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Remote Control of Home Lights Using Wi-Fi Technology on A Mobile Device.

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ABSTRACT

Traditionally electrical appliances in a home are controlled via switches that regulate the electricity to these devices. As the world gets more and more technologically advanced, we find new technology coming into our personal lives even at home. Remote control of home lights is becoming more popular around the world and is becoming a common practice. The process of home automation works by making everything in the house automatically controlled using technology to control and do the jobs that we would normally do manually. This study was to design and develop a control system via web browser using Wi-Fi as communication protocol and node MCU as server system to remotely control lights in a home. The user here will move directly into the system through a web-based interface over the web, where home lights are remotely controlled through easy website. The server will be interfaced with relay hardware circuits that control the lights via the mobile device or a computer system. One feature that makes the developed system better than other related existing works is its ability to remotely control home lights from anywhere in the world. The system will in future be explored further to using two switching system that will incorporate the Global System for Mobile communication (GSM) modem. Owing to its simplicity, C programming is used to programme the microcontroller. The developed device when tested with three lighting points operating on 220V power supply, gives an impressive performance in terms of accuracy and promptness.

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1. Introduction

Nowadays home and building automation systems are used almost everywhere, as they provide increased comfort especially when employed in a private home, offices, manufacturing industries (Hsu et al. 2010). On the other hand, automation systems installed in commercial buildings do not only increase comfort, but also allow centralized control of heating, ventilation, air conditioner and lighting. Hence, they contribute to overall cost reduction and energy savings, which is certainly a main issue today. The present age of information and computer technology (ICT) has redefined communication. With mobile phones, one could communicate with friends, family members, business associates, etc. from a distant location. However, the application of mobile phones cannot be restricted to sending SMS, calling friends or connecting to a hotspot for internet browsing. It could be deployed to use in areas that involves controlling of remote appliances. Managing of several home and outdoor appliances remotely is a subject of growing interest, which has seen many developments over the years. However, there is still the need for lots of improvement to make a breakthrough into future, especially in smart grid applications. An excellent application of remote control is the controlling of security lights in a big higher institution, such as a university. The system allows the operator to remotely control the lights using Wi-Fi via a mobile phone. by sending SMS containing commands to be implemented or connected to its module. The message when received is processed and the required operation is performed accordingly. SMS messages, also known as instant messages, allow quick transmission of short messages at an economic rate. Combined with this is the ability to still control the security or street lighting system without spending a dime when one is within a few meters to the device. This gives a great degree of freedom to the operator who can decide to stay in the control room and put on/off the security or streetlight at ease.

Another study shows that seventy-five percent of the market share is Android and one hundred and six million android smartphones were shipped in the second half of 2012. Android smartphone became the top operating system in the market in the present time worldwide and it became the most popular operating system known to man.

Motivation and Significance of the Study

The author came up with this system with the view of creating a flexible and efficient remote control of home lights that will allow among others, elderly, handicapped go about with their daily operations but only this time assisted by the system to make movement easier from the comfort of their chair or bedroom or any part of the house. The main motivation stemmed from the need to implement particular view points on issues concerning the movement of the handicapped and elderly but not limited to those but extends further to any person handicapped or not. Furthermore, it was imperative to manage other attributes of the system that encompassed the automation of lights and doors. The inspirations came from the concepts being implemented at shopping malls such as Kafubu Mall, Jacaranda Mall to mention but a few. Thus, this project is an investigation into the possibility

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of such an implementation in our local home setting.

2. Related Works

In the past, a number of researchers have devised different approaches to remotely control home or security lights. For example, Sriskanthan and Karand (2002) proposed a system that could control electrical appliances using Bluetooth. The setback of this system is that it is unable to control systems remotely from a far distance. Similarly, Ramli et al. (2006) developed a remotely control system of devices through spoken commands. The commands are sent in form of SMS but the cost of sending a voice SMS is quite expensive. In the same vein, Al-Ali and Al-Rousan (2004) presented a design and implementation of a Java based automation system through World Wide Web. The design focused on the use of internet to control the switching of home appliances. With this, the switching could be done anywhere in the world provided there is access to the internet. The limitation of this method is that the internet is not readily available and it is prone to hacking. Sakhare and Angal (2015) demonstrated the use of ZigBee network in proffering solution to the problem. Pan et al. (2008) presented a WSN-based intelligent lighting system, which acts in accordance with the user's profiles and activities. Bellido Outeirino et al. (2012) proposed a system focusing on automation of building lighting.

