EspyDynami: Power Monitoring Mobile Application Using Parsing Algorithm

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ABSTRACT

EspyDynami is a mobile application developed using Parsing algorithm which collects and organizes power data with the help of power analyzer and Arduino Uno.

The aims of this research include helping the users to monitor and be aware of their consumption in electricity within a specific place. Subsequent to this, the researchers developed a mobile application that will monitor not only power consumption (watt-hour) but also the voltage, current, power, and uptime. This mobile application presents a design for monitoring by showing the information needed. Likewise, it also has a feature that can shut off the electricity in a room in just one click and also a Resume button to turn on the electricity again. This application was possible with the use of Arduino where all the data will come. The core contribution of this thesis is enabling users to be aware of the other information on the electricity they consume. It was developed using the Java programming language and incorporates C++ in coding the program for Arduino.

Keywords: *Android, Arduino, Electricity, Java, Mobile application, Parsing*

1.0 INTRODUCTION

Electricity plays a vital role in people's daily living. Today, existence without power is practically inconceivable. Even the smallest things in this modern and mechanical life needs power. Appliances like electric fan, radio, television and warmer are run by electrical force.

In view of this, power utilization, its cost and the unwavering quality of electrical framework are the significant concerns of most power consumers. Electricity rate differs from one another depending on the basic category of consumers: industrial, commercial, governmental, and residential. Some power consumers doubt the cost of their high electricity bill while others are bothered if they switched off the lights and appliances inside their home before they leave.

Thus in order to solve this, the researchers, proposed a power monitoring mobile application. With the use of this application, the user

can see or monitor where the energy is being consumed and how high the consumption is. This will help the user reduce the consumption of power electricity and also monitor if the user leaves a device or appliances on.

Power Monitoring android mobile application will use Arduino Uno which will help gather the data to know the power consumption. It also displays voltage, current, power, watt/hour, and accessible via Wi-Fi. A master shut off switch will also be available to switch off all the running electrical objects and appliances in home/facility when leaving off or in a small establishment after closing time. There are many benefits dealing with power monitoring system. It is reliable for assessing accurate power data, allows maintaining and managing electricity consumption, and ensuring safety.

1.1 Objectives:

This research study aims:

1. To develop a mobile application that will monitor and display power consumption in a home or establishment.
2. To display voltage, current, power, watt/hour, uptime, day of the week, date and time.
3. To implement a master shut off switch that will disable the electricity within the coverage area.

2.0 REVIEW OF LITERATURE

2.1 Electricity

Electricity is the world's secondary energy source, a basic part of nature and the most widely used form of energy as defined by eia Independent Statistics and Analysis U.S. Energy Information Administration (2016). It is the flow of electrical charge or power. Electricity, being an energy carrier, was produced from other conversion of energy like coal, natural gas, solar, and wind energy that were referred to as primary energy sources.

Using electricity has dramatically changed human daily life. More than 100 years ago, there was no electricity yet. Houses were warmed and lighted with candles, whale oil or gas lamps, and food was kept in iceboxes.

Some scientists and inventors had notable accomplishments in the principles of electricity. One of those was Benjamin Franklin who

demonstrated that lightning is electricity. Another one was Thomas Edison who invented the first long-lasting incandescent light bulb. In the late 1800s, Nikola Tesla pioneered the generation, transmission, and use of alternating current (AC) electricity, which lessened the expense of transmitting electricity over lengthy distances. Tesla's creations utilized electricity to convey indoor lighting to homes and to control power industrial machines.

Regardless of its incredible significance in everyday life, few individuals most likely stop to consider what life would resemble without electricity. Like air and water, people tend to take electricity for granted. Be that as it may, individuals utilize electricity to do many occupations consistently from lighting, warming, and cooling homes to powering televisions and computers.

Since the application will monitor power consumption per room/area only, the table of Kremer (2012) below shows the estimated power consumption in watts of common appliances. Naturally, ratings will differ amongst brands and models. For more accurate information, look at the standard specifications (volts, wattage, hertz, etc.) on the appliance itself.

