

Remotely Located Energy Meter Monitoring and Billing System through IoT

Rasika Khandare¹, Dr. S. V. Rode²

¹M.E Scholar, Department of Electronics & Telecommunication Engineering, Sipna College of Engineering and Technology, Amravati, Maharashtra, India

²Professor, Department of Electronics & Telecommunication Engineering, Sipna College of Engineering and Technology, Amravati, Maharashtra, India

Abstract

We can see a man remaining before a house from power board, whose obligation is to peruse the vitality meter and handover the bills to the proprietor of that house each month. This is only meter perusing. As indicated by that understanding we need to pay the bills. The primary downside of this framework is that individual needs to go region by zone and he needs to peruse the meter of each house and handover the bills. Ordinarily mistakes like additional bill sum or notice from electric board despite the fact that the bills are paid are basic blunders. To defeat this downside we have thought of a thought which will kill the outsider between the purchaser and specialist co-op, even the blunders will be survived.

In our undertaking brilliant vitality meter utilizing IoT and Arduino have been presented. In this technique we are utilizing Arduino on the grounds that it is vitality productive that is it expends less power and is quickest. This is portrayed to gauge vitality utilization in the house and produce its bill naturally utilizing telemetric correspondence. This can help in decreasing vitality utilization in house as the proprietor is persistently being informed about the quantity of units that are devoured. Vitality meters which are as of now introduced at our homes are not supplanted, but rather a little alteration on the as of now introduced meters can change the current meters into brilliant meters. Our task objective is to create bill consequently by checking the power unit's utilization in a house and in an approach to diminish the physical work. The estimations are performed consequently and the bill is refreshed on the web by utilizing a system of Internet of Things. The bill sum can be checked by the proprietor anyplace internationally. Plan and execution of venture is primarily founded on controller utilizing IOT idea. In power transmission human association isn't required. Buyer pays the power bill for the devoured power. In the event that on the off chance that shopper neglects to pay the bill on time, power transmission can naturally killed. WIFI plays out the IOT activity and through which the data is sent to the Web server. One can undoubtedly get to the meter working through site page that we structured. Current perusing with expense can be seen on web server. Programmed ON and OFF of meter is conceivable. Sending of warning is the extra errand that we are performing.

Keywords: Arduino Uno, Wi-Fi module (ESP8266), Energy Meter, Microcontroller ATmega328,

I. INTRODUCTION

Power, a standout amongst the most vital areas for the financial advancement of a nation is utilized for the different purposes. In the present situation, the world is confronting vitality emergency. The ideal arrangement of this slanting issue is to screen and control the power utilization. In power framework, the quantity of buyer is developing quickly and in this manner the vitality necessity. Increasingly the vitality necessity more is have to spare vitality misfortunes. Due to the non-specialized reasons 5-7% control misfortunes of aggregate created influence. That is the reason customer needs to languish over this conflicting charging however they utilize the roughly same vitality in every month. To spare misfortunes we have to screen the influence utilization misfortunes, with the goal that we can use the created influence. As age is expanding thus are the necessities. The possibility of a remote information transmission is being proposed to lessen the human reliance to gather the month to month perusing and to limit the specialized issues with respect to the procedure. This ascertains normal power utilization of specific region or purchaser. There is an innovative headway required, so we build up a framework with quicker and cutting edge innovation i.e. IoT. The web of thing enables protest be detected and controlled remotely crosswise over existing system framework, making open doors for more straightforward reconciliation between the physical world and PC based frameworks, and bringing about enhanced effectiveness, exactness and financial benefit. The expanding age needs engaged devices by remote innovation which incorporates Bluetooth, Radio Frequency Identification, Embedded sensors and some more. In that IOT innovation has developed from its start and now by and by broadly utilizing it. The power assumes a critical job in our life Nowadays we have a consuming idea of parcel i.e. Web of Things through this idea or innovation the items are detected controlled remotely in the current system framework.

In the current charging framework the dissemination organizations can't monitor the changing most extreme interest of customers. The purchaser is confronting issues like getting due bills for bills that have just been paid and also poor unwavering quality of power supply and quality regardless of whether bills are paid frequently. The solution for every one of these issues is to monitor the buyers stack on opportune premise, which will held to guarantee precise charging, track most extreme interest and to distinguish edge esteem. These are every one of the highlights to be considered for

structuring a proficient vitality charging framework. This vitality meter uses the highlights of inserted frameworks i.e. mix of equipment and programming with the end goal to actualize wanted usefulness.

Proposed framework empowers the power office to peruse the meter readings month to month without a man visiting each house. This can be accomplished by the utilization of Arduino unit that persistently screen and records the vitality meter perusing. A Wi-Fi module is incorporated with electronic vitality meter of every substance to have remote access to the utilization of power and make a remote system. This framework constantly records the perusing and the live meter perusing can be shown on site page to the customer on demand. This framework likewise can be utilized to separate the power supply of the house when required. This framework is a viable method for information gathering and putting something aside for more prominent exactness and enhanced charging. It gives better customer benefits by sending caution of intensity expended and payable sum. IOT based vitality meter perusing comprises of two sections: Controller and WIFI part. Controller part assumes a noteworthy job in the framework, where all the data can send through this controller to the next piece of the framework and it additionally stores the data in it. WIFI part performs IOT activity as per the Arduino controller. This framework can be extremely quick, precise and proficient.

II. LITERATURE REVIEW

Mr. Samarth Pandit, Miss. Sneha Mandhre, Miss. Meghana Nichal “Smart Energy Meter using internet of Things (IoT)” VJER-Vishwakarma Journal of Engineering Research Volume 1 Issue 2, June 2017

Since today's energy meters have many drawbacks like two way communication, real time monitoring, energy tampered, etc. To cope up with these disadvantages. This paper projects the means to monitor energy consumption at domestic level. This helps in reducing energy consumptions and monitors the units consumed. The objective is to make the electrical appliances intelligent and provide comfort to consumer and to reduce power consumption in web applications. Design and implementation of the project is mainly based on Arduino UNO controller and IoT technology. If any tampering occurs the controller will send the data to the server as well as it is cut down the energy supply automatically. Ethernet performs the IoT operation through which the data is send to the web page. In this system, smart energy meter is designed to get telemetering, tampering detection and supplier can disconnect service to the consumer in the event of meter tampering or unauthorized use of energy. It makes the relation between utility and user more transparent and reliable. Power saving is possible which contributes towards the minimization of the problem of energy crisis [1].

