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Power Monitoring and Control with Integrated IoT for Housing Electrical System

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Abstract: Internet of Things (IoT) is becoming more popular for home usage, so the electrical load in the home can be regulated online using IoT devices that can be controlled from anywhere and at any time. This may make a person life easier and better with the advancement of technology. Some of the causes of these changes include people laziness or forgetfulness due to their hectic lifestyle. This initiative is being implemented to prevent these increasing power bills. This project aims to develop a versatile, viable, low-power doorway security solution with real-time response. People seek security in every situation, whether at home or away from home. This project system allows users to control the switching of electrical loads online through the phone, remotely control an electronic door lock, and receive notifications while interacting with the Blynk platform. Furthermore, this system is capable of handling the use of current and power consumption in each residence. It is accessible online via the Blynk app. This project design system includes an Arduino as the primary function of the microcontroller to program the system, an ESP8266 as a Wi-Fi module, a 5 V four relay channel, and a current sensor ACS712 and a Passive Infrared Motion Sensors (PIR motion sensor). This project can be controlled manually with buttons or through the Blynk system. Furthermore, it is for house safety and security because users can monitor the house condition when they receive a notification from Blynk.

Keywords: Internet of Things (IoT), Arduino Uno, Blynk Application, Door Lock,

1. Introduction and Background

Electric power usage has become evident in all fields because contemporary technology has made various electrical appliances and equipment widely available. Developing new methods for controlling and monitoring electrical energy use has become necessary[1]. Among them are the safety of the home area, the current temperature, and managing devices such as lights and sockets. Nowadays, technology is evolving, and the housing system is expanding to use programmable logic circuit systems, robot

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systems, and systems that can be operated automatically, mainly controlling electrical hardware devices using the phone[2]. Smart homes, as an essential component of the IoT, efficiently serve people by connecting with different IoT-based digital gadgets. All equipment in smart homes interacts with one another fluidly in the ideal form of a connected future. IoT-based smart home technology has transformed human existence by bringing connectivity to everyone, regardless of time or location. In recent years, home automation systems have gotten more advanced[3]. These systems provide infrastructure as well as strategies for exchanging various sorts of appliance information and services. A smart home is a type of the IoT, which is a network of physical devices that enable electrical, sensor, software, and network connection within a home[4]. Smart houses are automated structures that include detection and control devices such as air conditioning and heating, ventilation, lighting, hardware, and security systems[5].

A smart home is a convenient house setting in which appliances and devices may be managed remotely using a mobile or other networked device from anywhere with an internet connection. A smart home devices are connected via the internet, allowing the user to handle features such as home security, temperature and lighting from a far[6]. Smart home technology allows homeowners to manage smart equipment via a smart home app on their smartphone or other networked device, providing security, comfort, convenience, and energy efficiency. Smart home systems and gadgets, which are part of the IoT, frequently work together, exchanging consumer usage data and automating activities depending on the homeowner preferences. One of the most widely stated advantages of home automation is that it gives homeowners peace of mind by allowing them to remotely monitor and protect their houses from risks[7]. Smart homes may also suit user preferences for ease. Smart home technologies are not always energy efficient, but the majority of them may be used to help you save energy. When you have smart home appliances, lighting, or a smart thermostat, you can regulate when and how they turn on and operate. As a result, you have greater control over your energy use and are more inclined to modify your behaviors.

2. Methodology

Power Monitoring and Control with Integrated IoT for Housing Electrical System could be finished and implemented smoothly. To finish this project, careful planning is required so that it may be implemented in compliance with the guidelines and completed within the time frame specified. A detailed explanation of the project designation, workflow system, and component testing will be provided. step-by-step instructions for completing this project.

2.1 Power Monitoring and Control System

In this system, an ESP8266 is utilised as a Wi-Fi module in connection with an Arduino to transmit information to Blynk[8]. The primary goal is to control the house electrical system automatically. Arduino Uno digital output pins are linked to a 5V relay for online control through the Blynk program[9]. Following that, the Arduino Uno analogue input pins were linked to ACS712 current sensors to monitor the electrical home system[10]. The existence of a load attached to the ACS712 Current Sensors was observed. The load can be any form of electrical load in the housing, such as a light, fan, or other device. When switches linked to loads were turned on and the load was present, the current sensor detects the amount of current created when a load is applied. The Arduino Uno and the ESP8266 determine it. As a result, power consumption may be tracked and presented on the Blynk. The circuit was built around of the input-output devices, such as an PIR sensor module, alarm, a solenoid door lock, were attached. Two DC power supply units supplied electricity to the circuit. One was +12V DC to power remainder of the circuit, while the other was +5V DC the solenoid lock[11]. Passive Infrared Motion Sensor (PIR motion sensors) can detect animal/human movement within a specified range, if a PIR motion sensor detects a nearby object It will give the owner a notification[12]. The owner can keep an eye on everything via Closed-circuit television (CCTV). If anything unusual occurs, the owner can activate the alarm system to signal that the residence is in danger. Furthermore, if family members come to visit but the owner is not present or forgets to bring a key. It can also unlock the door remotely by controlling the solenoid lock.

2.2 Diagram of Project

A Figure 1 represents each system function, which includes inputs, processes, and outputs. Input components include a current sensor, a PIR motion sensor, and an ESP8266 Wi-Fi module. The essential element in this system is the Arduino Uno, which will run a specified code. In the event of a Blynk trigger, the relay will operate as a switch. The lamp, outlet socket, solenoid lock, and alarm appear next on the output side.

