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Energy Consumption Monitoring and Controlling using Data Visualization and IOT

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***Abstract*— In the Energy Management System, the fundamental limitations are exact metering, energy checking, controlling and execution of visual information for shopper load profile. The absence of validity of information procured through customary methods from an ordinary metering framework has decreased the viability of the Energy Management System. A keen IoT based Energy Management System which guarantees straightforwardness and believability of information as well as offers adaptability to the buyers by offering the office of controlling their home machines. This Project is proposed in planning a framework at home which screens the energy utilization of every gadget. Utilizing microcontroller work, consistent readings of energy meter are gathered and saved in NodeMCU, at that point the information is moved to a far-off worker of Blynk application which is an android application utilized for energy observing and controlling. This venture outfits genuine information concerning the heaps ordinarily utilized by private shoppers. Subsequently, the nonstop checking of the electrical apparatuses can be seen through the android application, besides, electricity bill of individual burden can likewise be observed. The client can likewise kill the gadget, which is devouring inordinate force. Hence, saving the energy utilization of the associated loads. Further, this work can be reached out for power utilization of entire structure and power bill can be resolved.**

Keywords—IOT, Energy Management System, Energy Observing and Controlling, NodeMCU.

I. INTRODUCTION

Energy observing means to give clients data about their utilization designs and that is completed utilizing Energy Monitoring application that accumulates utilization information, examine it and afterward gives helpful data straightforwardly to the customer's gadget. This shows clients how much energy they are utilizing and how it is utilized whenever of the day. Energy Controlling plans to give clients to control their electric machines utilizing Energy controlling application which will ultimately assist the client with saving the energy utilization on a day to everyday schedule. In the Energy Management framework, the primary limitations are exact metering, energy checking, controlling and execution of visual information for customer load profile. This Project is expected in planning a framework at home which Monitors and control the energy utilization of every gadget. The investigation can be made for the exact use or energy utilization of every gadget to additionally lessen the use of the gadget which is drawing the greatest measure of energy. These observing reports can be gotten to and would assist customers with making the necessary move to extemporize the energy utilization. The constant energy checking is pictured utilizing a portable application. The application additionally fills in as a brilliant home regulator where the client is equipped for controlling the electrical apparatuses distantly or controlled dependent on occasions set by the client.

II. RELATED WORKS

A study concerning the acquisition and identification of data provided by different loads and consumers has been presented. The identification of consumer load profiles was the main objective. The experimental tests furnish real data concerning the loads commonly used by residential consumers, which is made possible by applying the data analytics over the results obtained for the graphical visualization of each appliance usage. Usage of the smart metering technique allows for the accurate readings and un-tampered data for the proper calculation to monitor the energy consumption of each appliance. Drawing the signatures from the charts, data analytics provide the maximum and minimum usage of each appliance under each home. Thus, helping the consumers to visualize, monitor and act accordingly for further energy usage improvisation [1]. Integration of IoT with energy management
system has been demonstrated to make a more effective and reliable system compared with the conventional energy management system. Instead of collecting data from door to door, the key feature of the proposed system offers a more accessible way of collecting data from a server through internet, which is automatically updated after a short time interval via Wi-Fi [2]. To overcome all the disadvantages in the already existing energy meter. The Arduino esp8266 micro controller is programmed to perform the objectives with the help of GSM module. All the details are sent to the consumer’s mobile through the IoT and the GSM module and it is also displayed in the LCD [3]. Proposed an energy

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monitoring system which gives accurate values of energy consumption and also it calculates the energy consumption for every 1msec period. Therefore, it takes very little time to identify the damaged load and the user can able to control the load [4]. an IoT enabled smart energy meter with real time load control. A mobile application was also developed as a part of this paper to visualise the real time energy usage and generate tariff. The mobile application was also capable of controlling the appliances remotely [5]. Discussed how to monitor the electricity consumption of individual appliances in the household from one place at home without changing the wiring of the home. The knowledge of consumption of electricity at our home is now easy by the discussed proposed system, as now we can know it on our mobile and in a readable and understandable way. This system also enables us to monitor the appliances from a remote area [6]. Built a simple, compact and low-cost implementation of secure WiFi based power monitor sensor is proposed. It has been successfully implemented and tested at the premises of IITH. The accuracy of power measurement is shown to be suitable for reliable use as power monitoring sensor [7]. A smart power monitoring and control system and has developed towards the implementation of an intelligent building. This system monitors and controls the power consumption of home appliances remotely by using wireless network. And also protect the load from High voltages [8]. Proposed an idea for monitoring the consumption of electrical energy by household electrical devices and controlling the unnecessary loss of electrical energy by combining IoT and Blockchain technologies. A smart meter which constantly monitors electricity consumption of devices is designed. An android application which is used by the user to set the limit value is developed. Using the android application, the consumer can also view the total amount of electrical energy currently consumed by the appliances. He is also provided a notification alert when ninety percentage of the specified threshold value is reached. Using this information, he may either extend the threshold value or takes precautions to control the electricity. The two reading from the android application and the smart energy meter is stored in a database using blockchain technology. These values are compared and if the energy consumption exceeds the limit set by the user, the device will be turned off or switched from normal mode to power saving mode. The main disadvantage of the proposed system is the need for Internet to provide communication among the electrical devices [9]. Presented internet connected energy monitoring and controlling system that increases awareness of energy consumption amongst devices and users. Energy awareness enables the user to control the power state of the devices as per there needs which minimizes the energy use [10].