Ronanki Deepak Krishna, Pulavarty Jaya Kishan, Teki Sai Santosh Kumar “GSM Based Energy Meter Billing Via SMS” 3rd international conference on recent innovation in science engineering and management.

The vitality meter is intended for perusing electrical vitality devoured in units and in rupees to show on a LCD screen to the client. This information is likewise given to the electrical division utilizing GSM innovation for charging purposes. Attributable to high power cost nowadays it winds up fundamental for the purchaser to know concerning how much power is devoured to control power bill inside his financial plan. In this proposed framework, the purchaser will get his vitality utilization information on ongoing premise on a LCD show. Similar information is sent through GSM modem to the power division by means of SMS. A microcontroller of 8051 family is interfaced to the vitality meter to get the Watt Hour beats. The microcontroller then procedures these heartbeats concurring the program written in it, to figure the units consumed and cost involved. Further it gives command to the SIM loaded GSM modem for sending the data to the electricity department via SMS. Further this project can be enhanced by to control the electrical appliances remotely via SMS. Also, the electricity department can send the bill amount over SMS to the receiving unit for consumer information [2].

Dinesh Prasanth M K, “Live Energy Meter Reading and Billing System through GPRS” International Journal of Engineering Research & Technology (IJERT): 2278-0181 IJERTV Vol. 4 Issue 05, May-2015.

The current electric meter doesn't have provision to monitor our electricity consumption. Also, the provision for generating bills automatically is limited and inefficient. Until now, Automatic Meter Reading (AMR) system uses SMS as the medium to transfer data to the server. But, the designed energy meter uploads the reading periodically to a central public server through GPRS. GPRS is more cost effective than SMS and is very useful in frequent update. There is no need for a person to visit every home at the end of every month for checking the reading. The bills are generated automatically at the start of every month. In recent years, the number of smart phone users has increased drastically. The users can view their current Energy meter reading and also pay their Electric bills through mobile application. The users can also monitor their Energy meter on-line and they are also given an option of paying the bill on-line. By using this system, the users will be aware of the electricity usage in his/her home. With slight modifications to the system, it can be used by corporate companies to monitor their power consumption and help them reduce the power wastage to a greater scale. Live Electric Meter Reading and Billing system is successfully implemented using existing Electronic Energy Meters where GPRS is used as the communication medium to get the values of the meter. The earlier versions had used SMS as the communication medium; however the current implementation uses GPRS which reduces the cost of communication and enables frequent updates of the readings. The proposed system avoids electricity theft to a large extent and also makes the energy meter tamper proof. This system also helps the users to be aware of their energy consumption. The information is transmitted to the EB server using GSM/GPRS modem on GSM network using direct TCP/IP connection with EB server through GPRS. EB server uses PHP scripts to get the values from the energy meter

and stores this information in database. This information is available to authorized users of the system via website over the internet or using mobile application [3].

III. PROPOSED WORK

Circuit Diagram

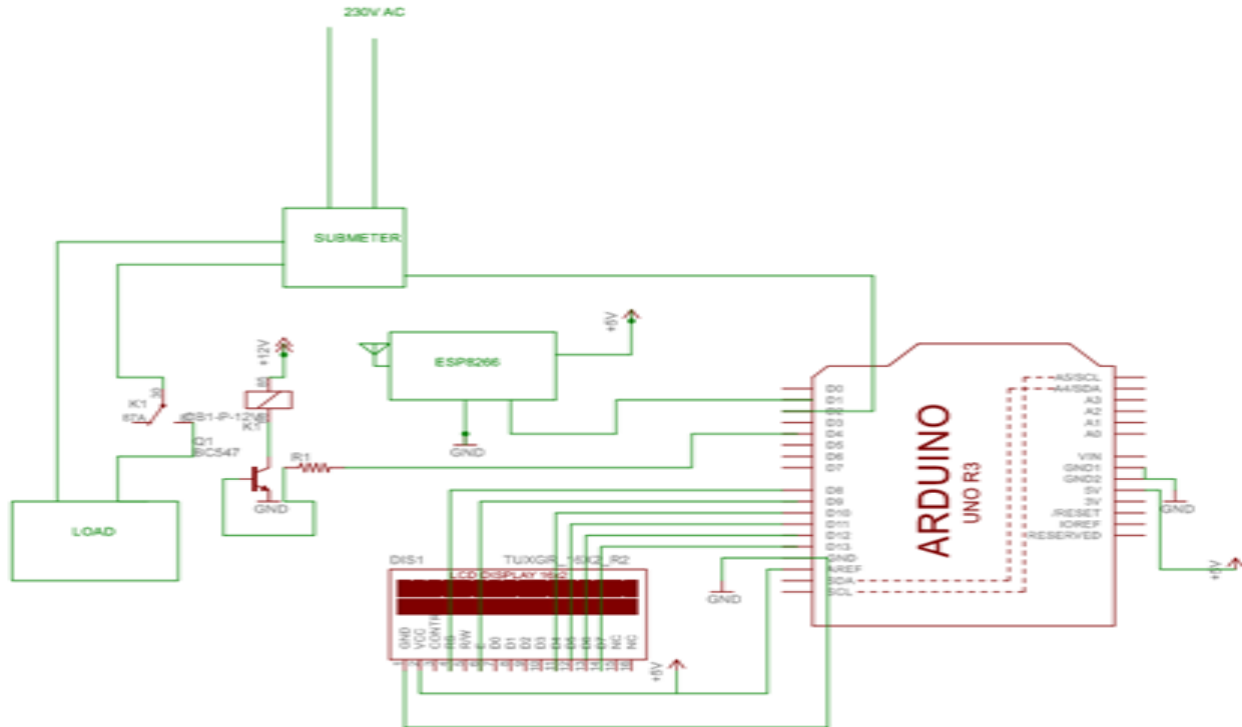


Fig: 1 Circuit Diagram of Remotely Located Energy Meter Monitoring With Load Control and Mobile Billing System through IoT

