CHAPTER I

THE PROBLEM AND ITS BACKGROUND

Introduction

Electricity is one of the most important blessings that science has given to mankind. It has also become a part of modern life and one cannot think of a world without it. Electricity has many uses in our day to day life. It is used for lighting rooms, working fans and domestic appliances like using electric stoves, A/C and more. All these provide comfort to people.

Electricity, as defined by US EIA (2019), is the flow of electrical power or charge. Electricity is both a basic part of nature and one of the most widely used forms of energy. The electricity that we use is a secondary energy source because it is produced by converting primary sources of energy such as coal, natural gas, nuclear energy, solar energy, and wind energy, into electrical power. Electricity is also referred to as an energy carrier, which means it can be converted to other forms of energy such as mechanical energy or heat. Primary energy sources are renewable or nonrenewable energy, but the electricity we use is neither renewable nor nonrenewable.

What is the reason why people should conserve as much energy in the form of electricity as they can? According to the SOE Team (2016), Although it may not be obvious, there's a direct connection between your energy use and the environment. When you consume less power, you reduce the number of toxic fumes released by power plants, conserve the earth's natural resources and protect ecosystems from destruction. By taking steps to reduce your energy intake, you'll contribute to a healthier and happier world. There are a number of reasons why you should consider cutting back on energy consumption.

First of all, reducing energy use limits the number of carbon emissions in the environment. Carbon emissions play a significant role in climate change, which is thought to be the cause of powerful natural disasters in recent years. With billions of harmful emissions in the atmosphere, cutting back is always a good thing. In turn, conserving energy produces a higher quality of life. Reduced emissions result in cleaner air quality. In addition, it helps create a healthier planet, or at least helps sustain the resources we already have. Being conservative with energy can ensure that lakes, trees and animals are around for future generations.

Environment aside, why save on energy? The answer is simple and practical. You can save money! Cutting back on the amount of energy you use can reduce your energy bill significantly. With a combination of simple energy changes, you could potentially save hundreds of moneys on your energy bills each year. There is always room for energy improvements for everyone, no matter who.

Based on an article published by MNN (2019), The Natural Resources Defense Council says the cost of plugged-in but not used devices is about $165 per household, or $19 billion across the U.S. That amounts to about 44 million tons of carbon dioxide, or 4.6% of the country's total residential electricity generation, points out The New York Times. Moreover, according to Scottish Fire and Rescue (n.d.), switching off at the socket and pulling the plug out is the only way to be sure no electricity is flowing through an appliance. If left plugged-in, many appliances still have power flowing through them even though they look like they're off. The same is true of equipment in 'sleep mode' or on 'standby'. Lots of electric appliances contain transformers which retain power, even when

the appliance is switched off. If a fault develops, the transformer could overheat and start a fire.

The number of fire incidents slightly increases throughout the years.Senior Fire Officer 2 Ramil Gillado of the Bureau of Fire Protection (BFP) said majority of the fire incidents in the past years were caused by electrical short circuits and unattended plugged-in electrical appliances or devices (Sunstar, 2018). Same thought was delivered on an article published by Philippine Star (2014), which stated that overloading or plugging in too many devices in a single socket is the most common way of abusing and damaging electrical wires. Wires can deliver only a certain amount of energy, depending on its size. When you plug in several devices to one socket, these wires are now forced to transmit electricity to all these devices beyond its capacity.

With increasing rate of fire incidents due to electrical wirings or unattended plugged-in appliances, an inspiration to avoid these incidents have emerged. This research study aims to create a mobile application that will monitor plugged-in devices and will be able to terminate the current when needed to. The application was named “ARTHECT“. The application will enable the user to track which devices are left plugged-in and is consuming electricity at their home wherever they are for as long as they are connected to the internet.

Statement of the Problem

The study aimed to create an electric current terminator application that will enable users to monitor plugged devices and terminate the electric current of that device. Specifically, the study ought to answer the following:

1. How accurate is the application in terms of detecting plugged devices and in terminating electric current of the plugged devices?
2. How long will it take for the device to terminate electric current?
3. How will be the device be evaluated in terms of the following:
    a. Accessibility
    b. Device Efficiency
    c. User's Satisfaction

Significance of the Study

This study seeks to contribute to the field of science and technology and to the development of knowledge. It also aims to help the following sectors of the community:

Homeowners. The device is significant to the homeowners because it will help them to decrease the electricity being consumed in their house. The application will alarm the user if there are any appliances left plugged in and the device will immediately cut off the flow of electricity in that particular socket manually. It can also avoid different kinds of incidents that involves leaving an electronic device plugged in.

Application Developer. This device can help the application developers to upgrade some features that the researcher's app already contains. The efficiency of the application may also be improved by the application developers.

Researchers. This device can help the future researchers to come up with a more advance device that can help the society. It can provide ideas and information that might help the researchers for their future studies.

Scope and Delimitations

The main purpose of the study was to build and program a device that will help homeowners to be aware whenever there are any basic appliances switched on. Primarily, the study focuses on how to control the electricity consumption and to prevent incidents regarding household appliances that are still plugged in electrical sockets. The program was based on the software Arduino and this device covers some of the basic electrical appliances inside the house and the application can only be navigated through a mobile phone and not on any another device.

Since the research used mixed method research design, both qualitative and quantitative data were collected. The researchers aim to determine how accurate is the application in terms of detecting plugged devices and in terminating electric current of the plugged devices. The researchers also recorded the time it took for the device to respond in terminating the electric current and in alarming the user of the left plugged devices through SMS. Moreover, the researchers conducted a structured interview for the evaluation of the device. A total of 10 respondents, Grade 12 students from Valenzuela City School of Mathematics and Science were interviewed. The respondents must also have internet connection at their homes since the application requires internet connection in order to function. The study was conducted for two and a half months starting from January to March 2020.

Definition of Terms

This part of the study provides the key terms used in writing the research paper. The conceptual and operational definitions were given for further comprehension of the paper.

Electric Meter. According to Wilson the electric meter is a device that measures the amount of electric energy consumed by a building, tenant space, or electrically powered equipment. In this study, a smart electric meter is used to read the consumption data and to monitor a user's energy consumption

Current Electricity. Defined by Jimblom as the form of electricity which makes all of our electronic gizmos possible. This form of electricity exists when charges are able to constantly flow. In this study, the current electricity is the one being cut off by the application.

Arduino. Arduino is an open-source electronics platform that is based on easy-to-use hardware and software. Arduino boards can read the sets instructions that a user input to create an output. This is the software being used by the researchers in creating the device

GSM Module. The GSM, stands for Global System for Mobile communication, is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands. In this study, the Module is used to send a message to the user once it detects a plugged appliance/device at its own home.

Efficiency. Defined by Banton as the sign of peak level of performance using small inputs to produce greater amount of output. This is one of the factors of the device being evaluated by the respondents in the study.

Accessibility. According to the Interaction Design Foundation, Accessibility defines the ability of a user to use a product and services. This is also one of the factors being evaluated by the respondents in the study

CHAPTER II

THEORETICAL FRAMEWORK

This chapter presents the related literature and studies that are necessary in increasing the knowledge of the researchers. The collected literature and studies will support the data gathering and help accomplish the main objectives of the study. Also, theoretical framework will be presented in this chapter, which describes the theories relevance that shapes the basis of the study, and conceptual framework of the variables and its connection with each other.

Relevant Theories

This part describes and expounds the theories that are somehow related to study and have concepts which can be applied and used to support the study.

Practice Theory. Smart metering is advancing rapidly and consumption feedback from smart meters is expected to help residents to reduce their energy and water consumption. In recent years, more critical views have been expressed based on theories of social practice, arguing that smart meter feedback ignores the role of various mundane practices where energy and water are consumed and instead targets individuals as active decision-makers. They present a review of qualitative studies on smart meter feedback and results of a survey to European smart metering projects. They argue that theories of social practice can be used to reframe the challenges and potentials of smart meter feedback that have been identified in the literature and our survey. This presents challenges of smart meter feedback as resulting from normalized resource intensive practices rather than from uninterested and comfort-loving individuals. Potentials of improving the effectiveness of smart meter. (Mela, 2018)

Internet of Things Theory. A range of IoT devices are connected that need appropriate software development and ultimately, they represent a large network. Internet of Things or IoT is a global network of physical devices connected to the Internet. These devices are equipped with sensors and other information transfer mechanisms. The devices are usually combined by means of connection to a control and/or processing unit. Internet of Things theory states that inanimate equipment will be able to speak. (Kh, 2015)

Related Literature

This part explains the related literature about some of the variables involved in the study. The concepts and notions mentioned was used to support and further understand the study.

Energy Consumption. All things plugged in will bleed some energy. Called "standby" electricity loss because it's so often associated with electronics in standby or idle mode, it's also known as "phantom" or "vampire" electricity. Even turned off, many appliances keep drawing power. Same goes for all those charger, whether or not a device is charging. Moreover, power supplies don't just convert energy; they consume it. Anything with a transformer draws power as long as it's plugged in, and because of poor design, these boxes waste up to three-fourths of the electricity that passes through them. The Department of Energy sets the loss at 5% to 8% of a single family home's annual usage, which is an entire month's energy bill. (Vadim, 2019). Similar article by Trulia (2015), also claimed that it’s estimated that households on average have 40 appliances that are constantly using power, contributing to 10% of household energy use. That adds up to about $100 a year.

Information is power in terms of human consumption behavior and monthly bills had been the standard feedback mechanism for residential electricity consumption. Even though it provides a collection and summary of electricity consumption of a household, it doesn't provide enough timely information to inform consumers about their decisions regarding on how they can reduce their own consumption (Naber, 2011)

Homes today consume 20% to 40% more energy compared to the energy homes necessarily need. In order to address this conflict, Advanced Metering Initiatives (AMI) is used. With the use of AMI, reduction only happens when there is a change in habitual behavior towards energy consumption since old habits occurring at homes influences the way homes consume energy. (Carroll, 2010)

In the residential sector, it consists of multiple small energy users compared to commercial and industrial sectors. In residential sectors there are houses, mobile homes, and apartments where its energy consumption accumulate fir up to 21% of the electricity used in United States and researches shows that almost 41% of that power is wasted. (Williams, 2007)

According to the results of the 2011 Household Energy Consumption Survey (HECS), statistics shows that in the Philippines, electricity remains as the most common source of energy used in households. About 87 percent of 21.0 million households used electricity from March to August 2011. The other sources used by a significant proportion of households include fuelwood, charcoal, LPG and kerosene with at least one-third of the total households using any of these types of fuel in 2011. (PSA, 2011)

Lighting Technology. According to Fetters (2004), an estimated of 40 percent of a commercial buildings' electrical energy is used for lightning. Although several programs have provided incentives for improving lighting efficiency, many buildings lighting systems have not yet been upgraded. If energy-efficient lighting systems were to be installed in these buildings, energy use and costs could be reduced dramatically and productivity increased. More so, according to Wood, Damon (2001), when it comes to alternative lighting systems, the smart investment is one that costs the least to both own and operate.