APPLIANCE	**WATTS****
Air Conditioner	750 - 3000
Clothes Dryer*	1300 - 3000
Computer + monitor	180 - 300
Dishwasher*	1500 - 3000
Hair Dryer	700 - 2500
Heater (room)	1500 - 3500
Iron	1000 - 2000
Kettle (electric)	1900 - 3000
Meat Grinder	400 - 600
Microwave	1100 - 1500
Mixer	350 - 700
Oven*	2000 - 3000
"Plata" Shabbat	200 - 400
Radio (small)	7 - 10
Range top - electric (most can be used with single or 3 phase)	5000 - 12,500
Refrigerator	500 - 1000
Sandwich Maker (toaster)	700 - 1800
Television	75 - 250
Toaster	700 - 1000
Toaster Oven	1200 - 2000
Urn (Shabbat) to boil water	1700 - 2000

keep hot setting	150 - 200
Vacuum Cleaner	750 - 3000
Washing Machine*	2000 - 3000

* European models

** 1000 watts = 1 KW

Figure 1. Table of Wattage for Common Appliances

2.1.1 Voltage

According to CTAYLOR (2013), voltage is characterized as the amount of potential energy between two points on a circuit. It is measured in volts and represented by letter "V". Voltage was named after Alessandro Volta who created the first chemical battery. It is the differences between the charges of two points that will impart one joule of energy per coulomb of charge that passes through it.

It is important to know the operating voltage of in-used appliances. If it is too low, appliance will not work. If it's too high, appliance will break.

2.1.2 Current

The amount of water flowing through the hose from the tank is called as current, exemplified by CTAYLOR (2013). The higher the pressure, the higher the flow, and the other way around. The volume of the water flowing through the hose could be measured in a specific timeframe. Just like water, electricity flowing through a circuit can also be measured. It is represented by letter "I" and referred to as "Amps" or Amperes which is defined as 6.241*1018 electrons or 1 Coulomb per second.

Current is also displayed in this application to know how much flow of electricity the appliance consumes.

2.1.3 Electric Power

Based on Rouse (2008), the converted electrical energy like electromagnetic field, heat, and motion is called electrical power. When used in equations, it is represented by letter "P". Watt (W) is the standard unit of electrical power but in utility circuits, kiloWatt (kW) is oftenly used with a conversion of 1 kW = 1000 W.

One watt is the power resulting from an energy dissipation, conversion, or storage process

equivalent to one joule per second. Power is sometimes called wattage. In a direct current (DC) circuit, wattage is computed as the product of voltage and current. The same rule applies to low-frequency alternating current (AC) circuits in which energy is neither stored nor released. But in high AC frequencies in which energy is stored and released, the expression for power is more complex.

Real Power is also important to know because it is the representation of Voltage*Current. It resembles the amount of electrical energy being used.

2.2 Mobile Application

According to Beal (2016), mobile applications are considered as Internet applications that were installed in smartphones and other mobile devices. Mobile application helps the user to easily access programs that were commonly opened in desktops or personal computers. Whenever and wherever the user is, he or she can use the Internet with the use of hand-held device. Mobile app varies from different categories whether is a messaging app, booking/ordering utility, game quest, and many other applications.

There are three kinds of mobile application: Native app, Web app, and Hybrid app.

According to Budiu (2013), **Native app** is a type of application that is installed into a phone device. It is represented by icons on the home screen of the device and can be downloaded in an app store. This kind of application is able to access device features such as camera, list of contacts, and many others. Moreover, it can use its notification system and work even without internet connection.

Power Monitoring mobile application was considered as a native app. It is specifically developed in Android platform and uses its Wi-Fi feature.

2.3 Algorithm

In developing the proposed mobile application, the researchers adapted the Push and Pop Algorithm which was used in gathering the data about the electricity. The main target

of the application is to monitor power consumption inside the house. So in order to meet the purpose, Data Parsing was also used. Data Parsing separates distinctively all the gathered information and provides an organized list of information with the help of strcat() and strtok() functions.