Circuit Description

The designed energy meter includes simple energy meter, ATmega328 microcontroller, ESP8266 Wi-Fi Module, LCD, 12V relay, server(web page) and load. The operating voltage of Arduino Uno board is 5 volts. Internet of things (IoT) is the main method of communication between the energy meter and the web server. It is also ideally suitable for data transfer over an always on-line connection between a central location and web page or mobile devices. The reading information from the energy meter in real time is uploaded to a central database via IoT. Each user of the system may access this information via the Internet. The main objective is to develop an energy meter that informs the consumer the exact consumption and billing that the load consumes through IoT. The blinking LED as seen on the front panel is directly proportional to the power consumed. More the power drawn faster becomes the LED blinking pulses. One sensor is placed above such blinking LED to derive the real time units consumed whose output goes to an ATmega328 microcontroller. Whenever the LED blinks, it then gives an interrupt signal to the microcontroller of the ATmega328 family and thus the program of the microcontroller counts the pulses and displays the reading on the LCD duly interfaced to the microcontroller for every minute / daily / weekly or monthly as programmed which is sent to the screen of server. For every 30 seconds, the PIC controller tries to send the value received to the central public server through IoT. We are using Wi-Fi which acts as a heart for IoT. Through Wi-Fi the consumer can set changes in threshold value, it can ON and OFF the energy meter.

The Prototype of the system is shown in the Fig. The power supply required for this unit is 5V D.C, 230V A.C is tapped from the single phase supply, stepped down to 12V A.C and then rectified to 5V D.C , regulated and given to the circuit. The supply will be provided for LCD display, micro controller and interfacing unit. When the load connected to the meter is ON then the meter will start counting the watt hour cycles being used, interface is provided between energy meter and microcontroller by means of a step down transformer and C program is embedded into the microcontroller which helps it to calculate the number of units used by the consumer by means of input KWH cycles taken by energy meter and the relay will operate for disconnecting the load. The calculated units are displayed on an LCD which is connected to microcontroller. By this user can manage his usage of power and save the electricity and plan his budget.

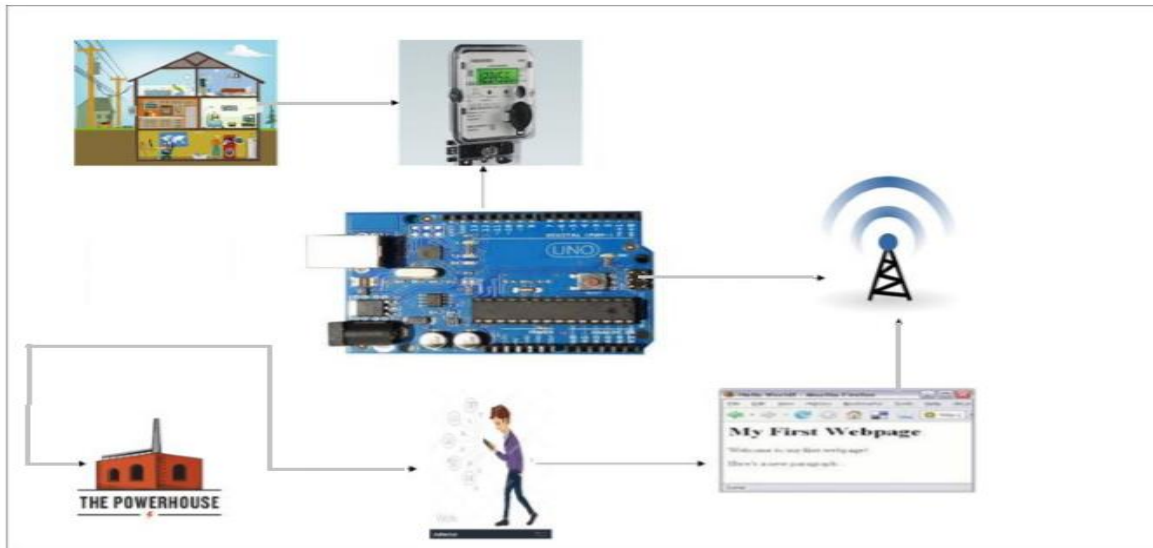


Fig.2: Block Diagram of System

Web Page

This is the web portal through which the daily energy consumption can be monitored; the graphical representation can be seen. The daily limit of energy usage can be set. The server collects all information received from the energy meter units installed in every home and stores it in a central database. It is accessible to end-users through web portal/mobile app. End-users can monitor their energy consumption and view their bills. Monitoring server actively monitors for the data from the energy meter and records the information received in the database. The switching of any load can be done. The web page will have a admin login option so that we can keep our system secure. This page can be access by both server and consumer. Bill generation is done automatically by this server at the end of every month without any manual work involved.

