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IOT BASED SMART ENERGY METER

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Abstract: Wireless automation in electricity and billing is the new innovation in terms of technology. Retrieving the data of units consumed by the consumers is not efficient. The current process of electricity billing is susceptible to errors. It is time and resource and labor consuming as well. The problem of the billing system becomes crucial when consumers try to tamper the meter, thereby pay less amount than what actually should be paid. In our proposed system, already installed energy meters at our houses are not replaced, but an additional small circuit design along with IoT on the already installed meters can change the existing meters into smart meters. Smart Electricity meter using Internet of Things (IoT) system present an efficient and cost-effective way to transfer the information of energy consumed to the consumer wirelessly and automatically without any human intervention, as well as it provides facilities to detect the illegal usage of the electricity. Aim of this project is to calculate the electricity consumption, formulate the bill automatically without any labor and transfer it using IoT. Bill amount is SMSed through IoT platform to the consumer at the start of every month with the help of RTC. Also, this study aims to detect and control the energy theft. A passive infrared (IR) sensor is engaged with the system to detect when any illegal alteration happens in the metering system. In such case, the system itself will notify it to the server, as well as it has the facility to disconnect and re-connect the electricity supply automatically using a Solid-State Relay, also the power supply can be disconnected and reconnected remotely in case of pending bills.

***Key words*- Wireless Automation, Internet of Things (IoT), Microcontroller, IR sensor, Solid State Relay, RTC.**

I. INTRODUCTION

Today, it can be considered as we humans are living in a society which is mostly based on machines where technology is interfaced at various levels in our daily activities. Electricity is one of the most basic requirements nowadays in almost every field which includes domestic, industrial and agricultural usage. Though there are developed sources of electricity, there are many problems related to distribution and billing of energy [1].

In India, utilities are using an older way of billing. A person from the administration office has to note the readings of each and every meter in the locality and provide these readings in the office, accordingly a bill is generated for each and every meter, which is based on a particular criterion set by the administration office.

In India, over the past years, the conventional electromechanical meters have been replaced by electronic meters because of the obvious disadvantages which majorly includes theft of electricity [2]. The cost of robbery of energy in India is around $16.2bn per year. The Indian administration has a total fund of around $21.6bn for installing smart grid infrastructures from 2015-2025. In the year November 2014, Prime Minister Mr. Narendra Modiji declared $4bn in financing for smart metering programs.

Our proposed project helps in minimizing the human efforts in the electricity meter reading. The units consumed by a particular household can be calculated by keeping a count of the number of times a 'CAL' led on the meter blinks. This number can be used to calculate the total bill generated and using the IOT platform it can be uploaded on the website where the user can easily see the monthly usage and other details [8].

II. RELATED WORKS AND MOTIVATION:

Existing Method: In India, energy distribution, keeping record of energy consumption is an essential part. Each time the required person is needed to come from the electricity department to record the reading of meter and create an appropriate bill based on the units consumed for the consumer [7]. Person takes the photo of the meter or record the units consumed and generates the bill accordingly. In some developed foreign countries, the reading is measured with the help of RF meter. In this technique, the communication device is there in the vehicle and the vehicle has to move from the locations where RF meter is installed to collect the readings [3]. It is costly and here also human is needed to carry the communication device. The Maharashtra state electricity broad (MSEB) has installed few AMR meter only at commercial sites where the power requirement is mores also the AMR meters are very costly and limited in number [2]. The RF meters are installed in few areas but due to the high cost and minimum availability of the tuneable frequencies available, these projects were unsuccessful in their results [8].

Proposed Method: This system principally monitors units consumed by the appliances and subsequently calculates electricity bill. It facilitates direct communication between the consumer and the service provider. It not only messages the electricity bills every month to the consumer, but also detects tampering and informs about it to the concerned authority. It also has the facility to Reconnect and disconnect the power supply remotely. The data about energy consumed by each user is stored on website using IOT for further details. User can also read the data in the form of graphs of day wise consumption, monthly consumption, etc. on IOT.

