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IoT Based Electricity Energy Meter

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Abstract- The demand for electricity is being increased in the World. Many of the consumers are using traditional electricity meters in their homes. These days most of the homes are connected to Internet via Wi-Fi. The use of Internet of Things (IoT) technology enables an Internet-based monitoring system to statistically collect information and display them accordingly. In this, the Information related to measurement of electrical energy parameters, such as real time measurement of voltage, current and power can be obtained. The information is then designed to an internet-based real time monitoring system for electrical energy consumption inside the house. The electricity consumption on a monthly basis can be observed by the user through a user-friendly mobile application and a webpage. These webpages can be connected to the electricity service provider in order to generate electricity bills automatically. The real time values are converted to units (kW/h) and sent to the database through Internet. Since the results can be seen through the webpage and a mobile app, the user may have some idea of reducing consumption of electricity than earlier. This device can be implemented to reduce the human dependency in collecting the monthly reading and minimize the technical problems encountered during billing process. The proposed smart energy meter controls and calculates the energy consumption using ESP 8266 12E, a Wi-Fi module and uploads it to the cloud from where the consumer or producer can view the reading. Therefore, energy analyzation by the consumer becomes much easier and controllable. This system also helps in detecting power theft. Thus, this smart meter helps in home automation using IoT and enabling wireless communication which is a great step towards Digital India.

Keywords: Electricity meters, Wi-Fi, Internet of Things (IoT), Voltage, Current, Power, ESP 8266

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. 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 [3]. 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.

II. OVERVIEW & BACKGROUND

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. 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. It is to make the electrical apparatuses insightful and give solace to devour and to lessen control utilization in web applications. This is suggested 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. 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 [4]. 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. 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. As shown in Fig. 1.

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. 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.

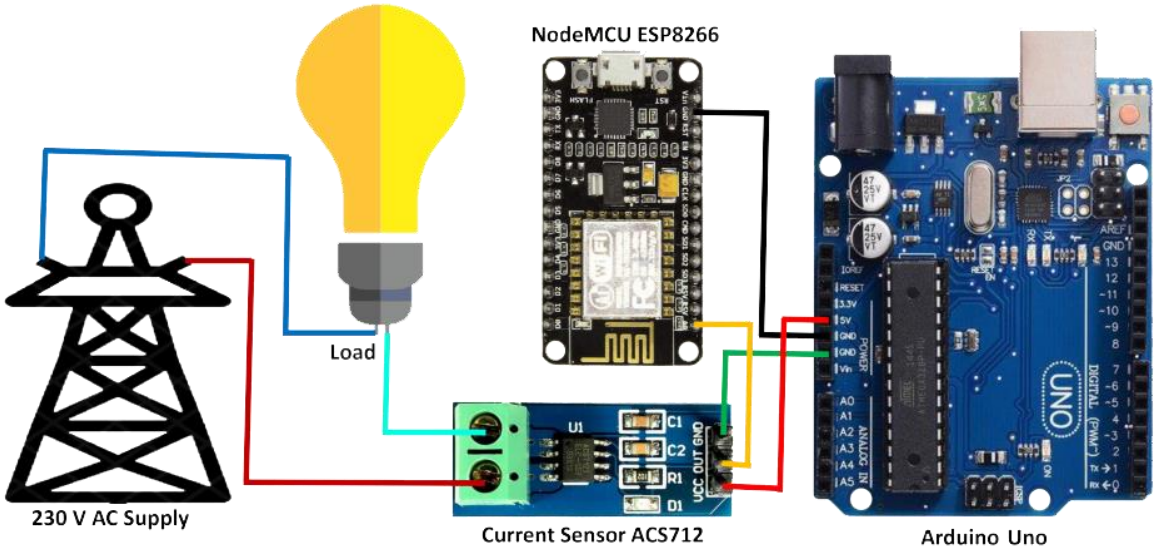

Fig. 1. Circuit diagram of the project

III. TECHNOLOGY INTERVENTION

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. 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 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 [12], [13].

A. ARDUINO UNO

Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarding, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR in-system programming (ISP) programming issued. As shown in Fig. 2.