Using newer lighting technology, the energy use realistically can be reduced by 30 percent to 50 percent. This represents a significant opportunity to save energy in commercial buildings. Just like in other countries where the use of computed is optimized in controlling the operation of different machines. One of those is in US where they use an electronic program to control the operation of the heater and cooler. These programs usually involve extensive modification and/or replacements of the heating, cooling and ventilation (HVAC) systems of a facility, such as installing an energy management system which electronically controls the delivery of hot or cold air to various sections of a facility based on the timing or occupancy of sensors. (Lester, 2015)

With the aid of the electronic controller just like computer will operate the lighting system automatically by writing program software to serve the purpose.

Smart Meter. Reducing the power supply-demand gap and increasing reliability of power supply are the challenges of current energy management. Implementation of smart grid, smart meters and smart metering can be a possible solution for power demand reduction, efficient power supply management, and optimization of management resource

usages. Smart meters include sophisticated measurement and calculation hardware, software, calibration and communication capabilities. For interoperability within a smart grid infrastructure, smart meters are designed to perform functions, and store and communicate data according to certain standards. In this work we discuss smart meter and various elements of smart metering, current state of the technologies related to smart grid, smart meter, advanced metering infrastructure (AMI), and meter data flow in smart grid. We also discuss standards related to smart meter, meter data format and data transmission, functions of smart meter, and functionalities of smart meters, currently deployed by utilities around the world. (Barai, G., et al., 2015)

Smart meters are tools used to manage and record electricity and performance of electronic devices in the home. What makes the meters "smart" is their ability to provide detailed and accurate analytics on electrical usage in real-time or at predetermined intervals, all without a technician. The strategic potential of collecting a broad spectrum of information about electricity consumption includes the value of quick, accurate measurements and the elimination of monthly estimates and meter-reading home visits. Despite being the most energy-efficient and profitable means to manage an electrical grid, there are concerns over the personal data that smart meters are collecting in real-time, including what may be unnecessary information about hourly electricity use. This collection of data could, potentially, be a violation of users' privacy. (Sunshine, 2019)

Smart meters give both you and your energy provider accurate and regular updates on how much electricity and gas you use. Like traditional gas and electricity meters, smart meters measure your energy use. The main difference is that they automatically send this information through mobile networks to your supplier. When you have a smart meter

installed, you'll get a smart electricity meter, a smart gas meter, and an in-home display (IHD). These elements will talk to each other wirelessly. Your electricity meter will be connected to the mains, and will monitor how much power you're using in real time. Your gas meter will be battery powered and 'asleep' for most of the time, waking up every half hour to give a reading and communicate this via your electricity meter. The electricity smart meter is connected to a communications hub. Sometimes the hub is built into it. This allows it to communicate with your IHD, using the smart meter home-area network. It also talks to the wider Data Communications Company (DCC) network, via the smart meter wide-area network, so it can send your energy-use data to your supplier. (Which, 2018)

Related Studies

This part explains the related studies about some of the variables involved in the study. The concepts and notions mentioned were used to support and further understand the study. It also described the new variables involved in the study which are different from past research.

Energy Saving. According to the study of Northern California by the Natural Resources Defense Council, devices in state of idle power mode consumes energy that is about a quarter of all residential energy consumption which means, devices that are on the said state can consume 50 large power plants worth of electricity and value greater than $19 billion in every year's electricity bill. Comparing the overall electricity production to an environmental issue, it equivalent to 37 percent of all carbon dioxide emitted by the United States, one of the main contributors of climate change. (Schlossberg, 2016)

Neglecting to shut down or unplug unused computers can waste 30 billion kilowatt-hours of energy or more and statistics shows that, if there is an efficient way to use computers, energy costs savings can be greater than $3 billion. (Uniblue, 2006)

In evaluating the effect of the developing associate of always-on gadgets on buyer service bills, the Natural Resources Defense Council along with Home Energy Analytics and the Stanford Sustainable Systems Lab utilized three separate informational indexes: keen meter information from 70,000 northern California homes; shrewd meter and extra data for 2,750 San Francisco Bay Area homes; and a point by point in-home review of 10 Bay zone homes. In conclusion, the discovery about "always-on" power use by latent gadgets speaks to all things considered almost 23 percent of northern California family unit power utilization. (Delforge, 2015)

Energy Management. Buildings in a new California office park are controlled for comfort, energy usage and security are done by state-of-the-art computerized systems that combine sophisticated monitoring capability with ease of management. After-hours security is enhanced by a combination of card readers and magnetic door locks that interfaces well with the computerized control system. (Duprin, 2017)

Energy management controls in each building turn air conditioning equipment and lighting on and off automatically, based on pre-programmed building and occupant requirements. The controls are totally automatic and adaptive to changing outside or inside environmental conditions. The result is "loadside optimization," providing the necessary comfort for building occupants while using the least amount of energy. Each building with its respective control system is monitored remotely by a standard personal computer (PC) located at the corporate centre's maintenance office. Through color graphics that enhance

operator interaction with the system, the computer provides valuable real-time information on building conditions and system operations. The system is "user friendly," which improves the efficiency of maintenance operations. The maintenance engineer can even diagnose problems and make adjustments to the system from home on weekends as tenant needs change. (Duprin, 2017)

The company can also calculate what type of power classrooms are giving off and suggest how to use it more efficiently. VanderVliet said that, a more effective strategy involving when to run lights can be suggested, and a computerized lighting system would save on electrical costs. (Davidson, 2008)

This study differs with the present study since the computer can monitor the personnel using the room. The program software can identify the authorized person to use the room within a period of time as specified during logging in the computer before using the rooms.

Lighting Control Technology. According to a web published research of the Greenbiz.com written by Dr. Piper today's scheduling control systems are more sophisticated, flexible and easier to use. With built-in controls that allow users to temporarily bypass the system, lights can be brought on earlier or left on later to provide lighting for special functions. Scheduling controls are used most widely in applications where building occupancy patterns are predictable and follow a set daily and weekly schedule. While the building can be divided into different control zones based on the occupancy of different areas, too many different control zones can make the use of scheduling controls difficult. Similarly, if areas within the building are unoccupied for more than an hour at a time during the day, it may be too difficult to take full advantage of

scheduling controls. Occupancy controls may be required to give the flexibility required. (Piper, 2012)

William Sandoval also wrote within the past decade, an increasing number of building management professionals have begun using lighting controls such as dimmer switches and timers to add comfort, flexibility, operational efficiency and, perhaps most important, energy savings to their buildings at the touch of a button. However, such controls have conventionally been "static" – that is, they require physical input from a user to operate, and they cannot collect any data about their surrounding environment or their own operational efficiency. (Sandoval, 2008)

Recently, a new web-based lighting control technology has been developed for commercial buildings that both gathers and analyzes data and communicates with other building systems to help ensure the most efficient lighting environment possible. Called the Digital microWATT system, this new integrated lighting automation technology has the potential to completely change the way buildings operate, leading to a greener, more comfortable building environment. (Oquino, 2005)

Parallel Ports. The parallel port is used generally to manage printers. However, since this port has a group of inputs and digital outputs, it can be used to make practical experimental of reading of data and control of devices. This work seeks to give more relevant aspects of the parallel port, so that it can be used like an input output interface that works from a subordinate way to software routines. The circuit of the interface device may contain a opto-isolator. This opto-isolator isolates the low voltage coming from the computer and the high voltage coming from the lighting system. When there is a voltage coming from the pin of the parallel port, it will trigger the driver transistor connected to

the electromagnetic switch controlling the lights. The low voltage coming from the computer parallel port may vary according to the instructions given by the user using a program. (Roca, 2014)

According to Tomi Engdalh, many computer programs can be used in controlling the parallel port among those are Borland Pascal 7, DOS Debug, Assembler, Basic, and C, and Linux. But in this design the researcher uses a Visual Basic 6, for the reason of convenience in writing the program codes than in any other programs. However, there are some limitations built into Visual Basic. VB cannot directly access the hardware on a system. All hardware requests must go through Windows. Because of this, the closest that one can get to manipulating the parallel port is with the Printer object. While it is possible to actually print something, it is useless when one wants direct hardware control. There is a need to know the address of the port one wants to use, there is also a need for two other things; the command to access the port and the number that is needed to set it to. The command will be explained in a little while. The ports work with numbers. These can be expressed in hex, binary or decimal, but for this document all values will be expressed in decimal. The operation of the port by sending a number that represents the binary pattern of the physical outputs on the port. (Engdalh, 2012)

After knowing about the port number, it is now ready to create a form in the visual basic environment. All the necessary tools are placed in the form. Moreover, the codes are written based on the port number assigned. Every port number determines what pins in the parallel port will receive the voltage in order to trigger the interface device.

The above cited related literature and studies herein reviewed indicate in some way a picture of the important ideas and background which guided the researcher in developing

the study. It further provided empirical data on the computerized lighting control system for energy regulation, the use of interface device and other related factors relevant to the present investigation.

Conceptual Framework

The research paradigm of the study provides a guide to follow throughout the research. It shows how the research proceeded and how the answers to the research questions were obtained. Figure 1 shows the research paradigm of the study.

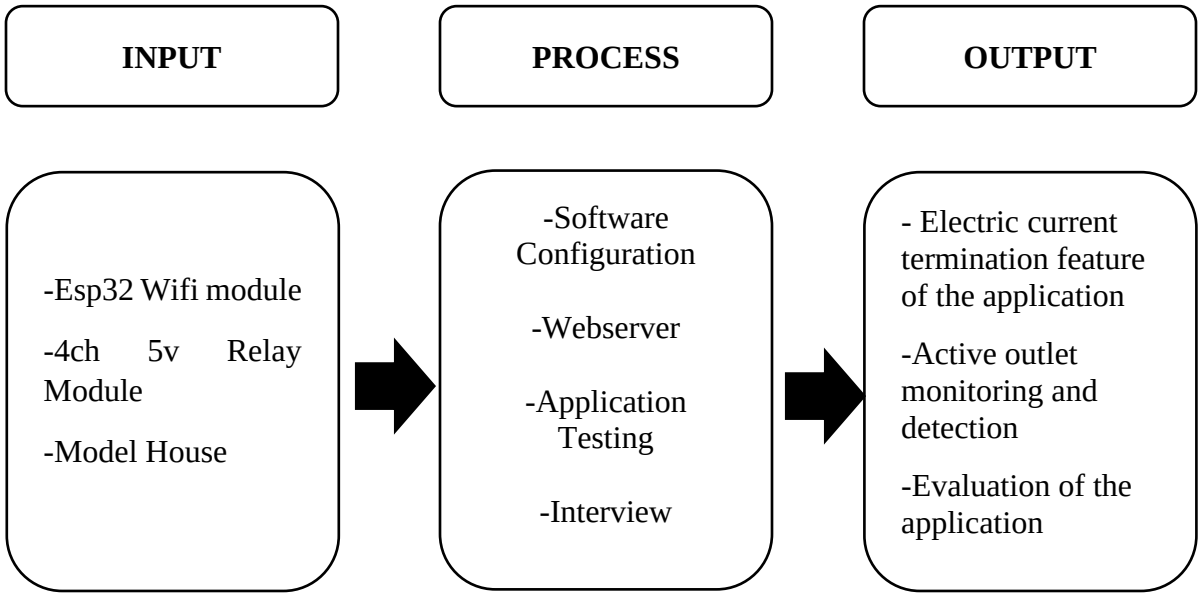

Figure 1. Research Paradigm of the Study

An input-process-output model was used in the study. The study made use of Esp32 WIFI module and a 4ch 5v Relay module in creating the product. A model house was also made in order to simulate a normal scenario inside a house. The software was then configurated and a webserver was made. After the application software has been made, it has undergone testing, and was evaluated by users through structured interview. The output of the study was an application that can monitor and terminate electric current of the outlets.