III. ARCHITECTURE

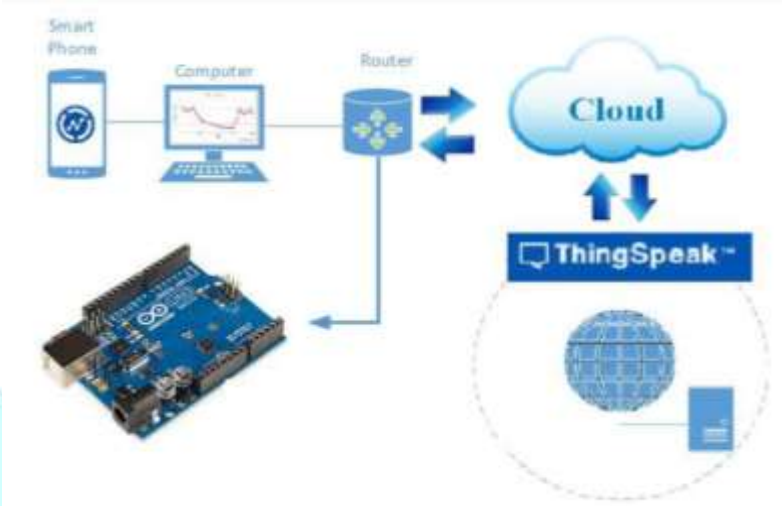

FIGURE 1: ARCHITECTURAL MODEL

- When the electronic appliances at the home or industry are running the power/energy meter displays the amount of energy consumed in units.
- When load is connected, the right most (Cal LED) blinks. From the calculations- 3200 blinks=1 KWH=1 unit consumed= Meter constant. This reading can be acquired by microcontroller form the meter and can be send to the respective consumer.
- The system proposed by us uses energy meter with the controlling element as AT mega 328 microcontroller and ESP8266 Wi-Fi module to monitor energy usage and using RTC every month the bill is send to the consumer by SMS.
- The live as well as old meter reading is also displayed on the webpage with the help of IOT. This allows consumer to easily access the energy consumption anytime along with the cost charged for the units consumed. User can also read the data in the form of graphs of day wise consumption, monthly consumption, etc.
- This system automatically disconnects the power supply of the house when bill is not paid on time and reconnect it remotely. It also used to detect tampering using IR sensor

IV. EASE OF USE

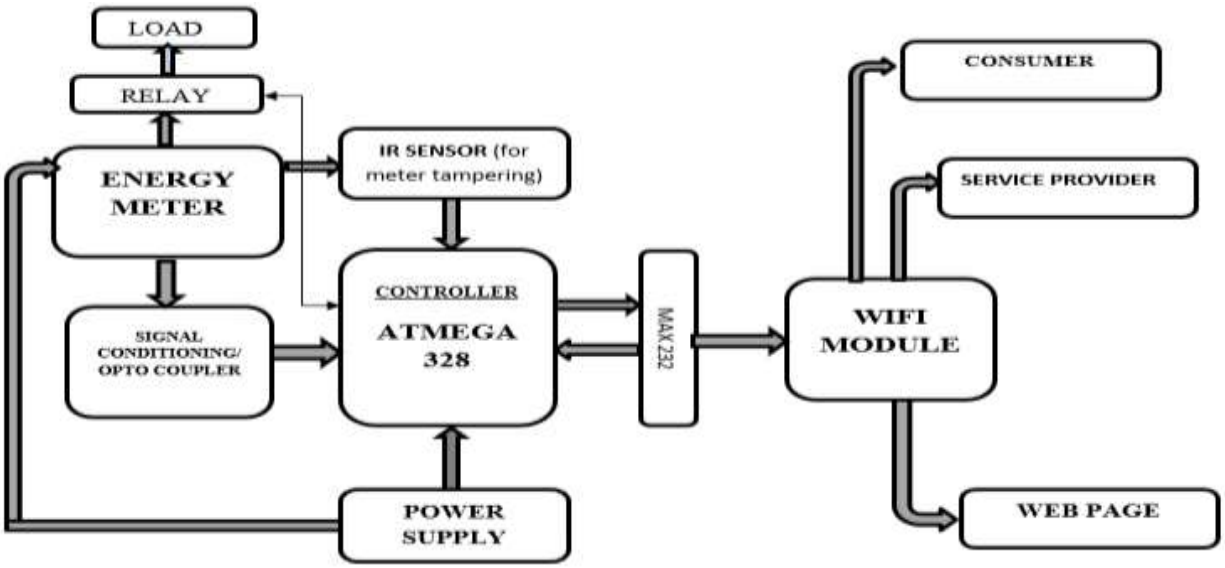

FIGURE 2: BLOCK DIAGRAM

A. ENERGY METER

The meter which is used for measuring the energy utilized by the electric load is known as the energy meter. Total power consumed at a particular interval of time by the connected load is energy. It has various applications in household, commercial and industrial fields for measuring the power consumption. Energy meters are installed by electricity board at entry point of every electrical consumer (domestic as well as industrial/commercial). Energy meters are also called as electricity meters or electric meters or electrical meters or watt-hour meter. Energy meters are calibrated using billing units. Unit here of every energy meter is expressed in terms of kwh and pulses. Electromechanical meters, Electronic meters and Smart meters are the 3 basic types of meters.

