Penerbit Akademia Baru

Journal of Advanced Research in Engineering Knowledge

Journal homepage: www.akademiabaru.com/arek.html
ISSN: 2600-8440

IoT-Enabled Electric Socket Test Bed Utilizing IFTTT and Node-Red

Open Access

Mohamad Taib Miskon[1,*], Muhammad Amirul Haziq Hasry, Muhammad Syafiq Rosle, Amar Danial Adlan Hidayah

[1] Fakulti Kejuruteraan Elektrik, Universiti Teknologi MARA Cawangan Terengganu, 23000 Dungun, Terengganu, Malaysia

ARTICLE INFO

Article history:
Received 5 June 2019
Received in revised form 4 September 2019
Accepted 12 December 2019
Available online 17 December 2019

ABSTRACT

Electrical socket outlet can sometimes be difficult to reach especially for people with limited ability or elderly if the location is under the table, behind the furniture or anywhere that requires physical movement. Other than that, most users have the tendency to forget to switch off the power outlet that can cause overcharging, overuse of electricity and can also lead to destructive burning. This project focused on the development of an IoT-enabled electric socket test bed utilizing recent IFTTT modules and node-red flows so that multiple digital services such as voice detection component of Amazon Alexa, Google Assistant, telegram notification and many more can be embedded and tested. The system architecture comprised of a nodeMCU microcontroller embedded with ESP8266 wireless module, Amazon Eco intelligent speaker, a power supply, several socket outlets, graphical interface and middleware based on Blynk, IFTTT and node-red. User interaction with the system can be established through both mobile apps and voice command recognition so that they can easily control common household appliances such as turning it on or off with minimal exertion. Even though the project are still at its early stage of development, test results indicated that the proposed system can be operated with full functionality and there is much room for improvement especially on the voice activation and security aspect.

Keywords:
Intelligent system; Blynk, cloud based; nodeMCU; Arduino

1. Introduction

The development of smart devices has seen a tremendous rise in recent years. The advancement of Internet of Things (IoT) technology enables interconnection between human and almost every digital devices around us. Future homes are expected to be equipped with IoT-enabled devices in which can be monitored and controlled via wireless communication over the internet. Being able to use smart technology will certainly help to enhance the quality of living for every citizen especially those with physical disabilities and seniors. For example, previous work by Iqbal *et al*., [1] aimed to provide a smart home system for elderlies and disabled that integrate Kinect module for gesture detection to control electrical appliances. Usability study indicated that the system managed to help

* *Corresponding author.*
E-mail address: mohamad.taib@gmail.com (Mohamad Taib Miskon)

the volunteers but was limited to a specific Kinect detection and coverage area. Besides, any effort to increase the coverage area and to exchange conventional appliances with a smarter device can be costly.

Alternatively, smart socket has been receiving much attention by many researcher as it can be used to intelligently control ordinary equipment without any expensive modification. Previous work contributed by Horvat *et al*., [2] and Lukac *et al*., [3] presented the development of smart plug solution based on Bluetooth Low Energy (BLE) with User Interface (UI) provided for smartphone user. The plug will establish direct Bluetooth link to the user's smartphone to control the proposed socket from a distance without any additional gateway or internet connection required. Authors in [4] and [5] attempted to design a smart plug that can be controlled via phone from any location by employing cloud service in addition to existing Wi-Fi link. However, it can only support a single load which might cause inconvenient if multiple electric equipment is concerned. Nguyen *et al*., [6] and Al-Hassan *et al*., [7] proposed to integrate multiple socket outlets interconnected within the same wireless network with the capability to recognize the type of electrical appliances being plugged in. Aiming for a better energy management features, voltage and current measurement was also embedded. However, the proposed product was relatively bulky due to various sensor inclusion and lacking in the aspect of prompt notification via phone or email. Meanwhile, Lin *et al*., [8] proposed MorSocket to control more than one socket outlet as opposed to single-socket control that are commercially available and capable to automatically alter the socket output based on its embedded sensor data. In addition, cheaper alternative solution has also been identified and reported [9,10]. Galioto *et al*., [10] raised up some concern about energy balancing between production and demand in which energy demand tend to be more variable and less controllable. Thus the implementation of smart, interconnected plug will enable real-time data measurement from domestic houses that will help to produce better domestic load control mechanism. Other than that, intelligent smart plug with shared knowledge capabilities has also been presented in Gomes *et al*., [11]. The plug was set to learn user behavior using Neural Network so that it can create electrical usage forecasting for better energy management.

