American Academic Scientific Research Journal for Engineering, Technology, and Sciences
ISSN (Print) 2313-4410, ISSN (Online) 2313-4402
https://asrjetsjournal.org/index.php/American_Scientific_Journal/index

Design and Construction of Voice Controlled Smart Power Strip

Winfred Adjardjah[a*], John A. Addor[b], Peter Otchere[c], Wisdom Opare[d]

[a]*Department of Electrical and Electronic Engineering, Takoradi Technical University, P. O. Box 256, Takoradi, Ghana*

[b]*Department of Mathematics, Statistics and Actuarial Science, Takoradi Technical University, P. O. Box, 256, Takoradi*

[a]*Email: winfred.adjardjah@ttu.edu.gh*, [b]*Email: john.addor@ttu.edu.gh*

[c]*Email: peterotchere@ttu.edu.gh*, [d]*Email: wisdom.opare@ttu.edu.gh*

Abstract

This paper focuses on voice control for smart power strips, which constitutes the crux of the study. As technology develops, it is obvious that there is a swift increase in the development of smart homes. This is why the project is important because it combines voice control with a secure biometric activator and a wireless connection between the voice control system and the power strip. Through a combination of programming, in-depth research, simulations and analysis of the results, the proposed technique exhibited better performance than the current techniques. The voice recognition module sends signals to the first transceiver, which acts as the transmitter, and from there, to the second transceiver, which acts as the receiver. Finally, the signal is sent to the relay module, which controls the socket.

Keywords: Internet of Things (IoT); Power Strip; Smart Power Strip; **Infrared** (IR)**;** Microcontroller.

1. Introduction

Electrical appliances such as television, electric kettles, toasters, etc found in homes, offices and workplaces requires power supply to function appropriately. Electrical appliances are used in our everyday life right from morning through to evening. Nevertheless, these electrical appliances depending on their power rating require a specific electric power to work and function effectively. In various homes and offices, power outlet are the means through which electric power can be extended to the [1,2,3]. Electrical appliances connected to it. Power outlets extend alternating current (AC) power supply since most electrical appliances require AC power source. They are installed in wall to extend power supply to the appropriate places [4,5,6]. Electrical power outlet such as plug, and sockets comes in different power rating.

Received: 4/19/2023
Accepted: 6/6/2023
Published: 6/26/2023

----

* Corresponding author.

They also differ in size, shape and connector type. Outlets are designed to meet international standards. This makes it easy for electrical appliances to be connected to any power outlet. Some power strips consist of electrical sockets attached to the end of a flexible cable that enables multiple electrical devices to be powered [7,8].

Technological advancement over the past decades has made the transition into remotely controlled devices possible. This thoroughly research project proposes a systematic work of a voice-controlled power strips. Unlike traditional power strips, that requires direct touch to switch and control the contacts, this proposed voice-controlled power strips enables users to remotely control their power strips with their voice via a network [9,10,11]. The voice-controlled power strips consist of a System on Chip, relays, rectifier circuit, sockets, etc which makes it possible to be controlled remotely via voice. In referencing to related projects over the years, the subsequent examples give detailed reviews how adventuring our proposed development.

A new way of controlling power strip that is remote control using the voice through mobile phone with the help of the internet was introduced. A system of controlling any appliances connected to the power strip without a physical contact was developed. With this system, one can also control the appliances from afar with the help of IoT. Home automation is in high demand due to the development of voice recognition software like Amazon Alexa [12,15]. The primary objective was to create a method for quickly and cheaply converting a conventional house into a smart house (i.e., a house with home automation capabilities) without rewiring the house. Many power-strips on the market now make an effort to accomplish this. The Smart Power-Strip, on the other hand, uses a programmable microcontroller to control the Smart Power-Strip and a smart phone to remotely control devices plugged into the Smart Power-Strip, targeting homeowners who want more automation control without the high cost [16].

One thing that is quite significant is controlling electrical equipment within a specific time range. By managing the home's existing appliances, like the air conditioner, TV, fans, etc. It is frequently discovered that some electrical instruments that survive are not used, which reduces the lifespan of the electrical equipment in addition to waste [12,13,17,18]. Consequently, we require management and oversight of electrical equipment employing intelligent power strips. prototype smart power strip for mobile devices IoT, also referred to as the "internet of things," is a concept designed to help understand the advantages of continuous internet connectivity [19,20]. Using this idea, electrical devices that link smart electrical terminals or power strips can be monitored and controlled. by utilizing an electrical terminal device linked with a smartphone-controllable system and module. Android is one of the numerous smartphone operating systems that can connect to or facilitate all human work. One such function is in terms of control, where Android serves as a remote-control media that can be accessible by household electronics and unquestionably has established the first connection with the IoT module. This study discusses making smart sockets or smart power strips that can be rotated using a smartphone so that any electrical equipment can be used on users who do not use home [21].

The Contactless Infrared (IR) Temperature Smart Power Strip measures both the average temperature across an area and the surface temperature of an object based on the emitted IR waves of the target. It is a fast-responding, high-precision, contactless sensor with these characteristics [22].

The concept of home automation has been around for more than ten years. The fundamental idea is to connect the electrical and electronic gadgets in a home via a network. The way people live has changed as a result of this growing technology [13,17]. However, none of the businesses have been able to make it a well-liked technology due to its complexity in installation and usage and lack of household customer customization. A voice-controlled Energy Management (VEMS), which will enable users to operate household appliances at home utilizing wireless devices based on user-dependent instructions for improve security, was proposed in [16,22,23].

Technologies such as the Internet of Things, smart phones, smart appliances, cloud computing sensors, and digital assistants such as Amazon Alexa, Google Home, Google Assistant, Apple Siri, and Microsoft Cortana are used in home automated appliances for control. The idea of building smart homes was muted to enhance the life of able men. Currently, people in smart homes are gaining the profits of security, smart controlling of appliances, energy saving, the ability to control their lighting, door locks, HVAC (heating, ventilation, and air conditioning), and coffee makers whereas living in their comfortable places, for instances in bed or siting in a train. Nevertheless, most of the designers of the devices did not take into consideration the limitations of the disable. Using smart technology in controlling devices has tremendous benefits for the aged and the physically challenge. The authors[24] presented a scheme that uses smart cameras, smart power strips, smart plugs, and a digital assistant such as Amazon Alexa, Google Assistant, Google Home, Apple Siri, or Microsoft Cortana to capture voice commands, from a person with physical disabilities, spoken in a much more natural way to control ordinary home electrical appliances in order to turn them on or off, with minimal exertion

As the study of science progresses, the comfortability related to our lifestyle also changes. Task that we used much effort to do in the past has changed with the click of a push button. However, having to satisfy our own comfort at the detriment of the disable remains a challenge. The author's [25] exploited the everyday challenge of the physically challenge which people sometimes refer to as luxury. To profess a solution to their problem, the writers using Kinect & X10 have built a smart home appliance control system for physically challenged people. The goal of their system is to make life much comfortable and easier by providing them with a friendlier environment. They developed a prototype in our laboratory environment and performed real user study to test the validate of the system's acceptability to the people.