Hypotheses

This part of the paper presents the hypotheses that predicts the outcome of the study. The following assumptions are made:

1. The application will not be 100% accurate in terms of detecting plugged devices and in terminating electric current of the plugged devices
2. The device will not take at least a second to terminate the electric current

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents an outline of the methods of the study. It provides the information about the methods and techniques of the study. This includes the population and the sample of the study. The instruments for data gathering are present along the data processing and statistical treatments in testing the hypothesis. The researchers also include the method for the qualitative data analysis.

Methods and Techniques of the Study

For the mixed method research design, the researchers used the innovation design in developing the device and the application in monitoring of electric consumption and in terminating the electric current for plugged appliances. The researchers developed the device and an application and made household residents, specifically, the grade 12 students of the Valenzuela City School of Mathematics and Science validate it in terms of accessibility, efficiency and user satisfaction respectively.

The researchers developed a floor plan of the structural-house model where the sockets with the device are placed. In order to construct structural-house model, the researchers gathered the necessary materials with its exact amount and measurements. The researchers included three small-scale devices, mini speakers, lamp, and an electric fan with wire connectors. Its purpose is to represent the appliances that can be found at the household. In order to construct the modified electric socket, the researchers gathered all the materials needed and made the device by connecting the wires to the Arduino uno with esp8266 wi-fi module and program the Arduino uno. The researchers made an application

where a household member can connect their appliances to the modified electrical socket. With this, the application made by the researchers are now subject in terminating the electric current is possible even while plugged. The researchers used structured interview in order to answer the evaluation of the application in terms of accessibility, efficiency and user satisfaction.

Population and Sample of the Study

The population needed for the interview will be carefully analyzed to ensure that the results gathered for the qualitative research is aligned with the topic and that the chosen respondents have the appropriate authority as well as experiences to answer the question. Purposive sampling will be used to identify and gather the participants.

Purposive Sampling, as defined by Crossman (2020), is a non-probability sample wherein the participants chosen is based on its classification in a population and on the objective of the study, also, a very useful method in gathering information from the respondents for a short period of the time respondents were qualified to participate in the research if they had the experience of being a household member. The researchers had randomly chosen ten (10) grade 12 students from the Valenzuela City School of Mathematics and Science living in Valenzuela.

Research Instrument

The researchers used an interview guide will serve as the guide for data gathering and the responses will be the study's data necessary in answering the research problem. Following the structured interview, the interview guide did not contain any follow-up

questions. The constructed interview questions were based on the research questions and it was validated by three (3) qualified teachers to prevent redundancy.

The insights of the respondents were gathered through a structured interview in order to evaluate the device and application in terms of accessibility, efficiency and user satisfaction. The structured interview, defined as a quantitative research method commonly used in survey research (Trueman, 2015). According to Yolanda Williams (2015), structured interviews are standardized and follow a fixed format, and questions are given in a specific order. Each person being interviewed is asked the same set of questions in the exact same order in the exact same way, increasing the reliability, or consistency, of one's interviews.

Materials and Design

The tables and figures provided are the materials, codes and diagrams needed to build the application, smart-outlet, and the structural-house model. This explained how the application worked and it served as a plan on how the researchers would collect and analyze the gathered data.

Materials and Equipment	
Materials	**Quantity/Dimension**
NodeMCU ESP8266	1 UNIT

ARDUINO UNO	1 UNIT
GSM MODULE	1 UNIT
4ch 5V Relay Module	1 UNIT
WIRES	1 M
ELECTRIC SOCKET	3 UNITS
DIODE	1 UNIT
12V SUPPLY	1 UNIT

Table 1: *Materials needed to build the ARTHECT and the smart-outlet*

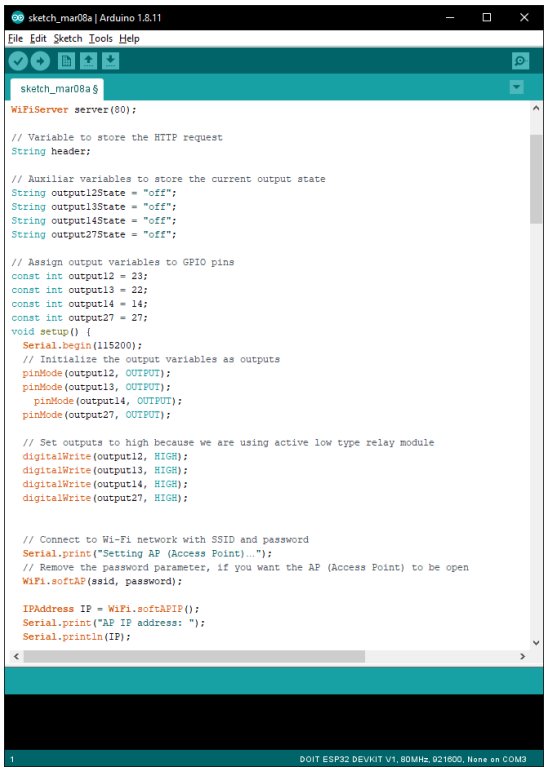

Figure 1: *Codes for connecting the ARTHECT to Wi-Fi*

Figure 2: *Codes for terminating the electric current of the smart-outlet*

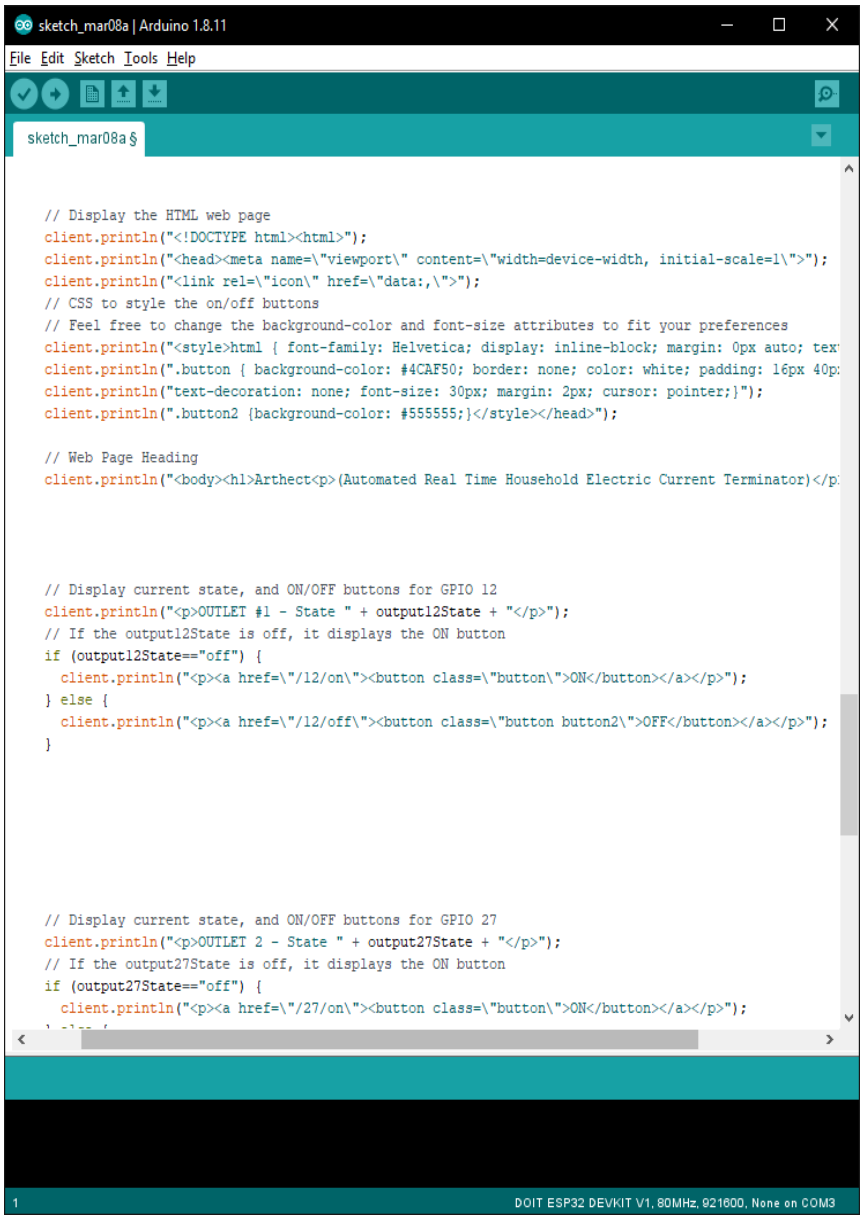

Figure 3: *Continuation of ARTHECT codes*

Materials and Equipment	
Materials	**Quantity/Dimension**
PLYWOOD	4 PIECES – 24” x 24” x 0.5” 1 PIECE – 24” x 24”x 1.5”
POPSICLE STICKS	7 PACKS
FOAM	8 PIECES – 2.25” x 3” x 1” /piece
VARNISH	3 BOTTLES
MINI ELECTRIC FAN	1 UNIT
DIMLIGHT	1 UNIT
MINI SPEAKER	1 UNIT

