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An Iot-Based Method for Managing Power Grids in Smart Way

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Abstract: System designers find it difficult to reduce power consumption. High power consumption leads to higher temperatures, affecting performance and reliability. Increasing energy prices and concerns regarding the impact of electronic systems on the environment highlight the importance of low power consumption. Smart grids are emerging as a new side of the power industry. They incorporate advanced technologies and solve many problems, but continue to face readiness challenges. A new technology called the Internet of Things (IoT) is making it possible to monitor and manage electricity consumption, wherever a variety of different technologies are utilized, including IoT cloud platforms. In this research, smart grid and IoT technologies are used to build a power management system. It is also discussed how the system functions and is automated. Through the design of a system that detects voltage, current, and weather conditions and gathers data to warn consumers in advance of power usage problems, A system is proposed to monitor power consumption by consumers and control power usage by electrical devices. According to the data, it is possible to enhance the system in the future according to the region in which it is located, and reduce loads by preparing the system accordingly.

1. Introduction

A new segment of the power industry is emerging as smart grids (SGs), which incorporate a number of advanced technologies. Smart grids are capable of resolving many of the problems associated with standard electrical networks. However, SG is still facing challenges in preparing for these changes. (Matusiak and Zieliński 2014). The Internet of Things (IoT) connects many smart objects to one another and they are communicating with each other, contributing to close the gap between the physical and cyber worlds. Depending on the needs of the user, data is gathered from smart objects, which are then analyzed and delivered to the user. (Luechaphonthara and Vijayalakshmi 2019). Wi-Fi-enabled, inexpensive devices of electricity monitoring are needed to reach the green networked standard for energy efficiency and reduce carbon emissions. This study suggests measuring electricity consumption on home appliances and assessing it on a weekly and daily basis in order to reach this standard. (Ray 2016). In this system design, the main characteristics of a smart grid are used in the construction of a system consisting of a group of sensors that monitor and automatically control the consumption of electrical energy. Other technologies, such as the use of IoT cloud platforms, are also used to collect, process, and display data. (Hasan et al. 2021).We can design a system based on a number of open-source microcontroller types such as AVR and others. PZEM 004t sensors determine electrical energy elements such as current, voltage, and hertz. This will enable us to carry out the physical aspect of the project.

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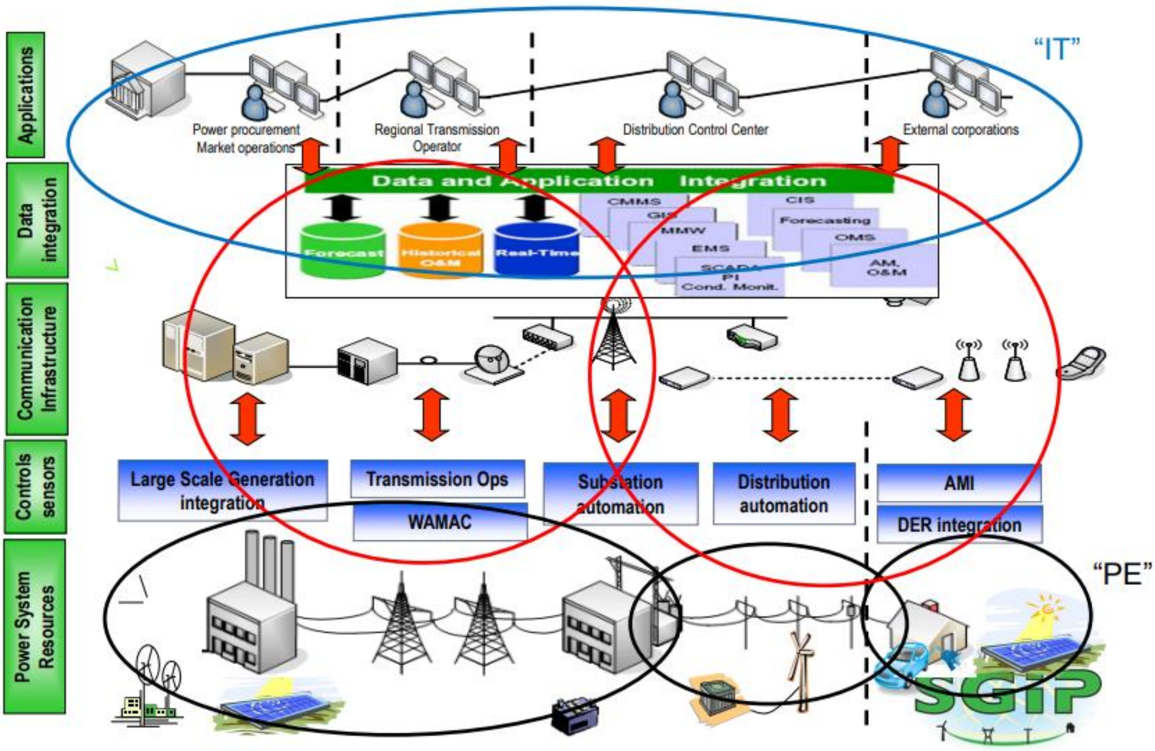