An artefact called a Smart Power-Strip was presented [26]. The use of a microcontroller to control an outlet adapter that can turn standard home into an automated home without additional construction was proposed. They used information provided by wi-fi connection or sensors for the microcontroller to make a decision based on the information obtained (e.g., programmed parameters). Additionally, a device that can control a Smart Power-Strip remotely by using Blynk are plugged into a device for the user to access information remotely which is designed for the Internet of Things (IoT). Consequently, the Smart Power-Strip can bridge the gap between the latest in consumer technology and standard homes

Voice was used to control doors or gates or any other security system [27]. This was done to reproduce human voice in the selection. In addition, voice gives a smart system that is mor convenient and effective to use. This permits the user to control his home security and it facilitates several conditions. It comprises the management and automation of security. The voice controlled smart locking system has the ability to control doors using a Smartphone Application with Bluetooth Wireless Technology and the locking system like gate or, Microcontroller & Servo motor. Smartphone application and Bluetooth wireless technology take input voice data from humans, then this data sends to microcontroller. In this system, a smartphone application was proposed, and bluetooth wireless technology take input voice data from humans, then transmits this data to a microcontroller. Microcontroller analyzing the audible signal to determine whether it matches the voiceprint stored in memory. The microprocessor performs the command instruction to control the function of the device if a match has been found.

In all the previous work, the controlled power strip was implemented without a feedback system, hence information about the operation of the system is unduly delayed. The systems were fitted such that only one socket can be controlled at any point in time. The implementation of the various smart power strip via IoT were done using older versions of internet, which might worsen delays. This paper therefore, contributes to knowledge by integrating a feedback system into the controlled smart power strip, this allow the transmission of timely information about the operation of the system to the user. In addition, the system is innovatively fitted to allow a simultaneous control of two or more sockets. Finally, the operation of the system is executed over IoT (using the latest version of internet google), which has proven to outperform the existing systems whose operations are executed via bluetooth and infrared. It is however significant to note that the proposed work is limited to the remote control of socket using human voice. The system would sense and respond only to specific voice signal from human. The system cannot work effectively without internet connectivity. The voice recognition feature is installed on the user's device, it can be controlled by the user only.

2. Materials and methods

This section gives a detailed description of the proposed design which includes the block diagrams, flow chart and a systematically sketched circuit diagram. The proposed design focuses on modernizing power stripe which utilizes already existing technologies such as wireless network and voice integration to switch sockets on a power strip. The proposed design combines four sub-system namely: the power strip module, control and transmission module, the power supply module and the cloud and voice development and integration. Each of the four subsystem works independently and collectively together to make voice control possible.

2.1 Block diagram of the proposed design

Figure 1 shows the block diagram of the proposed design and a precise summary of the design. The block diagram is made up of user's mobile device, server, temperature sensor, system on chip, relay, sockets and a power supply unit. Before the user can control the power strip, the microcontroller, transceiver and relay should be supplied with power from the power supply unit. The voice integration on the mobile device then connect to the smart strip over the internet. The user's voice commands are received from the mobile device and uploaded on the internet. The micro-controller receives command signals from the internet through the transceiver to control the relays. The relays open and closes contacts as instructed by the controller to switch the socket off and on Fig. 1.

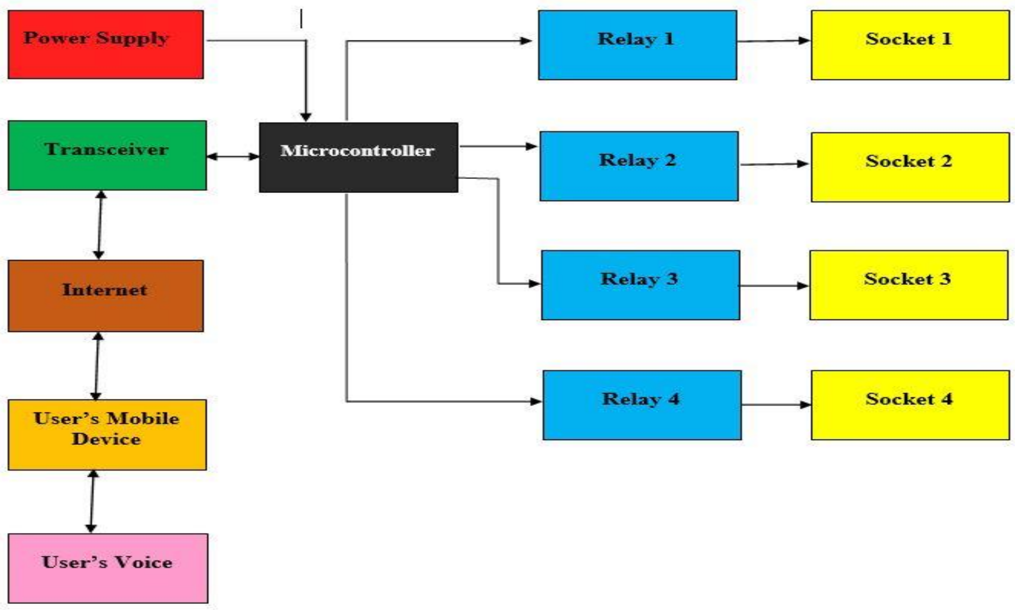

Figure 1: block diagram for the proposed design.

2.2 Flow chart of the proposed design

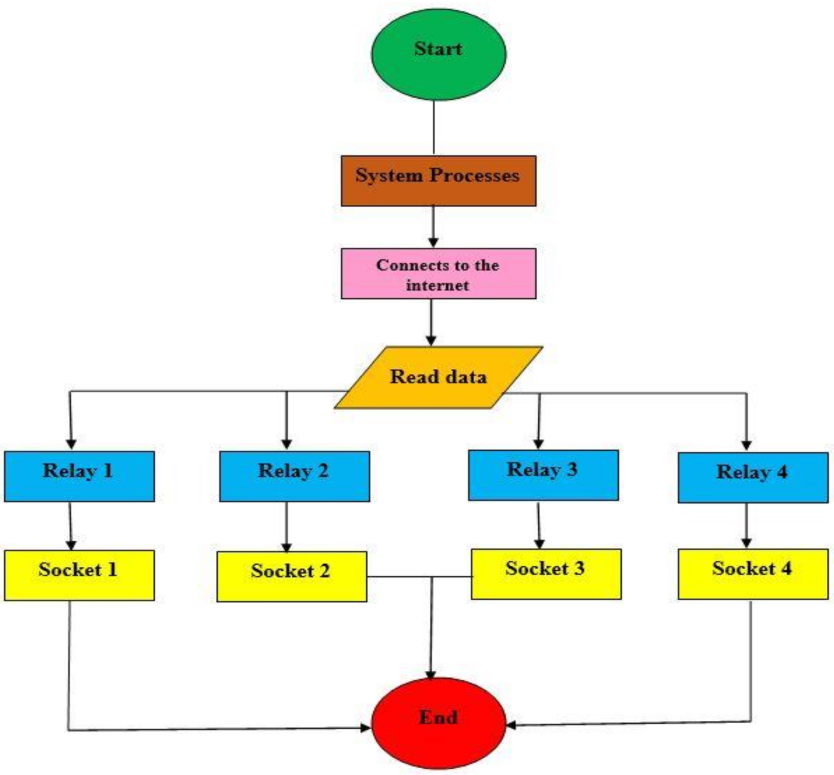

Figure 2: flow chart development

Figure 2 describes the flow chart of the proposed design which gives detailed description on how the algorithm is made. The structure of the firmware in the controller is described by the flow chart. When the smart strip is switched on, it will first connect to the internet to receive data from the user. After the data is received, the microcontroller passes the data to control the relay as desired by the user. The relays are turned on or off depending on the user's voice command received from the internet. It then controls the electrical appliance connect to the sockets.