Table 2: *Materials needed to build the structural-house model*

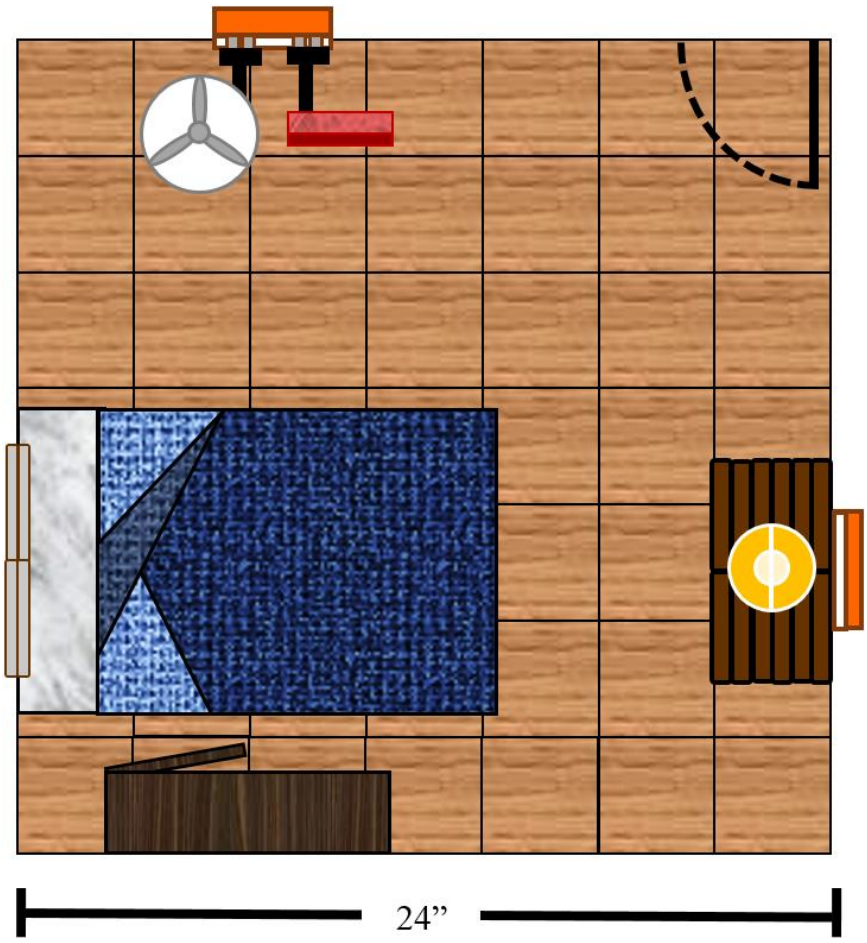

Figure 4: *The floor plan of the structural-house model*

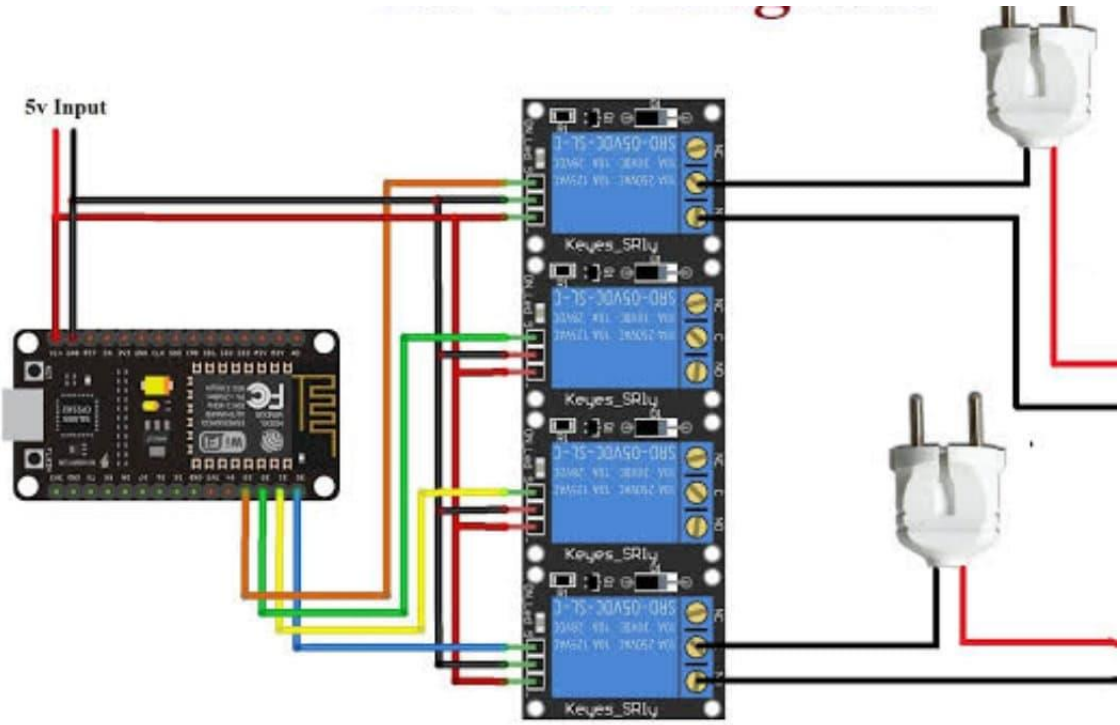

Figure 5: *Schematic Diagram of the ARTHECT and smart-outlet*

Data Gathering and Procedure

The methods that are used in the study starts by programming the application. Through the use of Arduino, the ARTHECT was made. At the same time, a structural-house model was made to visualize the effectiveness of the device better. After this, a series of test were conducted to obtain results. To get a feedback from the respondents, data gathering through interviews took place. The responses were decoded in order to get an overall theme.

Data Processing and Statistical Treatment

The gathered data was tabulated and interpreted. The statistical tool that was used is the Measures of Central Tendency. According to Frost (n.d), A measure of central

tendency is a summary statistic that represents the center point or typical value of a dataset. These measures indicate where most values in a distribution fall and are also referred to as the central location of a distribution. The statistical tool the researchers used is the mean, which defined as the arithmetic average calculated by adding up all the values and dividing it by the number of observations or tests. The researchers computed for the average time it took for the device *to terminate its electric current* and the average time it took for the user of the application to *receive an alert message* when there is a forgotten plugged device. The researchers would then interpret the results based on the data gathered.

Qualitative Data Analysis

After conducting the interviews, the responses of participants are consolidated and categorized according to the interview questions. Following the process, coding was done to determinate distinction of the participant's responses. According to Stuckey (2015), coding is defined as the process of determining and interpreting emerging themes from the data gathered. Important concepts are marked and noted in the responses and through the process of open coding, the researchers came up of a concept that can represent the point of interest noted in the responses. Once all the responses are determined by the code, the codes are organized according to its similarity in thought and category. In the process of axial coding, the codes grouped with similarity in thought and category are represented by a word or phrase that encompassed the categorized codes. In turn, these codes were analyzed regarding the primary idea they conveyed, or the emerging themes they suggested. From this, process of selective coding is conducted, and statements is formed that encompasses the axial codes and necessary to answer the research questions.

From these, the resulting coding was interpreted and used to explain the answer to its corresponding research question. These explanations and discussions have been ensured validity through the backing of related literature and references.

CHAPTER IV

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This entire chapter focuses on the discussion of the findings on the said research study. To avoid misunderstandings, the researchers used tables to present the result followed by a thorough explanation.

PART I. Accuracy of the device

This part presents and analyzes the quantitative data collected during data gathering. It shows the accuracy of the device. In order for data to be accurate, the data value must be the right value and must be represented in a consistent and unambiguous form

Table 3. Application's Response Table

TRIAL	OUTLET 1	OUTLET 2	OUTLET 3
1	D	D	D
2	D	D	D
3	D	D	D
4	D	D	D
5	D	D	D
6	D	D	D
7	D	D	D
8	D	D	D
9	D	D	D
10	D	D	D
Total	10 Detected 0 Undetected	10 Detected 0 Undetected	10 Detected 0 Undetected

LEGEND:

D – DETECTED **ND** – NOT DETECTED

Accuracy= (Total No. of Detected Trials 1..,10) / (Total No. of Undetected Trials 1,..,10) *100 %

= (3+3+3+3+3+3+3+3+3+3) / (0+0+0+0+0+0+0+0+0+0) * 100%

Accuracy= 100 %

The application was tested under 10 different trials wherein each of the outlets was intendedly left with plugged in devices. The application was tested whether it is successful in detecting that an appliance is currently plugged-in the outlet. After 10 trials, every outlet was detected with left plugged-in device. Calculating the total number of outlets detected throughout all of the trials and, dividing it to total number of outlet undetected throughout all of the trials, and multiplying it to 100%, yielded a total accuracy of the application of 100%.

PART II. Responding Time of the Application

In this part, the result of the quantitative data collected are presented and analyzed. It will answer the time it will take for the application to successfully terminate electric current on each outlet. This gave way into answering the second research question of the study.

Table 4. Termination of Electric Current

TRIAL	OUTLET 1 (secs)	OUTLET 2 (secs)	OUTLET 3 (secs)	AVERAGE TIME (secs)
1	0.82s	0.91s	0.87	0.867
2	0.91s	0.92	0.85	0.893
3	0.85s	0.83	0.84	0.83
4	0.83s	0.87	0.98	0.893
5	0.88s	0.85	0.91	0.88
				0.8726

The table 4 present the results of the time it took for the application to terminate electric current on each outlet. The time was measured from the moment the “Off” button

was pressed on the application, to the time the outlet lost it electric current flow. Varying but close are the values on each other. The average time for each trial was calculated and an overall mean 0.87 secs of was yielded. This means that the average time that it takes for the application to terminate the electric current passing through an outlet is less than a second. On the other hand, it will take an average of 2.224 secs to terminate all of the 3 outlets.

Part III. Evaluation of the device in terms of its usability, functionality, and features

This part presents the qualitative data of the study. In this portion summary of each responses are presented and analyzed. It answers how the device was evaluated in terms of its accessibility, efficiency, and satisfaction to the users.

Accessibility of the Application. It is important for an application to be accessible since it is the degree in which a product is available or can be used by as many people as possible. Based on the response of the respondents, it can be deduced that the application is accessible to the users despite being an internet-based application which requires an internet connection in order to function. Some respondents said that many people in today's time already have access to internet so this application can be access anywhere and anytime.

Interview Question No. 1 Responses

Response 1: "Yes, I think even though it is an internet-based application, it's still easy to manage."

Response 2: "Yes, yes, I think that many people have internet connection and using the app can be used by many users"

Response 3: “I think it can be widely used by the user because most of us have an internet connection in our phone”

Response 5: “Yes, because anyone in the household could use the application”

Response 8: “ Yes, despite the fact that the application is internet-based, I think that it is still a smart move to use the application because it will monitor which appliances are left plugged.”

Response 9: “ I think it can be widely used by the user because most of us have an internet connection in our phone.”

Response 10: “Yes. Yes I believe that it can really help in monitoring plugged devices and appliances especially when we are not home.”

Efficiency of the Application. An efficient device enables user to accomplish something with the least waste of time and effort. Two interview questions were asked to the respondents to see how the user evaluates application’s efficiency. From the interview questions, most of the respondents said that the application is effective and beneficial since its features as an automated electric current terminator can reduce hazard, and reduce electric consumption.

Interview Question No. 2 Responses

Response 1: “it is effective since it alarms the user and gives information”

Response 2: “Highly effective”

Response 4: “I think it will be very effective.”