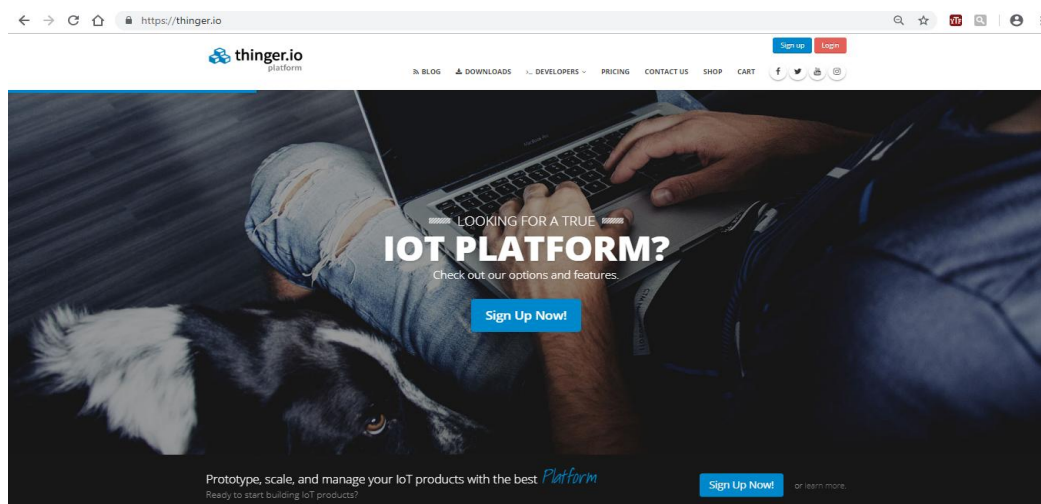


Fig. 3: Thinger's Sign Up Web Page

Thinger's IoT Platform

Thinger.io is an IoT stage that is anything but difficult to utilize and straightforward, with a perfect structure to give magnificent encounters to engineers. Creators can enlist with the expectation of complimentary records to begin constructing their IoT extends in minutes, simply utilizing its cloud foundation. Any source IoT stage gadget can be associated. Arduino, ESP8266, Raspberry Pi, Intel Edison, and so on.- that is not a problem. Thinger.io stage faculties and acts over gadgets continuously. Its innovation limits information data transfer capacity, handling power, code size and builds the server adaptability. Its information pails will effortlessly store any sort of data, and its dashboards can simply show the data put away or got continuously.

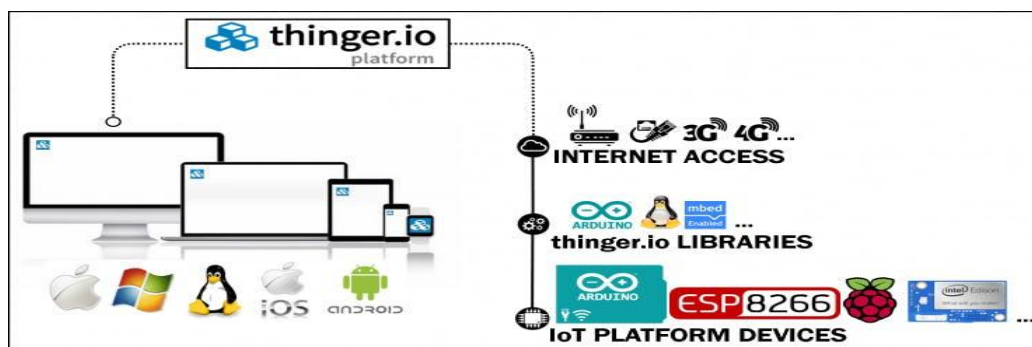


Fig. 4: Thingiverse's IoT platform

Access to the Platform

The simple initial step to work with thingiverse.io is to join in the stage, giving a client name, email address and secret word. You will get a message to affirm the email address and once it's done you can access and begin utilizing it.

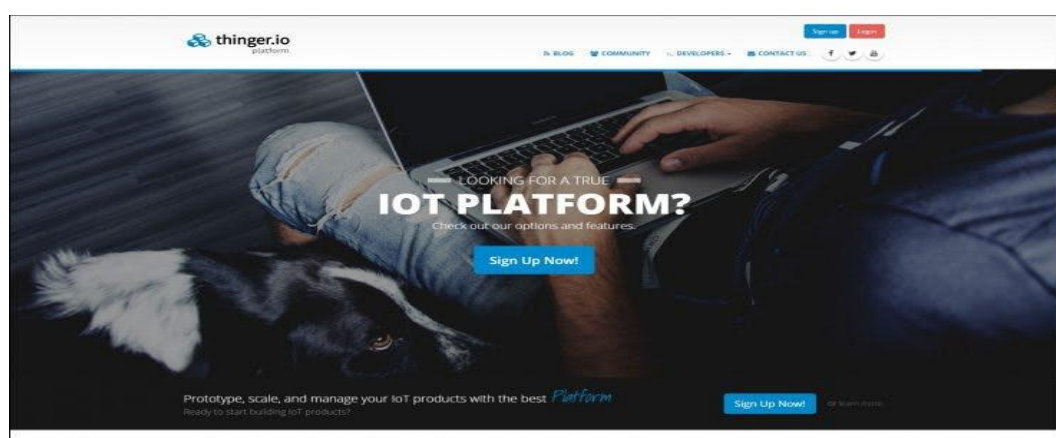


Fig.5: Thingiverse.io_sign up

After you have signed in, you have access to console dashboard, in which graphically, you can see the account starts(with the number of devices, dashboards data buckets and endpoints used), the location of the connected devices and the data transmission made by the devices(data transmitted and received).