2.3 Circuit diagram of the proposed design

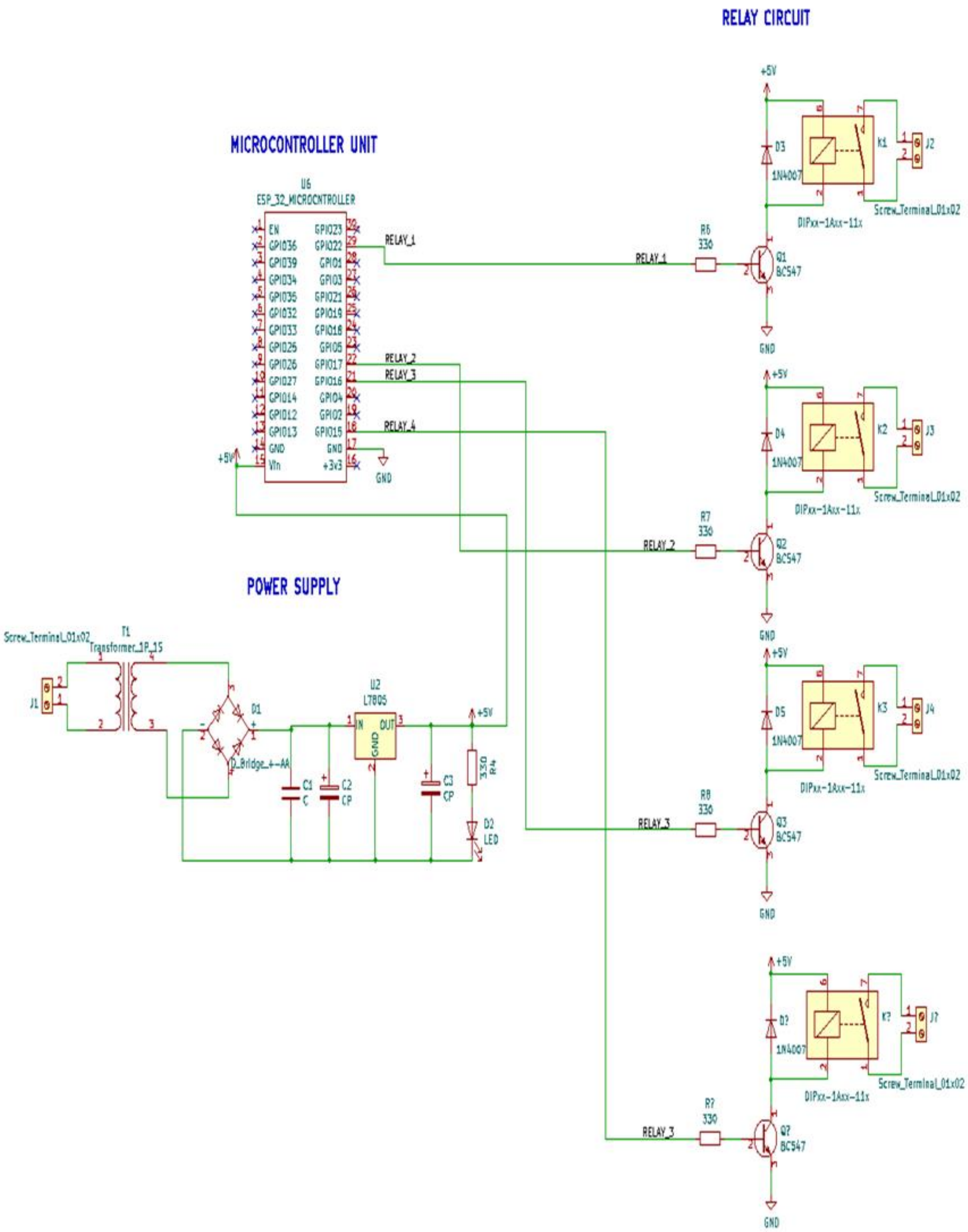

Figure 3: circuit diagram of proposed design.

The circuit diagram of the proposed design is divided into four subsystems, namely: the power supply circuit, the relay circuit and the microcontroller circuit. Figure 3 shows the circuit diagram of proposed design. It consists of power supply, micro controller and relay circuit. The power supply consists of a transformer which step down the 230AC to 12VAC and rectified by the bridge rectifier to 5VDC and smoothed by the capacitor. The 5VDC is supplied to the microcontroller which consist of WiFi transceiver that enables the connectivity among the sensor node, the user and the automatic sprinkler system. The relay circuit consists of 5VDC relays, terminal connectors, transistors, a diode and resistors. The connectors connect the relays to the sockets to be controlled by the micro controller.

2.4 Power supply module

Figure 4 shows the power supply circuit of the proposed design which consists of the transformer, bridge rectifier, polarized and non-polarized capacitor and 7805 voltage regulators. The transformer in the circuit transforms the feed voltage from 230VAC to 12VAC. It is then rectified by the bridge rectifier from 12VAC to 5VDC, and smoothed by the capacitors before and after the voltage regulator. The 5VDC supplies the relays, the controller and the indicating led light.

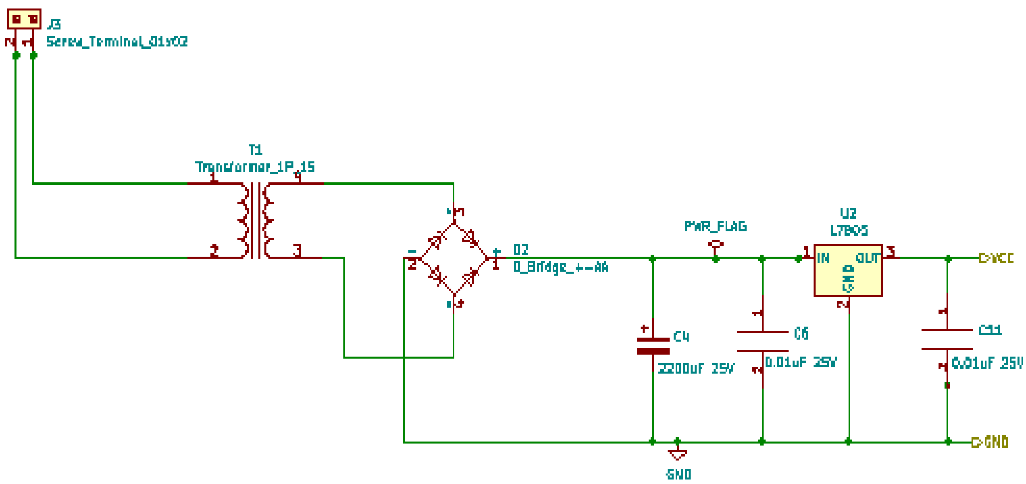

Figure 4: power supply circuit.

Table 1: Specifications of power supply unit.

