IOT based Real time Electric Energy Metering and Control

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Abstract: Electricity is the prime requirement for the development of mankind. There is a huge need of not only efficient generation and transmission but the way of utilization and metering. In the present scenario, for data collection and billing, man power is used in India. Likewise, human is involved to cutoff the power supply in case of nonpayment of bill by the consumer. Since large amount of revenue is spent towards these tasks. Thus the present methodology is proposed as smart meter technology which eventually uses either the existing electromechanical or electronic energy meter without the need to replace them. In this work, a wireless technique is used. This reads the energy consumption reading from meter and transfers to a PIC microcontroller. This controller calculates and send the monthly bill to the consumer through SMS using GSM900 and electric supply of unpaid consumers would be disconnected using a relay which would be controlled using IOT.

Index Terms **- PIC16F877A microcontroller, IOT, GSM900, Wifi-module, Web server, smart metering.**

I. INTRODUCTION

The World is emerging towards adapting wireless technologies, which in turn not only reducing human efforts but is helping in making systems smart and accurate. A system is considered to be intelligent when it can take the decisions and can work upon without any man interference. An Energy meter measures the total electrical energy in units consumed by the appliances which draw electrical energy from the main power supply. Electromechanical and Electronic meter are two types of meter available to measure the unit Consumption. Electromechanical meters are commonly used in rural areas of india, where the penetration of modern technology is not as high as it is in urban areas. There is a Non-magnetic metallic disc which rotates depending upon the power passing through it. Higher the number of rotations, higher is the reading. The power of around 2 Watts is consumed to make the disc rotate and this consumption is not registered on the meter.

Electromechanical meters has become obsolete now– a-days. Electronic meters are now used in place of electromechanical meters. This meter consists of LCD/LED to display the reading. Calibration Led is mounted on the meter which represents the units consumed. Impulses of led is calibrated as per the requirement. Generally 1600 impulses/kwh (kilowatt- hour) or 320impulses/kwh meters are available in market.[1] These meters are much more efficient than Electromechanical meters in the sense that they do register every small unit of power consumed. Manual work is required to read the meter and note down the reading. The reading on the meter is cumulative which is used to generate the electricity bill. An Energy meter (EM) does the same task without manual efforts. [2]

The EM system is controlled using PIC, which is a microcontroller board based on 16F877A. The purpose behind choosing this board is its efficiency and memory. It is more efficient in terms of memory and Analog pins as compared to Arduino. The data obtained is then sent to the web server through Wifi-module which is highly reliable and compatible device when used with PIC. Data obtained can be transferred wirelessly over long distance without any noise interruption using Wifi-module. As the data is directly sent to the server there is no occurrence of range and distance issues and is highly accurate and precise because of no human involvement. Other wireless technologies such as Zigbee, Bluetooth etc [5] are constrained to range thus cannot be used over very long distances effectively. This project envisage the use of Wifi-module and the concept of IOT by which the base station as well as the consumer remains updated with the current consumed data, changing the present issues faced by the electricity board and the consumer.

II. LITERATURE SURVEY

From the literature reviewed, it is observed that rigorous work has been developed for smart metering. Li,et all have developed standard models for data acquisition, processing algorithms for stakeholder applications. The benefits of smart meters and Implementation of smart cities are clearly emphasized. Reliability of data delivered over both wired and wireless technologies are analyzed. It is also observed that IoT- based energy meters powered by the cloud technologies can bring in revolutionary systems at low expenditure [3]. Ali et all have developed an AMR system to detect energy consumption. They have used optocoupler sensor to detect the optical pulse generated by the LED present in the energy meter. Based on the sensor output, the energy consumption is computed in the microcontroller [4]. A similar work is done in [5] by. Alternatively Chunchi Gu et all developed a system based on current and voltage transformers to read the meter. Using specialized integrated chips the power rate and power factor are determined [6]. These works are developed with communication medium used being PLC, HFC, and RF. In all the above-mentioned works, different standalone modules are integrated to accomplish the required task. This occupies more space and makes the real-time implementation as complex. Moreover, the operational power requirements also add to the complexity. Hence, the major contribution made in this research is the development of lightweight, low power, and compact design which is achieved by use of System on Chip (SoC). ESP8266 [7, 8] is the used in this research which contains a processor and in- built WiFi module. It is configured using Arduino IDE [7, 9].