Response 5: “it would be beneficial because it could reduce hazard on households”

Response 6: “ It is effective and beneficial to the user when it comes to electric bills and such. It can help conserve electricity and help lessen their electricity bill.”

Response 7: “ This is beneficial for the users in a way where they can monitor their electricity no matter where they are or what they are doing.”

Response 10: “it can adversely affect the user's life as it avoids the user to be forgetful of the plugged appliances”

Interview Question No. 3 Responses

Response 1: “I think when it shows that if there's an electricity current or not. Because it's a way for you to check and manage it”

Response 2: “By reducing the amount of electric consumption”

Response 3: "If people forget to plug out their devices while they are away from home. They could terminate the electricity online to conserve energy.”

Response 4: “ If you got a big house, it could be painstaking to unplug every appliance every night so there is a tendency to leave your appliances plugged even when not in use.

Response 5: “It could conserve electricity by automatically turning off the switch when it is not in use”

Response 7: “This device can help the citizens especially those who frequently left their appliances on. With the use of this device, the citizens may switch down their appliances and conserve electricity no matter where they are.”

User’s Satisfaction to the application. Satisfaction is fulfillment of an individual’s expectation or needs. Through the application, the researchers aimed to develop an application that will supply an unnoticed need of the people. Result of the conducted interview suggested that the application was successful in terms of satisfying the user with its simple user interface. Respondents claimed that the application is easy to use and to navigate. More so, this interface of the application made it convenient to use. However,

some respondents also suggested that further improvements may be done in order to make the application more functional.

Interview Question No. 4 Responses

Response 1: “ Yes, it's simple”

Response 2: “Yes, the user friendly system”

Response 3: “Yes, i think the app is user friendly because it is simple and easy to operate.”

Response 4: “ yes. the app is straightforward and could be used without instructions. the user interface is also good although it can still be improved.”

Response 6: “ Yes. Based on the features that I saw, I can say that it is easy to use because the application was very simple. When you open the app, you can already see the buttons for the outlets, the user will not be confused on how to use it.”

Response 7: “ Yes, the controls are easy to use and the buttons are not hassle to enable. Also, the LED lights are not misleading for the users and also visible. The switches are also functioning.”

Response 8: “ Yes, I think that the application is easy to be understood by the user. I really like the function of the application that can set time when will a certain plugged appliance will lose its electric current.”

Response 10: “I think the application is user-friendly. Because, one click is all it takes. There are no features that made it hard to use. The features are easy to understand and not complicated. It is applicable for all ages.”

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATION

This chapter presents the summary, conclusion, and recommendation of this research study. This also includes the answers to the questions based on the results of the experimentation. It provides the needed information about the study, the conclusion drawn based on the findings and recommendation of the researchers of the improvisations of further researchers.

Summary of Findings

This part of the paper presents the summary of the results of data collection process. The experimentations seek to describe the answer the research questions of the study. It aims to describe how accurate the application is, how long will it take for the application to terminate current on each of the outlets, and the evaluation of the users on the application.

1. **How accurate is the application in detecting plugged-in devices?**

   The accuracy of the application was computed by calculating the total number of detected active outlet divided by the total number of undetected active outlet, for each trial, and multiplied to 100%. A total of 100% was gathered, this suggests that the application is 100% accurate in determining which outlets are consuming electric current. More so, the null hypothesis to this research question must be rejected since the accuracy in detecting the outlets with plugged in appliance or device is 100%.

2. **How long will it take for the device to terminate electric current on each of the outlets?**

The average time it took for the application to terminate electric current on each outlet was gathered in order to answer the second research question. It takes an average time of 0.87 secs to terminate the electric current on a particular outlet. Hence, the null hypothesis must be accepted since the time it takes to terminate an electric current using the device is less than a second.

3. **How will be the application be evaluated based on its accessibility, efficiency, and satisfaction of the user.**

   The application was evaluated based on the following criteria: accessibility, efficiency, and user's satisfaction. The interview responses were analyzed and a selective code have emerged. Based on the results, the application is clearly accessible to the users despite the fact that it requires internet connection in order to function. Additionally, respondents said that the application is efficient because of its automated features and it can reduce hazard and reduce unwanted electric consumption. Lastly, respondents were satisfied with the application's user interface because of its simplicity which made it easy to use and to navigate.

Conclusion

1. The application is accurate in terms of detecting plugged devices and in terminating electric current of the plugged devices.
2. It takes less than a second for the device to terminate electric current.
3. The application is accessible, efficient, and satisfies the expectations and needs of the user.

Recommendation

The main objective of this study was to design and create an application that can monitor and terminate the current of the outlets with unwanted plugged in devices or appliances. The following recommendations were made based on the analysis and findings of the results:

1. A feature of the application which can monitor and terminate plugged devices through the use of SMS.
2. Compare the data gathered to other possible studies that may have used the same variables.
3. According to the response of the participants, the application would be better if there is a way to monitor and/or terminate electric current without the use of internet connection. Additional features such as real time detection of electric consumption of each plugged in devices will make the application much significant.

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APPENDICES

APPENDIX A

INFORMED CONSENT

WIFI based Household Electric Current Terminator

Lead Researcher
Jan Christian Torres
Valenzuela City School of Mathematics and Science
A.Pablo St. Malinta, Valenzuela City
09957211565
torresjanchristian02@gmail.com

PURPOSE OF STUDY

You are selected as one of the contributors as a study subject for a research study. Before proceeding as a participant, it is necessary for you to understand why this study is conducted or learn its research objectives and concerns. Read the following information below with full understanding. Questions will be answered accordingly.

The purpose of this study is to create an electric current terminator application that will enable users to monitor plugged devices and terminate the electric current of that device.
The interview questions will be answering the statement of the problem of the study which is: How will be the device be evaluated in terms of the following:

a. Accessibility
b. Device Efficiency
c. User's Satisfaction

STUDY PROCEDURES

The researchers are requesting responds from the respondents to their interview questions. Study Subject's Demographics as well as collected samples will be dealt with utmost confidentiality and anonymity. The researchers will conduct a structured interview using a validated interview guide that meets the study's objectives.

RISKS

The researchers assure that no harm in any form will be inflicted to you. You may decline to
answer any questions you deemed personal or inappropriate to answer

BENEFITS

The Development of the application will benefit home owners, application developers, and future researchers. Success of the study might also help conserve energy since it will terminate the electric current of the devices that are left plugged at home.

CONFIDENTIALITY

Your responses to this interview will be anonymous. Please do not write any identifying
information on your interview or for the purposes of this research study, your comments will not be anonymous. Every effort will be made by the researchers to preserve your confidentiality including the following:

- The researchers will assign code names/numbers for participants that will be used throughout the study.
- The data or information gathered from the participant such as notes, interview transcriptions, and any information that may reveal the participant's identity will be kept in the possession of a trusted member.

Participant data will be kept confidential except in cases where the researchers are legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

The data gathered from the participants will be kept confidential except in cases where the researchers are obliged to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

CONTACT INFORMATION

If you have queries, or experience negative effects brought by this study, you may inform the
Lead Researcher whose contact information is supplied on the first page of this consent. If you have questions regarding your rights as a participant of this study, or if problems arise which you do not feel you can discuss with the researchers you may inform their Inquiries, Investigations and Immersion (III) Teacher Rachel Lyn Mendoza

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether to decline our request or partake in this study. After you sign this consent form, you can still recede from this study any time you want and without giving a reason. Withdrawing from this study will not affect your relationship, if you have any, with the researchers. If you withdraw from the study before the collection of data is completed, the data gathered from you will be returned to you, or will be deleted or destroyed.

CONSENT

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature: _____ Date: _____

Lead Researcher's signature: _____ Date:_____

APPENDIX B

Validation Form

Republic of the Philippines
Department of Education
National Capital Region
Division of City Schools - Valenzuela
Valenzuela City School of Mathematics and Science
A. Pablo St., Malinta, Valenzuela City

REQUEST FOR VALIDATION OF RESEARCH INSTRUMENT

February 28, 2020

MERLYN GAMBOA
Teacher III
Valenzuela City School of Mathematics and Science
A. Pablo St., Malinta, Valenzuela City, MM

Dear Ma'am,

As part of the requirements in the subject Inquiries, Investigation, and Immersion we are conducting a research study entitled *SMARTHECT: System Monitoring Automated Real Time Household Electric Current Terminator.*

In this view, we would like to seek your expertise in validating the proposed interview questions in line with our data collection task.

Herewith is the accomplished research instrument validation form for your perusal and comment.

May this request merit your kind consideration and approval.

Thank you.

Respectfully,

JAN CHRISTIAN TORRES
Research Group Representative (12-Locke),
Valenzuela City School of Mathematics and Science

Noted:

(Sgd.) **RACHEL LYN MENDOZA**
Teacher, Inquiries, Investigation, and Immersion

Republic of the Philippines
Department of Education
National Capital Region
Division of City Schools - Valenzuela
Valenzuela City School of Mathematics and Science
A. Pablo St., Malinta, Valenzuela City

RESEARCH INSTRUMENT
VALIDATION FORM
(Inquiries, Investigation, and Immersion)

I. Research Title: SMARTHECT: System Monitoring Automated Real Time Household Electric Current Terminator.
II. Research Proponents: Jasmin, James; Nicolas, Von Ramwel; Torres, Jan Christian; Espinosa, Elyssa Kristine; Mendoza, Desiree.
III. Research Respondents: Household member

IV. Statement of the Problem:

The study aims to create a smart-meter application that will enable users to monitor their electricity usage through their mobile phones.

Specifically, the study aims to answer the following:

1. How effective is the SMARTHECT in household electricity conservation and monitoring?
2. Is the SMARTHECT a household electricity monitoring device, an easy to use device in terms of:
   a. Accessibility
   b. Device Efficiency
   c. User's Satisfaction
3. How long will it take for the device respond to the following?
   a. Termination of electric current b. Alert message for forgotten plugged appliances

V.

Research Question	Proposed Interview Question	Revision (if any)
1. Is the SMARTHECT a household electricity monitoring device, an easy to use device in terms of: a. Accessibility	**1.1.** Comparing to the traditional way of monitoring household electric consumption, in what qualities do they differ and does it make the SMARTHECT easier to access?	**1.1,** ibang word
	1.2. What are the advantages of the application in terms of electricity conservation and monitoring?	**1.2.** Despite being an internet-based application, do you think that SMARTHECT can be widely used by the people? If yes, if no.

No question for b. Device efficiency

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	1.3. In what ways do you think can SMARTECH be beneficial to the users?	**1.3.** this has nothing to do with accessibility - revise or omit
2. Is the SMARTHECT a household electricity monitoring device, an easy to use device in terms of: c. User's Satisfaction	**2.1.** Do you think that the application is user-friendly? If yes, then what features made it user friendly. If no, what features do you think should the application include?	**2.1.**
	2.2. Overall, how effective do you think is the application in serving its purpose, which is to enable the users to conserve and monitor electric consumption?	**2.2.**

Note: Please use blue or red pen in writing revision for each proposed interview question.