The project was accomplished by integrating Digital Addressable Lighting Interface (DALI) devices and wireless sensor networks. Furthermore Parise, et al. (2014) presented a lighting system that optimizes the characteristics of the room to determine the switching signal to be sent to appropriate relays. Byun et al. (2013) proposed LED lighting system, which considers energy efficiency and user satisfaction for indoor environments. This system uses multiple sensors and wireless technology to control the LED light according to the user state and surroundings

In 1977-78 crisp et.al. (36-37) reported a preliminary study on automated artificial light control in accordance with variation of daylight. The purpose was to supplement the available daylight art the task area with just enough electric light to meet the design level. The idea of computerized control of artificial light intended for daylight harvesting was primarily introduced.

(Hongping and Kangling, 2010) proposed the architecture of embedded remote monitoring system based on Internet. The system adopts embedded web server as a central monitoring node and results in improvement in stability and reliability of system. Moreover, utilization of dynamic monitoring web based on Java Applet improves the response capability and brings convenience for complex monitoring web design.

In 1987 by CRAB et.al (38-39). They developed a self-commissioning adaptive algorithm well enough for the real time prediction of natural light levels using the external vertical plane luminance measurements. This attempt of the authors could be viewed as framework for the model-based lighting control scheme.

(Yuksekkaya et al., 2006) developed wireless home automation system by merging communication technologies of GSM, Internet and speech recognition. GSM and Internet methods were used for remote access of devices of house whereas speech recognition was

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designed for users inside the house. The communication between the user and the home is established by the SMS (Short Message Service) protocol. A GSM modem is connected to the home automation server. The communication between the home automation server and the GSM modem is carried out by the AT (Attention) commands. To accomplish Internet connectivity, a web server is built to take requests from remote clients. The clients can send requests to the home appliances. The home appliances can send their statuses to be displayed for the remote client through the server. A web page is constructed as an interactive interface where commands can be submitted by the client to change and also monitor the status of the devices. A speech recognition program is written to control the house by means of human voice. Dynamic Time Warping (DTW) algorithm is used for speech recognition.

(Scanaill et al., 2006) developed a tele-monitoring system, based on short message service (SMS), to remotely monitor the long-term mobility levels of elderly people in their natural environment. An accelerometer-based portable unit, worn by each monitored subject, measures mobility. The portable unit houses the Analog Devices ADuC812S microcontroller board, Falcon A2D-1 GSM modem, and a battery-based power supply. Two integrated accelerometers are connected to the portable unit through the analog inputs of the microcontroller. Mobility level summaries are transmitted hourly, as an SMS message, directly from the portable unit to a remote server for long-term analysis. Each subject's mobility levels are monitored using custom-designed mobility alert software, and the appropriate medical personnel are alerted by SMS if the subject's mobility levels decrease.

(Alheraish, 2004) implemented home security system by means of GSM cellular communication network using microcontroller 89X52 and Sony Ericsson GM-47 GSM module. This system enables far end user through SMS facility to monitor the state of home door, provide password facility for key-based door lock and control home lighting system.

(Van Der Werff et al., 2005) proposed a mobile-based home automation system that consists of a mobile phone with Java capabilities, a cellular modem, and a home server. The home appliances are controlled by the home server, which operates according to the user commands received from the mobile phone via the cellular modem. In the proposed system, the home server is built upon an SMS/GPRS (Short Message Service/General Packet Radio Service) mobile cell module Sony Ericsson GT48 and a microcontroller Atmel AVR 169, allowing a user to control and monitor any variables related to the home by using any java capable cell phone.

(Kanma et al., 2003) proposed a home appliance control system over Bluetooth with a cellular phone, which enables remote control, fault-diagnosis and software-update for home appliances through Java applications on a cellular phone. The system consists of home appliances, a cellular phone and Bluetooth communication adapters for the appliances. The communication adapter hardware consists of a 20MHz 16bit CPU, SRAM and a Bluetooth module. The communication adapter board is connected to the home appliance and to the cellular phone through

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serial ports. The appliances can communicate with the cellular phone control terminal via Bluetooth SPP.

(Sung-Nien Yu and Jen-Chieh Cheng, 2005) proposed a wireless patient monitoring system which integrates Bluetooth and Wi-Fi wireless technologies. The system consists of the mobile unit, which is set up on the patient's side to acquire the patient's physiological signals, and the monitor units, which enable the medical personnel to monitor the patient's status remotely. The mobile unit is based on AT89C51 microprocessor. The digitized vital-sign signals are transmitted to the local monitor unit using a Bluetooth dongle. Four kinds of monitor units, namely, local monitor unit, a control center, mobile devices (personal digital assistant; PDA), and a web page were designed to communicate via the Wi-Fi wireless technology.