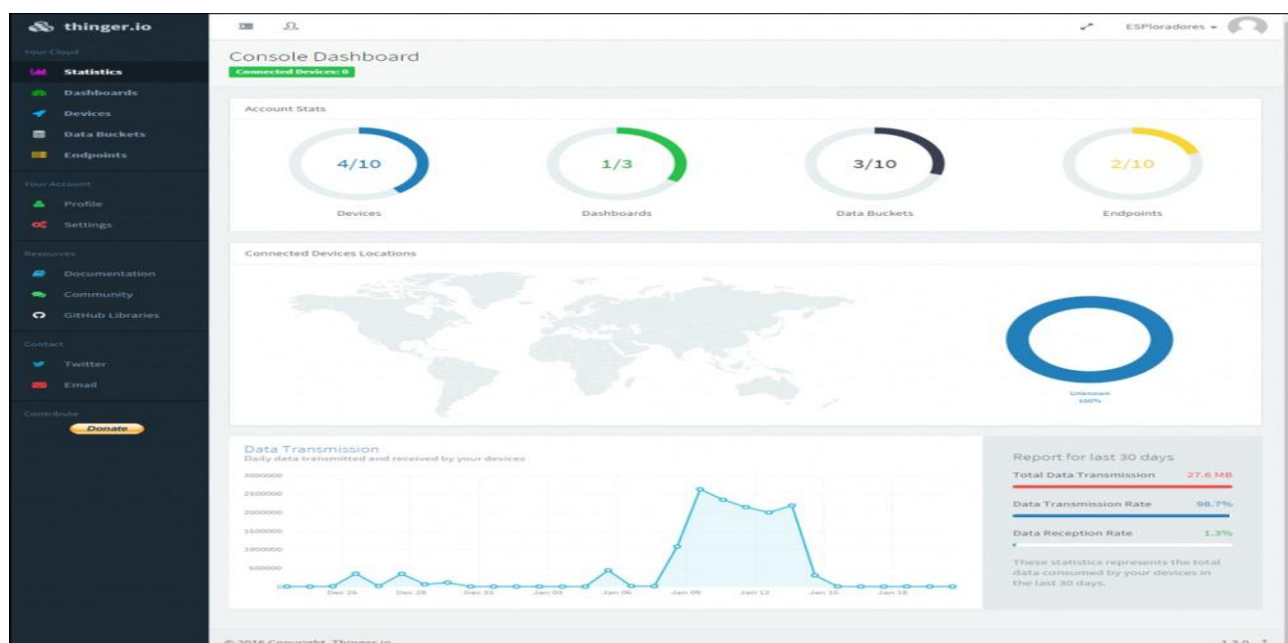


Fig.6: Thingiverse.io_Console

Configuration of a Device

To configure the connection to a device using thinger.io is quite easy. Select Devices > Add Device and fill the three requested fields:

Device Id: this is the name you want to assign to the IoT board you want to control or actuate. Spaces aren't allowed in the Device Id.

Device description: a brief description about the use of the device.

Device credentials: a key to establish and keep the connection between thinger.io and the device secure.

If you're following this project, it's time to fill the three fields:

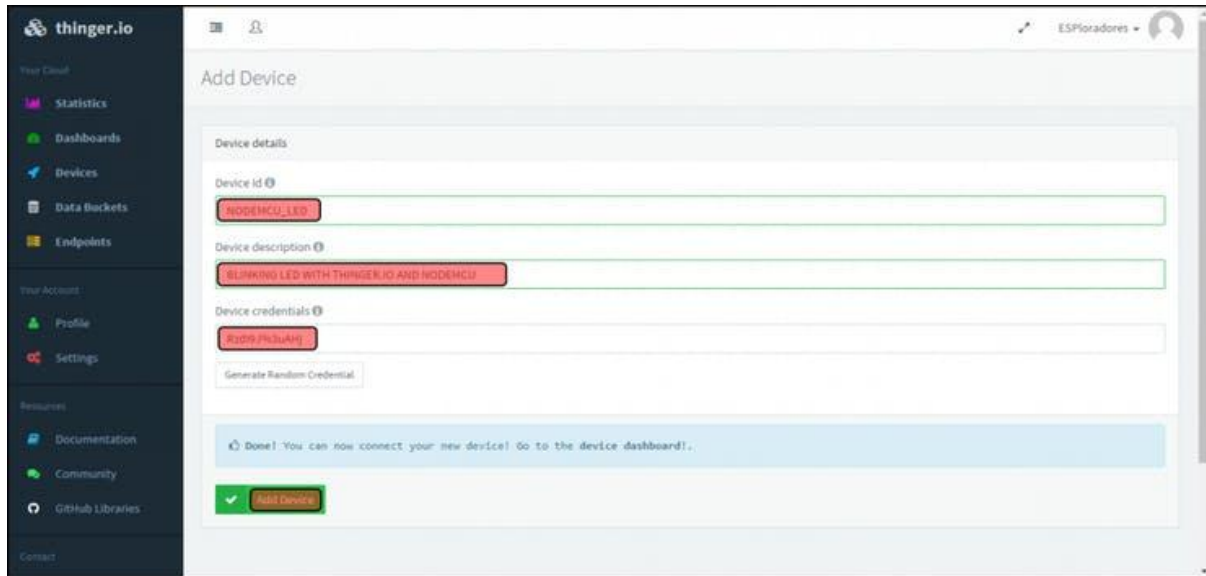


Fig.7: File Name- Blink_1

It's done. If you click **Statistics**, you can go back to the **console dashboard** and you will see that the device is added.

TURNING ON AND OFF THE LED

Turning on and off the LED from Thingy.io

To turn on and off the led from thinger.io, open the platform and click **Devices** and then your device - **NODEMCU_LED**.

Then the device will open.

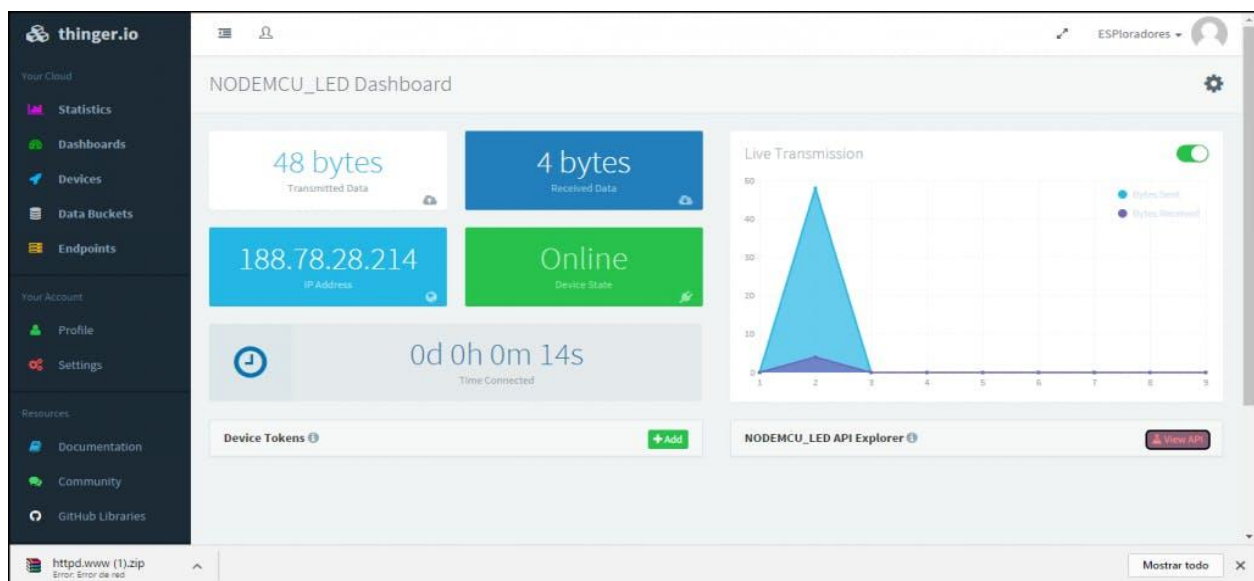


Fig. 8: Turning On and Off the LED

Then click on **View API** and **LED-Private**. Once it's done you can see switch to turn the LED on and off.