In this paper, a smart plug with multiple activation and monitoring strategy is proposed and presented. It involves the incorporation of voice command which was also reported in Mtshali *et al*., [12] and Yue *et al*., [13], text command via telegram, android or iOS application and also web interface for electrical usage monitoring.

2. Methodology

2.1 System Block Diagram

Figure 1 represents the block diagram of the proposed system. The project utilized NodeMCU as its core processor. Voice command will be captured and interpreted via intelligent speaker system known as Amazon Eco that employs digital assistant named ALEXA with the capability of understanding simple human conversation. Each voice command or instruction given will be evaluated and compared with the conditional instructions set through "If This than That" (IFTTT) module, a free web-based service that has the capacity to provide chains of simple conditional statements to trigger specific events such as sending notification through email, telegram, alarm system and so on. Once triggered, it will update the control signal through Blynk server which will be responsible to establish communication between smartphone apps and connected hardware. Socket activation can also be done through telegram and Blynk apps. Node-red was employed to listen to virtual port within the Blynk server and log the socket activation activity for further analysis and monitoring purpose.

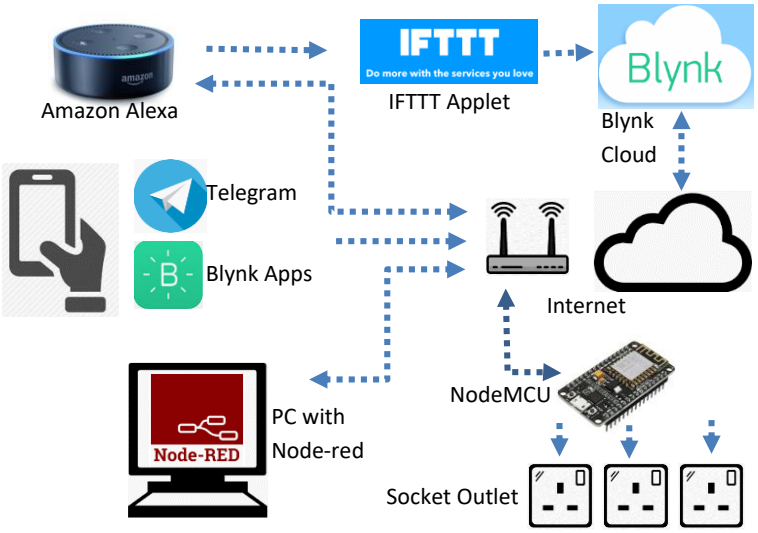

Fig. 1. Block diagram of the proposed system

2.2 NodeMCU

NodeMCU is a microcontroller specifically designed for IoT application and has been widely used by many [14,15]. It is embedded with ESP8266 WiFi module, GPIOs, PWM, I2C and ADC all in a single board. In this project, two GPIOs were used and were connected to two electrical relays. ESP8266 can be connected to WiFi module which credentials such as SSID and password needed to be set within the program code prior to the deployment. In line-of-sight (LOS) condition, nodeMCU can be deployed within 300m radius from the WiFi assess point. Meanwhile, in indoor situation, its effective range will depends on the type of walls or building materials at the location that might cause difficulty for the radio signal to pass through. Like many other microcontroller, NodeMCU requires 5VDC supply as its main power source. Thus, an AC to DC converter was also used to convert the 240VAC source to a 5 VDC to power up the NodeMCU in this project.

2.3 Blynk

Blynk platform plays an important role for the proposed project. It was designed specifically for IoT application and can be used to control and read input and output modules remotely [16]. Blynk consist of three main components including the Blynk App, Blynk Server and Blynk Library. Using the Blynk App, a unique identifier or auth token was created for the project which can be used to link all the hardware connection at the nodeMCU board to the smartphone. Once linked, it can control any I/O pin on the nodeMCU hardware directly and any data from the microcontroller can also be sent to the apps. Meanwhile, any changes on the project I/O data was also being stored and synced at Blynk server that can be retrieved if the internet connection was interrupted or reset. Besides, Blynk platform also comes with a comprehensive libraries to support most of the popular embedded hardware such as Arduino, NodeMCU, and Raspberry Pi, to enable communication with the server and process all incoming and out coming commands.