Figure 1: smart grid architecture.

The development of human civilization in the 20th century was heavily influenced by the advent of electronic interchange and electrical power. Alexander Graham Ringer and Edison laid the foundations for modern communication and power (Bruno et al. 2009). Thomas Edison would likely still be acquainted with all the key elements of the ability grid by the middle of the twentieth century, since the ability grid describes the quantity and locations where contemporary advances are currently truant (Maharjan et al. 2016). Electrical system design in such a manner implies economy, clarity of thought, and efficiency. Restructuring the power industry is imperative to address the issues associated with a digital society. By sourcing energy from a few nuclear generating nodes and distributing it to a wide range of customers. (Li et al. 2015) The sensible grid is a significant improvement over the power grid of the 20th century. The facility will instead be managed much more efficiently to respond to complex situations and will charge a premium to those who use it during peak hours. It has never occurred that Smart Grid has gained traction in any part of the world. (Hu, Li, and Chen 2015). SG systems are highly autonomous and increase the unit and efficiency of energy delivery. Edge companies can use existing infrastructure and reduce the need for new power plants and substations. This report aims to provide an overview of the smart grid system and its available intelligent technologies in support of renewable energy supply assets. (Dai, Liu, and Zhang 2020).

There are no automated power measurement systems in the State Company for Iraqi Power factories. The reports of power consumption extracted and distributed to distentions do not match each other. This leads to inaccurate financial reports with power consumption distribution. It also leads to accidents, which can be signed by the heads of work.

2. Related Work

The proposed solution has difficulty synchronizing the compound group of the Virtual Power Storage Space Scheme (VPSSS) throughout the brief notification to switch in order with neighboring aggregators. The crucial dynamic energy limit could be shared among the participating aggregators in a distributed management approach. (Meng et al. 2019).BluHEMS is an artificial neural network to maintain Home Energy Management (HEM) setups based on Bluetooth low energy devices. A full simulative assessment of the HEM solution is provided through the use of Network Simulator Version-2 (NS-2) in networks of demand profit, energy utilization, and consumer delays. (Collotta and Pau 2017).Optimal Power Flow and Unit Commitment models have published their perceptions of microgrid central energy management systems. ANN-based Housing Convenient Demand Profile Estimator (HCDPE) is a precise EHMS that can be urbanized using deliberate data as well as imitation data. (Chen et al. 2017).Energy usage in homes is monitored via smart gadgets that communicate with household appliances directly and both sides of the energy chain. Users can also use them to manage their home's electricity usage. (Al-Badi et al. 2020). It is anticipated to have fewer line losses, improved stability, less load variation, and cheaper operational costs, which will all help it better meet the demand for electricity. Enhancing energy efficiency in buildings is crucial for primary energy savings as well as corresponding decrease in carbon footprints. (Kumar, Zeadally, and Misra 2016).