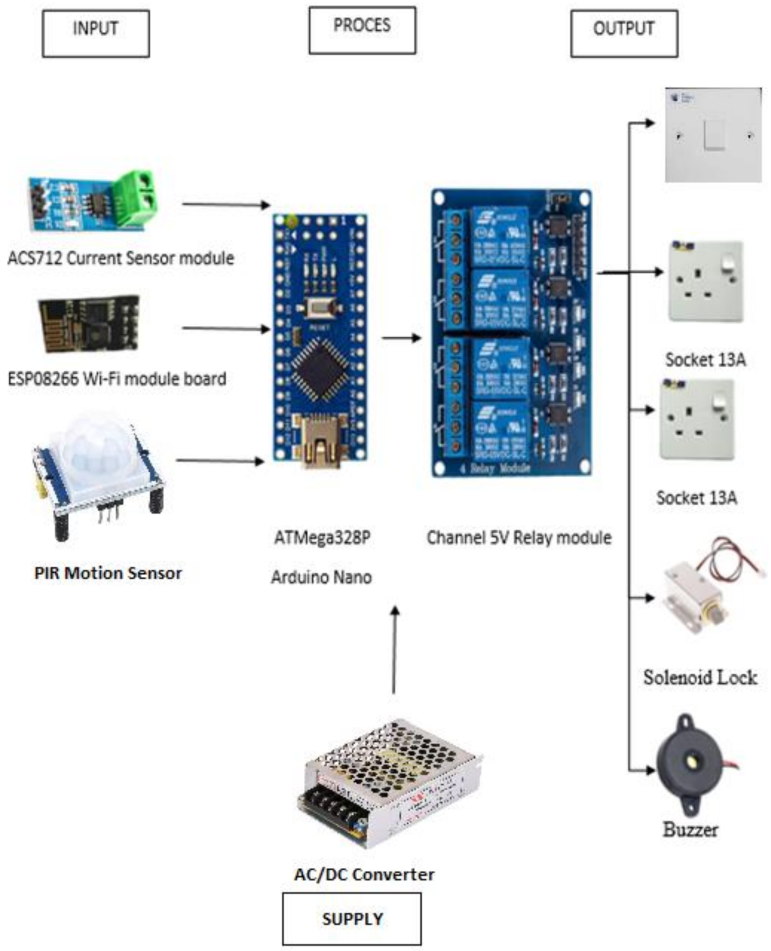


Figure 1: Diagram of project

The ACS712 current sensor is put between the load and the supply. The measured data is then relayed to an Arduino Uno, which serves as a microcontroller for the monitoring system subsequent calculation. The ESP8266 Wi-Fi module is the component that allows the Arduino Uno to connect to a Wi-Fi network. The relay is used to control an electrical component that acts as it receives data from the Arduino Uno and executes the command. The relay is linked to a load such as a light and two 13 A socket. Then, with a PIR motion sensor will detect of the person at the door outside and sends it to the Blynk server. Blynk immediately generates an alert message to notify the user that someone is at the door. The user has two options for opening the door used Blynk or push button. Set relay 2 to trigger the door lock the Blynk program was utilized since it was linked to the controller and the internet.

2.3 Schematic Diagram of System

Schematic diagrams show in Figure 2 the connections between components that make up a system. Analogue input pins, utilized to link to an ACS712 Current Sensor, which measured and read the amount of currency in use linked to a 4 channel 5 V power supply. Using the Blynk Application, a relay is used to allow the system to be controlled online. The ESP8266 Wi-Fi module enable the Arduino Uno to connect to a Wi-Fi network. The entire circuit show all of the input-output devices, including as an PIR motion sensor module, a solenoid door lock was linked to it through jumper wires. Two DC power supply units supplied electricity to the circuit. One was +12V DC to power the circuit, while the other was +5V DC to power the door lock[13].

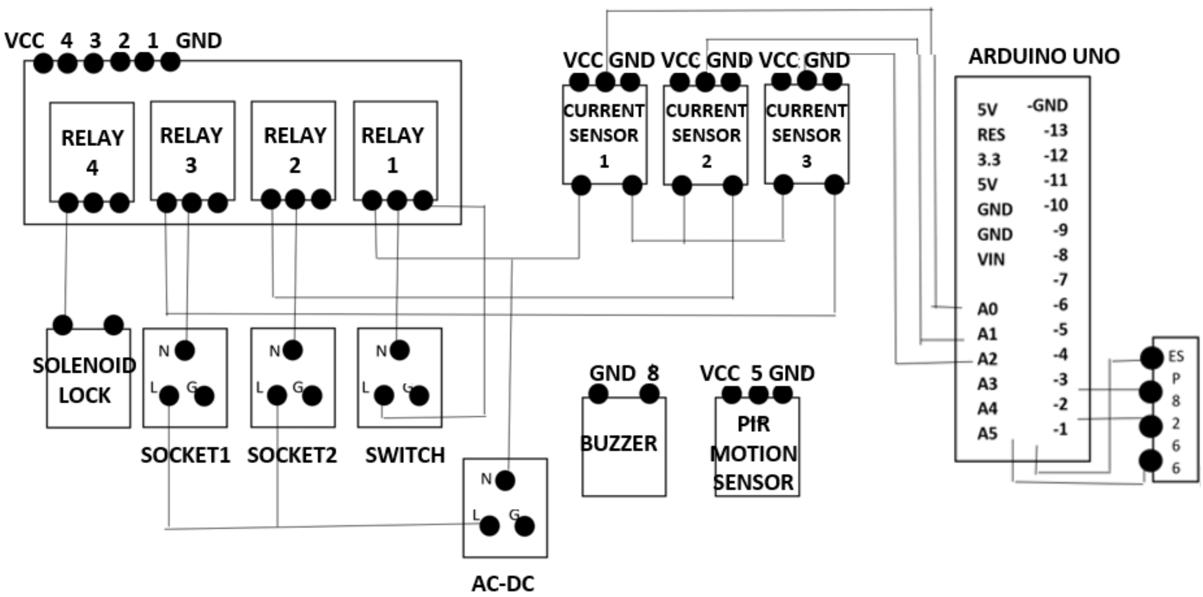


Figure 2: Schematic Diagram

3. Hardware Development

This part describes the methods and processes used to ensure the success of this project. It begins with gathering information, testing, and understanding how to use each component. After completing the prototype, all information should be recorded.