3. Problem Statement

Manual lighting controls range from a single switch to a bank of switches and dimmers that are actuated by toggles, rotary knobs, push buttons, remote control, and other means. Manual controls are the most cost-effective options for small-scale situations. However, as the size of the lighting system grows, manual controls lose their cost-effectiveness. However, they can still be an important part of a larger plan, as evidenced by the effectiveness of task lighting with manual controls. However, looking critically at the approaches that the researcher came across, one observes that their service may not be reliable and cost effective in operation since they are limited by distance e.g., Bluetooth, infrared.

To address this deficiency, the researcher considered one effective means of controlling the system. Therefore, Wi-Fi technology with the help a Blynk server, which provides access to the system anywhere, was considered. Wi-Fi technology is used when the operator with a smart phone or a computer is located anywhere to control system (Rajput et al 2013). This is done at no cost. However, the operator could explore another way of controlling the home or security lights by simply sending certain codes to a registered mobile number. (Das et al 2009), this option is chosen when the operator is outside the coverage area of the Wi-Fi network provided by the system. This offers more reliability and less operation cost especially when Wi-Fi technology is used. Meanwhile, this paper is an expanded version of the paper presented at the (IEEE PES Power Africa Conference: 2017)

Concept of remote control of home lights

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4. Methodology

System Development Methodology

The systems development methodology was used to describe the process for building systems, in a very deliberate, structured and methodical way. Extreme programming was used as the methodology of choice in developing a remote control of home lights using Wi-Fi technology.

Extreme programming was a software development methodology, which is intended to improve software quality and responsiveness to changing customer requirements. As a type of agile software development, it advocates frequent "releases" in short development cycles. This was intended to improve productivity and introduce checkpoints where new customer requirements can be adopted. The main goal of XP is to lower the cost of change in software requirements.

Extreme programming was carried out in the following manner; the phases are carried out in extremely small steps. First, one writes automated tests, to provide concrete goals for development.

Next was coding (by a pair of programmers). Design and architecture emerge out of refactoring, and come after coding. The same people who do the coding do design. The incomplete but functional system was deployed or demonstrated for the users. At this point, the practitioners start again on writing tests for the next most important part of the system.

Data Collection

The following techniques were used to gather information

I. **Semi-structured interviews:** Semi-structured interviews are conducted with an open framework, which allow for focused, conversational, two-way communication. They can be used to both give and receive information. In the process of developing the system, the developer interviewed the people at the author's home in order to identify the processes, obtain specific quantitative and qualitative information from the interviewees, obtain general information relevant to data entry, and to gain a range of insights on the process of home automation.

II. **Direct (Reactive) Observation:** Direct Observation is a method in which a researcher observes and records behavior / events / activities / tasks / duties while something is happening. This was used in correspondence to interviewing in order to gain a more holistic view of the home setup.

III. **Using available information**: This is a data collection method that involves the process of examining and evaluating already existent literature material to obtain facts and data regarding a specific subject. Locating these sources and retrieving the information can help in data collection.

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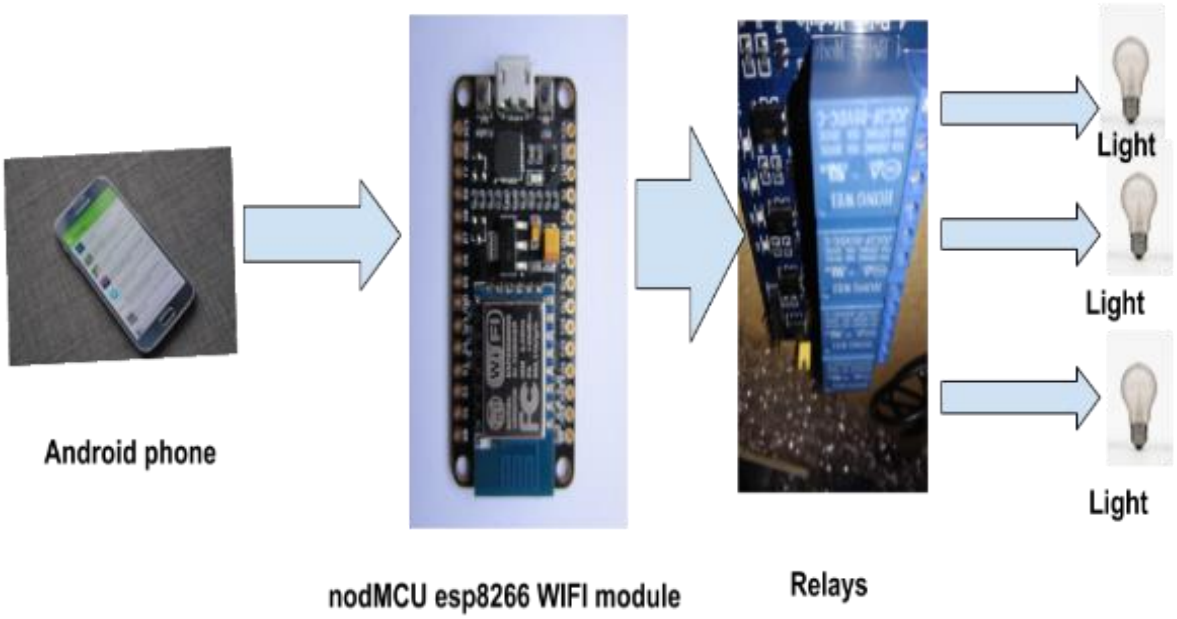
System design