As the proposed work provide ubiquitous and continuous monitoring, it uses ubidots cloud storage [9, 10] and cloud server for processing [11]. Further, it also uses Bot [12] for query processing and open source messaging application [13] for server –client interaction.

III. PROPOSED SYSTEM

In the proposed system design, two major issues related to electricity are highlighted and are brought to rectify using IEM Issues related to energy meter and line disconnection are

- Manpower requirement for meter reading, which is highly prone to error, lacks precision and highly time consuming.
- Consumers remain unaware of power theft. Consumer doesn't gets updated his regular power usage as well.
- Consumer may not receive the bill slip within due date resulting into over dues and unpaid bills.
- For disconnection of unpaid consumers, human involvement is required to cut the power connection manually.

The above mentioned issues could be easily resolved using Iot based energy meter. Our meter is connected with PIC16F877A which continuously monitors and sends the data to base station on web server using Wifi-module by using the concept of Internet of things. The data read by the PC at base station is sent to the consumer through SMS alerts. If the bill over dues, then the relay which is controlled by the base station, disconnects the load resulting into power cut. The heart of our proposed system is IOT, through which we are able to send data to the web server. Energy meter is fed through AC main supply which is then coupled to PIC16F877A through optocoupler. The output of calibration Led of energy meter, which blinks 3200 times for 1kwh i.e. 3200 impulses/kwh is given to optocoupler.

The output of calibration LED is high but the output voltage to be detected by PIC16F877A then its reads the data and sends it to the web server with the help of Wifi-module. The units consumed by the user and the bill of the consumed data are displayed on LCD display and is sent to the consumer as well using GSM 900 module.

At the base station this data is obtained at the server where continuously data is being monitored and updated. If the consumer does not pay the bill within the given deadline then the OFF button displayed on the web page of server is pressed which automatically disconnects the relay from the load connected through the energy meter at the consumer side.

Then any other complaint in consumer side it's sent to base station through the GSM 900 module. And consumer home temperature also updated from IOT.

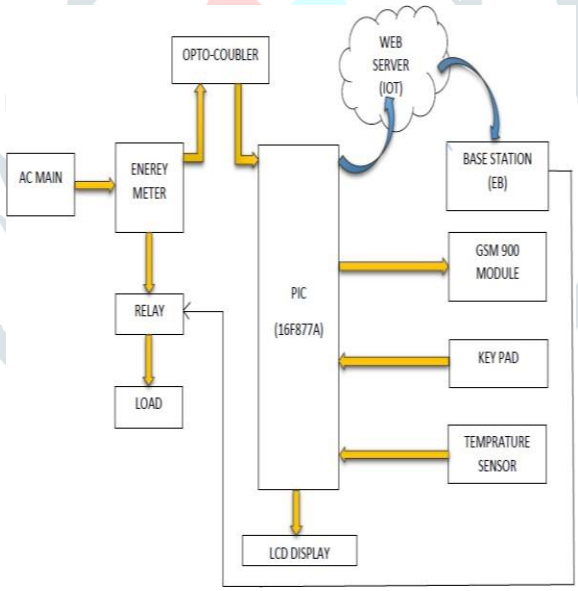


Fig. 1. Block Diagram of Proposed System

IV. SYSTEM ARCHITECTURE

4.1PIC 16F877A Microcontroller

PIC 16F877 A is a 40 pin microcontroller. It has two timers and two Capture, Compare, PWM modules. It have 10-bit, up to 8-channel Analog-to-Digital Converter (A/D). So It have robust and accurate calculating and signal handling capacity and thus can be used to real time processing of analog and digital signals. [14]

4.2 Wifi module (ESP8266)

ESP8266EX offers a complete and self-contained WiFi protocol. It can be used to host the application or to offload WiFi networking functions from another application processor. It can boot up directly from an external flash. In has integrated cache to improve the performance of the system in such applications. Alternately, It can be used with SPI/SDIO or I2C/UART interface. [15]

4.3 Optocoupler

An opto-isolator is an electronic component that transfers electrical signals between two isolated circuits by using light. An opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called di- electrical channel), and a photo sensor, which detects incoming light and either generates electric energy directly

4.4Internet of Things (IoT)

Internet of things has become heart of data transfer and communication. It is a network for inter- linking physical devices or objects with embedded platforms, sensors, actuators to exchange data from any part of the world. IOT technology is expanding exponentially and soon world will be observing all the technologies handled through IOT. The devices which are linked through IOT can be controlled and monitored from anywhere and at any time. There are so many Applications of IOT such as Environment monitoring, Infrastructure management, medicine, home automation, consumer application and many more.