3.1 Full System

The outcome should obtain after finishing the test case It is frequently documented within the test case. It is frequently compared to the actual outcome, and if the real result differs from the planned one, it is considered a failure.

3.1.1 Hardware/ Prototype Implementation

The project continued with the development of a complete prototype to test how the entire system performs after the system designation, test functioning for each component employed, and successful troubleshooting. The layout of the identification, as well as the wiring schematic that has been designed, determined the hardware development. The installation of housing accessories was the first step in developing this hardware. Following that, electronic components such as an Arduino Uno, an ESP8266

Wi-Fi module, a 5 V relay channel, a PIR Motion sensor, a current sensor, a solenoid lock, and so on are installed, shown in Figure 3.

Figure 3: The hardware/prototype implementation

The project continued with the development of a complete prototype to test how the entire system performs after the system designation and test functioning for each component employed. It was critical to verify that the connection between the electronic components was correct, as shown in Figure 4, the wiring circuit for this project because electronic components were critical to the system operation. Electrical load housings such as lights and socket outlets are installed to complete this hardware fully. The whole system functionality was tested to confirm that it worked as expected and that the goal was fulfilled. The test results were recorded to demonstrate the achievement of project objectives.

Figure 4: Wiring circuit for the system

The Arduino Uno source code was extraordinarily complex and challenging to modify. The first difficulty faced when finishing this project prototype was when doing a functioning test for the current sensor. The Arduino Uno could not read the appropriate data for the current value and the needed power. It just provided raw data to the Blynk platform. After several attempts, but still failing. This issue was fixed by adding another codding that Arduino Uno used to read and pass data for current and power from the ACS712 current sensor.

The second difficulty noticed was when connecting electronic components. A soldering method must be used to connect one current sensor to another current sensor and Arduino Uno. This method must be used carefully because the electrical components are susceptible and easily destroyed. Aside from that, the wire for the connection was relatively thin, making it very simple to unplug or detach, and the soldering technique must be repeated.

The following challenge required internet access. Because this project is based on the Internet of Things (IoT), it uses the internet by connecting the ESP8266 to Wi-Fi and then providing an interface with the Blynk platform. This technique requires a solid signal to function properly. The Wi-Fi signal, on the other hand, was poor and too weak. The interface between the Blynk platform and the ESP8266 does not work correctly, and connecting takes a long time. Due to a slowdown internet connection, the Blynk platform frequently unexpectedly pauses and fails to read the data when documenting findings, and the procedure must be restarted. Figure 5 shows the condition if Blynk is not associated with internet Wi-Fi.

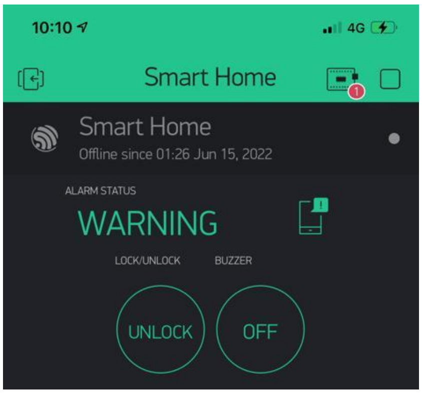


Figure 5: Blynk condition when offline

3.1.2 Result of Control System

The following results demonstrated the control system implementation in this project. As previously stated, housing electrical load can be performed in three ways manual, online, and sensor stimulation. Following Figure 6 was the electrical loads, such as lamp 1, will turn on when the 1 gang 2-way switches are triggered. The socket-outlet was then triggered since it required the relay to be in a normally open state.

Figure 6: Full hardware in ON condition

The Figure 7 shows the demonstrates the housing electrical load control through internet, which was the Blynk application button control. When the Blynk widget buttons were pressed, the microcontroller that received the command activated the relays. When the relays are triggered, the load connected to the lamps is turned on. When the manual switch was turned on, the socket-outlet began to operate. If the relay is triggered, it will turn off the socket-outlet. In this case, it can control both manual and online switches, but only in online if the manual switch is turned on.

Figure 7: Button in Blynk application to control system

3.1.3 Waveform Result of Control System

The control system was analysed in various situations to confirm its functionality and whether it could control the electrical load in the housing. No electrical load would function if both the manual switches and the widget buttons in the Blynk Apps were turned off since none of the controls was triggered. When both the manual switches and the widget buttons in the Blynk Apps were turned on, the result showed that lamp one was turned on, and when the controls were turned off, the Blynk triggered a relay to turn, the result showed that lamp one was turned on. This means that switches can be controlled manually and automatically, allowing loads such as lamps to be turned on. Furthermore, because the relay has a link to the microcontroller and has been used to enable the load to be conducted online, the relay will be triggered when the Blynk Apps button is turned on. Figure 8 shows the waveform result for the project.