5. Results

The results clearly show that successful application of the Remote control of home lights using nodMCU esp8266 module as a system server and Wi-Fi as a communication protocol. The experimental model was made according to the circuit diagram and the results were as expected. The loads (bulbs) are switched ON when the NODE MCU gets the signal correctly from android phone and it drives the particular load relay correctly. The loads are switched OFF only when the NODE MCU gets the OFF signal from android phone i.e., from the user. An efficient implementation for IoT (Internet of Things) used for monitoring and controlling the home lights via World Wide Web. Remote control of home lights uses the portable devices as a user interface. They can communicate with home automation network through an Internet gateway, by means of low power communication protocols like Wi-Fi.

It was user friendly and cost effective. It is user friendly because anyone can use just a click of a button on an android screen from anywhere in the world and everything works accordingly. In addition, it is cost effective because it will cost exactly as the project requires. It was able to switch on and off the lights as required. The figure below shows the prototype of the system.

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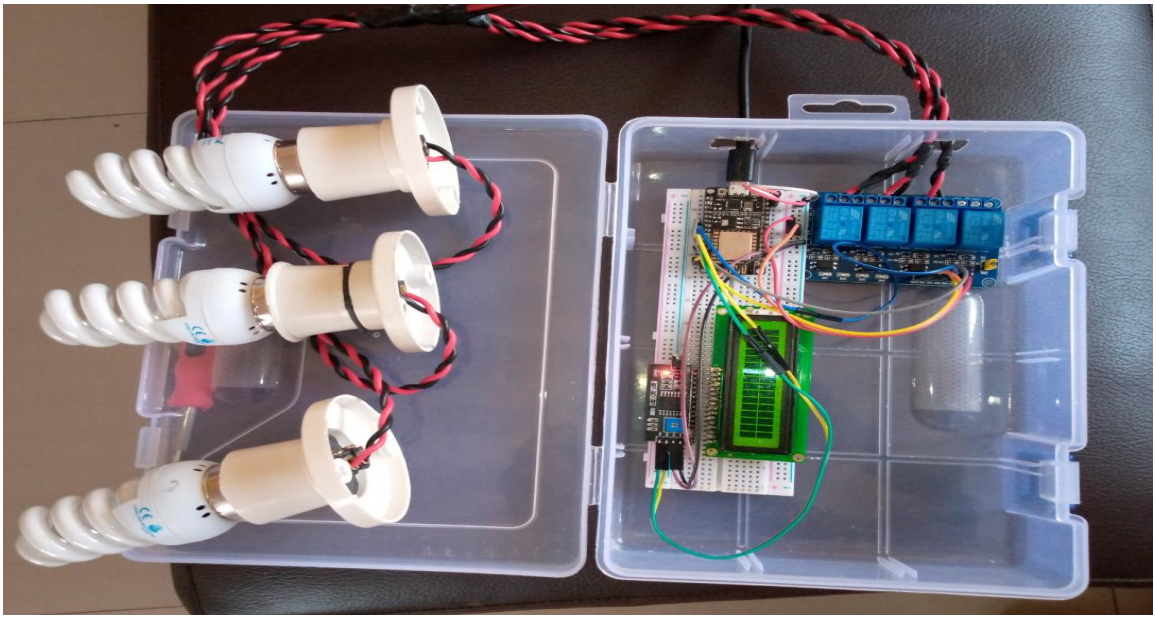
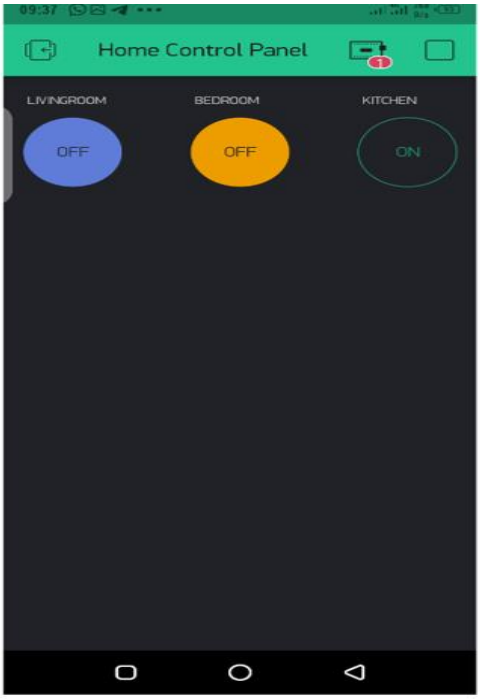
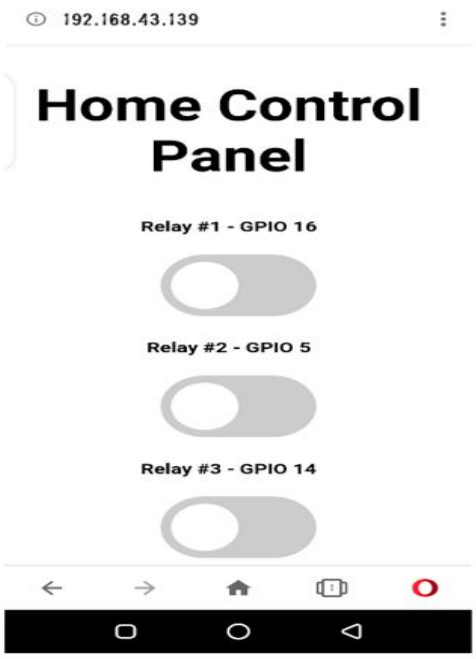
Final design of the system