B. ARDUINO UNO

Every system requires a microcontroller. Microcontroller is nothing but a small computer on a MOS integrated circuit chip. Here we are using Arduino as the microcontroller because it can be easily coded using C language using its very own IDE and has 3 UART as we require. ATmega328P is the basic component on an Arduino Uno board which is an open source microcontroller. It was developed by Arduino. Arduino controller is the heart of our system, used for interfacing all the hardware components. All the input and output devices are connected to it and it controls them. In our system the required 5V supply is given by the optocoupler, then the controller calculates the pulses of the meter and from that the units consumed can be calculated and accordingly the bill is generated. This data is then continuously stored on the IoT platform, which allows the consumers to visit the webpage anytime and check their energy usage. It also reacts accordingly as per coded by the programmer, to the circumstances like tampering, message sending, etc. Arduino controller is preferred over other controllers because its programming is very easy as compared to other controllers.

C. WIFI MODULE (ESP8266)

The ESP8266 WIFI Module is nothing but a microcontroller with advanced features and also an addition of a WIFI network. It consists of an inbuilt SOC (System on chip) and TCP/IP protocol stack. Application hosting can be easily done by using ESP8266 WIFI Module. WIFI stands for Wireless Fidelity. WIFI is a must for IoT, therefore we are using WIFI Module in our system because it is IoT based. The changes can be made in threshold value and even the energy meter can be made ON and OFF using WIFI Module. The webpage contains all the data about the units consumed and the cost, which is done with the help of WIFI Module based microcontroller on timely basis. Energy Meter and Arduino board is linked with the WIFI Module and the consumer can access through WIFI easily.

D. RELAY

An electrically operated switch is nothing but a relay. Its function is similar to that of a switch, which is to make or break a circuit. For its operation only a small amount of current is required. Relays have input terminals for a single or multiple control signals and even have contact terminals. Relay mainly consists of an electromagnet. High power circuits can be controlled easily with the help of Relay. Electromagnetic, Solid State, Hybrid, Thermal, Reed are the different types of Relays. Solid State relays are the most preferred one in our system. The connection of supply devices with the ATmega328 and energy meter is done with the help of Relay. Relays are used to disconnect the load supply when meter tampering occurs.

E. INTERNET OF THINGS

FIGURE 3: IoT Representation

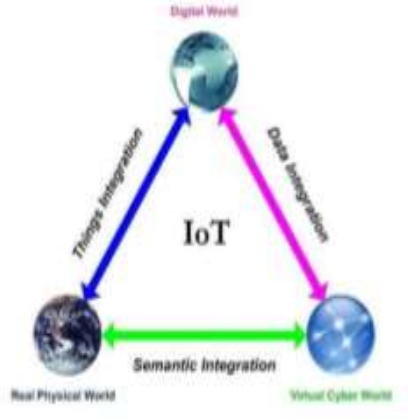

FIGURE 4: IoT Working

It is a network of objects connected through Internet which can collect and exchange data as well. The inventor of IoT is Kevin Ashton. He first used this term to describe a system where Internet is connected to the physical world using different types of sensors. IoT helps in creating opportunities for direct connections in the physical world by sensing and controlling. By linking IoT with the actuators and the sensors the technology is connected with both software and hardware systems, which confines technologies like smart devices, smart power generating houses, home automation and smart cities. Privacy and security are two important things that matters in IoT and these factors should be considered while implementing IoT in any type of system. IoT allows communication with non-living things effectively. Machine learning, Real time analytics, sensors, control systems, automation, embedded system, actuators all contribute towards enabling IoT.

Data analytics is the process of inspecting big datasets to reach conclusions regarding the data content. In this research, a platform of data analytics is used to monitor the data sent by the energy meter so as to calculate the bill and detect the electricity theft and send bill amount to the consumer on monthly basis.