2.4 If This, Than That (IFTTT)

IFTTT (If This, Than That) is an online platform that enable interconnection between various digital services available across the internet such as Google, e-mail, Amazon, smart phones, smart

devices online shopping apps, credit cards and much more [17]. This platform was used for this project as it allows the adoption of voice recognition services provided through Amazon Alexa application. To set up the IFTTT service, user need to specify the 'condition', which represented by the term 'IF' and the 'consequence', which represented by the term "than that". For example, if the condition is set to detect someone saying "hey Alexa, find my phone", than, a triggering action can be set such as ringing the phone out loud or obtaining the GPS location of the phone. In this paper, an applet was developed to activate each relay and another applet was constructed to deactivate them. Figure 2 shows the IFTTT applet developed for this project.

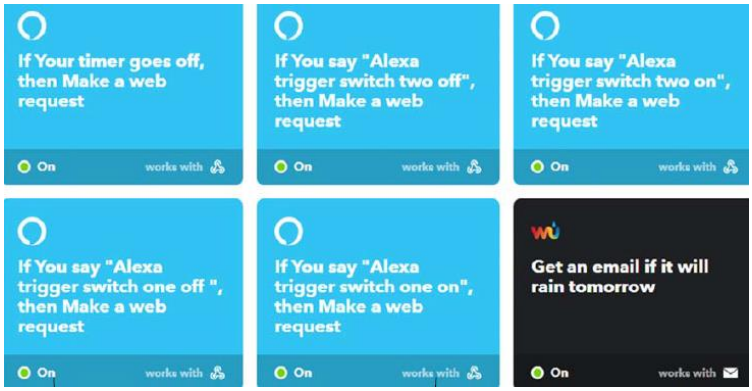

Fig. 2. Some of IFTTT applet developed for the project

2.5 Node-red

Node-red is a visual programming tools design by IBM to help IoT developers to ease the implementation of complex tasks such as HTTP request, sending notification through email, SMS or telegram, storing and also loading data [18]. With Node-red, one can easily upgrade the features of the project without any hardware or code modification. In this project, Node-red was deployed to listen to events from Blynk server linked to this project so that additional data logging can be made. By doing so, it is possible for user to keep track their daily household load activities for certain period of time. Figure 3 depicts a sample of node-red flow used to monitor the status of the socket. Based on the flow, if the socket is activated, it the user interface shown in figure 4 will be updated.