This has spurred the creation of "smart" homes, where practically all equipment are locally maintained and regulated in real time (Fatima, Qasuria, and Ibrahim 2020). Numerous research examine the impact of informing clients about their electricity usage while utilizing cutting-edge technology (Zafar, Bayhan, and Sanfilippo 2020). It was shown that providing customers with real-time information on the consumption of the electricity had significantly changed their behavior, resulting in energy savings of as high as 30% .

Table1. Descriptions and examples of the HEMS types.

Category	Technology	Description	Examples
Control devices	Centralized	It allows communicating with multiple appliances in the home environment. The users can manage them from a single location and often using multiple inputs	• Home automation (HA) systems; • Whole-home lighting control systems; • Security systems
	Device/Appliance-Level	User controls a single device or function and standalone control	• Lighting control with motion sensors, dimmers, remotes, scheduling; • Thermostats; • Smart plugs; • Smart power strips
	On-Board (automated on appliance level)	Control functionality integrated in the device	• Smart appliances, e.g., that respond to grid; • Office equipment power management; • Smart light bulb
Graphical User Interfaces	Home Energy Display	Stand-alone in home display; often portable	• Many HEDs on the market have compatible web dashboards or are able to connect to third party freeware; • Utilities implementing smart meters often provide their customers with web dashboards
	Web Dashboard/Portal	Online interface accessible from any Internet-enabled device	
	Smartphone Application	Device-specific interfaces for iPhones, Android phones, and others	• Current products typically pull information from a home energy display and generates processed data;
Graphical User Interfaces	Others (e.g., TV)		• Multimedia approaches include combinations of display/web/phone feedback
Enabling Technologies	Sensing	Acquisition of dynamic variables within the home environment	• Smart meters; • Temperature sensors; • Occupancy sensors
	Communications	Physical devices necessary to support the network	• Gateways; • Range extenders; • Home area networks
	Communication Protocols	Standards that allow individual nodes within a network to communicate	• Insteon; • Z-wave; • ZigBee; • Others

3. Internet of Things

IoT can be defined as a technological revolution representing the future of communications and computing. The Internet represents a global network of linked networks which uses the TCP/IP, or standard internet protocol suite, in order to connect billions of users worldwide. IoT will tag every object so as to automate, monitor, identify, and control it. (Reddy, Mamatha, and Reddy 2018).

	Home/Office	City	Transportation	Agriculture	Retail
Number of Users	Very Few	Many	Many	Few	Few
Communication	RFID and WSN	RFID and WSN	WSN	WSN	RFID and WSN
Network	Small	Medium	Large	Medium	Small
Internet	Wi-Fi, 3G, 4G	Wi-Fi, 3G, 4G	Wi-Fi, Satellite	Wi-Fi, Satellite	Wi-Fi, 3G, 4G
Bandwidth	Small	Large	Medium	Medium	Small
Test Beds	Smart Home	Smart Cities	Few	PSCM System	Retail centers

Table 2 IoT Application Domains

Several advantages and services are provided by IoT to users. It is therefore necessary to include certain elements in order to utilize them effectively. In this section, we examine the elements required to provide IoT capability (Yaqoob et al. 2019). The specifics and names of these elements are:

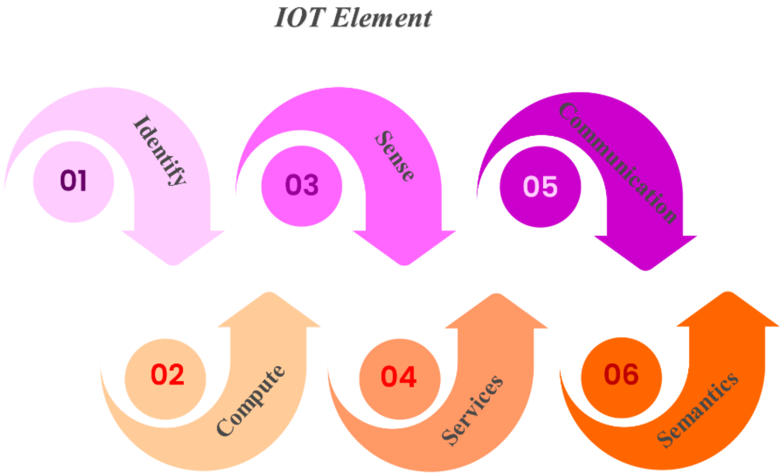

Figure 2: The elements of the IoT.