System Implementation Results

When the IP address is searched on a web browser, a home control panel indicating switch buttons are displayed as shown below:





[Source: author, 2020]

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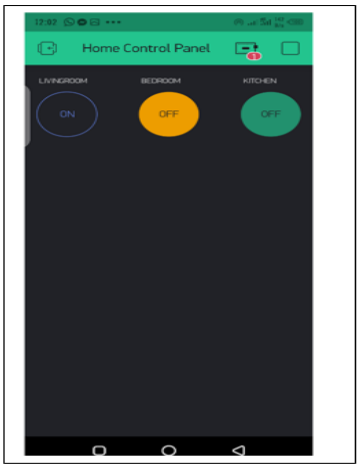
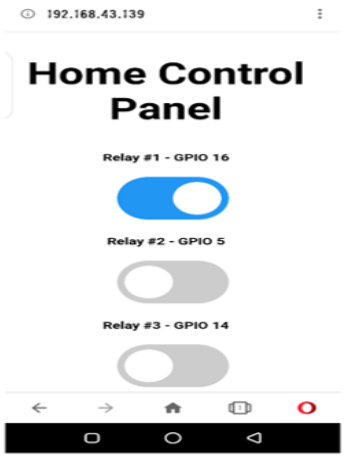
When the Blynk button #1 or relay #1 button is pressed, the corresponding light connected the relay is turned on as shown below