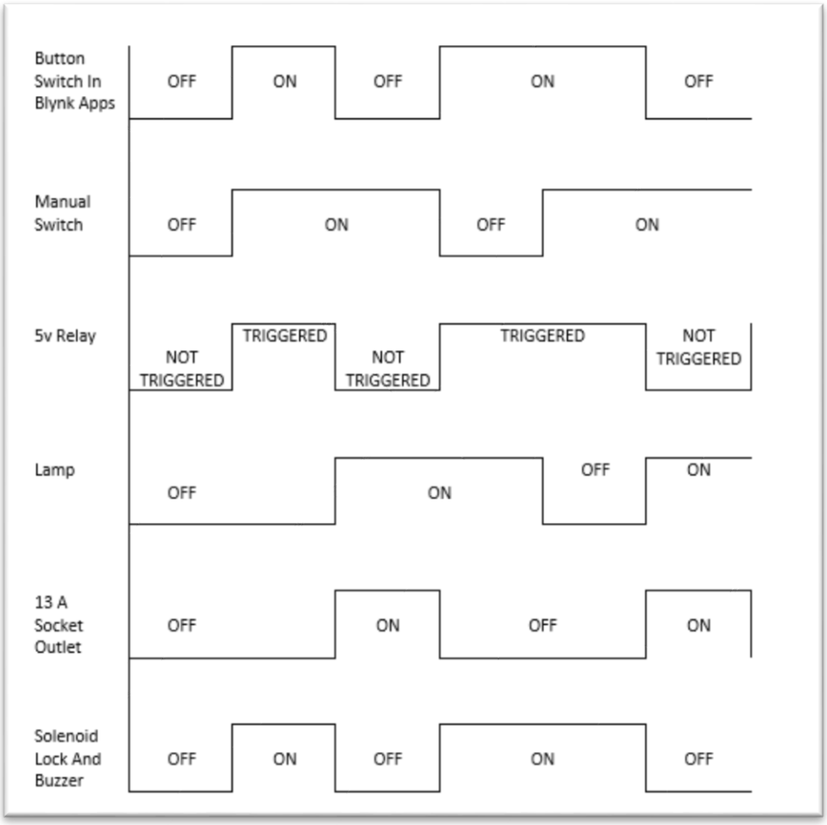


Figure 8: Waveform result for the project

4. Experimental Result

The testing results for each housing electrical current monitoring system used in this project were displayed. The Blynk application displays have been provided to compare clamp meter and Blynk application measurements to verify the system capabilities to measure the current value per load.

4.1 Results of Actual Amount Current from Testing of Project System

The testing results for each housing electrical current monitoring system used in this project were displayed. The Blynk application displays have been provided to compare clamp meter and Blynk application measurements to verify the system capabilities to measure the current value per load.

4.1.1 Results of Lamp

The loads may be well managed once the hardware has been successfully installed. The next step in the system testing was looking at the load Blynk measurements. The clamp meter was put on the load to be monitored while Blynk took the readings. The amount of current produced as in Figure 9 when lamp one was turned on was 0.087A, as shown in the Blynk programmed, and 0.08A as measured by the clamp meter. The measurements produced with clamp meters are highly similar to the values read by the Blynk application. The offset value may result in a slightly different matter. The amount of current focus on load lamp one is seen in this graph. Since then, there has been a fluctuating movement in the current and power used Blynk Apps, on the other hand, was able to record readings for lamp 1. This proves the goal was achieved because Blynk could produce a task incredibly near the actual number.

Figure 9: Current and power consumption used when ON lamp

4.1.2 Results of Charging Smartphone and Laptop

Figure 10 shows a reading of current and power consumption while charging a smartphone. The clamp meter reading is 0.12 A. The readings provided by the Blynk application are in the 0.09 A-0.12 A range. After that, then the value of power consumption on Blynk is 21.6 W until 28.8 W. It is most likely due to an overly sensitive sensor current. On the other hand, the reading range is within the approximate reading range. Figure 11 depicts the reading when the laptop is charging. The clamp meter for current value is 0.40 A, while the Blynk application reading is between 0.30A and 0.40A then the value of power consumption on Blynk is 72 W until 96 W. This modification is also most likely due to a connection issue on the ESP8266.

Figure 10: Current and power consumption while charging a smartphone

Figure 11: Current reading when the laptop is charging

4.1.3 Results of Value Current when Hair Dryer in ON Condition

The hair dryer is the next load to be measured. Figure 12 shows the value measured on the clamp meter when speed 1 is 0.71 while speed 2 is 2.37. However, the Blynk application recorded a reading of 0.58A to 0.70A for the first speed. The second speed range for value current is 1.52 A to 2.23 A. These updates are currently in the works.

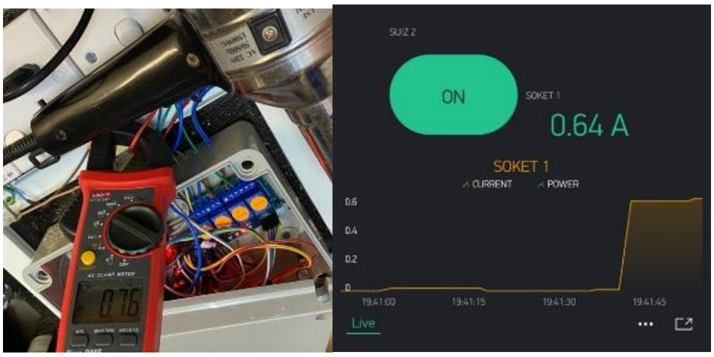
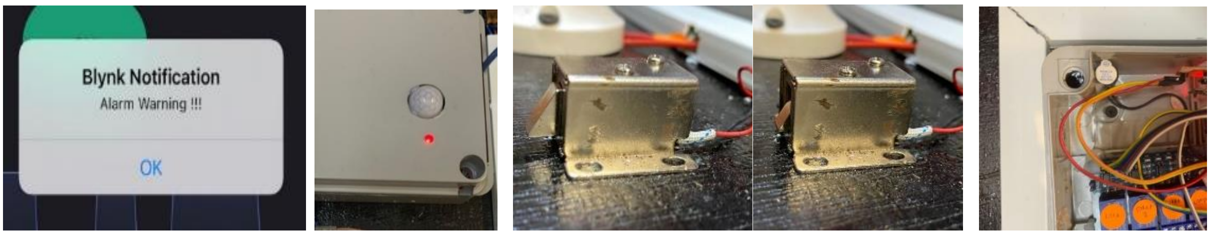