4. Methods

This is describes the materials used throughout the project, a microcontroller, and a set of sensors. Hardware design, circuit planning and image design were created at intervals. Software code development was occurring at intervals, and the entire, complete image was operated by programming codes.

4.1 Hardware

4.1.1 ESP32 microcontroller

ESP32 is a Soc chip from Espressif, developers of the Esp8266 chip. It contains the Xtensa LX6 -32bit microprocessor and is integrated with wi-fi and Bluetooth. This makes it suitable for projects that run on low power, such as wearable devices, audio equipment, smartwatches, etc. (Grier 2020).

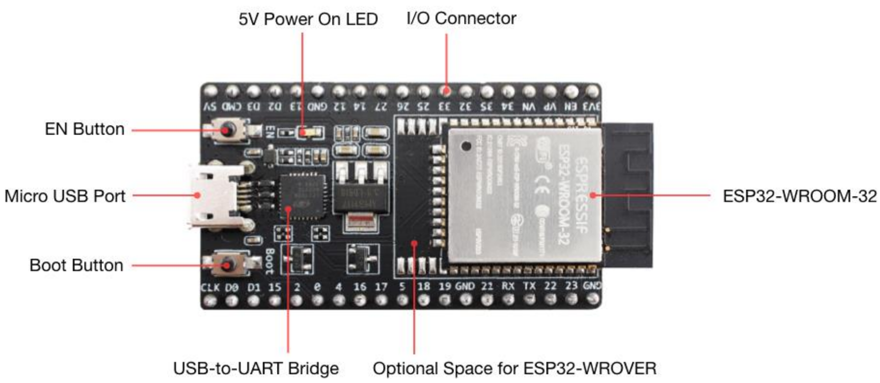

Figure 3: ESP32 microcontroller overview

4.1.2 DHT11 temperature and Humidity sensor

The DHT11 sensor is one of the most digital sensors used to measure and determine the level of temperature and humidity. It generates a digital signal and is compatible with various embedded systems. A high-performance 8-bit micro-controller connected to a resistive element and a wet NTC temperature measurement device are also included. (Sevier and Tekeoglu 2019).

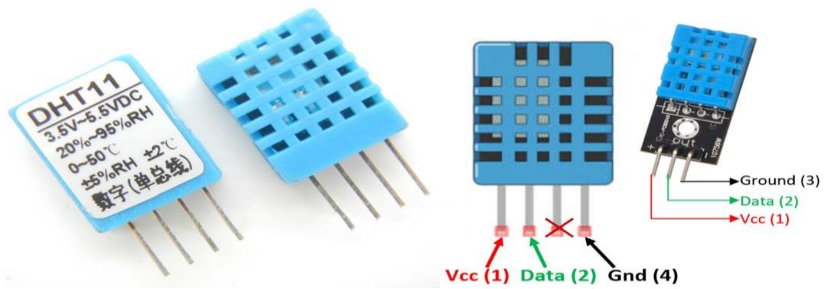

Figure 4: DHT11 Overview and his Pin out

4.1.3 LCD 16x2 screen display

Liquid display is also known as a liquid crystal (LCD, display, digital display) or alphanumeric display. It is a single, impressive electronic display module used in a wide range of circuits and technology. Most commonly, LEDs with numerous segments and seven segments are used in such displays. (Danbatta and Varol 2019).

