

# Research Paper

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# IOT based Smart Energy Meter Monitoring and Controlling System

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**Abstract** - In recent time e-meter (electronic meter) place a major role for the power consumption & cost efficient system. In advanced future it has high reliable and productive programmed meter perusing framework (AMRS). This paper aims to plan a straightforward ease. IOT based energy meter reading system which includes fault indication. Unit usage after (i.e. for 15 days once). Mode selection (automatic & manual) and SMS alert to user. Mode selection option is included. To avoid more power consumption automatic mode is used to cut-down the appliances for the user convenience. If there is a fault in the e-meter it sends a notification to the user. If there is any fault in E-meter the LED will glow. EEPROM (Electrically Erasable Programmable Read Only Memory) used as flash memory to store a data. The proposed system neglects the regular digital meter reading system and allows remotely access the electronic meter. Legitimate validation, user can get to the created webpage points of interest from anyplace on the planet. The advantages of this project are to reduce cost and save more power and also reduce man power and time consumption. This project is implemented is hardware and software used are ARUDINO IDE (using embedded C language).

**Keywords** - ARMS (Automatic Meter Reading System), IOT (Wi-Fi) as communication, Real Time Clock (RTC), Arudino IDE

## I. INTRODUCTION

The Internet of things concept enables us to connect the normal day to day devices with each other over the internet. The devices connected through IOT concept can be controlled and analysed remotely. The IOT concept provides the basic infrastructure and opportunities to form a connection between the physical world and computer based systems [8]. The concept has been gaining importance with more and more wireless devices that are increasing rapidly in the market. It connects the hardware devices with each other over the internet. The ESP 8266 Wi-Fi module used in the system provides the connectivity with the internet in the system. Now-a-days the demand for electricity is increasing at a constant rate throughout the population and is being utilized for various purposes wiz, agriculture, industries, household purposes, hospitals etc.,. So, it is becoming more

and more complicated to handle the electricity maintenance and requirements. Therefore there is an immediate requisite to save as much electricity as possible. As the demand from the newer generations of population for electricity is increasing so in accordance with it the technology improvement is needed.

The proposed system provides a technical twist to the normal energy meters using the IOT technology. Also there are other issues that we have to address such as power theft and meter tampering which in turn generate economic loss to the nation. Monitoring, Optimized power usage and reduction of power wastage are the major objectives that lie ahead for a better system. The present system vastly depends on human involvement for billing. Billing requires a human individual to visit each and every customer's energy meter and generate the bill by taking the unit readings from the energy meter. This is a time consuming process.

To address all the mentioned constraints we developed a system on the basis of IOT technology. Smart energy meter using Wi-Fi system is designed based on three major objectives. They are

- To provide automated meter reading over an immediate basis.
- To use the electricity in an optimized manner
- In order to reduce the power wastage.

Similarly the system should also be useful to the service end. So the system basically can be classified on the basis of service ends in two ways.

- Consumer end
- Service end.

The data from the system is displayed on a webpage which can be accessed by both the consumer and service provider. The system is designed on an Arduino micro controller [2]. It can be structurally differentiated into three parts controller, theft detection circuit and a WiFi unit. The controller performs the basic calculations and processes the information. Theft detection circuit provides information about any meter tampering and the most important role is played by the Wi-Fi unit to send the information from the controller over the Internet. The service end can remind the consumer about the bill generated for the usage over a

common messaging platform. The Arduino controller is programmed on the Arduino software IDE which is a prerequisite to operate on the Arduino board. Its code is derivative of the C language.

The block diagram consists of an Arduino UNO board, an ESP 8266 Wi-Fi module and a 16\*2 LCD display. The Wi-Fi module is the main component used in the IOT operation. The centre piece being the Arduino board provides the connection between the different components of the proposed system. The Arduino UNO board is based on the ATmega 328p processor. It is the core of the system which is necessary for the principle operations that are necessary to be carried out such as the automatic electricity billing and tampering detection inputs from the tampering circuit. The load represents the devices that require the electricity to operate. The AC supply is connected to the system through the transformers to power the system. The Meter is also connected to the system to automate the power usage of the household. The readings from the energy meter are then processed and are updated over the Wi-Fi through the ESP 8266 Wi-Fi Module.