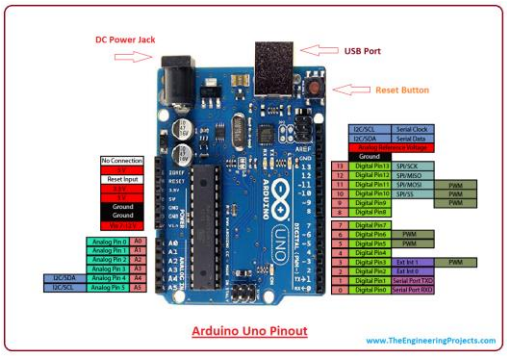

Fig. 2. Pin diagram of Arduino Uno

B. NodeMCU ESP8266

ESP8266 is Wi-Fi enabled system on chip (SoC) module developed by Espresso. It is mostly used for development of IoT (Internet of Things) embedded applications. It employs a 32-bit RISC CPU based on the TensilicaXtensa L106 running at 80 MHz (or over clocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM [2], [6]. External flash memory can be accessed through SPI.ESP8266 module is low cost standalone wireless transceiver that can be used for endpoint IOT developments. To communicate with the ESP8266 module, microcontroller needs to use set of AT commands [10], [11]. Microcontroller communicates with ESP8266-01 module using UART having specified Baud rate. As shown in Fig. 3.

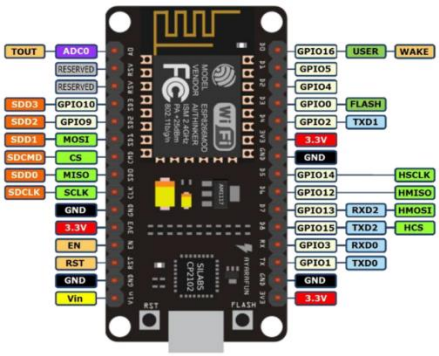

Fig. 3. Pin diagram of NodeMCU ESP8266

C. Current Sensor ACS712

In the present work ACS712 current sensor operates from 5V and outputs analogue voltage proportional to current measured on the sensing terminals. Microcontroller along with ADC is used to read the values [8], [9]. ACS712 current sensor gives precise current measurement for both AC and DC signals. These are good sensors

for metering and measuring overall power consumption of systems. The ACS712 current sensor measures up to 5A of DC or AC current. In this system it is used in order to measure the power theft. As shown in Fig. 4.

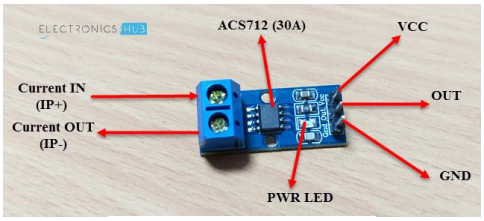

Fig. 4. Current Sensor ACS712

D. Communication with Internet

IoT communicates info to folks and systems, like state and health of kit (It's on or off, charged, full or empty) and knowledge from sensors that may monitor a person's important signs. In most cases, we tend to didn't have access to the current info before or it had been collected manually and often [5], [7]. For example, AN IOT-enabled HVAC system will report if its filter is clean and functioning properly. Virtually each company includes a category of assets it may track. GPS-enabled assets will communicate their current location and movement. Location is very important for things that move, like trucks, however it's additionally applicable for locating things and folks at intervals a company. Within the health care business, IoT will facilitate a hospital track the placement of everything from wheelchairs to internal organ defibrillators to surgeons. Within the transportation business, a business will deliver period of time pursuit and condition of parcels and pallets. As an example, Maersk will use sensors to trace the placement of a cold shipping instrumentality and its current temperature.

E. Control and Automation

Control and Automation during a connected world, a business can have visibility into a device's condition. In several cases, a business or client also will be ready to remotely management a tool. As an example, a business will remotely activate or close up selected piece of apparatus or regulate the temperature during climate-controlled surroundings. Meanwhile, a client will use IoT to unlock their automotive or begin the washer [1]. Once a performance baseline has been established, a method will send alerts for anomalies and presumably deliver an automatic response. As an example, if the constraint on a truck is close to fail, it will prompt the corporate to require the vehicle out of service and mechanically schedule maintenance.

IV. TECHNOLOGY INTREVENTION

This system principally monitors electrical parameters of appliances and subsequently calculates the units consumed. As WSN's are having many advantages, here we have designed smart meters predicting the usage of power consumption. However it is low-cost, flexible, and robust system to continuously monitor and control based on consumer requirements, Wi-Fi technology for networking and communication, because it has low-power characteristics, which enable it to be widely used in home and building environments. To analysis the proposed energy monitoring system, the system is practically implement in the lab. As shown in Fig. 5.