Devices

Thingier's.io_platform will show the number of device connected to the dashboard.

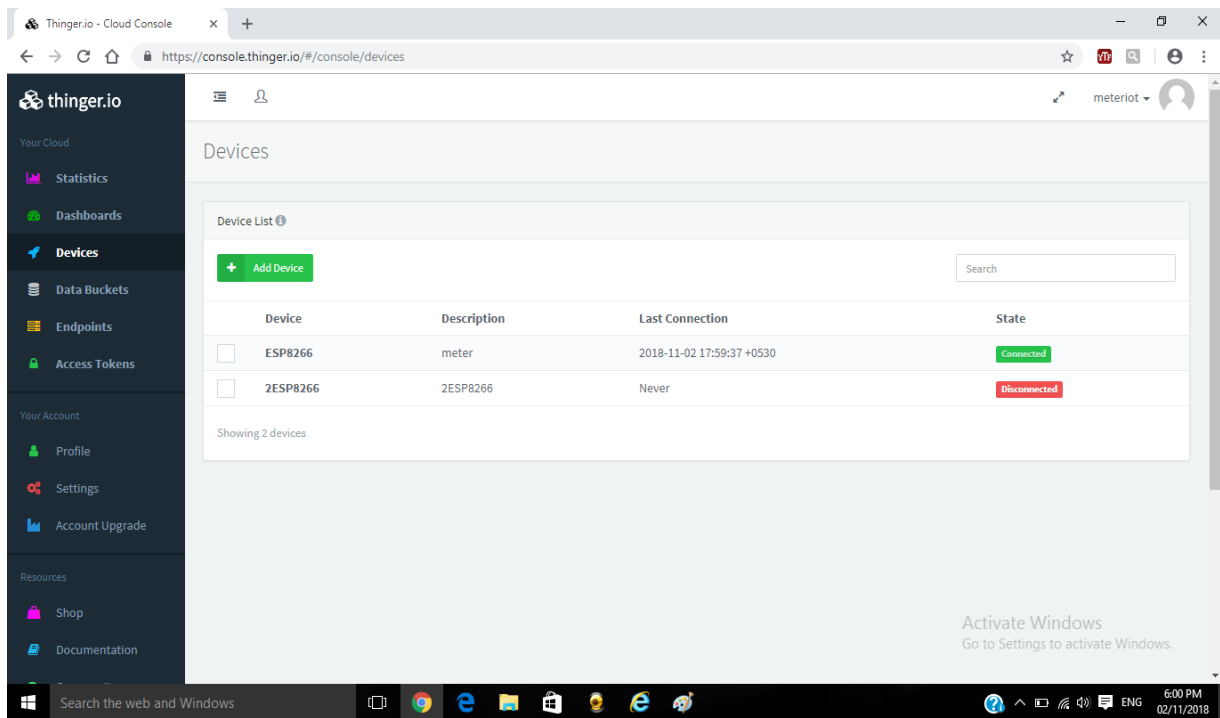


Fig.9: Devices

IV. HARDWARE DESCRIPTION

Energy Meter

A power meter or vitality meter is a gadget that estimates the measure of electric vitality devoured by a habitation, business or an electrically controlled gadget. Power meters are normally adjusted in charging units, the most well-known one being the kilowatt hour(kWh). Occasional readings of power meters set up charging cycles and vitality utilized amid a cycle. The most well-known unit of estimation on the power meter is the kilowatt(kWh) hour, which is equivalent to the measure of vitality utilized by a heap of 1 kilowatt over a time of 60 minutes, or 3,600,000 joules. Some power organizations utilize the SI super joules.

Vitality meter or watt-hour meter is an electrical instrument that estimates the measure of electrical vitality utilized by the shoppers. Utilities is one of the electrical offices, which introduce these instruments at each place like homes, enterprises, associations, business structures to charge for the power utilization by burdens, for example, lights, fans, fridges and other home apparatuses. .Electric meters are regularly aligned in charging units, the most widely recognized one being the kilowatt hour. Vitality meter estimates the quick voltage and flows, compute their item and give momentary power. This power is incorporated over a period interim, which gives the vitality used over that day and age. The structure of this vitality meter is with the end goal that the encompassing things don't influence its working. The development is with the end goal that it is UART good i.e. the perusing recorded through vitality meter is imparted to the controller and showed on the site page.



Fig.10: Energy Meter

Relay

A hand-off is an electrically worked switch. Many transfers utilize an electromagnet to mechanically work a switch, however other working standards are additionally utilized, for example, strong state transfers. The hand-off is utilized to controls the heap. It is situated in mid of load and vitality meter. This hand-off plays out the capacity to chop down of intensity supply if the issued bill isn't paid and reconnecting of intensity supply when the bill is paid. The transfer is likewise used to control the heap remotely. Transfers are utilized where it is important to control a circuit by a different low-control flag, or where a few circuits must be controlled by one flag. The first transfers were utilized in separation broadcast circuits as speakers: they rehashed the flag rolling in from one circuit and re-transmitted it on another circuit. Transfers were utilized broadly in phone trades and early PCs to perform intelligently activities.



Fig.11: Virtual Relay

Microcontroller ATmega328

The ATmega328 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328 achieves throughputs approaching 1MIPS per MHz allowing the system designers to optimize power consumption versus processing speed.



Fig. 12: Microcontroller ATmega328

Features

- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture:
 - 131 Powerful Instructions – Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 20 MIPS Throughput at 20 MHz
 - On-chip 2-cycle Multiplier

Arduino UNO Board

The Arduino Uno is a microcontroller board dependent on the ATmega328. It has 14 computerized input/output pins (of which 6 can be utilized as PWM yields), 6 simple sources of info, a 16 MHz gem oscillator, a USB association, a power jack, an ICSP header, and a reset catch. It contains everything expected to help the microcontroller; essentially associate it to a PC with a USB link or power it with an AC-to-DC connector or battery to begin. The Uno contrasts from every single going before board in that it doesn't utilize the FTDI USB-to-sequential driver chip. Rather, it includes the Atmega8U2 customized as a USB-to-sequential converter.