Figure 12: Value current by hair dryer

4.1.4 Results of PIR Motion Sensor, Solenoid Lock and Buzzer

Only the Blynk app is used for the PIR motion sensor shows in Figure 13 (a). When it detects movement close to it, the motion sensor is closely linked to the solenoid lock shown in Figure 13 (b) and buzzer components shown in Figure 13 (c). Because it is a security system because when the PIR motion sensor detects the presence of a movement around it, especially on the door, the information will be sent to the user through the Blynk application if the user has access to a CCTV application, the user can then view about the house area.



(a) (b) (c)

Figure 13: (a) PIR motion sensor detect movement (b) Solenoid Lock Trigger (c) Buzzer as alarm

Two scenarios will occur next in the solenoid lock part. First, if the owner left the key in the house, the owner might open the door by pressing the Blynk system switch. It will also help if family members visit the place without the user knowing. The owner can activate the solenoid lock from a distance away. Then, in the second scenario, if the PIR Motion sensor detects and the owner receives a notification. Still, while viewing the house CCTV, there is a suspicious situation the owner can also turn on the buzzer as an alarm to alert people nearby that the house area is in danger.

4.2 Graph Results of Monitoring the Amount of Current and Power Consumption Per Load

The total current of each electrical load in the house was monitored and recorded using the Blynk programmed in the allocated period. The recorded result considers both Blynk application values and clamp meter readings. This was to justify ensuring that the reading on the Blynk was accurate. The collected data is provided in graph form for simple evaluation.

4.2.1 Graph Result for Value of Current and Power when Switch Operate

The following diagram shows the amount of current used by the lamp as monitored by the Blynk application. As observations are made on graphs, both graphs fluctuate. For the Blynk Apps, the value ranged from 0.05 A to 0.07 A, as shown in Figure 14, while the clamp meter ranged from 0.07 A to 0.08 A. However, the value obtained from the clamp meter and the Blynk application was nearly the same, showing that it was still acceptable and comparable to the actual value. To begin an evaluation, data were collected for 7 minutes for 7 hours and graphed. The graph in Figure 15 illustrates the fluctuation of the power recorded by the Blynk, which ranges between 13 W and 15 W. Because this occurrence is possible due to many causes, the readings are still acceptable because they have a value close to the actual value of 19 W.