2.3.1 Push and Pop

Via Tutorials Point Simply Easy Learning (2016), the process of putting a new data element onto stack is known as PUSH Operation. Push operation involves series of steps:

Step 1 − Check if stack is full.

Step 2 − If stack is full, produce error and exit.

Step 3 − If stack is not full, increment top to point next empty space.

Step 4 − Add data element to the stack location, where top is pointing.

Step 5 − return success.

Accessing the content while removing it from stack, is known as pop operation. In array implementation of pop() operation, data element is not actually removed, instead top is decremented to a lower position in stack to point to next value. But in linked-list implementation, pop() actually removes data element and deallocates memory space.

A POP operation may involve the following steps:

Step 1 − Check if stack is empty.

Step 2 − If stack is empty, produce error and exit.

Step 3 − If stack is not empty, access the data element at which top is pointing.

Step 4 − Decrease the value of top by 1.

Step 5 − return success.

The application's process starts by pushing the collected stream of characters from the power analyzer to the Arduino. Then, the Arduino pops the string of characters to the mobile application.

2.3.2 Parsing

According to Manu (2016), Data

Parsing is the process of analyzing text made of a sequence of tokens to determine its grammatical structure with respect to a given (more or less) formal grammar. In a simplest definition, it is breaking a data block into smaller chunks by following a set of rules, so that it can be more easily interpreted, managed, or transmitted by a computer or mobile application.

To display a user-friendly mobile application interface, EspyDynami used strcat() and strtok() functions to parse power data.

strtok() divides the string into tokens; which are sequences of contiguous characters separated by any of the characters that are part of delimiters.

strcat() function is used when collecting data from the power analyzer and strtok() function separated those data by “,” commas. Data parsing was also implemented in the allocation of information in the mobile application’s interface.