"Uno" implies one in Italian and is named to check the up and coming arrival of Arduino 1.0. The Uno and variant 1.0 will be the reference renditions of Arduino, pushing ahead. The Uno is the most recent in a progression of USB.

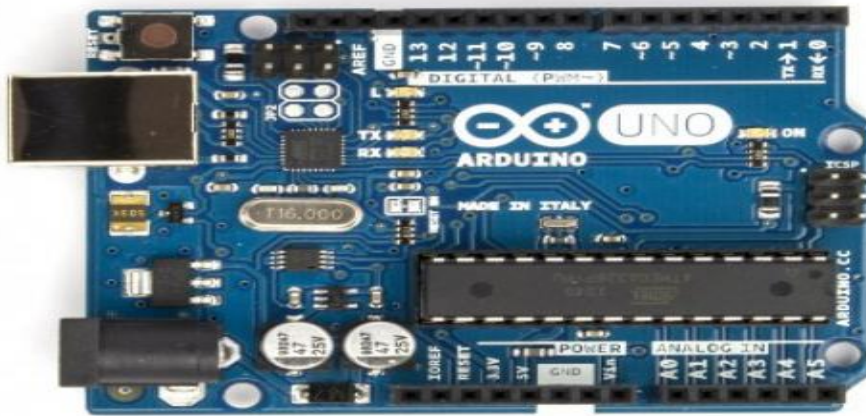


Fig. 13: Arduino Uno Development Board

Wi-Fi Module (ESP8266)

Wi-Fi stands for Wireless Fidelity. We are using Wi-Fi which acts as a heart for IoT. Through Wi-Fi the consumer can set changes in threshold value, it can ON and OFF the energy meter. Time to time the readings of units and cost are displayed on webpage. Consumer can access the Arduino board and meter with help of Wi-Fi. It is a low cost chip with TCP/IP stack and microcontroller. In our project main importance of Wi-Fi is it performs IOT operation. The simple device is connected from microcontroller to send the information.



Fig.14: Wi-Fi Module (ESP8266)

LCD Display

A fluid precious stone showcase (LCD) is a thin, level presentation gadget made up of any number of shading or monochrome pixels exhibited before a light source or reflector. Every pixel comprises of a section of fluid gem particles suspended between two straightforward anodes, and two polarizing channels, the tomahawks of extremity of which are opposite to one another. Without the fluid gems between them, light going through one would be hindered by the other. The fluid gem bends the polarization of light entering one channel to enable it to go through the other.

LCD screen is an electronic presentation module and locate an extensive variety of utilizations. A 16x2 LCD show is exceptionally essential module and is normally utilized in different gadgets and circuits. These modules are favored more than 7 portions and other multi section LEDs. The reasons being: LCDs are practical; effectively programmable; have no confinements of showing unique and even custom characters (not at all like in seven portions), movements, etc. In this undertaking, we utilize a 16x2 LCD implies it can show 16 characters for each line and there are 2 such lines. In this LCD each character is shown in 5x7 pixel network. This LCD has two registers, to be specific, Command and Data. The order enlist stores the direction guidelines given to the LCD. An order is a guidance given to LCD to complete a predefined assignment like instating it, clearing its screen, setting the cursor position, controlling presentation and so on. The information enroll stores the information to be shown on the LCD. The information is the ASCII estimation of the character to be shown on the LCD. Snap to take in more about inner structure of a LCD. Thus, the LCD show is utilized to give an alarm alert which reminds client about the bill. This is for the client adaptability, here we additionally give LCD Display. This helps the client for checking the information when SMS is sent to the vitality Provider Company. This decreases botches done by the laborers amid taking the vitality meter perusing.

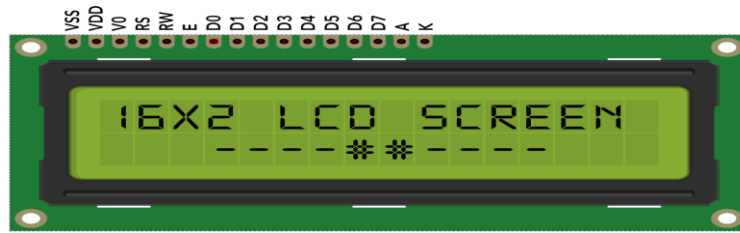


Fig. 15: 16×2 LCD Display
V. RESULT

The Remotely Located Energy Meter Monitoring with Load Control and Mobile Billing System through IoT is presented below:

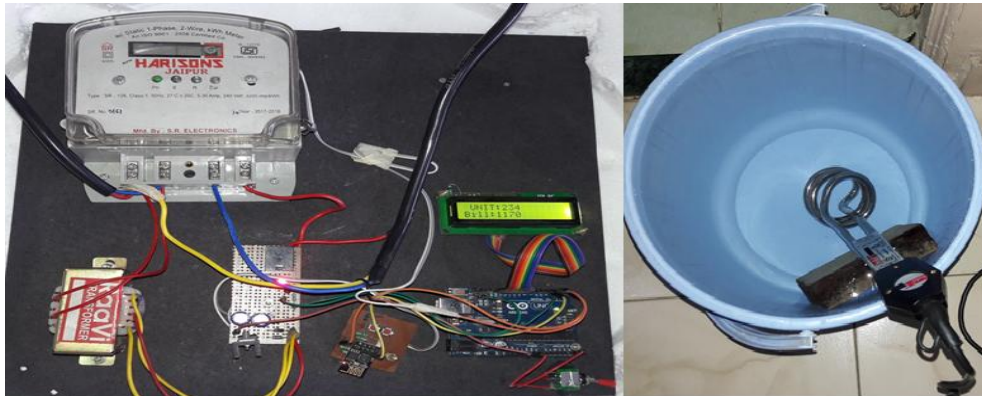


Fig 16: Energy Meter Monitoring Setup

The fig.16 shows the representation of consumers end implementation of IoT based system consists of ATmega328 controller, Arduino Uno, Wi-Fi module ESP8266, etc.