III. PROPOSED SYSTEM

In the Energy Management system, the main constraints are accurate metering, energy monitoring and implementation of visual data for consumer load profile. This can be achieved by using Smart Meters. This Project is intended in designing a system at home which monitors the energy consumption of each device, and displaying the usage in a graphical way. Live energy consumption reading from the Smart energy meter is sent back to the BLYNK application periodically and details are updated. The interface is created for the users to track the consumption of each appliance in the home continuously from anywhere and anytime. This project proposes a secure, ubiquitously, accessible, remotely controlled solution for home automation. Looking at the current scenario we have chosen Android platform so that most of the people can get the benefit. The technology is easy to use and targeted for people without technical background.

IV. MATERIAL USED

1. **ESP8266 WIFI Module**: The ESP8266 is a very user friendly and low-cost device to provide internet connectivity to your projects. The module can work both as a Access point (can create hotspot) and as a station (can connect to Wi-Fi), hence it can easily fetch data and upload it to the internet making Internet of Things as easy as possible. It can also fetch data from internet using API's hence your project could access any information that is available in the internet, thus making it smarter. Another exciting feature of this module is that it can be programmed using the Arduino IDE which makes it a lot more user friendly. However, this version of the module has only 2 GPIO pins (you can hack it to use up to 4) so you have to use it along with another microcontroller like Arduino, else you can look onto the more standalone ESP-12 or ESP-32 versions. So if you are looking for a module to get started with IOT or to provide internet connectivity to your project then this module is the right choice for you.
2. **16-Channel Multiplexer**: The CD74HC4067 High-Speed CMOS 16-Channel Analog/Digital Multiplexer Breakout Module is a breakout board for the very handy 16-Channel Analog/Digital Multiplexer/Demultiplexer. This chip is like a rotary switch – it internally routes the common pin (COM in the schematic, SIG on the board) to one of 16 channel pins (CHANxx). It works with both digital and analog signals (the voltage can't be higher than VCC), and the connections function in either direction. To control it, connect 4 digital outputs to the chip's address select pins (S0-S3), and send it the binary address of the channel you want (see the datasheet for details). This allows you to connect up to 16 sensors to your system using only 5 pins!
3. **4-Channel Relay Module:** The four-channel relay module contains four 5V relays and the associated switching and isolating components, which makes interfacing with a microcontroller or sensor easy with minimum components and connections. There are two terminal blocks with six terminals each, and each block is shared by two relays. The terminals are screw type, which makes connections to mains wiring easy and changeable.
4. **ACS Current Sensor:** The ACS712 Module uses the famous ACS712 IC to measure current using the Hall Effect principle. The module gets its name from the IC (ACS712) used in the module, so for you final products use the IC directly instead of the module.
5. **ZMPT101B Voltage Sensor:** Voltage Detection Sensor Module is a simple and very useful module that uses a potential divider to reduce any input voltage by a

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factor of 5. This allows us to use the Analog input pin of a microcontroller to monitor voltages higher than it capable of sensing. For example, with a 0V - 5V Analog input range, you are able to measure a voltage up to 25V. This module also includes convenient screw terminals for easy and secure connections of a wire.

6. **Arduino Nano:** Arduino Nano 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.

7. **Potentiometer:** Potentiometers also known as POT, are nothing but variable resistors. They can provide a variable resistance by simply varying the knob on top of its head. It can be classified based on two main parameters. One is their Resistance (R-ohms) itself and the other is its Power (P-Watts) rating. The value or resistance decides how much opposition it provides to the flow of current. The greater the resistor value the smaller the current will flow. Some standard values for a potentiometer are 500Ω, 1K, 2K, 5K, 10K, 22K, 47K, 50K, 100K, 220K, 470K, 500K, 1 M.