VALIDATED:

MERLYN GAMBOA
(Signature over printed name)

DATE OF VALIDATION
03 / 02 / 2020

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National Capital Region
Division of City Schools - Valenzuela
Valenzuela City School of Mathematics and Science
A. Pablo St., Malinta, Valenzuela City

	1.3. In what ways do you think can SMARTECH be beneficial to the users?	**1.3.**
2. Is the SMARTHECT a household electricity monitoring device, an easy to use device in terms of: c User's Satisfaction b.	**2.1.** Do you think that the application is user-friendly? If yes, then what features made it user friendly. If no, what features do you think should the application include?	**2.1.**
	2.2. Overall, how effective do you think is the application in serving its purpose, which is to enable the users to conserve and monitor electric consumption?	**2.2.**

Note: Please use blue or red pen in writing revision for each proposed interview question.

VALIDATED:

ROMEO MICLAT
(Signature over printed name)

DATE OF VALIDATION
02 / 28 / 20

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National Capital Region
Division of City Schools - Valenzuela
Valenzuela City School of Mathematics and Science
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	SMARTECH be beneficial to the users?	
2. Is the SMARTHECT a household electricity monitoring device, an easy to use device in terms of: c. User's Satisfaction	**2.1.** Do you think that the application is user-friendly? If yes, then what features made it user friendly. If no, what features do you think should the application include?	**2.1.**
	2.2. Overall, how effective do you think is the application in serving its purpose, which is to enable the users to conserve and monitor electric consumption?	**2.2.**

Note. Please use blue or red pen in writing revision for each proposed interview question.

VALIDATED:

RUEL DOGMA
(Signature over printed name)

DATE OF VALIDATION

___/___/___

APPENDIX C

Interview Guide

Republic of the Philippines
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Valenzuela City School of Mathematics and Science
A. Pablo St., Malinta, Valenzuela City

Interview Questions:

1. Despite being an internet -based application, do you think that SMARTHECT can be widely used by the users? If yes, do you think that it is smart move to use the application? Explain. If no, what factor do you think made SMARTHECT?

2. How effective and beneficial to the user is the devise as a real time household electricity terminator?

3. In what way do you think does the device can help in conserving electricity?

4. Do you think that the application is user-friendly? If yes, what features made it easy to use? If no, what features do you think should the application improve or include?

APPENDIX D

Interview Transcript

<table>
<tr><th colspan="4">Interview Question No.1
Despite being an internet -based application, do you think that ARTHECT can be widely used by the users? If yes, do you think that it is smart move to use the application? Explain why. If no, what factor do you think made ARTHECT ?</th></tr>
<tr><th>Response</th><th>Open Code</th><th>Axial Code</th><th>Selective Code</th></tr>
<tr><td>Response 1 “Yes, I think even though it is an internet-based application, it's still easy to manage but lack of internet connection is still a small problem on using it”</td><td>• Accessible</td><td rowspan="6">Accessibility of the application despite internet requirement

Ability to reduce hazard, conserve electricity and monitor plugged devices</td><td rowspan="6">The application is accessible to the user and it is smart move to use it</td></tr>
<tr><td>Response 2 “Yes, yes, I think that many people have internet connection and using the app can be used by many users”</td><td>• Accessible</td></tr>
<tr><td>Response 3 “I think it can be widely used by the user because most of us have an internet connection in our phone. Although, it can be used by everyone i think only a few people will use this app.”</td><td>• Accessible</td></tr>
<tr><td>Response 4 “Yes. Yes, because it can help in conserving electricity and preventing fires that could be caused by unplugged appliances.”</td><td>• Accessible
• Minimizing hazard
• Conserve electricity</td></tr>
<tr><td>Response 5 “. yes, because anyone in the household could use the application”</td><td>• Accessible</td></tr>
<tr><td>Response 6 “ • Yes, it is a smart move to use the application.”</td><td>• Accessible</td></tr>
</table>

Response 7 “ Yes, I think that using this application is a smart move especially to those people who often stay at their houses such as mothers and other household members.”	• Accessible		
Response 8 “ Yes, despite the fact that the application is internet-based, I think that it is still a smartmove to use the application because it will monitor which appliances are left plugged.”	• Accessible • Monitoring		
Response 9 “ I think it can be widely used by the user because most of us have an internet connection in our phone. Although, it can be used by everyone i think only a few people will use this app.”	• Accessible		
Response 10 “Yes. Yes I believe that it can really help in monitoring plugged devices and appliances especially when we are not home.”	• Accessible • Monitoring		

Interview Question No.2

How effective and beneficial to the user is the device as a real time household electricity terminator?

Response	Open Code	Axial Code	Selective Code
Response 1 “it is effective since it alarms the user and gives information”	• Effective • Alarms	Different levels of effectivity and beneficiality	The application is effective and beneficial to the user for its features which can reduce hazard, minimize risk, and
Response 2 “Highly effective”	• Highly Effective		
Response 3 “I think this app will help people a bit.”	• A little Effective		

Response 4 “i think it will be very effective.”	• Highly Effective	Ability to reduce hazard, conserve electricity and monitor plugged devices	reduce electric consumption.
Response 5 “it would be beneficial because it could reduce hazard on households”	• Beneficial • Reduce hazard		
Response 6 “ It is effective and beneficial to the user when it comes to electric bills and such. It can help conserve electricity and help lessen their electricity bill.”	• Effective • Beneficial • Conserve electricity • Minimize electric bill		
Response 7 “ This is beneficial for the users in a way where they can monitor their electricity no matter where they are or what they are doing. This can also open the possibilities of lesser consumption of electricity.”	• Beneficial • Conserve electricity • Monitor		
Response 8 “ I think that it is effective and beneficial to the user in a way that it can lessen unwanted electric consumption. Moreso, it can also avoid the incidents involving this matter.”	• Conserve electricity • Minimize hazard		
Response 9 “ I think this app will help people a bit.”	• A little beneficial		
Response 10 “it can adversely affect the user's life as it avoids the user to be forgetful of the plugged appliances. and this is beneficial in a way that it will save more energy and save time as he no longer has to return to his home to fully unplug the appliance, he has left plugged.”	• Beneficial • Conserve electricity • Monitor		

Interview Question No.3 In what way do you think does the device can help in users?			
Response	**Open Code**	**Axial Code**	**Selective Code**
Response 1 “i think when it shows that if there's an electricity current or not. Because it's a way for you to check and manage it”	• Monitoring	Ability to reduce hazard, conserve electricity and monitor plugged devices	Through automated electric current terminator, electric consumption may be reduced and minimize work required.
Response 2 “By reducing the amount of electric comsumption”	• Reducing electric consumption		
Response 3 "If people forget to plug out their devices while they are away from home. They could terminate the electricity online to conserve energy.”	• Reducing electric consumption • Monitoring		
Response 4 “ if you got a big house, it could be painstaking to unplug every appliance every night so there is a tendency to leave your appliances plugged even when not in use. with smarthech, it will be easier to prevent the said scenario.”	• Monitoring • Minimize work • Automated current terminator		
Response 5 “it could conserve electricity by automatically turning off the switch when it is not in use”	• Automated current terminator • Reducing electric consumption		
Response 6 “ The device is very effective because for example, you left your phone while it’s still charging in your house. Through the device you will be able to turn off the electric current in that outlet.”	• Automated Terminate current • Monitoring		
Response 7 “This device can help the citizens especially those	• Monitoring		

who frequently left their appliances on. With the use of this device, the citizens may switch down their appliances and conserve electricity no matter where they are. “	• Automated current terminator		
Response 8 “ I think it will eliminate the unwanted electric consumption consumed by plugged appliances.”	• Automated current terminator • Reducing electric consumption		
Response 9 “ If people forget to plug out their devices while they are away from home. They could terminate the electricity online to conserve energy.”	• Automated current terminator • Reducing electric consumption		
Response 10 “I think the device can help conserve electricity in a way that the user will not have a chance to leave any plugged appliances any more because he/she has this device already.”	• Reducing electric consumption • Automated current terminator		

Interview Question No.4

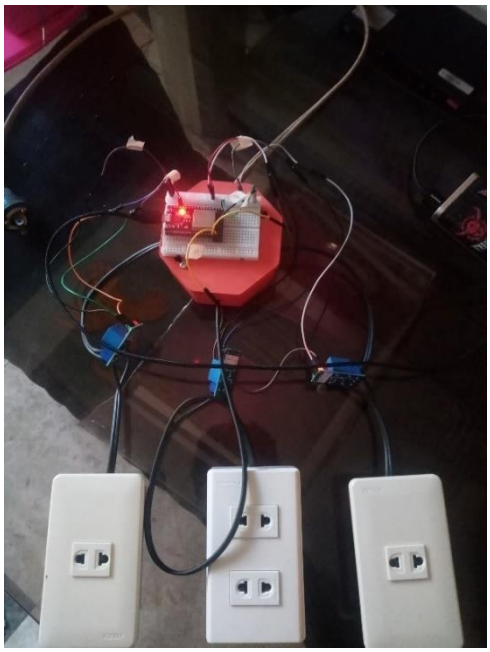
Do you think that the application is user-friendly? If yes, what features made it easy to use? If no, what features do you think should the application improve or include?