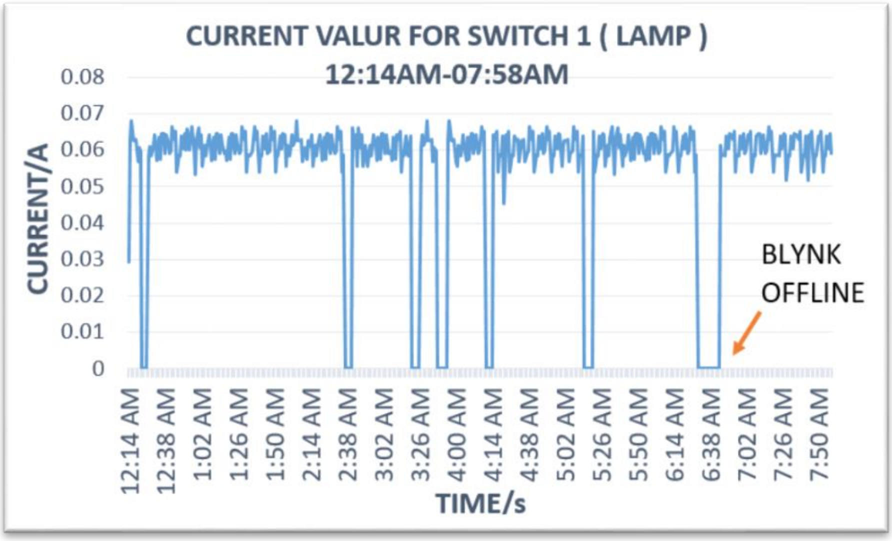


Figure 14: Value of current

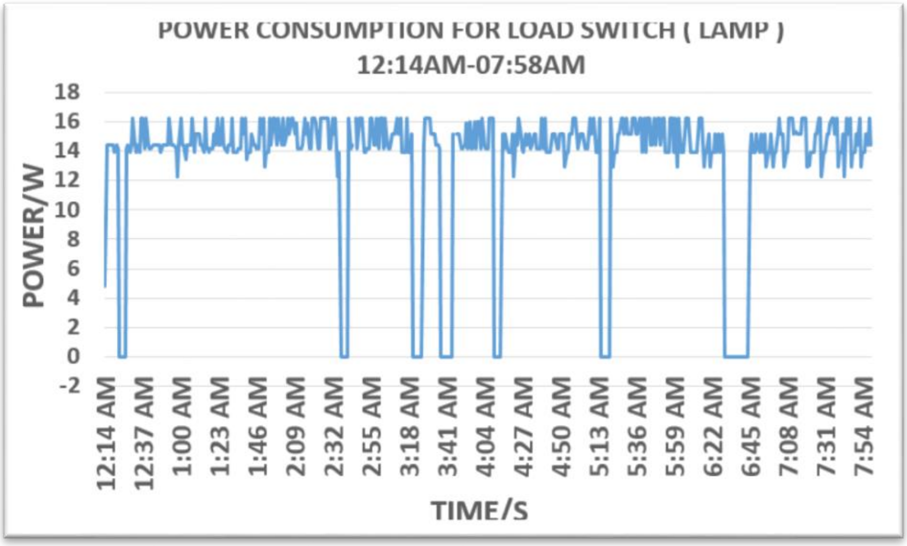


Figure 15: Fluctuation of the power recorded

4.2.2 Graph Result for Value of Current and Power at Socket 1

Data for current and load readings are collected for 7 hours. Figure 16 shows that when the fan is placed on socket 1, the speed of the two current values is as much as 0.18 A to 0.20 A and the power consumption is 43.2 W until 48.0 W. Next, when the fan speed is reduced to speed 1, current measurement ranges from 0.10 A to 0.14 A. The graph illustrates the fluctuation of the power recorded by the Blynk, which ranges between 24.0 W and 33.6 W The observed current also changes when the load on the socket is modified by charging the laptop. While charging the laptop, the current detected ranges from 0.30 A to 0.40 A The graph illustrates the fluctuation of the power recorded by the Blynk shown in Figure 17, which ranges between 72.0 W and 96.0 W. It most likely changes due to a particularly sensitive sensor current. There was virtually little change in the values measured based on graph observations. The clamp meter provided accurate readings.