Components	Number	Rating
Transformer	1	220VAC – 12VAC
Bridge diode rectifier	1	12VAC – 12VDC
Capacitors	3	2200uf/25V, 0.1uf/25V
7805 voltage regulator	1	12VDC – 5V DC

2.5 Relay circuit

Figure 3.5 describes the relay circuit of the design. It consists of 5vdc relays, terminal connectors, a BC547 transistor, a 1N4007 diode and 220 ohms resistor. The connectors connect the relays to the sockets, to be controlled by the micro-controller. The transistors serve as switches mediating the micro-controllers to the relays. The specifications of the relay circuit is accordingly summarized in Table 2.

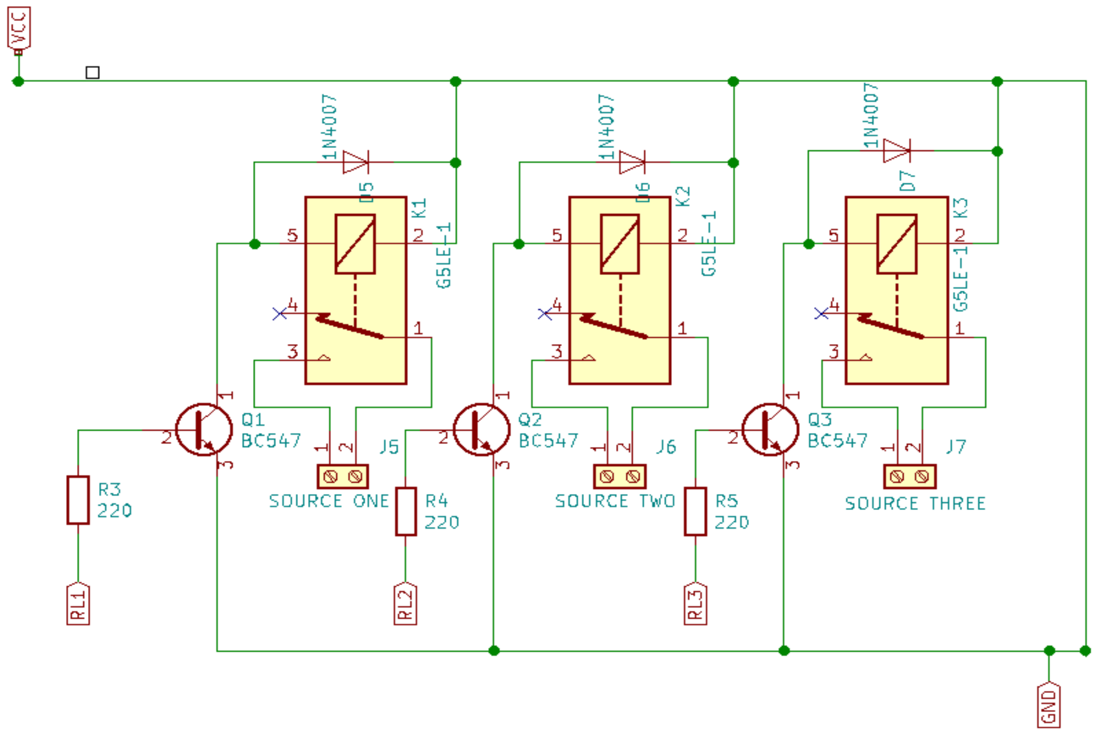

Figure 5: Relay circuit.

Table 2: Specifications of Relay Circuit.

Components	Number	Rating
Relay	3	5V
BC 547	3	200 mA, 5V
Resistor	3	220 ohms
1N4007 diode	3	1 A, 5V

2.6 Microcontroller unit

The microcontroller unit consist mainly of an ESP32 microcontroller**.** This microcontroller combines its controller with a WiFi transceiver on a single chip. It is normally referred to as a system on chip. The WiFi transceiver enable connectivity among the sensor node, the user and the automatic sprinkler system. It enables data packet to be transmitted to the automatic sprinkler system and the user. Below are some vital specifications of esp 32. The specifications of the microcontroller unit is also given in Table 3

Table 3: Specifications of microcontroller unit.

Features	**Specification**
Chip Type	Tensilica LX6
Module Interfaces	UART, SPI, I2C, PWM, ADC, DAC, GPIO, pulse counter, capacitive touch sensor
Integrated SPI flash	4 MB
Integrated Connectivity Protocols	Integrated Connectivity Protocols
Operating Current	80 mA (average)
Operating Voltage	3.3V
Operating temperature range	−40 − 85 degrees Celsius

2.6 Construction and testing of the device

The construction of the artefact was achieved in two phases namely the software developmental phase and the hardware developmental phase. In the software developmental phase, the following stages were undertaken: development of block diagram, flow chart and the schematic diagram; development and debugging of firmware and testing the schematic diagram with the developed firmware. In the hardware developmental phase, the following stages were taken: testing of components using a multimeter; connecting the components as shown in the schematic above and checking the integrity of the circuit by monitoring the continuity, resistance, voltage and current.

2.7 Software tools

The software used in the design and construction of the project includes kicad and vs code. Kicad software was used in design the circuit diagram. VS code was used in programming the microcontroller.

3. Results

The designed and developed artefact is analyzed and discussed. The system is tested by subjecting it to several different conditions to monitor and observe its integrity and functionalities, in the testing phase some bugs in the system were exposed and corrected and retesting of the system was carried out. The sections below describe the results when tested in various condition.

3.1 Packaging of the artefact

Electronic components used in the construction of the projects were mounted and soldered on a circuit board (Figure 6). The circuit board was then packed into a 200mm x 200mmx 80mm junction box.

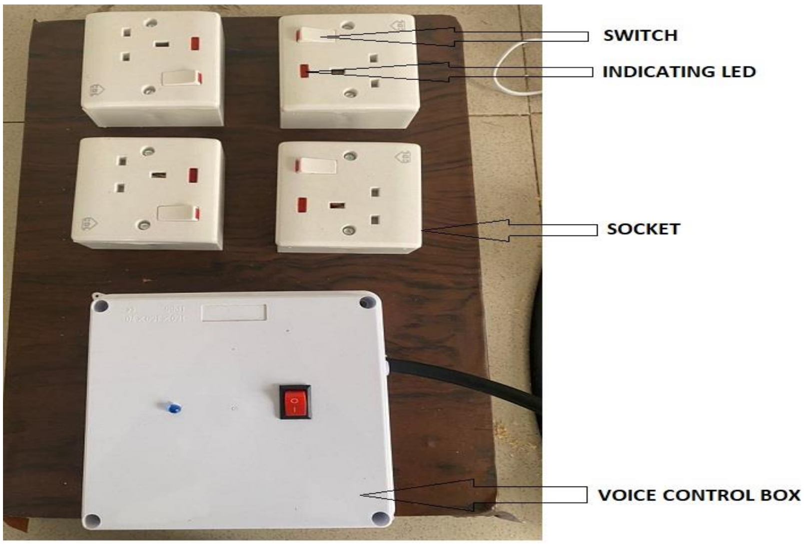

Figure 6: Labelled designed artefact.

The voice control system integrated into the socket power strip is enabled using Google Assistant on a mobile device. The user press and hold the google assistant on the mobile device, then voice out commands, the voice phrase is recorded and sent to the cloud. Data from the cloud is then sent to the hardware (socket power strip) to trigger a functionality based on the commands of the user.