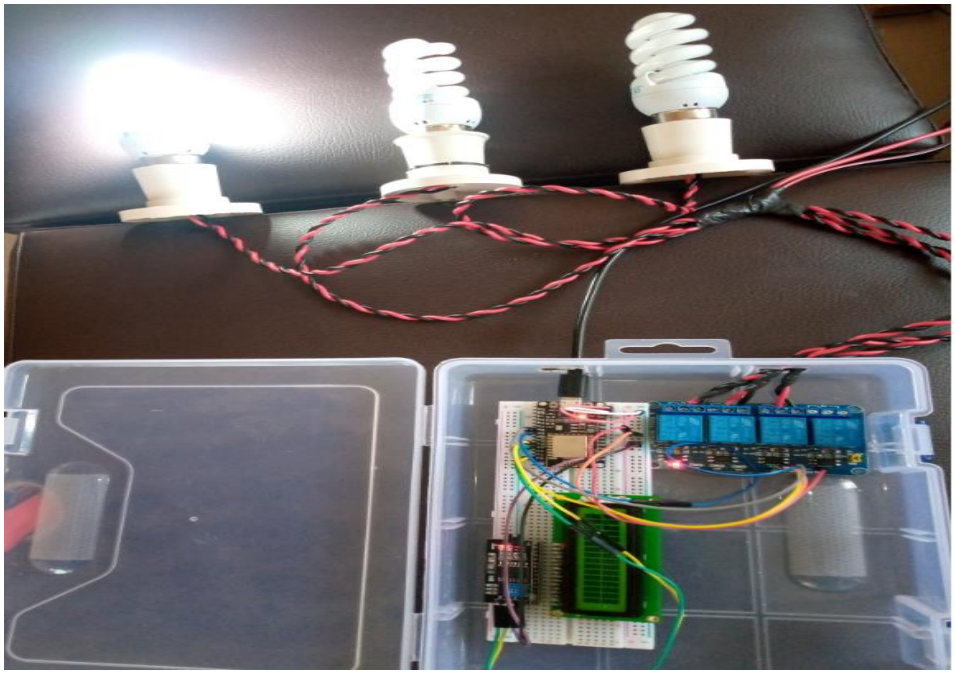
Blynk #1 button ON



relay#1 button ON



Relay#1button or Blynk #1button Corresponding bulb ON



[Source: author, 2020]

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When the relay Blynk button #2 or relay #2 button is pressed ON, the corresponding light connected the relay is turned on as shown below

Blynk #2 Button ON

Relay#2 button ON

Relay#1button or Blynk #1button Corresponding bulb ON

[Source: author, 2020]

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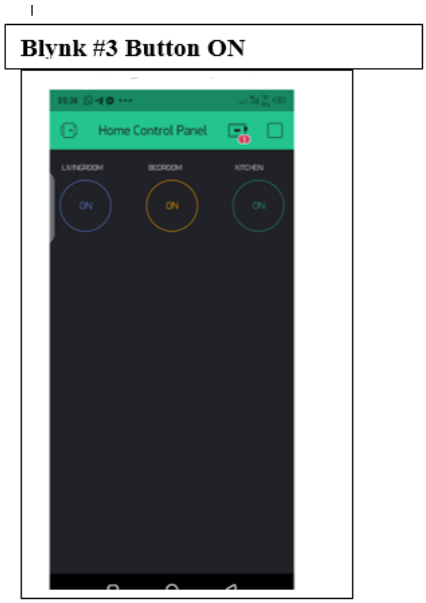
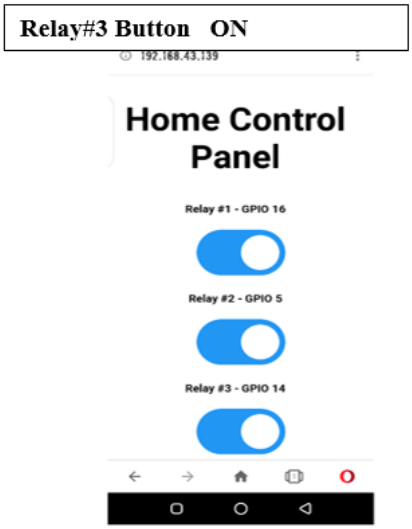
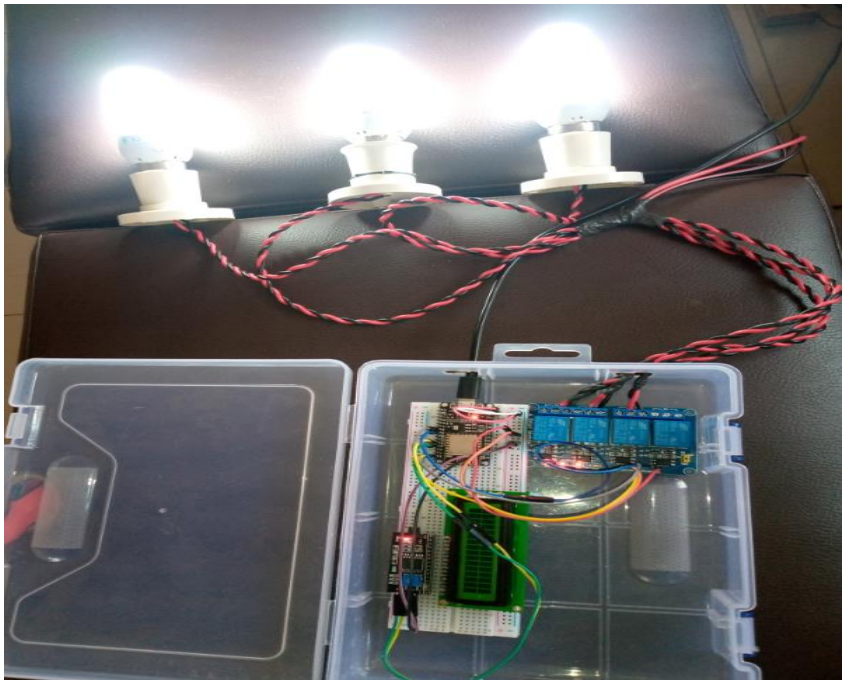
When the Blynk button 3 or relay #3 button is pressed, the corresponding light connected the relay is turned on as shown below