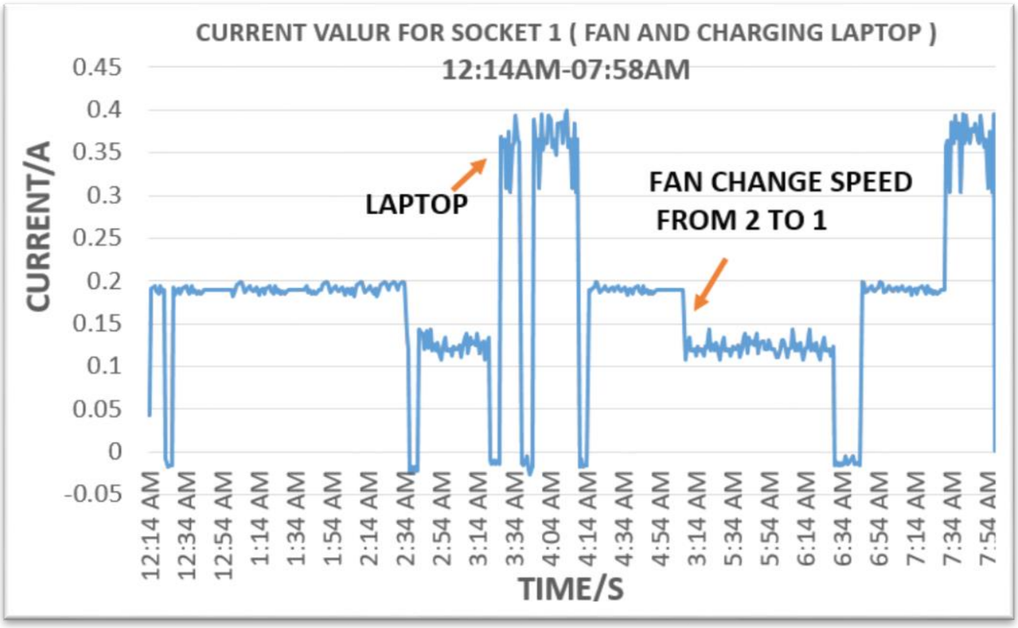


Figure 16: Current Value for Socket 1

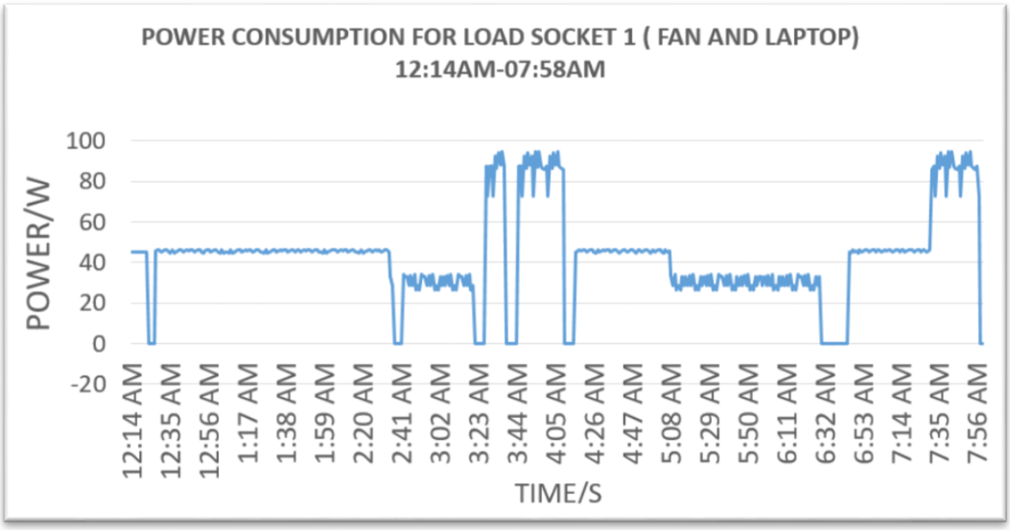


Figure 17: Power value for Socket 1

4.2.3 Graph Result for Value of Current and Power at socket 2

A two-speed hair dryer, a mobile phone charger, and a laptop charger were tested on socket 2. As a result, various current readings due to different types of loads are used on the graph in Figure 18. First and foremost, the load on socket two is used to charge the phone. The current reading given by Blynk ranges from 0.09 A to 0.13 A, while the power reading ranges from 21.6 W to 31.2 W as shown in Figure 19. The load is then reinstalled with the aid of a hair dryer. First, the hair dryer is set to the lowest, with a detected current of 0.58 A to 0.65 A and a power reading of 139.2 W to 156.0 W. When the hair dryer speed is increased to 2, the current reading of 1.52 A to 2.24 A is obtained. In addition, power ratings range from 364.8 W to 537.6 W. There was virtually little change in the values measured based on graph observations. The clamp meter provided accurate readings. The load imposed on socket two is then used to charge the laptop. When the load is mounted, the current ranges from 0.30 A to 0.42A. The movement of the graph fluctuated when readings from the Blynk application were inspected. The measured power range is 72.0 W to 100.8 W. However, the clamp meter and the Blynk application gave only significantly comparable findings.

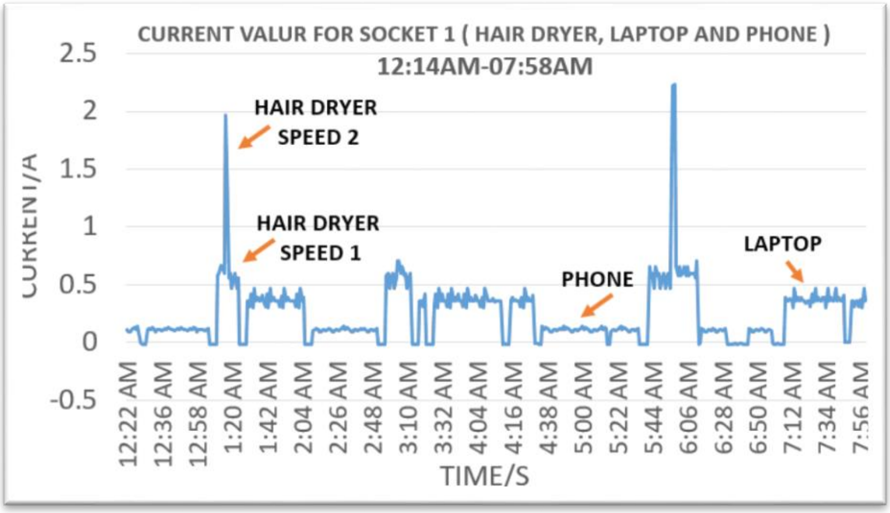


Figure 18: Current value for socket 2

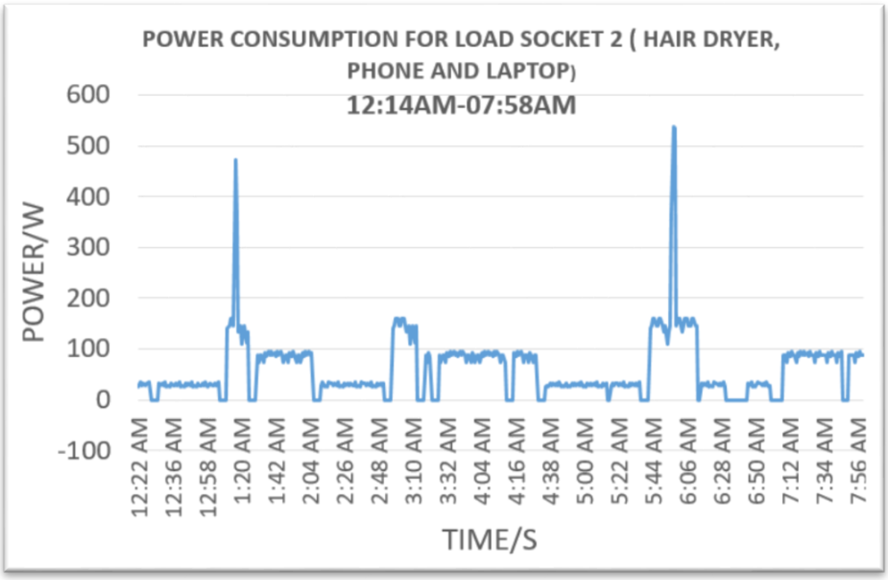


Figure 19: Power consumption for socket 2

4.3 Total Power Consumption Per Load

The electrical load in the housing comprises lamp 1, socket 1 with the load laptop and fan, and socket 2 with the load hand phone, hair dryer and laptop. The entire amount of electricity consumed by each load over a certain period has been recorded. The previously recorded power values have been combined to obtain the total amount of power consumed by each load, allowing a comparison of which load uses the most and least power. According to the graph, the most significant usage was recorded by the hair dryer speed 2 is 537.6 W, while the lowest readings were recorded by lamp, 15.0 W. The total power usage per load is shown in Figure 20.