Scenario I: Testing of socket one when turned on

The testing of the artefact was done on an android phone using Google Assistant, to turn on/off a socket the user voice out a command while pressing and holding the google assistant on the mobile, therefore in this case the user voice out the following command 'OK GOOGLE ACTIVATE SOCKET ONE ON' (Figure 7a) which turns on socket one (Figure 7b).

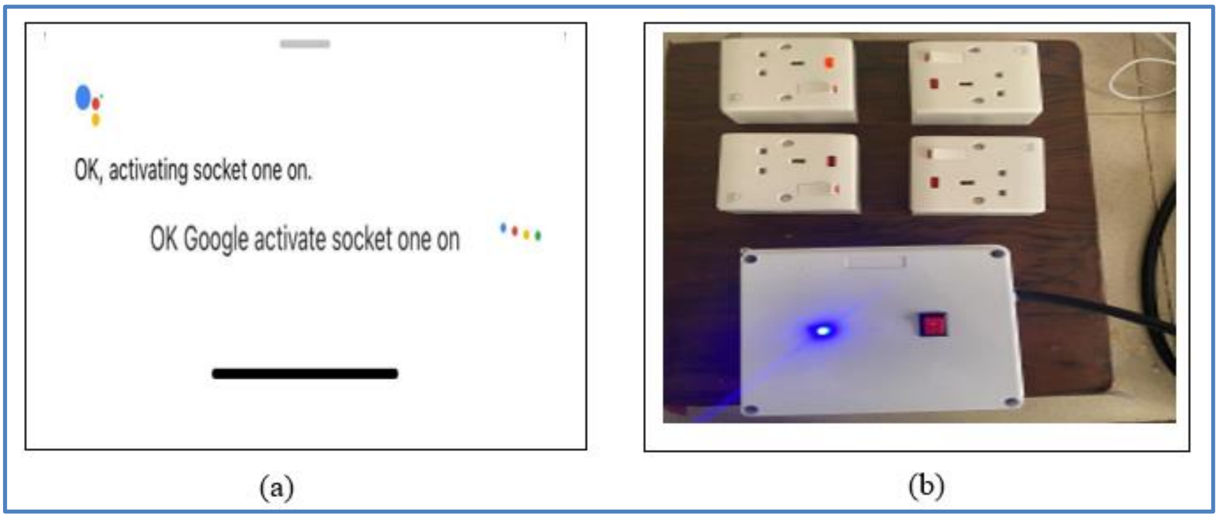

Figure 7: google assistant feedback when socket one is turn on (a), socket one turned on (b).

Scenario II: Testing of socket one when turned off

In this case, when socket one is turned off the user voices out the command 'OK GOOGLE ACTIVATE SOCKET ONE OFF' (Figure 8a) which turns off socket one remotely (Figure 8b).

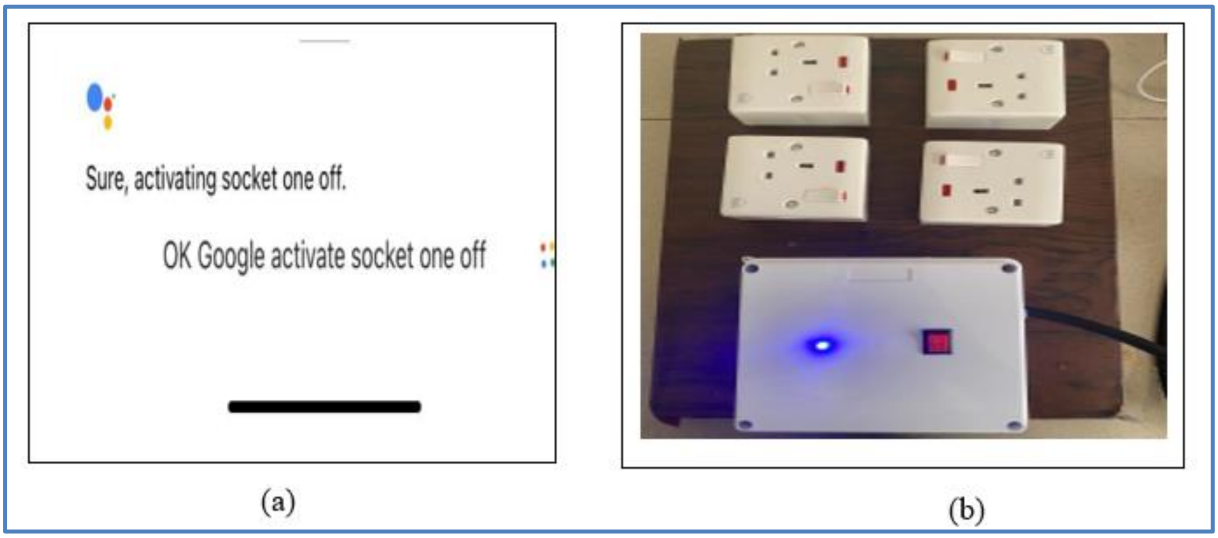

Figure 8: google assistant feedback when socket one is turn off (a), socket one turned off (b).

Scenario III: Testing socket two when turned on

In this case, when socket two is turned on the user voices out the command 'OK GOOGLE ACTIVATE SOCKET TWO ON' (Figure 9a) which turns on socket two remotely with voice control (Figure 9b).

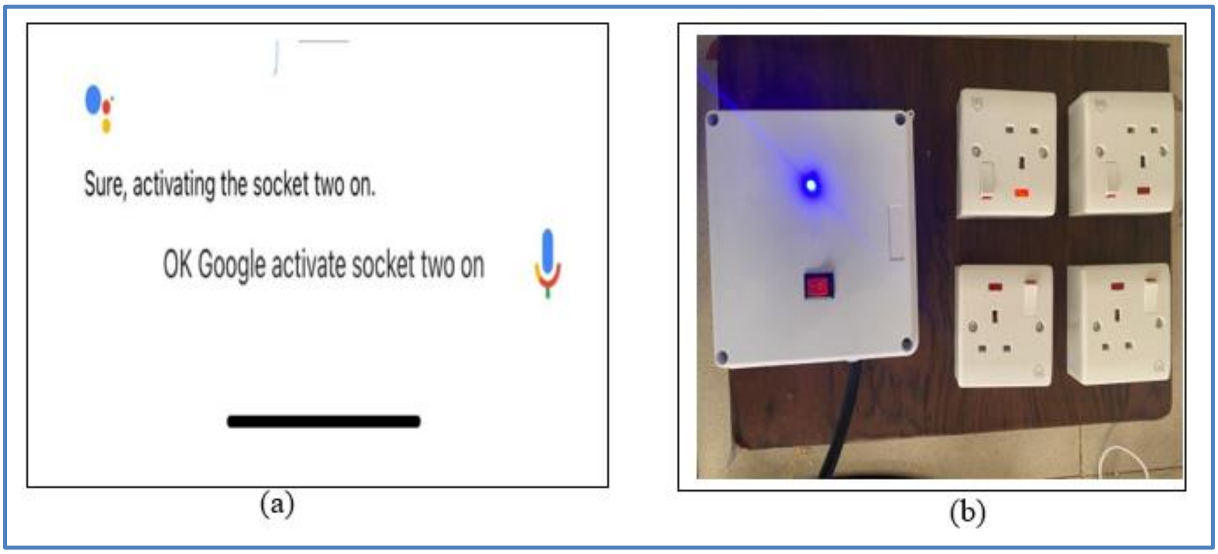

Figure 9: google assistant feedback when socket two is turn on (a), socket two turned on (b).