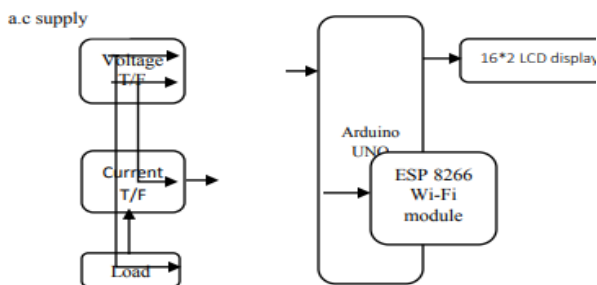


Figure 1: Block Diagram

If any tampering is detected the system updates the situation on the webpage used to display the energy readings. After updating the energy readings on the webpage, the system then displays the energy readings on the LCD display. In case of any tampering the buzzer will go off making a loud noise. All the information from the system is readily available on a webpage called Thingspeak.com.

#### Advantages

- To reduce wastage of energy.
- Prevent electricity shortage during dry seasons.
- Make every customer a self-interested guardian of the power (energy) supply.
- Real time bill monitoring
- Time reduced receiving bill.

#### Applications

- Residential and commercial building in a public energy supply system
- MUNICIPAL CORPORATION
- PUBLIC POWER SOURCES
- MSEB
- Govt. Energy plant

## II. LITERATURE REVIEW

Internet of things (IOT) based and highly desirable in field of energy, in this framework customer can do control administration by knowing vitality utilization time to time, the buyer needs to pay the bill on plan. On the off chance that couldn't the electric power availability can be killed self-ruling from the far off host. [1] Explained the modelling and working of different units of the system and also discussed the components and their functions such that IOT and its working microcontroller and its architecture.

Reducing energy consumption and monitors the units consumed. To make the electrical apparatuses insightful and give solace to devoured and to lessen control utilization in web applications. [2] Suggested it in light of ARDUINO UNO controller and IOT innovation. On the off chance that any altering happens the controller will send to information to the server and in addition it is chopped down the vitality supply naturally.

At the point when most extreme request of vitality expends will be shown in the meter utilized by the customer. [3] Clarified in the wake of surpassing the greatest request, the meter and subsequently the association will be consequently disengaged by an installed framework embedded in the meter sensor. The LDR (Light Dependent Resistor) sensor placed on energy meter which sense LED blinking pulse. At that time microcontroller sending this reading via GSM module and its send this message to electricity board.

In this framework a keen vitality meter is introduced in each customer unit a server is kept up at the specialist co-op side. [4] Implemented both the meter a server furnished with GSM module which encourages bidirectional correspondence between the two closures utilizing the current GSM foundation. Shopper can without much of a stretch energize their vitality meter by sending a stick number covered up in a scratch card to the server utilizing SMS.

In order to avoid all these drawbacks we have intended to construct an IOT based energy meter so that proposed energy meter measures the amount of power consumed and uploads it to cloud from which the concerned person can view the reading. The power reading send to cloud using ESP8266, a Wi-Fi module. [5] Explained the power reading from digital wattmeter is read using the coupler and transmitted digitally to the Arduino. So it automates the process of measuring the power consumption at homes using IOT.

## III. PROPOSED SYSTEM

In the proposed technique the customer can deal with their vitality utilization by knowing their vitality use time to time. The strategy not just gives two path interchanges amongst utility and purchaser yet in addition gives different capacities that are if the customer neglects to pay the power charge the vitality supply would be chopped down from the utility side and once the bill is paid the vitality supply is reconnected.

In addition with the existing system innovative to include an alert message to the user energy consumed for 15 days once, constant alert message with payments details and power usage until the payment is done. To avoid the further consumption of energy, we are setting a limit for each household and if the limit exceeds methods are used to cut down the appliances according to the user convenience both automatically and manually. If there is a fault in e-meter it also sends a notification to the user.

**IOT Server** - Cayenne.com is used as a cloud server. Cayenne is a first online builder/tool to create IOT projects. Voltage and current values are continuously stored in server. Alerts can be scheduled in a server.

