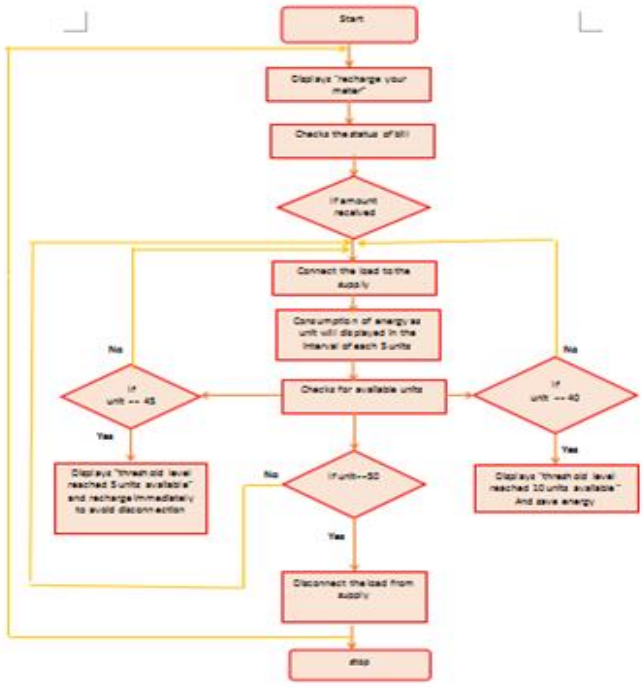

Fig. 5: Detailed Flowchart of the Systems

- The LED on meter continuously blinks which counts the meter reading. Based on the blinking, the units are counted [30] – [33].
- In this project the Arduino Uno act as main controller, which continuously monitor energy meter.
- As per the blinking of LED on energy meter the Arduino will measure the unit consumption.
- The threshold value can be set on consumer's requirement. In this 50 unit meter we set the threshold value at two points as 40 and 45. When the consumers reading will be near about to the set threshold value it will send a notification value to the consumer.
- This threshold value notification will increase the awareness amongst the consumer about the energy.
- When the consumer gets the notification they are need to pay the electricity bill through online mode on by bank account because it is a prepaid mode meter.
- If the consumer is not aware with the threshold notification, then the meter will automatically get OFF when the unit reaches 50 units. Then the consumer has to pay the bill for needed period to get the meter ON.

If there is any indisciplinary of the consumer, then the connections will get turned OFF manually by the service provider through HTML page. The Fig. 5 shows detailed flowchart of the systems.

3.3. Considerations for 50 unit meter:

- ✓ Checks for billing amount.
- ✓ If paid Connect the load to the supply.
- ✓ Displays the number of units consumed by the loads. Also the consumption by the individual loads.
- ✓ Checks for threshold values
- ✓ If unit == 40

  Displays threshold value reached 10 units available

  Also display "Save energy".
- ✓ If unit == 45

  Displays threshold value reached 5 units available.

  Also displays "Recharge immediately to avoid disconnection".

3.4. Calculations:

The unit of the energy is kWh (or) unit .basically 1000W is equal to 1kW. The consumption of that 1000W power in one hour is considered as 1unit of Energy. The voltage will be sensed by the voltage sensors and is taken as V, and the respective current will be sensed by CT1270. The instantaneous power will be calculated with the multiplication of those two parameters. The respective energy will be obtained by the integration of those powers with respect to the consumption period.

Let,

Voltage Measured = V (Volts)

Instantaneous Current = I (Amps)

Instantaneous power P = VI (Watts)

The energy consumption will be calculated as

$$E = \int_t Pdt$$

(units)

4. CONCLUTION

Thus the intelligent energy meter was designed for the efficient monitoring as well as control of a electrical energy consumption system. It is a pleasure benefit for the EB department for taking readings in meter by meter, calculation of bill, and connection, disconnection processes. It also

encourages the people to pay the money in advance to avoid over billing.

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