Relay#3 Button or Blynk #3 Button Corresponding bulb ON



[Source: author, 2020]

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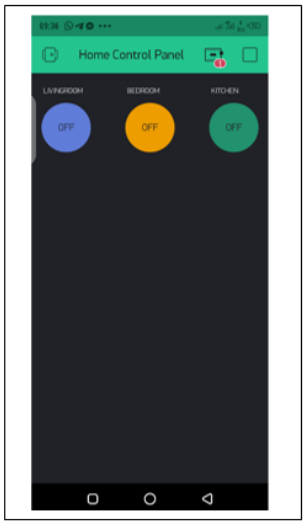
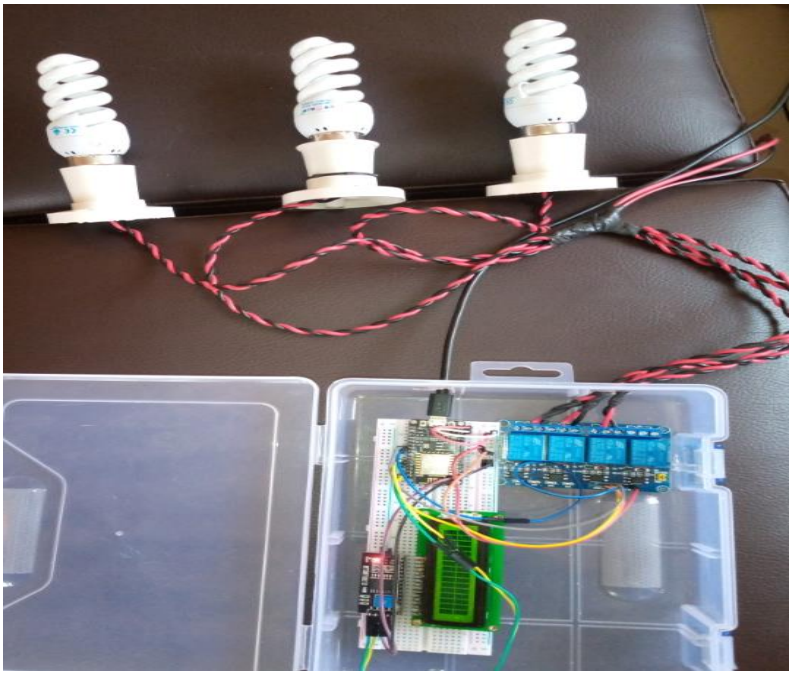
Turning off all the relays, turns off all the lights respectively

Blynk OFF Positon



Relays OFF Position

Corresponding bulbs OFF Position



[Source: author, 2020]

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7. Discussion

The experiment clearly showed that the application was able to create and handle users. Any user, when in the Wi-Fi network range, (100m) is able to control the home lights as long as they are connected to the same network, however when outside the network range and or on different network, any user can remotely control the lights using a Blynk application that connects the system to the cloud, to submit as well as retrieve information, which was the main aim of creating the application. The application is able to handle many users.

6. Conclusion

Here we have used NODEMCU which has inbuilt Wi-Fi module to control relays locally as well as globally. It is one of the easiest and most pocket friendly remote-control system based on IOT. The project proposes an efficient implementation for IoT (Internet of Things) used for monitoring and controlling the home appliances via World Wide Web. Home automation system uses the portable devices as a user interface. They can communicate with home automation network through an Internet gateway, by means of low power communication protocols like Zigbee, Wi-Fi etc. The user here will move directly with the system through a web-based interface over the web, where home lights can be remotely controlled through easy website. The server will be interfaced with relay hardware circuits that control the appliances running at home. The server communicates with the corresponding relays. If the web affiliation is down or the server is not up, the embedded system board still will manage and operate the appliances domestically. By this, we provide a climbable and price effective Home Automation system.

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REFERENCES

[1] Ahmed Elshafee, Ph.D., Assistant Professor, "*Faculty of Computer Science and IT, Ahram Canadian University*", *City, Giza, Egypt. & Member IEEE,* 6th October.