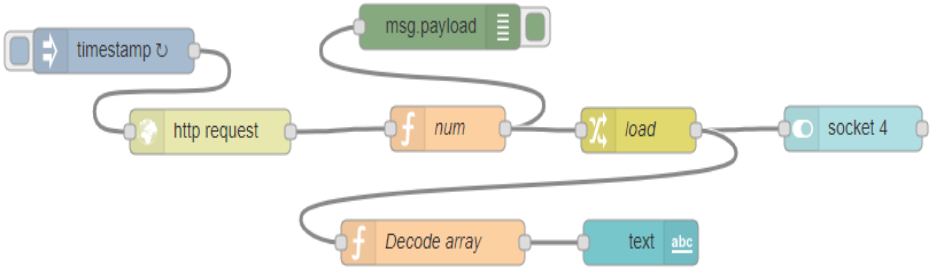

Fig. 3. Node-red flow used to update socket status via web interface

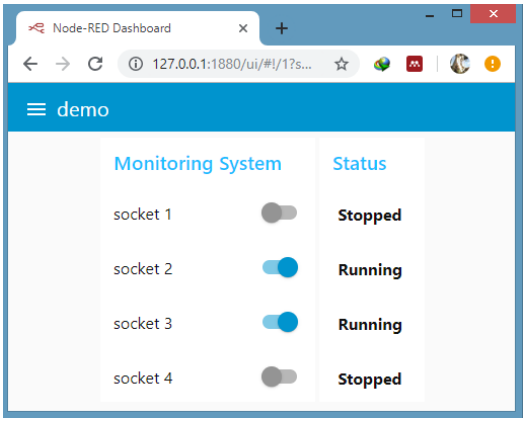

Fig. 4. Dashboard served as user interface for the project

2.6 Relay Module

Relay module was used in this project as a switch that will open or close the connection of the live wire at the socket outlet. It consist of a coil that can be energized using 5VDC supply, a normally open (NO) contact, and a normally close (NC) contact. Upon receiving input signal from nodeMCU, the relay coil will be energized and the contact will switch position from NO position to NC position and vice versa as the result of electromagnetic force generated around the coil. In order to hold the contact position, the coil need to be energized continuously and if the power is cut, the contact will automatically return to its initial position. In this project, each contact used for the socket outlet can sustain up to 10Amps of AC current rated at 240VAC. Consequently, each socket outlet developed in this project will be able to support electrical loads that are rated below 2000watt of power. Among them are smart TV, computer, table fan, phone charger, small rice cooker, radio and much more.

2.7 Functionality Test

Figure 5 illustrates the experiment setup to test the functionality of the proposed smart socket. The test consists of three experiments as described in the following section.

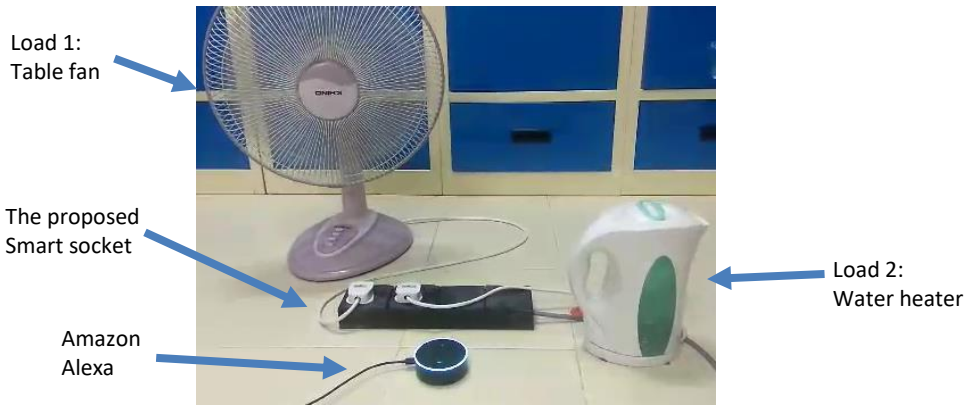

Fig. 5. Experimental setup

2.7.1 Experiment 1: Voice activation

During this test, a specific voice command set for the project was used. For example, use can say "Alexa, trigger switch 1" in order to activate the load connected to the first socket. Three different users were also selected to give the voice command in order to test Alexa's capability to cope with different English accent. For security reason, Alexa can also be set to respond to voice command from certain user only.

2.7.2 Experiment 2: Activation using Blynk Apps

The second test utilized the Blynk application installed on an iOS device to activate the load attached to the second socket outlet. A table fan was used as a load during this test. A customized button widget representing the socket's activation switch was pressed by the user to activate the table fan as shown in figure 6.

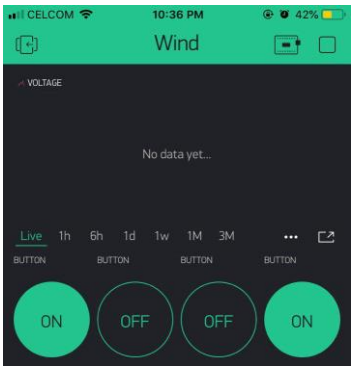

Fig. 6. Blynk Apps with custom switch widget for socket activation

2.7.3 Experiment 3: Activation via Telegram apps

During this procedure, a text such as '/status' was sent using telegram apps and the system responded by providing the information of all the available socket outlet. If given text was '/switch1ON', then the system will respond by enabling socket outlet number 1. Figure 7 depicts the use of Telegram Apps to check the activation status of the connected socket outlet.