V. IMPLEMENTATION

A. Hardware Implementation: The Figure 1.1 shows the complete connections involved in our project. ESP 8266 is the Brain of our project as it handles both the controlling and monitoring part of the system. The 16-channel relay Module is connected to the Node MCU which is used to trigger the connected load i.e. To switch ON and OFF the connected load. The Acs-Current Sensor Module and the Zmpt101B Voltage sensor are also connected to the Node MCU to measure the current and voltage consumed by the load. These readings of current and voltage are stored on the Esp-8266 and then transferred to the Blynk Application servers which then displayed in the application through the visualizations widgets available inside the Blynk application. As Esp-8266 has only one analog pin because of which only one sensor can be connected. To overcome this problem a 16-channel multiplexer is connected to the Node MCU and the current and voltage sensors are then connected to the multiplexer. Arduino is also connected to the Node Mcu and the multiplexer, therefore, the values of current and voltage are also stored in Arduino and with help of these values individual bill of the connected load is calculated and displayed on the 16x2 LCD screen. Arduino is mainly added for the safety measures. If only Node Mcu is used and if the system is working 24/7 then the load on Node Mcu will increase which will eventually damage the Node Mcu. Thus, by using Arduino and Node Mcu the workload is divided and it ensures the safety even if the device works 24/7.

B. Software Implentation:

i. **Arduino IDE:** The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. The Arduino development environment contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Software written using Arduino are called sketches. These sketches are written in the text editor. Sketches are saved with the file extension .ino. It has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino environment including complete error messages and other information. The bottom right-hand corner of the window displays the current board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

ii. **Blynk Application:** Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the Internet of Your Things. Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

• Blynk App - Allows to you create amazing interfaces for your projects using various widgets we provide.

• Blynk Server - Responsible for all the communications between the smart phone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

• Blynk Libraries - For all the popular hardware platforms - enable communication with the server and process all the incoming and out coming commands.

iii. **IFTTT:** IFTTT stands for If This Then That. It is a free web-based service for creating chains of simple conditional statements, called as applets. These applets are triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, Google Assistant or Pinterest. For instance, an applet is capable of sending an e-mail message if the user tweets using a hashtag, or copy a photo on Facebook to a user's archive if someone tags a user in a photo. In addition to the web-based application, the service runs on IOS and Android.

iv. **Google Assistant:** Google Assistant is an artificial intelligence powered virtual assistant developed by Google which is basically available on mobile and smart home

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devices. Google Assistant can engage in two-way conversations living behind company's foregoing virtual assistant. Moreover, it is available in different languages providing comfort to customer.

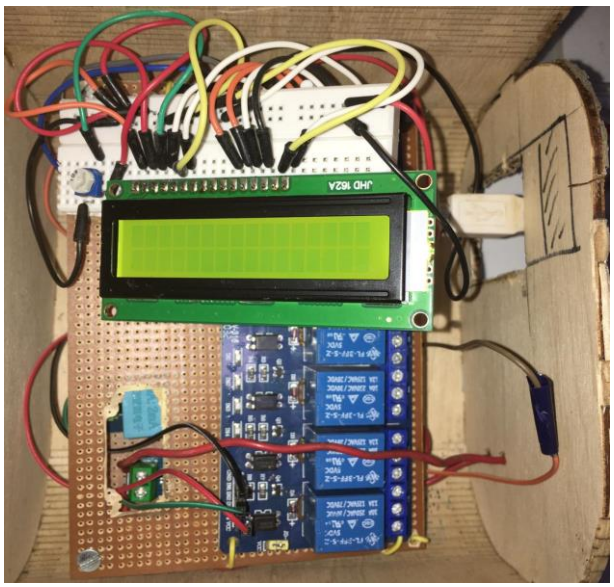

Fig 1.3: Main hardware circuit.

Fig 1.4: Power Reading on the Lcd Display.