The proposed framework for the most part works in two modes.

1. Automatic Mode
2. Manual Mode

**Mode Selection -**

- Automatic Mode: In this mode it crossed to the limit automatically device will cut-off. The device is selected by user convenience.
- Manual Mode: In this mode the switch is manually turned to manual mode. During the manual mode the customer can consumed as much as it is required by the presence of customer known.

**Problem Analysis** - The power board have used to the manual procedure and they oblige it despite the fact that there are numerous worries combined with it. In light of the human blunders in the wake of getting staff charge, it is the issue of client to get yet adjusted from the vitality supply board. All things considered client needs to visit the workplace, remain in line and get it rectified. The issue is a result of human intercession. To maintain a strategic distance from human mistakes in the building procedure, in this new age a programmed perusing meter perusing framework came in to the existence and explained in the following figure(1).

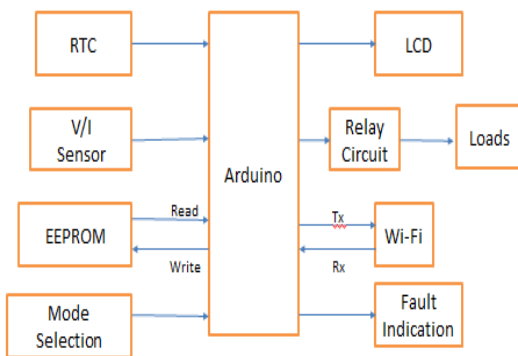


Figure 2: Block diagram of e-meter

**IV. RESULT**

**Implementation** - The smart electricity meter using Wi-Fi module can be easily deciphered in to two parts. The first part being the physical part and the second one being the Webpage.

**The physical part** - It consists of the Arduino board, ESP 8266 Wi-Fi module, 16\*2 LCD display, buzzer and power supply. 3.1.1. Arduino Uno board Arduino is a microcontroller board and it is based on the AT mega 328P. It consists of 14 digital I/O pins and 6 analog input pins and a crystal oscillator of 16 MHz frequency, a power supply jack and a USB port to dump the code, ICSP header and a reset button. It can be powered with the power jack at the start and later can be powered with AC to DC adapter or with a battery.

**ESP 8266 Wi-Fi module** - The ESP 8266 Wi-Fi module is a low cost component with which manufacturers are making wirelessly networkable microcontroller module. ESP 8266 WiFi module is a system-on-a-chip with capabilities for 2.4GHz range. It employs a 32 bit RISC CPU running at 80 MHz. It is based on the TCP/IP (Transfer control protocol) . It is the most important component in the system as it performs the IOT operation. It has 64 kb boot ROM, 64 kb instruction RAM, 96 kb data RAM. Wi-Fi unit performs IOT operation by sending energy meter data to webpage which can be accessed through IP address. The TX, RX pins are connected to the 7 and 8 pins of the Arduino microcontroller.

**16\*2 LCD display** - LCD (Liquid crystal display) screen is an electronic display module and finds a wide range of applications. 16\*2 display means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5\*7 pixel matrix. The 11, 12, 13 and 14 pins of the display are used as data pins for Arduino interfacing. It is used to display the wattage.

**Working of E-Meter** - The meter which is utilized for estimating the vitality and uses by the electric board is known as the vitality meter. The vitality is the aggregate power expended and used by the heap at a specific interim of time. It is utilized as a part of residential and mechanical AC circuit for estimating the power utilization. The meter is more affordable and precise.

Essential unit of energy is watts. One thousand watts is one kilowatt. In the event that we utilize one kilowatt in 60 minutes, it is considered as one unit of vitality devoured. These meters measure the prompt voltage and streams. This power is incorporated over a period which gives the vitality used over that day and age.

**Hardware Structure**



Figure 3: Output of automatic mode

**Hardware Description -**

**Arudino ATMEGA328** - The Arudino ATMEGA 328 is a low power CMOS 8-bit microcontroller in light of the AVR upgraded Reduced Instruction Set Computer (RISC) design. It is low power and advantageous size.