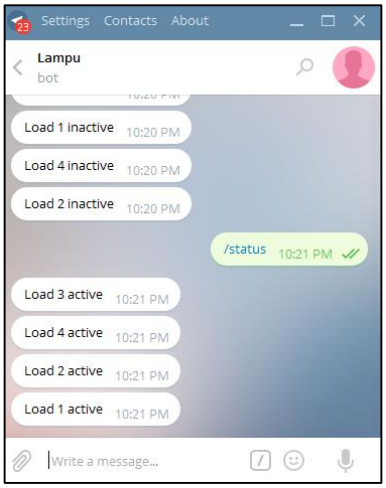

Fig. 7. Socket outlet status monitoring via Telegram apps

3. Results

3.1 Functionality Test

Table 1 presents the results of the functionality tests described in the previous section. It is clear that the proposed socket is ready to be used with full functionality. Alexa managed to interpret voice command given from user and update Blynk virtual port through the IFTTT service. However the effectiveness of the voice detection might vary depending on the user's distance from the smart speaker. Still, the proposed smart socket manage to offer several alternative such as using Telegram text or smart phone application in order to control the attached electrical appliances.

Table 1
Functionality test

No	Functions	Result
1.	Voice command detection	PASS
2.	Socket activation via voice command	PASS
3.	Socket activation via Blynk Apps	PASS
4.	Socket activation via Telegram Apps	PASS
5	Web interface	Operational

3.2 Plug Usage Monitoring System

In addition to web-based socket activation status display, user can also keep track of their socket activity so that they were more aware of their electrical usage. Figure 8 illustrates the sample of real-time data for the socket activity within one hour. Based on the graph, value '0' indicated that the plug was OFF while value '1' indicated that it was turned ON.

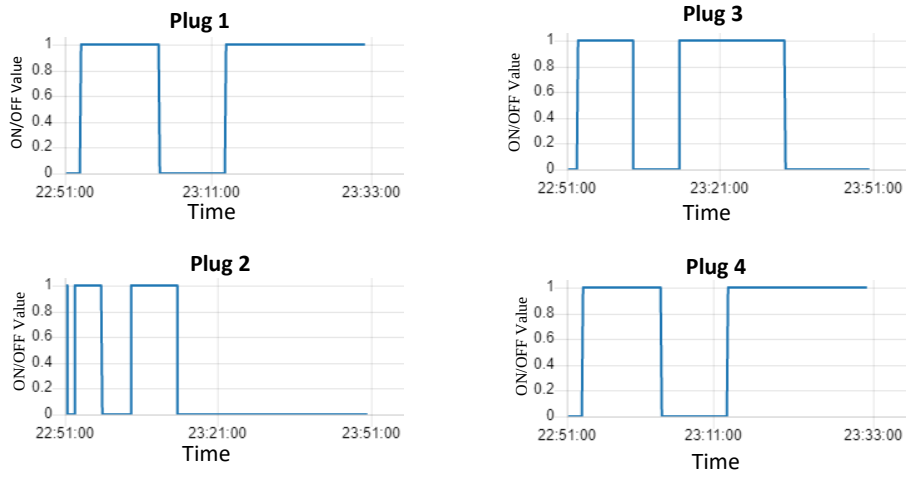

Fig. 8. Socket outlet activity log via web interface

4. Conclusions

In this paper, a smart socket with multiple activation method was presented and discussed. Results indicated that it can be operated with full functionality and ready to be used. Future research might integrate the existing setup with the ability to provide real time electricity bill estimation as presented in Ramavarapu *et al.*, [19] and utilize machine learning method for better energy management and utilization.

References

[1] Iqbal, Md Ahsan, S. K. Asrafuzzaman, Md Mahfuz Arifin, and SK Alamgir 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)*, pp. 891-896. IEEE, 2016.

[2] Horvat, Igor, Nikola Lukac, Roman Pavlovic, and Dusan Starcevic. "Smart plug solution based on bluetooth low energy." In *2015 IEEE 5th International Conference on Consumer Electronics-Berlin (ICCE-Berlin)*, pp. 435-437. IEEE, 2015.

[3] N. Lukac, R. Pavlovic, V. Vukobrat, and N. Teslic, "Bluetooth Smart Plug," *2015 IEEE 1st Int. Work. Consum. Electron. - Novi Sad, CE WS 2015*, pp. 16–18, 2017.