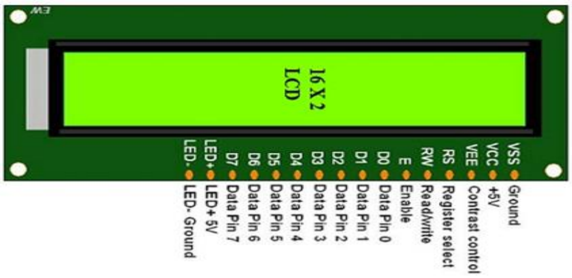

Figure 5: LCD 16x2 Overview

4.1.4 I2C to 16x2 LCD converter

In order to use LCD digital displays (alphanumeric displays), we typically need at least six free spins. PCF-8574A I2C I/O expander allows us to use only 2 pins from the microcontroller. The PCF8574 is connected to all the alphanumeric display data pins, while P0, P1, P2, P4, P5, P7 are each connected to the D4, D5, and D7. (Eridani, Rochim, and Cesara 2021).

Figure 6: I2C to 16x2 LCD converter

4.1.5 SD card data logger

The data logger can be defined as an electrical device for recording information or data over a period of time. Such devices occasionally include two central units: the storage/communication unit and the sensor unit. The latter may use an embedded device among the devices or an associated link external instrument. (Tagle et al. 2018).

Figure 7: SD card overview

4.2 Software

4.2.1 Arduino IDE

Code can be uploaded from a PC to a microcontroller by connecting the microcontroller to the PC, and then uploading the code quickly. Arduino and Esp32 work in the same environment using the Arduino IDE, which is available for various operating systems, Windows, Linux, Mac.

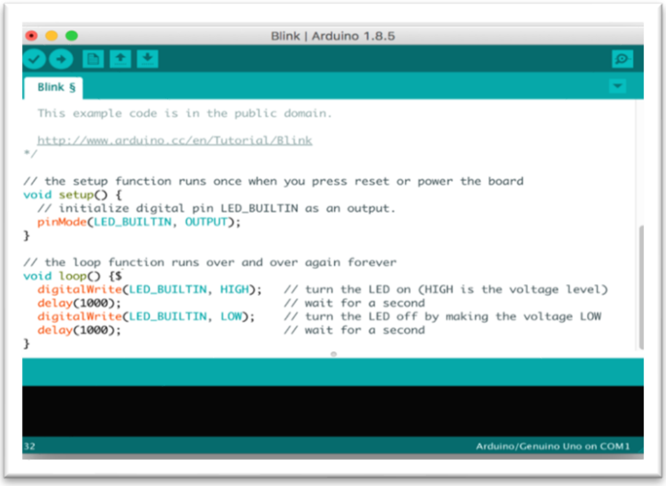

Figure 8: The Arduino Software (IDE)

4.2.2 Blynk mobile application

• It is one of the IoT cloud platforms that has many features that make it highly suitable for IoT projects, as this platform is lettering for Android and IOS a mobile application.

The platform consists of three main parts:

1- The Blynk application: provides the ability to link new projects, and several forms have appeared on them, including movements, various devices, and display

2- Server: Responsible for all communication the hardware and the smartphone. as well as the open-source server that connects many devices to it

3- Blynk library: which is a special library for the possibility of connecting physical devices with the server and processing the sent and received instructions.

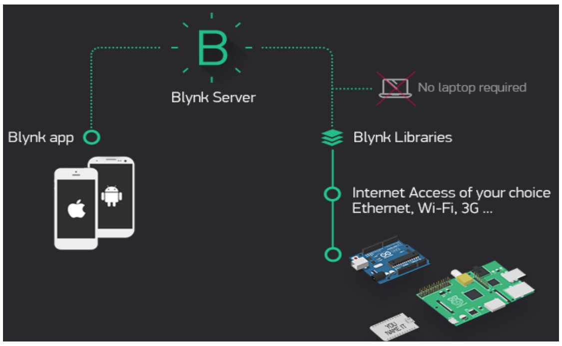

Figure 9: Blynk application overview

5. Result & Discussion

5.1 System Schematic:

The following diagram shows the elements of the system and its connection with the ESP32 microcontroller, as shown in the following diagram. The ESP32 microcontroller was connected to an SD card using the SPI protocol. PZEM power sensor TX connected to port No. 16 and RX to port no. 17, and Buzzer and Relay connected to ports No. 4 and 15.