[2] Al-Ali, A., & Al-Rousan, M.A. (2004). Java-based home automation system. *IEEE Transactions on Consumer Electronics, 50,* 498-504.lheraish, (2004*) "Design and Implementation of Home Automation System*," IEEE Transactions on Consumer Electronics, vol. 50, no. 4, pp.1087-1092,

[3] Bellido-Outeirino, FJ., Flores-Arias, JM., Domingo-Perez, F., Gil-de-Castro, A. and MorenoMunoz, A., (2012) *Building lighting automation through the integration of DALI with wireless sensor networks*. IEEE Transactions on Consumer Electronics, 58(1): 47 - 58.

[4] Byun, J., Hong, I., Lee, B. and Park, S., (2013) *Intelligent household LED lighting system considering energy efficiency and user satisfaction*. IEEE Transactions on Consumer Electronics, 59(1): 70 - 76.

[5] Crab A. l, (1987). "Artificial Light intended for daylight harvesting", pp (33-39

[6] Hongping F, Fang K, (2010) *"The Design of Remote Embedded Monitoring System based on Internet"* International Conference on Measuring Technology and Mechatronics Automation.

[7] Hsu, C.L., Yang, SY. and Wu, WB., (2010). "*3C intelligent home appliance control system Example with refrigerator*. Expert Systems with Applications."

[8] Kanma, H. N, Wakabayashi R., Kanazawa, Ito H, (2003) *"Home Appliance Control System over Bluetooth with a Cellular Phone,*" IEEE Transactions on Consumer Electronics, vol. 49, no. 4, pp.1049-1053.

[9] Karim Alaa Hamed, B.Sc., Teaching assistant, "Faculty of Computer Science and IT, Ahram Canadian University", *City, Giza, Egypt,*6th October

[10] Khusvinder Gill, et. Al (2009). "*A ZigBee-based Home Automation system*" *IEEE Transactions on Consumer Electronics,* vol. 55, No. 2. pp 422-430

[11] Ming Y and Hao S, (2013)" *smart living using Bluetooth based android smartphone*"

[12] Pan M.S, Yeh L.W, Chen Y.A, (2008) "*A WSN-Based Intelligent Light Control System Considering User Activities and Profiles," IEEE* Sensors Journal, vol. 8, no. 10.

[13] Parise, G, Martirano, L, Cecchini, G. (2014) "*Design and Energetic Analysis of an Advanced Control Upgrading Existing Lighting Systems*". IEEE Trans. Ind.

[14] Raj, JR., Rahman, SM.K. and Anand, S., (2016) *Microcontroller USB interfacing with MATLAB GUI for low-cost medical ultrasound scanners*. Engineering Science and Technology, an International Journal, 19(2): 964 - 969.

[15] Rajput, K.Y., Khatav, G., Pujari. M and Yadav, P. 2013. "Intelligent Street Lighting System Using GSM", International Journal of Engineering Science Invention, Vol2, Issue 3, PP. 60-69.

[16] Ramli, M.I., Wahab, A., Helmy, M. and Ahmad, N., (2006). "*Towards smart home: control electrical devices".* In International Conference on Science and Technology:

ISSN: 3471-7102, ISBN: 978-9982-70-318-5

Application in Industry and Education, Penang, Malaysia, 1 – 7

[17] Rousan A.L –Ali A.L, (2004)., "*Java-Based Home Automation System R."* IEEE Transactions on Consumer Electronics, Vol. 50, Member, IEEE & M.

[18] Sakhare, AB. and Angal, YS., (2015*) High efficient and intelligent lighting and security remote control system using a Zigbee network.* In 2015 International Conference on Industrial Instrumentation and Control (ICIC), Pune, India, 551 - 555.

[19] Scanaill C. N, Ahearne B, Lyons G. M (2006) *"Long-term telemonitoring of mobility trends of elderly people using SMS messaging".* IEEE Trans Inf Technol Biomed, 10(2): 421–3

[20] Sriskanthan, N., Tan, F. and Karande, A., (2002) *Bluetooth based home automation system. Microprocessors and Microsystems*, 26(6): 281 - 289.

[21] Sung-Nien Y and Jen-Chieh C (2005), "*A Wireless Physiological Signal Monitoring System with Integrated Bluetooth and Wi-Fi Technologies",* Proceedings of the 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference Shanghai, China.

[22] Van Der W.M, Gui X, and Xu W.L. (2005) "*A Mobile-Based Home Automation System"* Mobile Technology, Applications and Systems, 2005 2nd International Conference

[23] Yuksekkaya B., Kayalar A. A., Tosun M. B., Ozcan M. K., and Alkar A. Z., (2006) "A GSM, internet and speech controlled wireless interactive home automation system", IEEE Trans. Consumer Electronics, vol. 52, no. 3. pp. 837–843.