[4] Zhang, Yu Ping, Tao Liu, Zhong Xiao Yang, Yi Mou, Yu Hua Wei, and Dong Chen. "Design of remote control plug." In *2015 IEEE International Conference on Applied Superconductivity and Electromagnetic Devices (ASEMD)*, pp. 29-30. IEEE, 2015.

[5] Jakovljev, Sava, Miloš Subotić, and Ištvan Papp. "Realisation of a Smart Plug device based on Wi-Fi technology for use in home automation systems." In *2017 IEEE International Conference on Consumer Electronics (ICCE)*, pp. 327-328. IEEE, 2017.

[6] Nguyen, Thanh Dat, Viet Khang Tran, Tan Duy Nguyen, Ngoc Thien Le, and My Ha Le. "IoT-Based Smart Plug-In Device for Home Energy Management System." In *2018 4th International Conference on Green Technology and Sustainable Development (GTSD)*, pp. 734-738. IEEE, 2018.

[7] Al-Hassan, Eslam, Hussain Shareef, Md Mainul Islam, Addy Wahyudie, and Atef Amin Abdrabou. "Improved smart power socket for monitoring and controlling electrical home appliances." *IEEE Access* 6 (2018): 49292-49305.

[8] Lin, Yi-Bing, Chun-Ming Huang, Li-Kuan Chen, Gang-Neng Sung, and Chih-Chyau Yang. "Morsocket: an expandable iot-based smart socket system." *IEEE Access* 6 (2018): 53123-53132.

[9] Gupta, Ashish Kumar, Pappu Naga Sravya, and Rohit Sharma. "Automatic Extension Board using Esp826612e (IoT)." *Journal of Network Communications and Emerging Technologies (JNCET) www. jncet. org* 8, no. 5 (2018).

[10] Galioto, Giovanni, Natale Galioto, Costantino Giaconia, Laura Giarré, Giovanni Neglia, and Ilenia Tinnirello. "Smart plugs: A low cost solution for programmable control of domestic loads." In *2014 AEIT Annual Conference-From Research to Industry: The Need for a More Effective Technology Transfer (AEIT)*, pp. 1-6. IEEE, 2014.

[11] Gomes, Luis, Filipe Sousa, and Zita Vale. "An Intelligent Smart Plug with Shared Knowledge Capabilities." *Sensors* 18, no. 11 (2018): 3961.

[12] Mtshali, Progress, and Freedom Khubisa. "A Smart Home Appliance Control System for Physically Disabled People." In *2019 Conference on Information Communications Technology and Society (ICTAS)*, pp. 1-5. IEEE, 2019.

[13] Yue, Chan Zhen, and Shum Ping. "Voice activated smart home design and implementation." In *2017 2nd International Conference on Frontiers of Sensors Technologies (ICFST)*, pp. 489-492. IEEE, 2017.

[14] Dzulqornain, Muhammad Iskandar, M. Udin Harun Al Rasyid, and Sritrusta Sukaridhoto. "Design and Development of Smart Aquaculture System Based on IFTTT Model and Cloud Integration." In *MATEC Web of Conferences*, vol. 164, p. 01030. EDP Sciences, 2018.

[15] Satapathy, Lalit Mohan, Samir Kumar Bastia, and Nihar Mohanty. "Arduino based home automation using Internet of things (IoT)." *Int. J. Pure Appl. Math* 118 (2018): 769-778.

[16] Chennakesavan, C. "Implementation of Cloud Connected Smart Plug with Energy Monitoring System." *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)* 8, no. 3 (2017): 702-704.

[17] Tibbets, Linden. "Connecting Everything With Everything: The Sky Is the Limit." *GfK Marketing Intelligence Review* 10, no. 2 (2018): 48-53.

[18] A. Javed, *Complex Flows: Node-RED*. 2016.

[19] Ramavarapu, V. P., R. Sowers, and Ramavarapu S. Sreenivas. "A smart power outlet for electric devices that can benefit from Real-Time Pricing." In *2017 International Conference on Control, Electronics, Renewable Energy and Communications (ICCREC)*, pp. 11-17. IEEE, 2017.