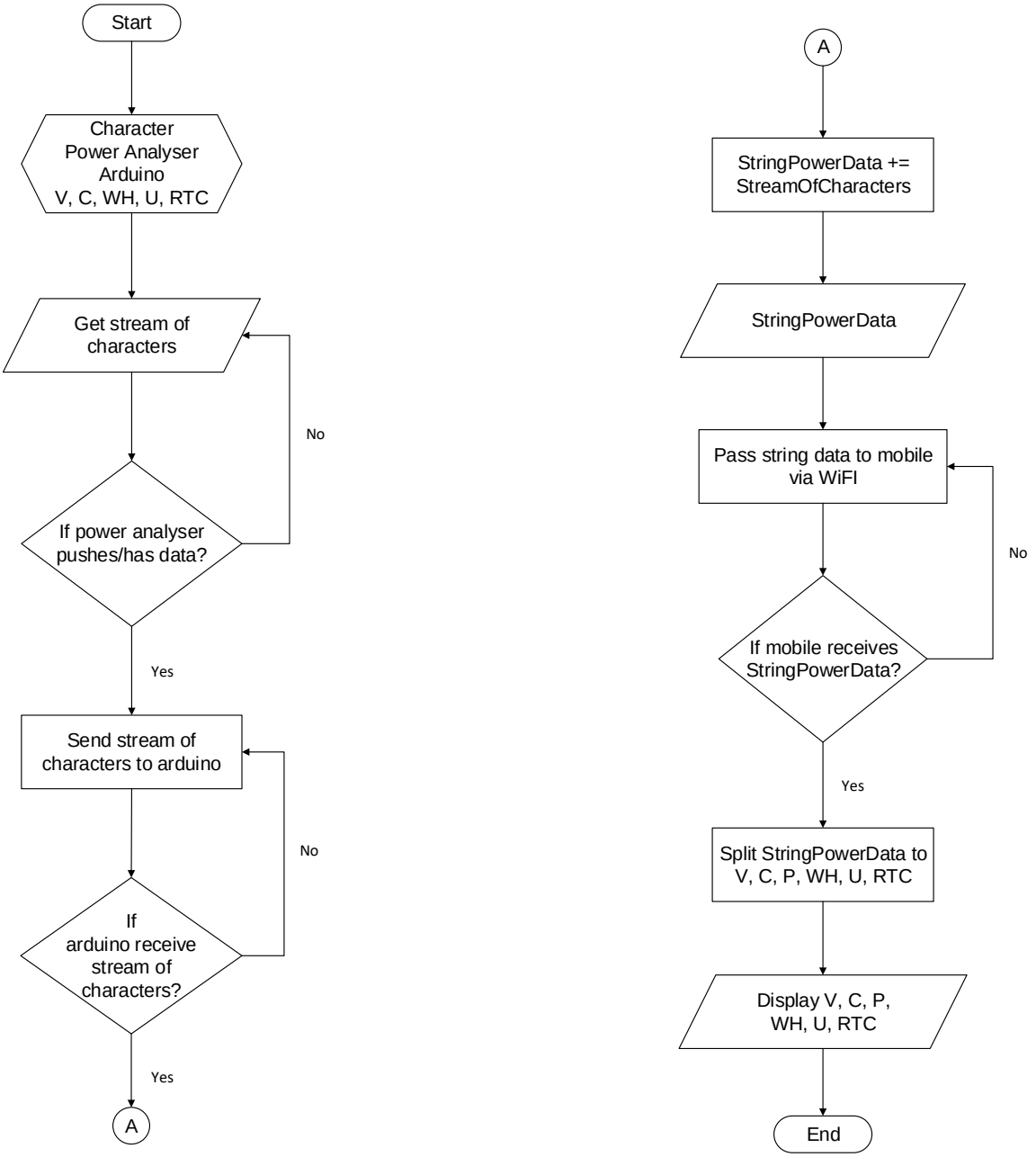

Figure 2. Algorithm Flowchart

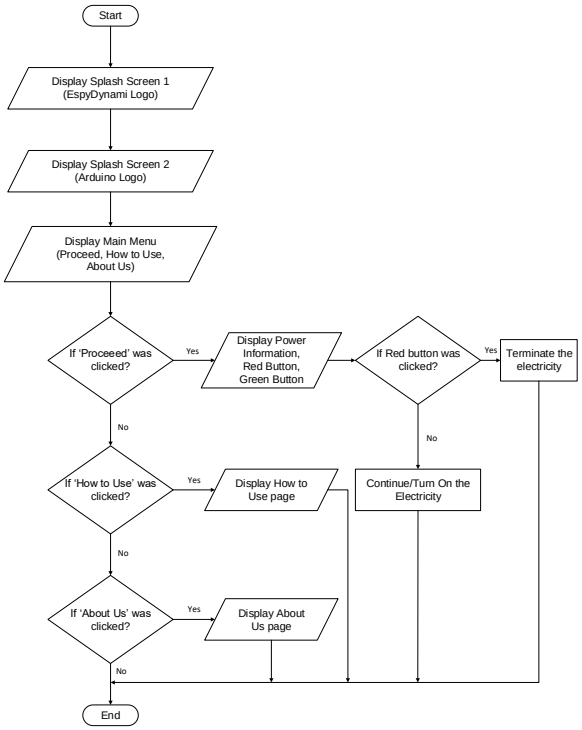

Figure 3. Application Process Flowchart

2.4 Programming Language

Creating the Power Monitoring mobile application was possible with the use of Java as its programming language. Processing Development Environment (PDE) was used to make and to write an easy Processing program. According to Fry and Reas (2012), created programs are called sketches and those were written in Text Editor. Sketches were compiled in a folder called Sketchbook.

Processing's capabilities are extended to its Libraries and Tools. Hundreds of libraries are available to make things beyond the central coding. Community contributed to enhance of what can be added to sketches that resulted to new things like 3D shapes, computer vision, and connection to other hardware. Tools were extended to PDE which

provides interfaces for creating better sketches like adding colors to the design. (Fry and Reas, 2012)

Processing can adapt to different programming languages but Java mode is the default one. It will help the user to deploy sketches to different platforms in different ways. (Fry and Reas, 2012)

2.5 HARDWARE

The researchers made an own-designed hardware that will help to gather electricity information. The hardware includes power analyzer, Ethernet shield, Arduino, breadboard, modem, relay, and real-time clock.