Fig. 17: LCD display of consumed units and bill

The fig. 17 shows LCD display of consumed units and bill for the consumed units. The output is displayed on LCD display in the form of watt along with the cost of consumed energy. By assuming RS.5 per unit power, the bill for a month will be calculated.

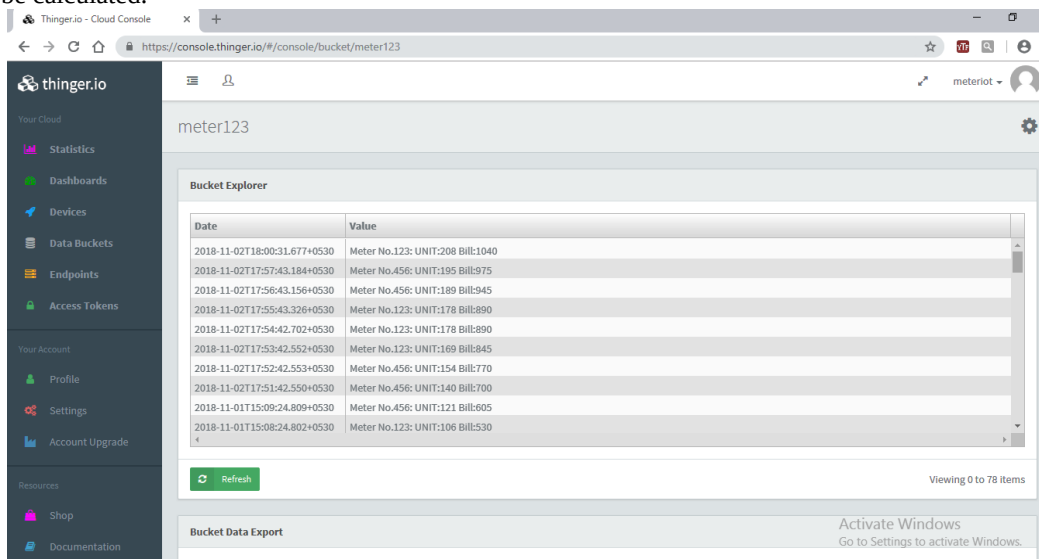


Fig. 18: Display of consumed Units and Bill on Webserver

The fig.18 shows the consumed units and bill on the webserver with time and date. The Wi-Fi module receives data from the consumer energy meter and this received data uploaded to the webserver. It shows time-to-time power utilization of the load connected to the system.

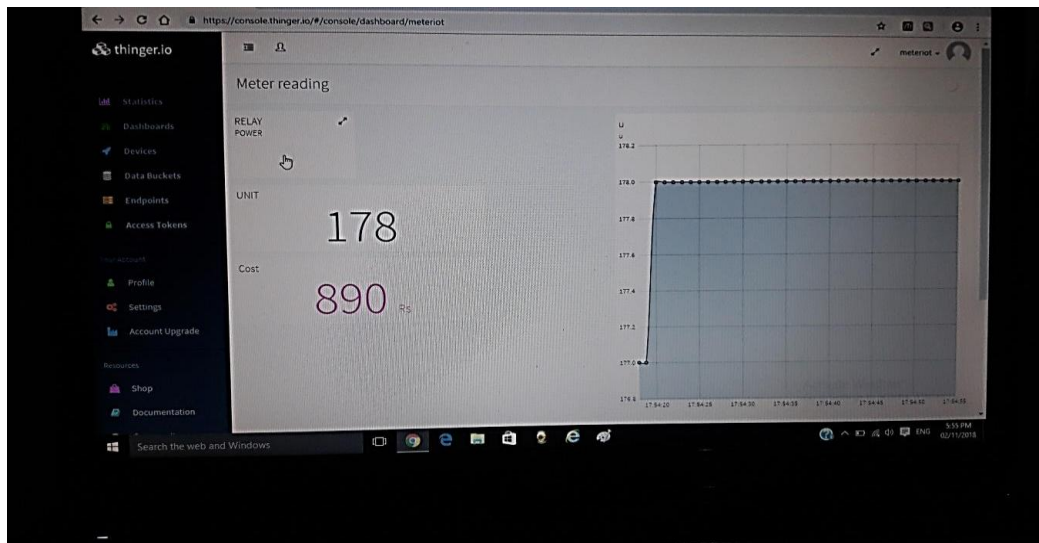


Fig. 19: Graphical Representation of Meter Reading

The power utilized by load and its cost is displayed on Things.io platform graphically as shown in fig.19. There is no need to go at consumer side to disconnect the supply line, using IoT it can be monitored by online only. If the user paid the bill, the supply will be continuously. The meter reading can be accessed from anywhere on the globe 24×7.

VI. CONCLUSION

Computerized innovation is turns out to be increasingly prominent on account of its minimal effort and usability. This innovation permits us a quicker and more advantageous access to the world. For legitimate administration of electrical vitality and in addition to raise the dimension of cognizance among the general population about the use of electrical power correctly, shrewd metering is the best arrangement in this viewpoint. Customary observing of load and advanced charging framework gives the estimation framework greater unwavering quality and precision. The prime prospect of this undertaking is to execute remote mechanized checking and charging framework through web of things. In this time of vitality emergency, conceiving methodologies which helps in adequately controlling vitality utilization and staying away from vitality wastage is imperative. Here vitality utilization is determined by checking alignment beats from vitality meter. In the proposed framework, IoT based meter perusing and exchange the information to a focal server which can be access from anyplace on the globe whenever. The specialist organization can disengage the power supply at whatever point the purchaser does not pay month to month bill. This framework disposes of the human contribution in vitality the executives. Vitality meter checking through the web is simple. It gives the power utilization and also exact perusing, and furthermore it requires less works and less time to screen the vitality meter. This framework likewise encourages the clients to know about their vitality utilization. Power sparing is conceivable which contributes towards the minimization of the issue of vitality emergency.

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