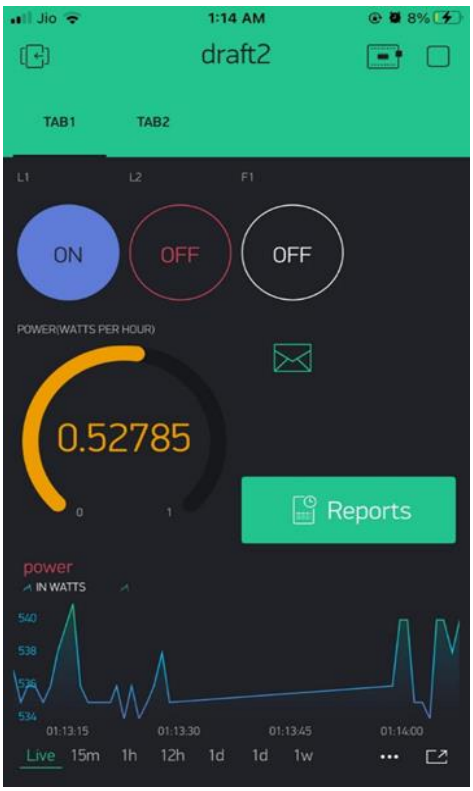

Figure 1.2: Screenshot of the Blynk application showing the graph of the power consumed and the On & Off Buttons to Control the connected load.

Fig 1.5: Average Price/hr reading on the Lcd Display.

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Figure 1.3: Serial Output of Arduino IDE

VI. CONCLUSION

An attempt has been made to make a practical model of **"Energy Consumption Monitoring And Controlling Using Data Visualization and IOT"**. The propagated model is used to calculate the energy consumption of the household, and even make the energy reading to be handy. Hence it reduces the wastage of energy and bring awareness among all. Even it will deduct the manual intervention. This project proposes a secure, ubiquitously accessible controlled solution for home automation. Looking at the current scenario we have chosen Android platform so that most of the people can get the benefit.

VII. FUTURE SCOPE

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. The performance of the proposed design can be improvised in future with some modifications in design considerations and AI can be used so as to make a single sensor capable of measuring, alerting and notifying the user all together.

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IX. REFERENCES

[1] Suvidha Biradar1, Prof. Rahul Hiware2, IOT Based Data Analytics and Web Monitoring of Energy Load Profiling for the Households, Vol. 5, Issue 5, May 2017.

[2] Md. Rakibul Hasan, Eklas Hossain, Hossain Mansur Resalat Faruque, Tipu Sultan, IoT Based Smart Energy Management in Residential Applications, 1st International Conference on Advances in Science, Engineering and Robotics Technology 2019 (ICASERT 2019).

[3] Prathik.M, Anitha.K, Anitha.V, Smart Energy Meter Surveillance Using IoT, International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), 2018 IEEE.

[4] Bandi Narasimha Rao, Reddy Sudheer, Energy Monitoring using IOT, Proceedings of the Fifth International Conference on Inventive Computation Technologies (ICICT-2020) IEEE Xplore Part Number:CFP20F70-ART; ISBN:978-1-7281-4685-0.

[5] Sai Shibu N B, Aravind Hanumanthiah, Sai Rohith S, Yaswanth CH, Hemanth Krishna P, J VS Pavan, Development of IoT Enabled Smart Energy Meter with Remote Load Management, 2018 IEEE International Conference on Computational Intelligence and Computing Research.

[6] Anket Narkar1, Karan Kunnumal2, Sagar Kanteliya3, Suvarna More4, Vikrant More5, Power Consumption Monitoring and Home Automation using iot, International Conference on Innovative and Advanced Technologies in Engineering (March-2018).

[7] Jalpa Patel1, K. Avinash Reddy2, M. Kirti3, Dr. D. B. K. Kamesh4, Dr. J. Sasi Bhanu5, MEASURING ELECTRICITY CONSUMPTION OF APPLIANCES AND MONITORING THEM USING IoT AND MACHINE LEARNING, International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 04 | Apr42018.

[8] Akshay Ramesh Jadhav, P. Rajalakshmi, IoT Enabled Smart and Secure Power Monitor, Department of Electrical Engineering, Indian Institute of Technology Hyderabad, India Email: ee16resch01002, raji@iith.ac.in , 2017 IEEE.

[9] 1Dr.P V Rama Raju, 2G. Naga Raju, 3G V P S Manikantah, 4Abdul Vahed, 5A L Bhavyaw, 6Ganesh Reddy, IOT Based Power Monitoring System and Control, Journal of Emerging Technologies and Innovative Research (JETIR), November 2017, Volume 4, Issue 11.

[10] V.Subbulakshmi, D.Aiswarya, A.R.Arulselvi, Monitoring and Controlling Energy Consumption Using IOT and Blockchain, Special Issue Published in Int. Jnl. Of Advanced Networking & Applications (IJANA).