Scenario IV: Testing socket two when turned off. In this case, when socket two is turned off the user voices out the command 'OK GOOGLE ACTIVATE SOCKET TWO OFF' (Figure 10a) which turns off socket two remotely with voice control (Figure 10b).

Figure 10: google assistant feedback when socket two is turn off (a), socket two Turned off (b).

In the testing phase of the project, it was noticed that the device performed well when it was tested under different conditions. It could successfully remotely control the socket power strip with voice as expected.

3.2 The speed of the system

The figure 11 shows the graph of distance against time. The speed at which the system operate is determined by the distance and time.

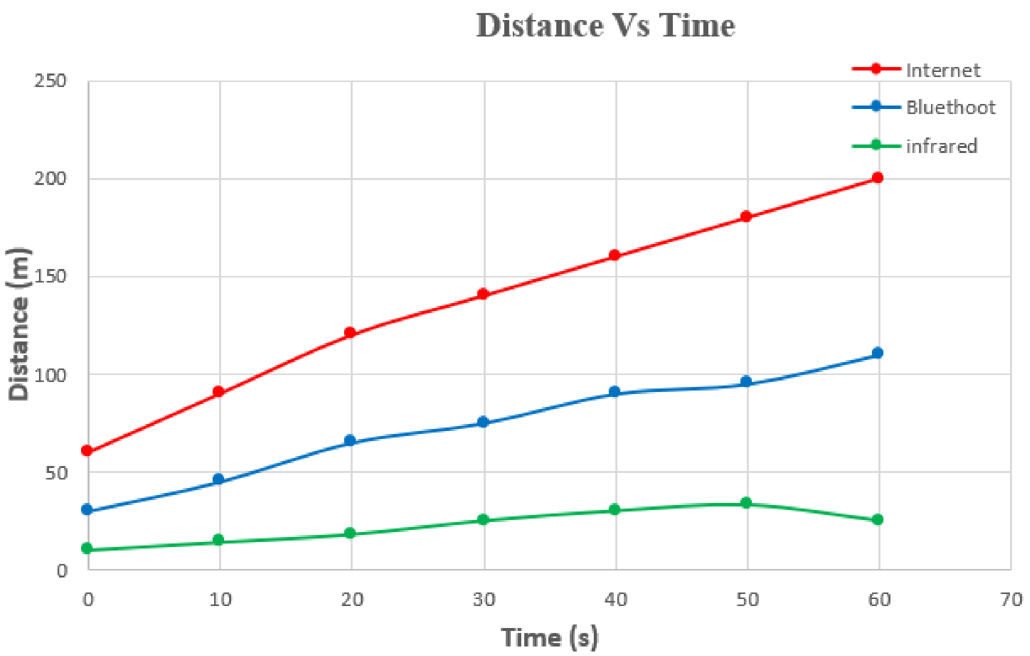

Figure 11: a graph of distance against time.

As the distance increases, the time at which the system operates increases and as the distance decreases the time at which the system operates also decreases.

Therefore, the shorter distance approach to the artefact decreases the time the system uses to operate and thus, making the system works at a faster speed. In similar related works, the means of initiating command to the system was done via bluetooth and infrared with a limited distance, but in this work the means of initiating command to the system is done via the internet with no limited distance which makes it possible to initiate command at any distance approach. Thus, comparing the speed of the three schemes; internet, bluetooth, infrared, our scheme (the internet) shows a higher speed compare to the other two schemes. The faster the speed of the network the better it will be for the user to receive the notification, since faster network will help the sockets to either switch ON or OFF when the request is made.

3.3 Delay in the system

The figure 12 depicts the graph of pitch against time. The delay of the system is determined by the intensity of the pitch and time the system used to recognize the voice signal.

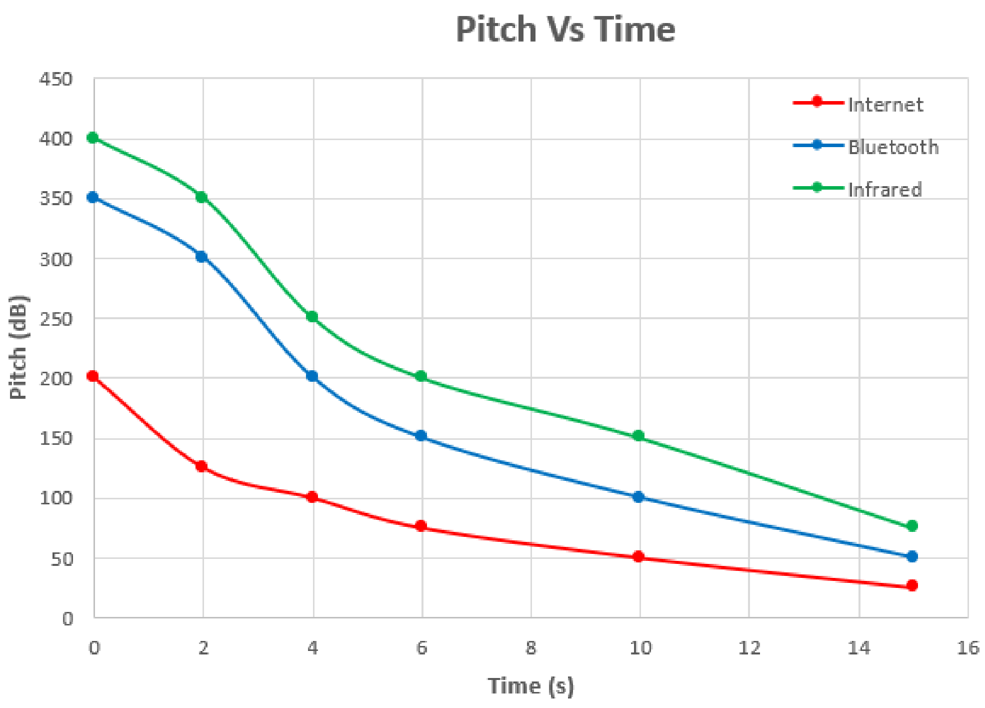

Figure 12: a graph of pitch against time.

Delay is the time taken for the transmitter voice to be recognized by the IOT system. As the intensity of the pitch increases, the time at which the system used to recognize the voice signal decreases and as the intensity of the pitch decreases, the time at which the system uses to recognize the voice increases. Therefore, greater intensity of the pitch from the user gives a shorter time for the system to recognize the voice signal and thus, making the system function efficiently.

In terms of delay, our proposed technique via the internet outperforms the benchmark techniques implemented over bluetooth and infrared. It is clear that the delay difference in respect of the internet is lower than that of the other related works that uses bluetooth and infrared. In reference to Figure 12, the pitch needed for the system to operate at a specific time rate under internet is lower than that of bluetooth and infrared. Specifically, a delay of 2 seconds is accomplished at a pitch of 125 approximately via the internet, but at pitches of 300 and 350 via bluetooth and infrared respectively. This holds for all other delays. In general, a given time delay can be achieved at a comparatively lower pitch over the internet.