4.5GSM (SIM 900)

GSM is an ultra-compact and reliable wireless module used in communication. The GSM sim900 is used for communicating over voice, sms, data and fax in a small form factor and with very low power consumption [2].GSM is controlled and configured via AT commands. It is low power consuming device. In our proposed method we have used GSM 900 to send units consumed by the consumers and the electricity bill according to their usage.

4.6RELAY

Relay is an electrically operated device that typically incorporates an electromagnet, which is activated by a current or signal in one circuit to open or close another circuit. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. Low power devices such as microprocessors can drive relays to control electrical loads beyond their direct drive capability.

V. HARDWARE IMPLEMENTATION

The final implementation of the hardware is shown in Fig.2. which contains all the hardware module discussed before. We have used analog electronic energy meter to measure the total energy consumed by the load. Firstly, the overall implementation is tested with the help of PROTEUS IDE software.

Fig.2. Hardware Implementation of the Proposed System

In the following proposed method to calculate the real time consumption and rupees per unit consumption, following calculations were performed. Here 3200 impulses of energy meter is considered as 1 unit and

1 unit is equal to 1kwh.Thus 0.0003125kwh is represented by each blink. Let us consider this for 40 blinks.

So the calculation is done as followed,

Let the previous unit consumed be 70kwh

After 40 blinks the consumed units will be

=0.0003125x40

=0.0125kwh

Thus the total used energy will be

= (70+0.0125) kwh

=70.0125kwh

To calculate the bill from the above data following equation is used;

Electricity Bill = (Current month use energy- paid used energy)* Per Unit cost

For example,

Paid used energy=812kwh

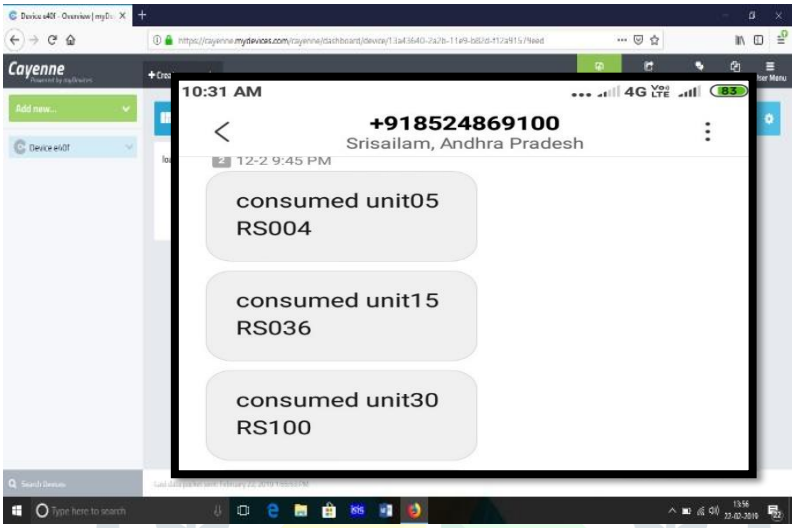
Current month used energy =924kwh
Per unit cost =12 rupees

Therefore, Electricity bill = (924-812) x 12=1344rupees

As shown in Fig.2.PIC is connected with LCD display that displays the fetched data from the energy meter which is shown in Fig.3.

Fig.3. LCD display that represents the consumed units, rupees and temperature

All the calculated data is sent to web server with the help of a wifi-module to the server of base station which is shown in Fig.4.
Fig.4. Web page at the server of the base station



The bill generated and the units consumed is sent to the consumer through message alerts which displays the units and bill and also notify to pay the bill on time. Fig.5 shows the same.

Fig.5. SMS received by the consumer

The consumer side complaint are sent to the EB phone number through GSM module its show in fig.6.Therefore,

Fig.6. complaint SMS received by EB

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V. CONCLUSIONS

This present work was successfully demonstrated in both hardware and software and that can be implemented in real time system. This system thus reduces human interface and can be used to replace the technically old systems as low power and compact implementation. This system could be further enhanced using Mobile Application feature by using real time data to the user anytime and from a distant location just by entering login Id and password.

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