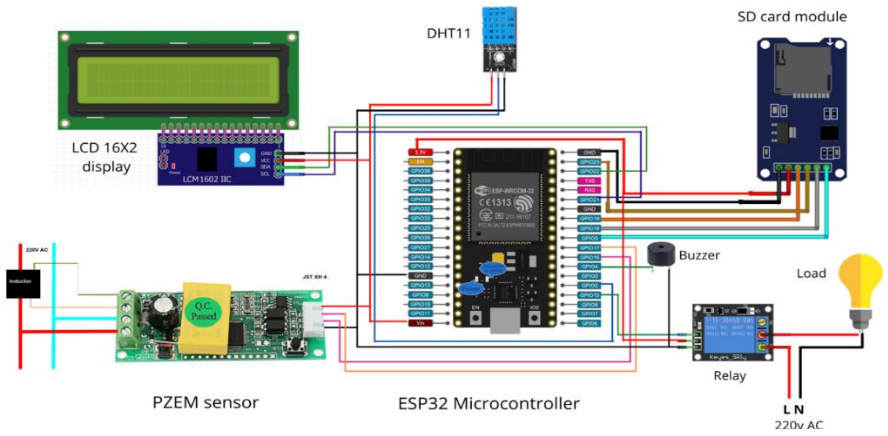

Figure 10: System Schematic

5.2 Validate the new proposed system

In this part, connect the sensors and all the components of the circuit, and then check this system by testing the sensors, as well as reading the temperature and humidity from the sensors and displaying it on the screen, testing all components of the system in general and monitoring the transmission of data to blynk app and stored on SD card and displayed on the LCD screen. In the first step, install the project sensors and the LCD screen in the box. In the second step, install the Microcontroller ESP32 on the board and install it inside the box appropriately connecting it with sensors and the rest of the electronic parts of the circuit. Finally in the third step, connect all the sensors and circuit components with the ESP32 and connect the SD card so that the circuit is ready for programming and uploading its code and linking it with the server of the Blynk application. Figure 11: shows the components installed.