**EEPROM** - EEPROM memory also has a special chip erase mode by which entire chip can be erased in 10ms. This time is quite small as compared to time required to erase EPROM and it can be erase and reprogrammed with device right in the circuit. However, EEPROM's are most expensive and the least dense ROM's.[10]

**Regulated Power Supply** - The power supply plans contain a substantial mains transformer (which likewise gives separation between the information and yield) and a dissipative arrangement controller circuit. The controller circuit could comprise of a solitary zener diode or a three terminal direct arrangement controller to deliver the required yield voltage.

**LCD** - A Liquid Crystal Display (LCD) is additionally has 64 bytes of character-generator (CG) RAM. This memory is utilized for characters characterized by the client.[11]

**RTC** - A Real Time Clock (RTC) is used to reset the data and it's stored in online and offline mode.

**Relay Circuit** - The hand-off works just if the positive and the ground are associated with the proper terminals of the hand-off loop. In its least complex shape a hand-off comprises of a loop utilized as an electromagnet open and close switches contacts.

**IOT Server** - Cayenne.com is used as a cloud server. Cayenne is a first online builder/tool to create IOT projects. Voltage and current values are continuously stored in server. Alerts can be scheduled in a server.

**Wi-Fi Module (ESP8266)** - ESP8266 is a Wi-Fi module which appropriate for adding Wi-Fi usefulness to a current microcontroller venture by means of a Universal Asynchronous Transmitter Receiver (UART) serial association. The module can even be reinvented to go about as an independent Wi-Fi associated gadget.

**Voltage Sensor** - To get DC motion from an AC framework for contribution to a microcontroller, we are utilizing this voltage detecting circuit. The circuit gives a precise technique to making this DC flag. The voltage is detected by utilizing a potential transformer and the got flag is amended at the primary operation amp stage and enhancer at the second operation amp arrange.

**Current Sensor** - The current is detected from by utilizing current transformer and it is corrected at the main operation amp stage and enhancer at the second operation amp arrange.

**V. CONCLUSION**

The main cause for the design of IOT based E-meter is to reduce the power consumption in house. It avoids the human intervention reduces the cost, save human power. It works both automatically and manually. This meter sends billing directly to mobile before due date without causing human intervention.

This computerization for diminish the work costs as well as makes the framework more effective and exact.

The system is mainly intended for smart cities with public Wi-Fi hotspots. The project is based on the internet of things concept. This is aimed at replacing the old energy meters with an advanced implementation. It can be used for automatic power reading by which one can optimize their power usage thereby reducing the power wastage. The readings from the meter are uploaded to Thingspeak.com where a channel with the energy usage for a particular energy meter can be viewed by both the service end and the customer.

**Conclusion** In the era of smart city advancement, this project is concentrated on the connectivity & networking factor of the IoT. In this project, an energy consumption calculation based on the counting of calibration pulses is designed and implemented using PIC16F\* & A MCU in embedded system domain. In the proposed work, IoT and PLC based meter reading system is designed to continuously monitor the meter reading and service provider can disconnect the power source whenever the customer does not pay the monthly bill and also it eliminates the human involvement, delivers effective meter reading, prevent the billing mistake. The Project has achieved following objectives:-

1. Ease of accessing information for consumer from energy meter through IoT.
2. Theft detection at consumer end in real time.
3. LCD displays energy consumption units and temperature.
4. Disconnection of service from remote server. Future enhancement In the present system, IoT energy meter consumption is accessed using Wi-Fi and it will help consumers to avoid unwanted use of electricity. The performance of the system can be enhanced by connecting all household electrical appliances to IoT.

So, in future following objectives can be achieved to save power and avoid thefts:-

1. We can make an IoT system where a user can monitor energy consumption and pay the bill Online.
2. We can make a system where a user can receive SMS, when he/she crosses threshold of electricity usage slab.

**VI. FUTURE SCOPE**

The project is focused on the government's plan to turn the major cities of the country into smart cities. The project provides the entire energy readings at one's finger tips. The project can be further extended to detect the energy meter tampering. A smart app can be designed to provide various alerts based on the readings from the device. A unified can be provided to the customers for both viewing the energy usage and a platform to pay the bill online following the digital India initiative. In one case the service provider can evaluate the bills which are not paid and can disconnect the energy connection remotely.

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