Response	Open Code	Axial Code	Selective Code
Response 1 “ yes, it's simple”	• Simplicity	Application is simple, convenient, and has an overall good user interface	Simple and complete user interface made the application convenient for the users
Response 2 “Yes, the user friendly system”	• Simplicity		
Response 3 “Yes, i think the app is user friendly because it is simple and easy to operate.”	• Simplicity • Convenient		

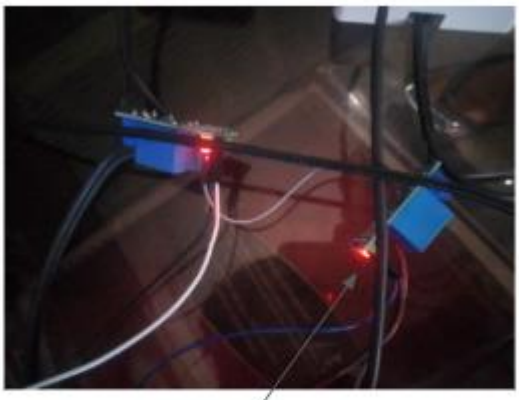
Response 4 " yes. the app is straightforward and could be used without instructions. the user interface is also good although it can still be improved."	• Simplicity • Good User Interface	Application has great function and complete features	
Response 5 " yes, because all the controls needed are on the application"	• Completeness		
Response 6 " Yes. Based on the features that I saw, I can say that it is easy to use because the application was very simple. When you open the app, you can already see the buttons for the outlets, the user will not be confused on how to use it."	• Simplicity		
Response 7 " Yes, the controls are easy to use and the buttons are not hassle to enable. Also, the LED lights are not misleading for the users and also visible. The switches are also functioning."	• Simplicity • Organized		
Response 8 " Yes, I think that the application is easy to be understood by the user. I really like the function of the application that can set time when will a certain plugged appliance will lose its electric current."	• Simplicity • Functional		
Response 9 " Yes, i think the app is user friendly because it is simple and easy to operate."	• Simplicity • Convenient		
Response 10 "I think the application is user-friendly. Because, one click is all it takes. There are no features that made it hard to use. The features are easy to understand and not complicated. It is applicable for all ages."	• Simplicity • Convenient		

APPENDIX E

Documentation

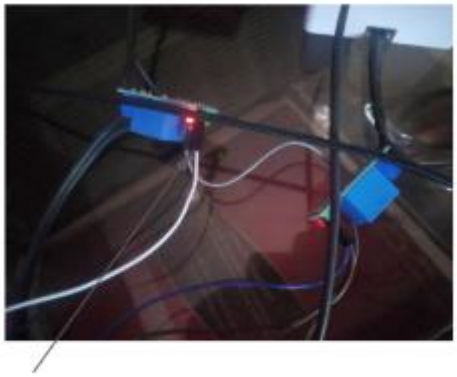


Creating the product



ONLY ONE LIGHT

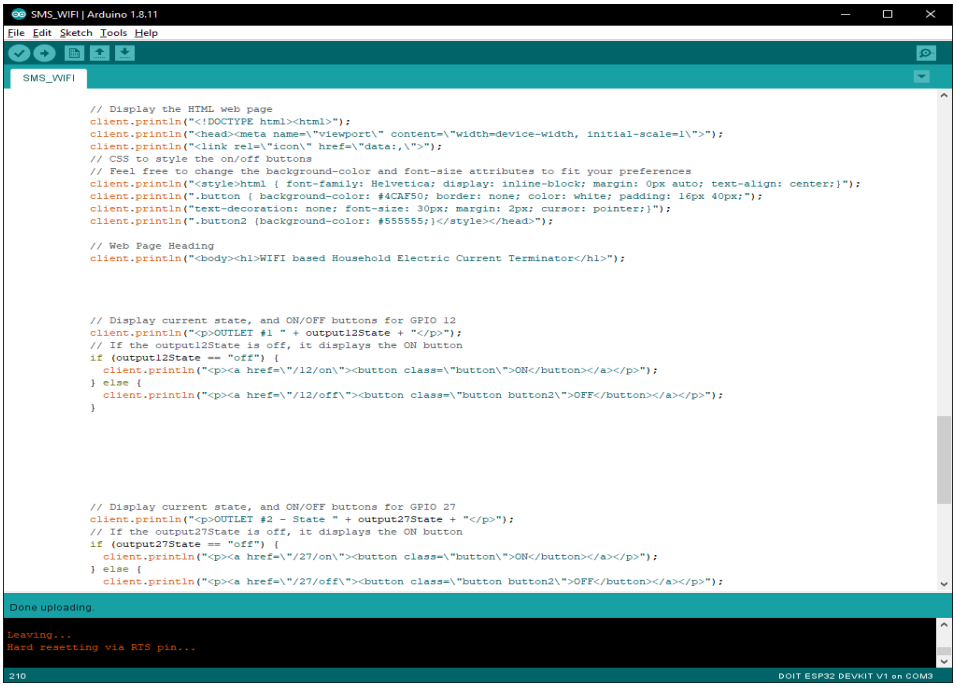
Testing: All of the outlets are o



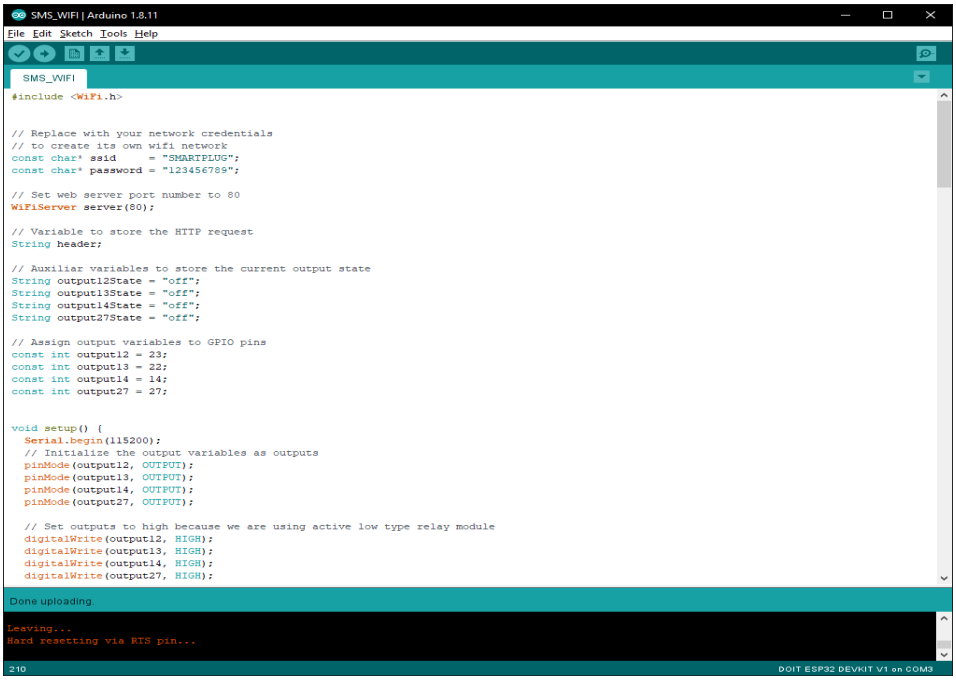
2 LED ON = THE ELECTRIC CURRENT IS PRESENT

Testing: Two outlets were turned off are on

Programming Codes



```
SMS_WIFI | Arduino 1.8.11
File Edit Sketch Tools Help
SMS_WIFI

            // Display the HTML web page
            client.println("<!DOCTYPE html><html>");
            client.println("<head><meta name=\"viewport\" content=\"width=device-width, initial-scale=1\">");
            client.println("<link rel=\"icon\" href=\"data:,\">");
            // CSS to style the on/off buttons
            // Feel free to change the background-color and font-size attributes to fit your preferences
            client.println("<style>html { font-family: Helvetica; display: inline-block; margin: 0px auto; text-align: center;}");
            client.println(".button { background-color: #4CAF50; border: none; color: white; padding: 16px 40px;");
            client.println("text-decoration: none; font-size: 30px; margin: 2px; cursor: pointer;}");
            client.println(".button2 {background-color: #555555;}</style></head>");

            // Web Page Heading
            client.println("<body><h1>WIFI based Household Electric Current Terminator</h1>");



            // Display current state, and ON/OFF buttons for GPIO 12
            client.println("<p>OUTLET #1 " + output12State + "</p>");
            // If the output12State is off, it displays the ON button
            if (output12State == "off") {
              client.println("<p><a href=\"/12/on\"><button class=\"button\">ON</button></a></p>");
            } else {
              client.println("<p><a href=\"/12/off\"><button class=\"button button2\">OFF</button></a></p>");
            }



            // Display current state, and ON/OFF buttons for GPIO 27
            client.println("<p>OUTLET #2 - State " + output27State + "</p>");
            // If the output27State is off, it displays the ON button
            if (output27State == "off") {
              client.println("<p><a href=\"/27/on\"><button class=\"button\">ON</button></a></p>");
            } else {
              client.println("<p><a href=\"/27/off\"><button class=\"button button2\">OFF</button></a></p>");

Done uploading.

Leaving...
Hard resetting via RTS pin...

210                                                    DOIT ESP32 DEVKIT V1 on COM3
```



```
SMS_WIFI | Arduino 1.8.11
File Edit Sketch Tools Help
SMS_WIFI
#include <WiFi.h>


// Replace with your network credentials
// to create its own wifi network
const char* ssid     = "SMARTPLUG";
const char* password = "123456789";

// Set web server port number to 80
WiFiServer server(80);

// Variable to store the HTTP request
String header;

// Auxiliar variables to store the current output state
String output12State = "off";
String output13State = "off";
String output14State = "off";
String output27State = "off";

// Assign output variables to GPIO pins
const int output12 = 23;
const int output13 = 22;
const int output14 = 14;
const int output27 = 27;


void setup() {
  Serial.begin(115200);
  // Initialize the output variables as outputs
  pinMode(output12, OUTPUT);
  pinMode(output13, OUTPUT);
  pinMode(output14, OUTPUT);
  pinMode(output27, OUTPUT);

  // Set outputs to high because we are using active low type relay module
  digitalWrite(output12, HIGH);
  digitalWrite(output13, HIGH);
  digitalWrite(output14, HIGH);
  digitalWrite(output27, HIGH);

Done uploading.

Leaving...
Hard resetting via RTS pin...

210                                                    DOIT ESP32 DEVKIT V1 on COM3
```

SMS_WIFI | Arduino 1.8.11

File Edit Sketch Tools Help

SMS_WIFI

```
void loop() {
 WiFiClient client = server.available();   // Listen for incoming clients

 if (client) {                             // If a new client connects,
   Serial.println("New Client.");          // print a message out in the serial port
   String currentLine = "";                // make a String to hold incoming data from the client
   while (client.connected()) {            // loop while the client's connected
     if (client.available()) {             // if there's bytes to read from the client,
       char c = client.read();             // read a byte, then
       Serial.write(c);                    // print it out the serial monitor
       header += c;
       if (c == '\n') {                    // if the byte is a newline character
         // if the current line is blank, you got two newline characters in a row.
         // that's the end of the client HTTP request, so send a response:
         if (currentLine.length() == 0) {
           // HTTP headers always start with a response code (e.g. HTTP/1.1 200 OK)
           // and a content-type so the client knows what's coming, then a blank line:
           client.println("HTTP/1.1 200 OK");
           client.println("Content-type:text/html");
           client.println("Connection: close");
           client.println();

           // turns the GPIOs on and off
           //foe GPIO12
           if (header.indexOf("GET /12/on") >= 0)
           {
             Serial.println("GPIO 12 on");
             output12State = "on";
             digitalWrite(output12, LOW);
           }
           else if (header.indexOf("GET /12/off") >= 0)
           {
             Serial.println("GPIO 12 off");
             output12State = "off";
             digitalWrite(output12, HIGH);
           }


           //for GPIO13
```