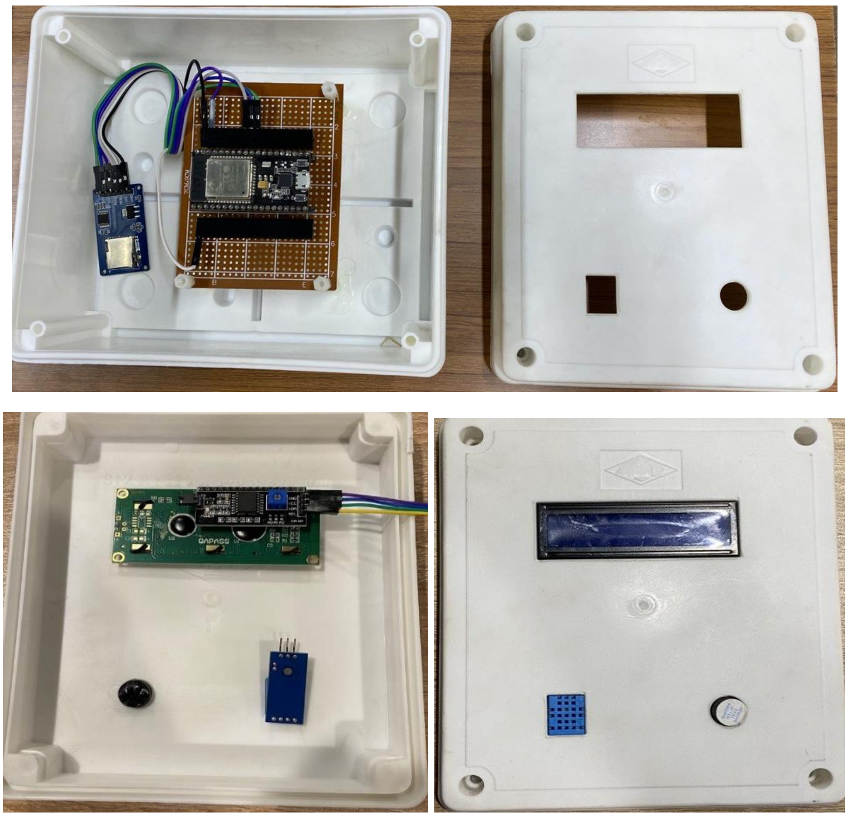

Figure 11: components of the system installed

After connecting all the sensors and electronic parts of the system, uploading its code, and linking it to the blynk application server, we got correct and good results. They were displayed on the blynk application in real time and stored the data inside the SD card. The system works correctly on a voltage of 5V and is also easy to use. Figure 12show all the system installed.

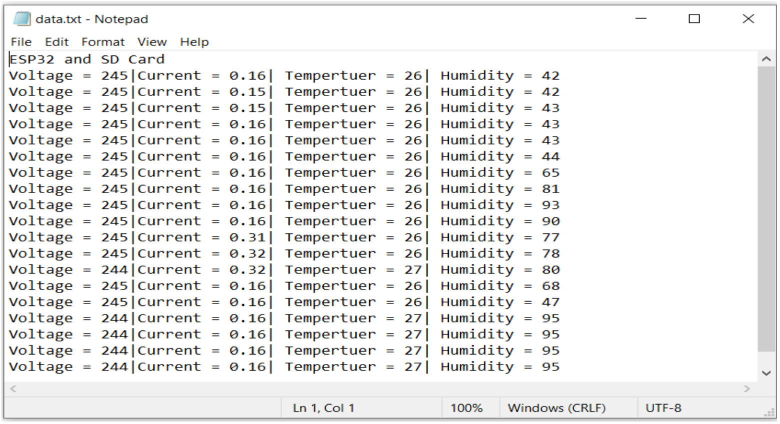

Figure 12: Sensors data on the SD card.

Preparing the blynk dashboard and setting the variables for each sensor, where it is given the name (V) and represents a variable and is linked through the code before it and is prepared to have the application on the mobile phone and also a website on the Internet also to monitor the system. Figure 15: show Blynk application dashboard setup.

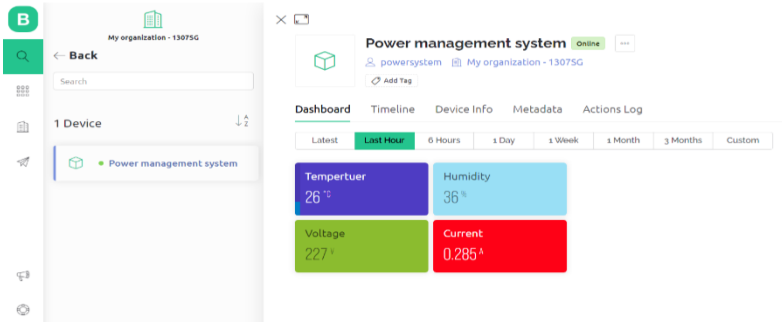

Figure 13: Blynk application website dashboard setup.