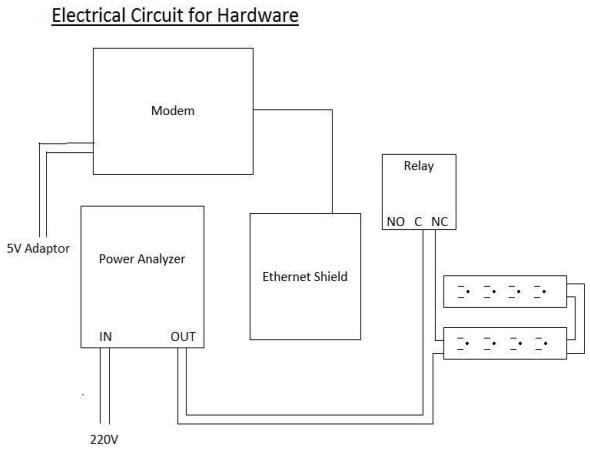

Figure 4. Electrical Circuit for Hardware

2.5.1 Power Analyzer

Based from Yokogawa (2016), power analyzer is also known as power meters or wattmeter's and it measures consumed electricity. It analyzes different parameters such as motor drives, home appliances, office equipment, power supplies, industrial machinery and other devices. In the hardware, the power analyzer is used to measure power information that is passed to the Arduino in a form of stream of characters.

2.5.2 Ethernet Shield

The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 Ethernet chip (datasheet). The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. The Ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield. (Arduino, 2016)

2.5.3 Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board. (Bruce, 2011)

Arduino in this application will receive the data from the power analyzer. There is a string concatenation process in which the stream characters will be processed. The codes for Arduino will be coded at the computer, in order to load new code onto the board – the user can simply use a USB cable.

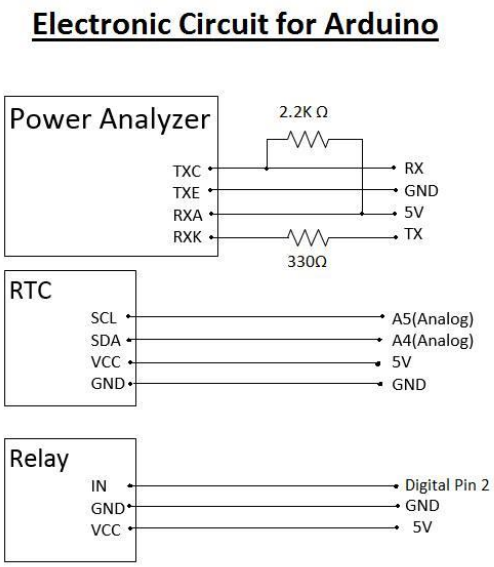

Figure 5. Electronic Circuit for Arduino

2.5.4 Breadboard

A breadboard is used to build and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted. The bread board has strips of metal which run underneath the board and connect the holes on the top of the board. (Dmercer, 2014)

2.5.5 Modem

Based from TechTerms (2016), a modem is a communications device that can be either internal or external to the computer. It allows one computer to connect to another computer and transfer data over telephone lines.

In this research, the modem will be used to transfer the data from the Arduino to the user's Android mobile phone.

2.5.6 Relay

A relay switch often opens and closes circuits via electromechanical or electronic means as defined in Reference.com (2016). They control one electrical circuit or output device by opening and closing the contacts on another circuit. Relay contacts are identified as normally open (NO) or normally closed (NC). NO contacts are open when they are not energized and NC contacts are closed when they are not energized. However, electric current will change the state of either type of contact.

Relays are able to control the flow of current between when a low-voltage circuit controls a high-voltage circuit. Relays also come in two different forms:

- Electromechanical
- Solid state (SSR)

An electromechanical relay (EMR) uses magnets to open and close the circuits while solid state (SSR) relays use electronics.