3.4 Signal to Noise ratio

Figure 13 depicts the noise ratio for the operation of the system. The noise ratio increases as the unwanted signal decreases.

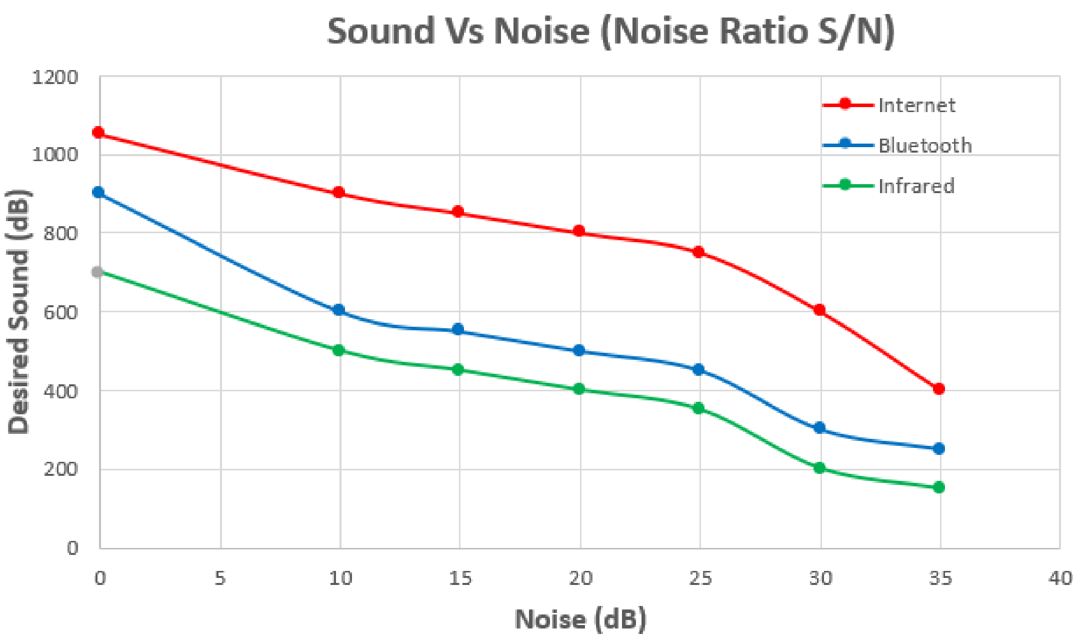

Figure 13: a graph of desired sound against noise signals.

Twisted-pair cable is one of the most used wiring types in local-area networks (LANs). It is frequently referred to as UTP (unshielded twisted pair) cable. Twisted-pair cable comes in a variety of grades that can handle either high-frequency pulses or low-frequency music. The qualities of a wire depend on its size, insulation type, and twist density (inches per twist). It is referred to as shielded twisted-pair (STP) cable and is available with an all-over braid shield. Four pairs are contained in the most popular version's common insulated tubing.

Noise ratio is the measure of desired sound signal of the speaker's voice against the unwanted signal which is noise. A system tends to operate more efficiently with a greater signal to noise ratio. Therefore, increasing in the speaker's voice increases the recognition quality or efficiency of the system. However, increase in noise signal or decreasing in the sound of the speaker's voice signal decreases the noise ratio which tend to decrease the recognition quality of the system. It is obvious that the operation of the system using internet gives the highest signal to noise ratio. Foe example, at a noise levels ranging from (0 to 40) dB, the desired sounds are the highest in the case of the internet, followed by the bluetooth and infrared in that order (Figure 13).

3.5 Distance against connectivity signal

Figure 14 depicts the graph between distance against the connectivity signal. The effectiveness of the system is determined by the distance and the connectivity signal (that is the connection between the user mobile device and the artifact). As the distance is increasing, the connectivity signal decreases and as the distance is decreasing, the connectivity signal increases. This indicates an inverse relationship between the distance and the connectivity signal. Since the system requires a faster connection, decreasing the distance will increase the connectivity signal which enable the system to connect at a higher rate connectivity. In comparison of the various systems in respect of distance and signal of internet connectivity, our proposed technique which guarantees the operation of the system over the internet outperforms the benchmark techniques via bluetooth and infrared. It can be realized that even at a long-distance range to the artifact the system tends to connect at the highest connectivity in the case of the internet. Bluetooth has the second highest connectivity followed by infrared.

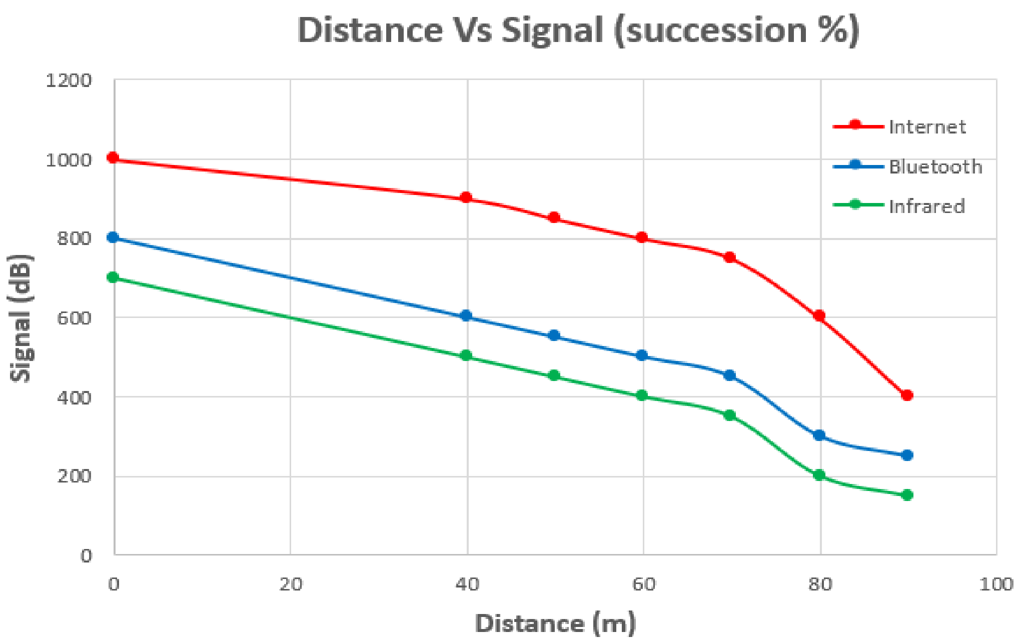

Figure 14: A graph of distance against connectivity signal.

4. Conclusions

After the testing and experimental phase, it could be said that the main aim and objectives of the project were achieved, the artefact performed as expected. Observing the performance of the artefact, it can also be said that the device will ensure that the electrical appliances connected to the power strip are remotely controlled and that users are protected from high voltages and current when exposed to the power strip yet it noticed that some improvements could be made to the system in future times.

From the perspective of the graph, based on the four graphs established which represent speed, delay, noise ratio and succession. Due to the IoT system adopted, our project performance performed effectively due to high speed of the internet. In contrast, the noise ratio was better and higher due to quality of our desired voice over the surrounding noise. Delay was also minimum in our system due to the rapid recognition response of our system being used (IoT system) regardless of distance magnitude.