Done uploading.

```
Leaving...
Hard resetting via RTS pin...
```

210 DOIT ESP32 DEVKIT V1 on COM3

SMS_WIFI | Arduino 1.8.11

File Edit Sketch Tools Help

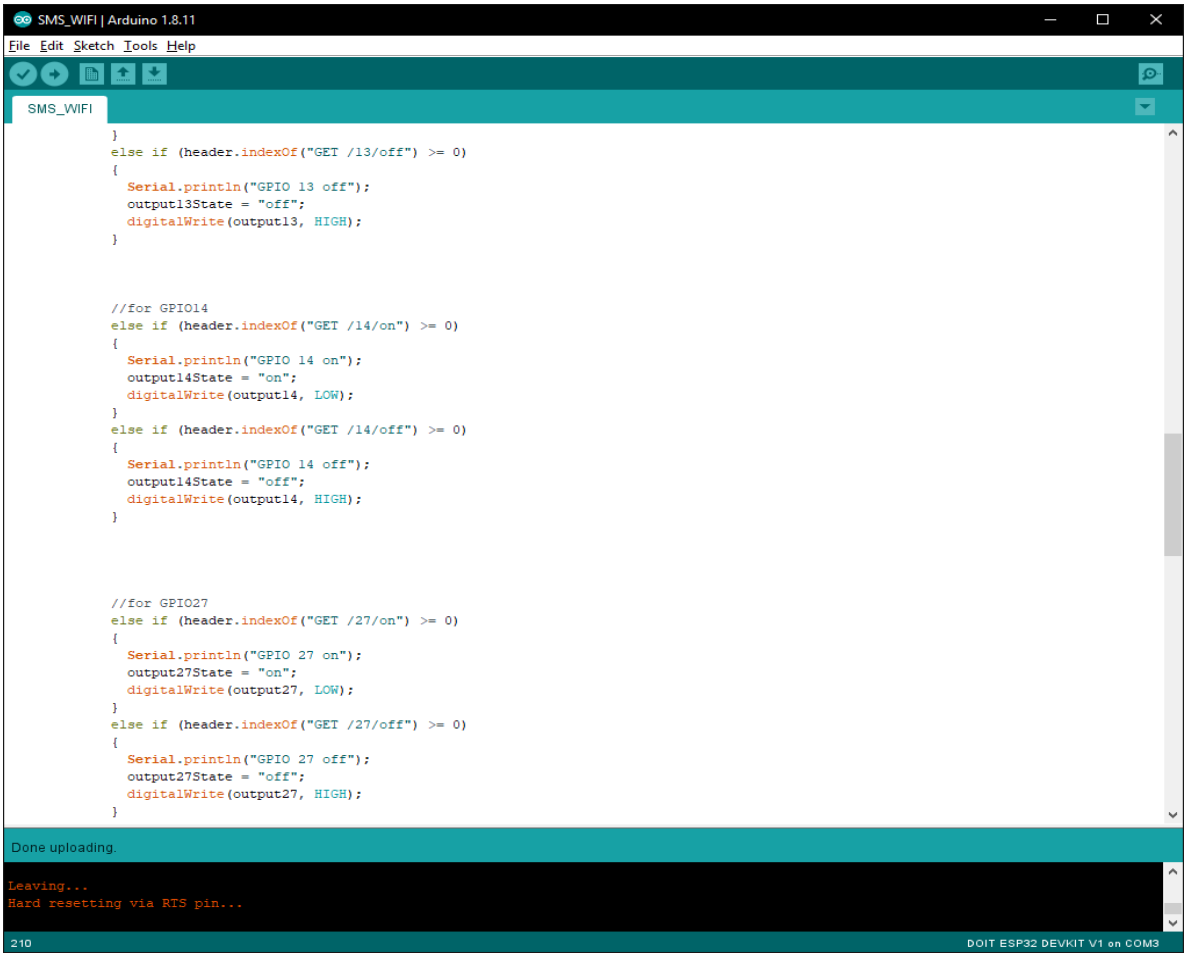
SMS_WIFI

```
           client.println("<p>OUTLET #2 - State " + output27State + "</p>");
           // If the output27State is off, it displays the ON button
           if (output27State == "off") {
             client.println("<p><a href=\"/27/on\"><button class=\"button\">ON</button></a></p>");
           } else {
             client.println("<p><a href=\"/27/off\"><button class=\"button button2\">OFF</button></a></p>");
           }


           // Display current state, and ON/OFF buttons for GPIO 13
           client.println("<p>OUTLET #3 " + output13State + "</p>");
           // If the output13State is off, it displays the ON button
           if (output13State == "off") {
             client.println("<p><a href=\"/13/on\"><button class=\"button\">ON</button></a></p>");
           } else {
             client.println("<p><a href=\"/13/off\"><button class=\"button button2\">OFF</button></a></p>");
           }

           // Display current state, and ON/OFF buttons for GPIO 14
           client.println("<p>OUTLET #4 - State " + output14State + "</p>");
           // If the output14State is off, it displays the ON button
           if (output14State == "off") {
             client.println("<p><a href=\"/14/on\"><button class=\"button\">ON</button></a></p>");
           } else {
             client.println("<p><a href=\"/14/off\"><button class=\"button button2\">OFF</button></a></p>");
           }



           client.println("</body></html>");


       }
     }
   }
 }
}
  }
```

Done uploading.

```
Leaving...
Hard resetting via RTS pin...
```

210 DOIT ESP32 DEVKIT V1 on COM3


SMS_WIFI | Arduino 1.8.11
File Edit Sketch Tools Help
SMS_WIFI
}
else if (header.indexOf("GET /13/off") >= 0)
{
Serial.println("GPIO 13 off");
output13State = "off";
digitalWrite(output13, HIGH);
}
//for GPIO14
else if (header.indexOf("GET /14/on") >= 0)
{
Serial.println("GPIO 14 on");
output14State = "on";
digitalWrite(output14, LOW);
}
else if (header.indexOf("GET /14/off") >= 0)
{
Serial.println("GPIO 14 off");
output14State = "off";
digitalWrite(output14, HIGH);
}
//for GPIO27
else if (header.indexOf("GET /27/on") >= 0)
{
Serial.println("GPIO 27 on");
output27State = "on";
digitalWrite(output27, LOW);
}
else if (header.indexOf("GET /27/off") >= 0)
{
Serial.println("GPIO 27 off");
output27State = "off";
digitalWrite(output27, HIGH);
}
Done uploading.
Leaving...
Hard resetting via RTS pin...
210
DOIT ESP32 DEVKIT V1 on COM3

APPENDIX F

Curriculum Vitae

CURRICULUM VITAE

JASMIN, CHRISTIAN JAMES B.

#4735 St. John Apartment, Pantaleon St.

Malanday, Valenzuela City, Philippines

Jamesjasmin43@yahoo.com

PERSONAL INFORMATION

Birthday: February 19, 2002

Birthplace: Manila City, Metro Manila

Religion: Catholic

Mother's Name: Cristina B. Jasmin Occupation: Housewife

Father's Name: Boy S. Jasmin Occupation: Collector Inspector

_____

_____

EDUCATIONAL BACKGROUND

Valenzuela City School of Mathematics and Science

2014-2020

A. Pablo St. Malinta, Valenzuela City

Academic Track – STEM Strand

Andres Fernando Elementary School

2006 – 2014

M.H. Del Pilar St., Malanday, Valenzuela City

CURRICULUM VITAE

NICOLAS, VON RAMWEL J.

#1 St. Elsewhere I. Fernando St., Malanday, Valenzuela City, Philippines

elyssaespinosak@gmail.com

PERSONAL INFORMATION

Birthday: June 20, 2002

Birthplace: Manila City, Metro Manila

Religion: Catholic

Mother's Name: Maria Cristina J. Nicolas Occupation: Nurse

Father's Name: Von Rommel T. Nicolas Occupation: n/a

Siblings: Crisza Joy Nicolas

Von Raphael Nicolas

EDUCATIONAL BACKGROUND

Valenzuela City School of Mathematics and Science

2014-2020

A. Pablo St. Malinta, Valenzuela City

Academic Track – STEM Strand

San Diego Parachial School

2007– 2014

Polo, Poblacion, Valenzuela City

C. Alejo Learning Center

2006-2007

Valenzuela City

CURRICULUM VITAE

TORRES, JAN CHRISTIAN L.

26 C. Santiago St.

Viente Reales, Valenzuela City, Philippines

Torresjanchristian8@gmail.com

PERSONAL INFORMATION

Birthday:	July 09, 2001	
Birthplace:	Marilao, Bulacan	
Religion:	Roman Catholic	
Mother's name:	Susana L. Torres	Occupation: Housewife
Father's name: Operator	Reuben T. Torres	Occupation: Businessman
Siblings:	Jean Charmaine T. Manuel	
	John Carlo L. Torres	
	Jo Camilo L. Torres	

EDUCATIONAL BACKGROUND

Valenzuela City School of Mathematics and Science

2014-2020

A. Pablo St. Malinta, Valenzuela City

Academic Track – STEM Strand

Malinta Elementary School

2007-2014

A. Pablo St. Malinta, Valenzuela City

CURRICULUM VITAE

ESPINOSA, ELYSSA KRISTINE A.

#132 Jamaica Dr., Arbor Towne Village

Gen. T. De Leon, Valenzuela City, Philippines

elyssaespinosak@gmail.com

PERSONAL INFORMATION

Birthday: June 20, 2002

Birthplace: Manila City, Metro Manila

Religion: Iglesia ni Cristo

Mother's Name: Nerisa A. Espinosa Occupation: Principal

Father's Name: Edmund T. Espinosa Occupation: Bank Manager

Siblings: Edriane Nico A. Espinosa Eris Ryan A. Espinosa

EDUCATIONAL BACKGROUND

Valenzuela City School of Mathematics and Science

2014-2020

A. Pablo St. Malinta, Valenzuela City

Academic Track – STEM Strand

Malinta Elementary School

2011– 2014

A. Pablo St. Malinta, Valenzuela City

St. Louis College of Valenzuela

2006-2011

#005 Maysan Rd., Maysan, Valenzuela City

CURRICULUM VITAE

MENDOZA, DESIREE T.

#669 B. Mendoza St.

Coloong, Valenzuela City, Philippines

ishimendoza3@gmail.com

PERSONAL INFORMATION

Birthday: January 3, 2002

Birthplace: Manila City, Metro Manila

Religion: Roman Catholic

Mother's Name: Elvira T. Mendoza Occupation: Housewife

Father's Name: Ernesto Andres C. Mendoza Occupation: Fish Vendor

Siblings: Gabriel Aldrin T. Mendoza

Lancer Andre T. Mendoza

EDUCATIONAL BACKGROUND

Valenzuela City School of Mathematics and Science

2014-2020

A. Pablo St. Malinta, Valenzuela City

Academic Track – STEM Strand

Nuestra Senora De Guia Academy

2006 – 2014

A. Deato St. Balangkas, Valenzuela City

APPENDIX G

Certification of Grammarian

APPENDIX H

Certification of Statistician

APPENDIX I

Plagiarism Test