2.5.7 Real-time Clock

A real-time clock (RTC) is a computer clock, usually in the form of an integrated circuit that is solely built for keeping time. Naturally, it counts hours, minutes, seconds, months, days and even years. RTCs can be found running in personal computers, embedded systems and servers, and are present in any electronic device that may require accurate time keeping; being able to still function even when the computer is powered down through a battery or independently from the system's main power is fundamental.

(Techopedia, 2016)

3.0 METHODS

EspyDynami application was made in Java programming language and only an android-based application.

Other hardware materials were considered in order to make this application possible. First and foremost, power analyzer was used to compile all the power that was consumed. The data collected was passed through in a serial communication to the Arduino in a form of stream of characters by the method string concatenate and string tokenizer. Processing was used as an IDE which is an open source language/development tool for writing **programs in** *other* **computers. It is useful when the user wants those other computers to "talk" with an Arduino, for instance to display or save some data collected by the Arduino. The application gets the power data from the Arduino through Wi-Fi connection which has the Ethernet protocol to communicate with Arduino with Wi-Fi Shield. The application also has a stream of characters and performs the data parsing to it to distinguish information that will be displayed.**

The main objective of this application is to monitor power consumption by displaying the voltage, current, power, watt/hour, and its uptime. A real time clock is another tool that was used to get the time, date, and the day of the week which can also be shown in the application. A master shut off switch was also included as a button to cut the current of the power which loses, stops, or turns off all the connected or plugged-in appliances /devices. This was done by cutting the connection to the Relay device by the correct designated codes. The 'Reset' button was also included to turn on and reconnect the current of the power.

4.0 RESULTS AND FINDINGS

EspyDynami is a mobile application that monitors and displays power data. It used an Arduino to gather those data that are needed. Those data undergo the process of Data Parsing which is the algorithm that was used.

The users can see how much electricity they are consuming. In this way, they become aware of their current consumption of electricity and able to limit the use of their appliances in a specific room.

From the results obtained during a series of tests, EspyDynami is a working mobile application that can be used to monitor power consumption, voltage, current and watt-hour. It also proved that the shut off switch button can stop the flow of electricity. Trying different devices and appliances in the hardware prototype was a success. To prove this process, the researchers conducted various types of tests which were categorize based on the number of devices working and how far away from the modem the application can work by showing data and showcasing the shut off switch. EspyDynami is surely 100% accurate on the information that is shown and provided.

Similarly, the results of the trials and tests of the mobile application also showed the limitation and scope of the application. EspyDynami only monitors and shows data per area or room only. It cannot identify specifically what the devices and appliances in the room that works at the same time.

Figure 6. EspyDynami App Drawer

Figure 7. Splash Screen 1 (EspyDynami Icon)

Figure 8. Splash Screen 2
(Arduino Icon)

Figure 9. Main Menu

Figure 10. Monitoring Screen

Figure 11. About Us Layout

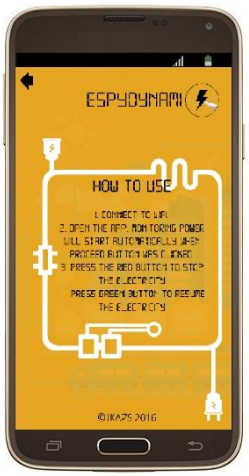

Figure 10. How to Use Layout

5.0 CONCLUSION

EspyDynami is a mobile application created to provide power data. It was developed to monitor and show power consumption, voltage, current, real power and uptime of a specific place with the use of their android phones. This study was developed not just to show data but also to help the users be aware in terms of electricity consumption. This application differs from other systems which are computer based since this uses Data Parsing as its algorithm and Arduino hardware in processing the data that need to be displayed. Users simply have to connect their android phone to the Wi-Fi and it will automatically do the monitoring.

6.0 RECOMMENDATION

This study can be a reference for future researchers who are developing mobile application projects in Processing as their IDE and give background information about Arduino. Furthermore, it is recommended that the design be enhanced by adding more features and functionalities such as being able to identify what devices or appliances are running and which of them consumes electricity the most. It is also recommended that the application be modified by displaying the monitored power simultaneously in different rooms for better comparison and viewing of power consumption.

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