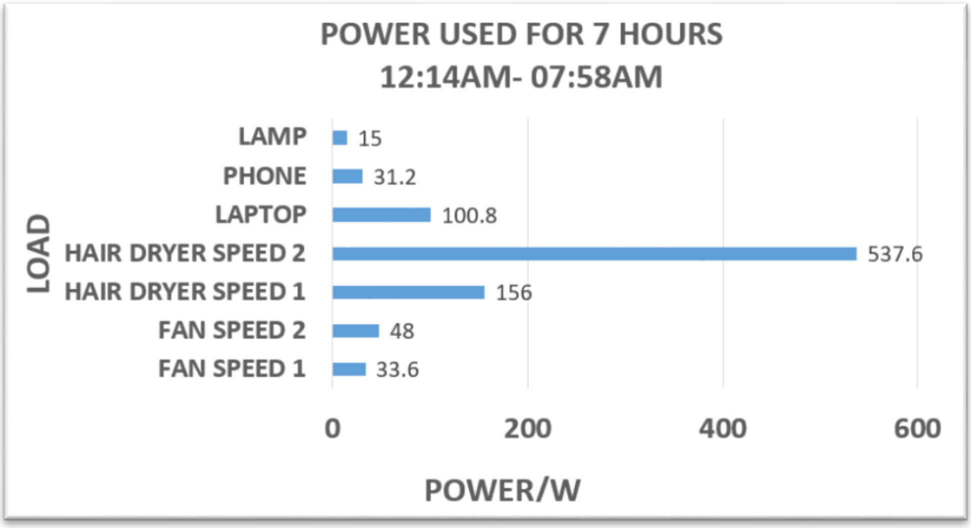


Figure 20: Total power usage for three load.

5. Conclusion

This project manages electrical equipment at home either manually or remotely, and the reading of each load and current consumption may be monitored regularly. This program will significantly help consumers control and reduce the waste of energy resources, specifically with the daily workload. This help to lower electricity bills to some extent. The primary goal of this project is to investigate IoT devices that used to monitor and regulate a home electrical system. The second goal was to design a housing electrical load control and monitoring system for residential usage with IoT functionality. This goal was also met because it can be managed manually or remotely. However, it only be controlled online while connected to the internet. Finally, the developed system functionality must be validated. Each piece of information collected is recorded and compared to actual readings

Acknowledgement

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References

[1] S. Pawar, V. Kithani, S. Ahuja, and S. Sahu, "Smart Home Security Using IoT and Face Recognition," Proc. - 2018 4th Int. Conf. Comput. Commun. Control Autom. ICCUBEA 2018, pp. 1–6, 2018, doi: 10.1109/ICCUBEA.2018.8697695.

[2] V. Govindraj, M. Sathiyanarayanan, and B. Abubakar, "Customary homes to smart homes using Internet of Things (IoT) and mobile application," Proc. 2017 Int. Conf. Smart Technol. Smart Nation, SmartTechCon 2017, pp. 1059–1063, 2018, doi: 10.1109/SmartTechCon.2017.8358532.

[3] S. Kashan Ali Shah and W. Mahmood, "Smart Home Automation Using IOT and its Low Cost Implementation," Int. J. Eng. Manuf., vol. 10, no. 5, pp. 28–36, 2020, doi: 10.5815/ijem.2020.05.03.

[4] S. S. Chowdhury, S. Sarkar, S. Syamal, S. Sengupta, and P. Nag, "IoT Based Smart Security and Home Automation System," 2019 IEEE 10th Annu. Ubiquitous Comput. Electron. Mob. Commun. Conf. UEMCON 2019, vol. 7, no. 04, pp. 1158–1161, 2019, doi:

10.1109/UEMCON47517.2019.8992994.

[5] T. S. Gunawan et al., "Prototype design of smart home system using internet of things," Indones. J. Electr. Eng. Comput. Sci., vol. 7, no. 1, pp. 107–115, 2017, doi: 10.11591/ijeecs.v7.i1.pp107-115.

[6] T. S. Gunawan, I. R. H. Yaldi, M. Kartiwi, and H. Mansor, "Performance evaluation of smart home system using internet of things," Int. J. Electr. Comput. Eng., vol. 8, no. 1, pp. 400–411, 2018, doi: 10.11591/ijece.v8i1.pp400-411.

[7] M. Al-Kuwari, A. Ramadan, Y. Ismael, L. Al-Sughair, A. Gastli, and M. Benammar, "Smart-home automation using IoT-based sensing and monitoring platform," Proc. - 2018 IEEE 12th Int. Conf. Compat. Power Electron. Power Eng. CPE-POWERENG 2018, pp. 1–6, 2018, doi: 10.1109/CPE.2018.8372548.

[8] H. Durani, "Smart Automated Home Application using IoT with Blynk App," 2018 Second Int. Conf. Inven. Commun. Comput. Technol., no. Icicct, pp. 393–397, 2018, doi: 10.1109/ICICCT.2018.8473224.

[9] E. Media's, . S., and M. Rif'an, "Internet of Things (IoT): BLYNK Framework for Smart Home," KnE Soc. Sci., vol. 3, no. 12, p. 579, 2019, doi: 10.18502/kss.v3i12.4128.

[10] Admin, "Interfacing ACS712 Current Sensor with Arduino, Measure Current with Arduino," Electronicshub. 2018, [Online]. Available: https://www.electronicshub.org/interfacing-acs712-current-sensor-with-arduino/.

[11] I. Gani et al., "IoT-Enabled Door Lock System Related papers Prot ot ype of Smart Lock Based on Int ernet Of T hings (IOT) Wit h ESP8266 IoT-Enabled Door Lock System," IJACSA) Int. J. Adv. Comput. Sci. Appl., vol. 10, no. 5, 2019, [Online]. Available: www.ijacsa.thesai.org.

[12] B. Alathari, M. F. Kadhim, S. Al-Khammasi, and N. S. Ali, "A framework implementation of surveillance tracking system based on pir motion sensors," Indones. J. Electr. Eng. Comput. Sci., vol. 13, no. 1, pp. 235–242, 2019, doi: 10.11591/ijeecs.v13.i1.pp235-242.