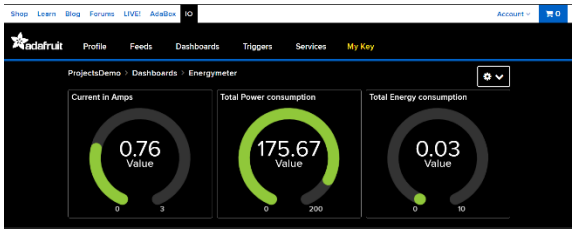

Fig. 5. Adafruit Cloud Display

V. METHODOLOGY

The proposed system uses ARM7-LPC2148 Processor that can process the instructions according to our requirements such as power delivered to appliances and status of devices, on state or off state. The control signals generated through Wi-Fi/GPRS are fed to the microcontroller which will drive the appliances that are connected to LPC2148 through energy meter [3], [4]. The energy meter that is connected to LPC 2148 through opt coupler will regularly calculates the number of units consumed and the billing amount. The same will be displayed on LCD along with the same information will send to web server about number of units consumed in terms of graph. We could able to reduce the consumption of power by switching off through web links that are

defined while programming the web server and ARM. As we are defining the prepaid energy meter we need to refill the number of units that are required approximately per month by estimating the consumable load. However we could able to add the units if completed early. Units are remained at the end of the month will added to next month if they done the refill before consumption of remaining units. Prepaid bill payments can be done by using RFID based prepaid recharge tags or through wallets that are supported the parent organization which will be supplying power. The detailed billing graph will be provided in web server which can be accessed by giving the user details. The whole arrangement provides an effortless, convenient, quick and smooth navigation experiences. The hardware implementation of this projected system consists of an ARM7 microcontroller, Energy Meter with opt coupler for connecting with processor, appliances connected through relays to micro controller. To communicate with server we need Wi-Fi/ GPRS and RFID reader along with prepaid tags for bill payment. RFID reader is used to read the tag information check about validity, available amount for the purpose of power subscription. As shown in Fig. 6.

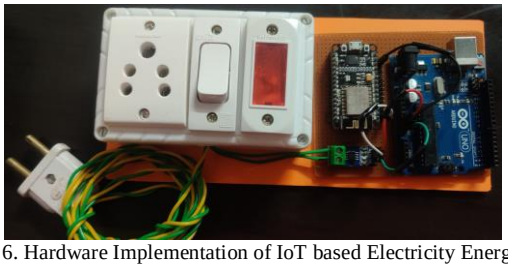

Fig. 6. Hardware Implementation of IoT based Electricity Energy Meter

VI. APPLICATION AREA

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 [2]. 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 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.

VII. 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.
- There is no need for the user to estimate the bills anymore. The user would be charged according to its power consumption.
- In case any technical difficulty occurs or there is any electrical issue that would be notified to the user.
- The bill can be paid in advance.
- The provider companies can offer various schemes and offers for energy consumption.
- It offers the ability to check the power consumption remotely.
- It will help to provide the accurate power consumption.
- As soon as there is exceed in the power consumption with respect to the set threshold consumption value, the relay will be cut off the power supply.

VIII. DISADVANTAGES

Installation of Wi-Fi/GPRS enabled meters at consumer end will not be possible over a certain period. It takes a lot time to do. Man power requirement will be high at the time of installation and initialization. The cost of implementation will be high. The requirements of the system vary based on place the consumer need the smart energy meter. According to the requirements given by consumer need to develop the hardware and it should be configured according to the rules and regulations framed by that state government. As the unit charges will be varies according to the category of supply and power distribution units. This system will have many drawbacks in hill stations, forests and the places where the network coverage problems arise.

IX. CONCLUSION

In the era of smart city, smart grid advancement, prototype smart energy meter is a step forward and it mainly focusses on the connectivity & networking factor of the IoT. In this system, an energy consumption calculation based on the counting of calibration pulses is designed and implemented using Arduino Uno MCU in embedded system domain. In the proposed work, IoT based meter reading system is used to continuously monitor the meter reading, current energy consumption, theft detection and service provider can disconnect the power source whenever the consumer does not pay the monthly bill. All these information are sent in the form of message alerts to the consumer mobile phone. Also it eliminates the human intervention, delivers effective meter reading, prevent the billing mistakes.

X. 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 follow 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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