Here we will be using Adafruit IO platform to display, respond and interact with the energy meter. Adafruit IoT platform keeps the data private and secure. Using this IoT platform energy consumed by the user and bill generated will be stored. Monthly energy consumption can also be analyzed through Adafruit. Monthly energy consumed bill amount can be emailed or SMSed to the consumer as well, very easily. The infrared sensor is used to detect tampering, and then these tampering signals are sent on the Arduino pin and Arduino then in turn gives instruction to its WIFI interface units. The WIFI module informs the authority about the tampering and then the required actions can be taken accordingly. The state electricity board may have several energy meters to be watched and it is difficult for them to monitor all the meters at the same time. Adafruit is linked through Arduino IDE software. Adafruit applet once made has all graphical data as and when needed.

F. SIGNAL CONDITIONER (OPTOCOUPLER)

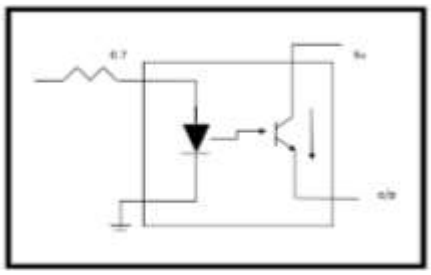

FIGURE 5: Signal Conditioning Circuit

As a signal conditioning block in our project we are using an optocoupler. The signal conditioning is mainly used due to the differences in the voltage levels of the meter and the controller. Signal conditioning makes them compatible to interface. It makes the 0.7V output of CAL led blink to 5V input which is required at the controller pin for this particular application. Hence, this block amplifies the voltage.

G. IR SENSOR

An electronic instrument that is used to detect some kind of characteristics from its surroundings is an IR Sensor. IR Sensor does this by either detecting or emitting infrared radiation light. IR sensors are also capable of detecting motion and even measuring the heat given by an object. Here IR sensor is used to sense the occurrence of tampering in the energy meter.

H. RTC MODULE

Real Time Clock module is a simple TIME and DATE based remembering system which also has a battery setup. RTC keeps the module running even in the absence of external power. This module keeps the TIME and DATE of the system up to date. Every system which needs time to time updation requires RTC while designing it. Our system requires regular pulse calculation for generation of billing amount therefore RTC is used here.

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V. ABBREVATIONS

1. IoT - Internet of Things
2. WIFI-Wireless Fidelity
3. KWH-Kilo Watt Hour
4. IR-Infrared
5. RTC-Real Time Clock
6. AMR-Automatic Meter Reading
7. IDE-Integrated development environment
8. SOC-System on Chip
9. TCP/IP-Transmission Control Protocol/ Internet Protocol

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VI. MATHEMATICAL FORMULA/CALCULATIONS:

From our meter when the 'Cal' LED blinks 3200 times it implies that 1 unit of energy is consumed.

3200 blinks=1 KWH=1 unit= Meter constant.

For 1KW-3200blinks in 1 Hour Energy Consumed.

For 1blink-1000/3200=0.3125watt in 1 Hour Energy Consumed.

For 1blink,1KW-0.3125/60=0.0052watt in 1 Minute Energy Consumed.

For 1blink,1W-0.0052/1000=0.0000052watt in 1 Minute Energy Consumed.

FIGURE 6: Conventional Energy meter

Suppose we take a load of 200W blub:

For 1blink,200W-0.0052*200/1000=0.00104watt in 1 Minute Energy Consumed.

For 1KW-53blinks in 1 Minute(60sec).

For 200W-11blinks in 1Minute(60sec).

The price for 1 unit is different for different places and different consumption units i.e. for commercial and domestic purpose. It also changes as per the units consumed.

For Maharashtra:

1 unit=Rs 2.93 up to 100 units

1 unit=Rs 5.18 from 101 to 300 units

1 unit=Rs 7.79 from 301 to 500 units

1 unit=Rs 9.20 for 501 units above

Bill can be calculated as,

Cost Charged =cost*0.3125/1000

For 200W bulb,

Cost Charged=cost*0.00104/1000

VII. CONCLUSION AND FUTURE SCOPE

This project practically describes the usage of "IOT BASED SMART ENERGY METER". The technological advancement in every field is a non-stop process. Smart electricity meter using IOT is based on new and efficient technology to achieve future prospective.

The proposed model automates the process of billing and detects tampering, eliminating the manual intervention. It also allows remote monitoring of energy meter.

In future, the proposed system can be extended to be used as prepaid energy meters. These meters can be recharged according to the user's need thus saving any additional cost in the billing.

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