In addition, from our result it has been establish that voice controlled smart power strip with IoT is more preferable than that of Bluetooth and infrared.

During the testing phase, it was well noticed that the device performed extremely well as expected, however, the ability to control the power strip remotely by voice was made possible with internet connectivity, in conditions where there was no internet connectivity, it was noted that the said functionality of the system could not be achieved, therefore in future works it is recommended that the microphone chip should be integrated in the power strip.

References

[1]. A. Dahroni, M. F. Prathama, & Putra, E. “Prototype Mobile-Based Smart Power Strip”. In *Journal of Physics: Conference Series*, Vol. 1477, No. 5, pp. 052011, 2020.

[2]. O. T. Ibitoye, M. O. Onibonoje, & J. O. Dada, “A review of IoT-based techniques for smart power systems architectures,” in *2022 IEEE 7th International Energy Conference (ENERGYCON),* 2022, pp. 1-5).

[3]. Q. Yang. “Internet of things application in smart grid: A brief overview of challenges, opportunities, and future trends.” *Smart Power Distribution Systems*, pp. 267-283, 2019.

[4]. A. Hashizume, T. Mizuno, & H. Mineno. “Energy efficient data sending scheme in smart power strip sensor networks,” in *The 1st IEEE Global Conference on Consumer Electronics 2012*, 2012, pp. 733-736.

[5]. J. Kang, J. Kim, D. H. Yeo, J. Hyun, P. M. Jung, T. Choi, & S. Kim. “Peaksave: energy monitoring service,” in *Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems*,2012, pp. 367-368.

[6]. M. Naznin, & A. S Chowdhury. “Energy efficient zone based data gathering in a wireless sensor network,” in *2015 International Conference on Networking Systems and Security (NSysS),* 2015, pp. 1-7.

[7]. B. Son, Y. S Her, & J. Kim. “A design and implementation of forest-fires surveillance system based on wireless sensor networks for South Korea mountains.” *International Journal of Computer Science and Network Security (IJCSNS)*, vol. *6*(9), pp. 124-130, 2006.

[8]. G. M. Abdulsahib, & O. I. Khalaf.” An improved algorithm to fire detection in forest by using wireless sensor networks.” *International Journal of Civil Engineering & Technology (IJCIET)-Scopus Indexed*, vol. *9*(11), pp. 369-377, 2018.

[9]. C. H. Lien, H. C Chen, Y. W. Bai, & M. B. Lin.” Power monitoring and control for electric home appliances based on power line communication,” In *2008 IEEE Instrumentation and Measurement Technology Conference*, 2008, May, pp. 2179-2184.

[10]. C. H. Lien, Y. W. Bai, H. C. Chen, & C. H. Hung. “Home appliance energy monitoring and controlling based on power line communication,” in *2009 Digest of Technical Papers International Conference on Consumer Electronics* ,2009, January pp. 1-2.

[11]. Y. S. Son, T. Pulkkinen, K. D. Moon, & C. Kim. “Home energy management system based on power line communication.” *IEEE Transactions on Consumer Electronics*, vol. *56*(3), pp. 1380-1386, 2010

[12]. D. M, Han, & J. H. Lim. “Smart home energy management system using IEEE 802.15. 4 and zigbee.” *IEEE Transactions on Consumer Electronics*, vol. *56*(3), pp. 1403-1410, 2010.

[13]. M. P Gupta, “Google assistant-controlled home automation.” *International Research Journal of Engineering and Technology*, vol. *5*(5). 2018.

[14]. J. Austerjost, M. Porr, N. Riedel, D. Geier, T. Becker, T. Scheper, & S. Beutel. “Introducing a virtual assistant to the lab: A voice user interface for the intuitive control of laboratory instruments.” *SLAS TECHNOLOGY: Translating Life Sciences Innovation*, vol. *23*(5), pp. 476-482, 2018.

[15]. F. Nakazawa, H. Soneda, O. Tsuboi, A. Iwakawa, M. Murakami, M. Matsuda, & N. Nagao. “Contactless power sensor for smart power strip networked to visualize energy conservation,” in *2012 Ninth International Conference on Networked Sensing (INSS),* 2012, pp. 1-2.

[16]. J, Han, C. S, Choi, & I. Lee. “More efficient home energy management system based on ZigBee communication and infrared remote controls.” *IEEE Transactions on Consumer Electronics*, vol. *57*(1), pp. 85-89, 2011.

[17]. M. Raugei, & E. Leccisi.” A comprehensive assessment of the energy performance of the full range of electricity generation technologies deployed in the United Kingdom.” *Energy Policy*, vol.*90*, pp.46-59, 2016.

[18]. R. Y. M Li, H. Li, C. Mak, & T, Tang. “Sustainable smart home and home automation: Big data analytics approach.” *International Journal of Smart Home*, vol. *10*(8), pp. 177-187, 2016.

[19]. Y. Lee, J. Jiang, G. Underwood, A. Sanders, & M. Osborne, “Smart Power-Strip: Home automation by bringing outlets into the IoT,” in *2017 IEEE 8th Annual Ubiquitous Computing, Electronics and*

Mobile Communication Conference (UEMCON), 2017, pp. 127-130.

[20]. F. Nakazawa, H. Soneda, O. Tsuboi, A. Iwakawa, M. Murakami, M. Matsuda, & N. Nagao. “Contactless power sensor for smart power strip networked to visualize energy conservation,” in *2012 Ninth International Conference on Networked Sensing (INSS),* IEEE. 2012, pp. 1-2.

[21]. D. Guinard, V. Trifa, & E. Wilde. “A resource-oriented architecture for the web of things,” in *2010 Internet of Things (IOT),* IEEE, 2010, pp. 1-8.

[22]. A. Dahroni, M. F. Prathama & E. Putra. “Prototype Mobile-Based Smart Power Strip.” In *Journal of Physics: Conference Series*,Vol. 1477, No. 5, pp. 052011, 2020.

[23]. W. A. Jabbar, T. K. Kian, R. M. Ramli, S. N. Zubir, N. S. Zamrizaman, M. Balfaqih, & S. Alharbi. “Design and fabrication of smart home with internet of things enabled automation system.” *IEEE access*, vol. *7*, pp.144059-144074, 2019.

[24]. P. Mtshali, & F. Khubisa. “A smart home appliance control system for physically disabled people”. In *2019 Conference on Information Communications Technology and Society (ICTAS)*, IEEE, pp. 1-5, 2019.

[25]. M. A. Iqbal, S. K. Asrafuzzaman, M. M. Arifin, & S. A. Hossain. “Smart home appliance control system for physically disabled people using kinect and X10”. In *2016 5th International Conference on Informatics, Electronics and Vision (ICIEV)*, IEEE, pp. 891-896, 2016.

[26]. Y. Lee, J. Jiang, G. Underwood, A. Sanders & M. “Smart Power-Strip: Home automation by bringing outlets into the IoT”. In *2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference (UEMCON)*, IEEE, pp. 127-130, 2017.

[27]. M. Ali, B. Hossain, M. M. Islam, M. Islam & M. Kashem. “*An experimental study on voice controlled smart locking system.* Doctoral dissertation, Sonargaon University, 2021.