6. Discussion

In the previous two sections, the most critical sensing and detection technologies that support the Internet of Things are described. The traditional Smart power management and control methods were clarified. Therefore, the systems currently available for monitoring the power follow the old methods of follow-up, and this thing is due to pay attention to the old method of follow-up and work in these ways may cause many problems, including information and occur, such as a weather condition as well as their financial reports, and this is what this research focuses on. The results of the data we obtained through our proposed system indicate results that are characterized by providing power leak and consumption monitoring and remote monitoring of its temperature, Humidity which is not found in conventional manufactures. Moreover, sending alerts via Wi-Fi to a mobile application is the opposite of the warning that we get it is through the local traditional manufactures or home, in addition to storing and following up the data quickly to benefit from it in the development of the work in the future. Which reduces cost and effort and increases the speed of follow-up to improve the management of smart power management furthermore, reduce the risks resulting from power cut off. The proposed study also shows a relationship between the data collected by the system that the weather temperature and humidity have a significant impact on potential problems in the system, including device cut off form a high or low percentage showing in so, temperature and humidity can influence, which indicates the study mechanism in this is system. The study also showed the existence of the relationship, and thus, following up on these two factors continuously through automated system can alert the problem at an early stage to intervene and find a solution to it before it escalates. Comparison of the previous research that proposed in the first chapter on the old methods used in traditional power system to monitoring and control, which require field presence to collect data and reports data. Therefore, the proposal by this research provides the ability to display information on the screen and monitor this data on an application at any time, if the device is connected to the Internet. For the temperature and humidity measure it and gather data, as it varies from place to place according to the weather condition in Iraq. Based on the data develop a new futures specification for household appliances, as well as transformers and devices for the electrical network, and thus reach the network to the best condition. furthermore, voltage and current measuring helps to know the increase in loads. When the loads increase, the voltage decreases.

Accordingly, an instruction is sent to the tap changer in the transformer to raise the voltage to the required level. After the tap change reaches the max level, we resort to the alternative solution, which is to determine the load according to specific controls. also, the automated approach that new proposed has more accuracy if it is more time or less time for the activity to perform show in figure14. And figure 15.

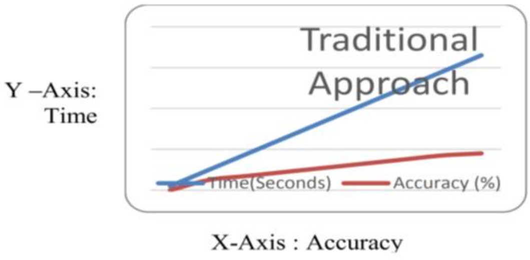

Figure 14: Graph of Traditional Approach

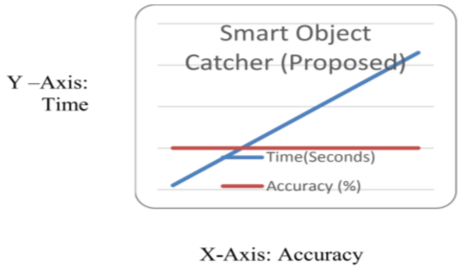

Figure 15: Graph of Proposed Approach

Comparison of Automatic and Standard Approaches (**Figure 14** and **Figure 15**) Based on the accuracy and time in the example above, the automatic approach uses more time accurately. Semi-traditional or traditional procedures, on the other hand, take longer to get accuracy. Whether the activity takes more time or less time to complete, the automated approach is more accurate.

7. Conclusion

The designed system, besides observing the detector information, Power consumption, and weather sensors, additionally actuates a technique as per the need; it additionally stores the detector parameters within the cloud in a very timely manner. This may facilitate the user to research the condition of various parameters anytime, anyplace. The code provided is generic and versatile in an effortless manner. It might be efficiently extended for future applications like power management, surveillance, etc. Moreover, this technique is better than other power management system methods. Utilizing smart grid and IoT technologies in power management manufacturing entails combining all electrical devices for controlling, monitoring, and alerting in novel ways. With the use of application services as an interoperable layer for communication between the remotely present user and the manufacturer's devices, a standalone, novel, flexible, and affordable manufacturing monitoring and controlling system has been developed for addressing the problems of flexibility and functionality. Research has proven that open-source software and ESP32 could programmatically control a variety of power manufacturing devices, enabling users to design solutions that are specific to their own requirements. As a result, the suggested system has better adaptability, scalability, and security compared to the power manufacturers that are already on the market.

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