# A Wemos-D1-R2-Based Remote-Switching Module for Home Internet of Things Applications

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**Abstract-**This paper reports the design and construction of an Internet of Things (IoT) module for remote-control of home appliances/circuits. The objective is to reduce stress by remotely controlling the switching of home appliances while providing a secure system to connect the operation of home appliances. A web browser is used as the user interface to connect to the WeMos D1 R2 via a secure wireless local network. The WeMos D1 R2 switches ON/OFF the select circuit(s). The module is capable of independently switching eight circuits. When all switching circuits are in operation, the device only consumes about 60W of power. The design was successfully implemented and tested. Consistent accurate results confirmed the accuracy of the design. This design has the potential of being connected to a cloud service for data storage and processing.

***Keywords**: Home automation, internet of things, IoT, WeMos D1 R2.*

## 1. Introduction

Home automation can be viewed as the use of electronics to complete various household tasks with minimal human efforts and interaction (Hill, 2015). A home automation system will typically control entertainment systems, lighting, refrigerator, security systems, and other appliances. Remote control is one important aspect of home automation as it offers a convenient way for a user to operate and control a home appliance that is out of convenient reach. Remote control can be achieved using ultrasonic, infrared, Bluetooth, Wi Fi (with or without internet), voice, and motion sensing.

When the home automation system is connected to the internet, the home devices constitute the Internet of Things. According to (ITU-T, 2012), the internet of things is the global infrastructure which enables advanced services by interconnecting things based on interoperable information and communication technologies. Internet of things offers many benefits such as smart home, elder care (Demiris & Hensel, 2008), medical and healthcare (da Costa, Pasluosta, Eskofier, da Silva, & Righi, 2018), transportation, to mention a few.

The concept of home automation has been around for decades and some commercial devices using different technologies are available in the open market. Different authors have achieved this using different technologies and microcontrollers. The Bluetooth based home automation systems have been designed by (Kumar, 2016; Ramlee et al., 2013). The system designed by (Kumar, 2016) adopted an android app as the interface. This limits the user device's compatibility as other smartphones running a different operating system are not able to use the mobile application. In (Arul, 2014; Dhiman, Sharma, Chaudhary, Fatima, & Rajput, 2016) a home automation system and security system based on the ZigBee technology (ZigBee, 2003) was implemented. Some of the systems is based on voice command.

Designs based on Raspberry Pi are presented in (Babu, Lakshmi, Bhargavi, Ravi, & Sasidhar, 2018; Bhaskar & Uma, 2015; Prashant, Khizaruddin, Kotian, & Shubham, 2017). The modules designed in (Babu et al., 2018; Prashant et al., 2017) send and receive user command over the internet. This makes it unusable in households without internet connection as is the case in most homes in Nigeria and other developing countries. The system implemented in (Bhaskar & Uma, 2015) however, does not require internet connection but uses a mobile application which makes its use dependent on operating system of a mobile device. Finally, designs based on Radio Frequency communication (Khan & Hasan, 2017) and Dual Tone Multiple Frequency system (Panigrahi, Ranjan, Subhasish, & Kumari, 2017; Ruhidas, Ghosh, Ghosh, & Sengupta, 2018) are also developed for home automation.

A major and common drawback of the designs discussed is the lack of universality. That is, a user without the appropriate interfacing device will be unable to use these systems. Furthermore, some of the designs discussed inherently will require extra modules for connection to the internet for internet of things applications. These designs also adopt non-standardized technologies which limits compatibility and upgradability. These drawbacks are overcome in the design presented in this paper by using the WeMos D1 R2 board, which makes it compatible with any device with Wi-Fi connectivity and web browser application, for example any smartphone, laptop computers, and desktop computers with Wi-Fi card.

Section 2 discussed the system design and description. The implementation and testing of the system are discussed in Section 3. Finally, Section 4 concludes the paper.

## 2. System Design and Description

In this section, the design of the system is presented and discussed. The block diagram of the design is shown in Figure 1 and consists of the DC power supply unit, the WeMos D1 R2 board, and the relay switching units. Each block is discussed subsequently with corresponding circuit diagrams when applicable.

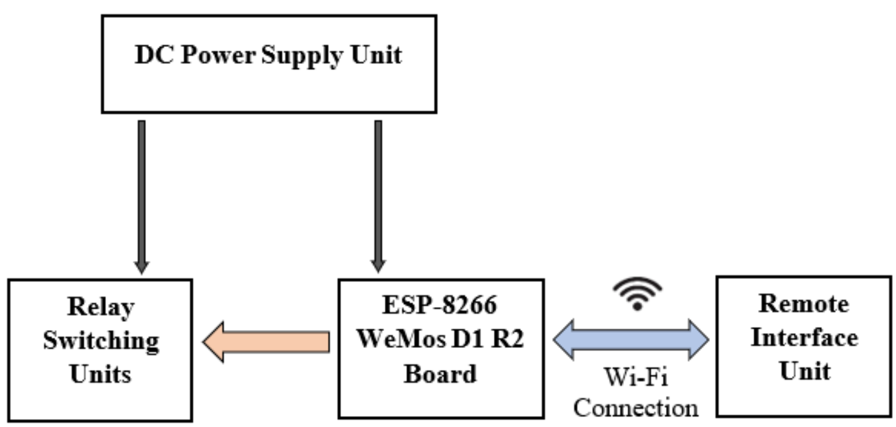


Figure 1: Block diagram of the design.

### A. WeMos D1 R2 ESP-8266 Board

The WeMos D1 R2 is low-cost IEEE 802.11 b/g/n Wi-Fi capable microprocessor development board built around the ESP8266 Wi-Fi module. The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability (RhydoLabs, 2019). An image of the board is shown in Figure 2. The WeMos D1 R2 has full TCP/IP stack hence functions as an HTTP server.

The board has same form factor as the popular Arduino Uno, with dimension of 53.4 mm × 68.6 mm, and weighs just 25 g. It also has a CH340 USB to serial interface making it possible to be programmed via the USB interface. Once connected to the computer, and drivers have been installed, the WeMos development board will appear as a standard serial COM port and can be programmed directly from an Arduino IDE.


Figure 2: ESP-8266 WeMos D1 R2 board (RhydoLabs, 2019).

For this work, the WeMos is operated in the access point mode which enables the connecting device connect to its password-protected Wi-Fi connection. Once connected, the user opens a browser and enters the IP address (http://192.168.4.1) into the address bar to receive the control interface from the WeMos issued as a webpage. The controlled circuits' current states are displayed, and on pressing a button on the webpage, the corresponding circuit is turned ON/OFF by the WeMos.

The input/output pins D0, D1, D2, ···, D8 were set to input mode. Pins D0 to D7 were used for the relay switching while pin D9 was used for the interrupt trigger for the system. This interrupt stops the device from receiving commands from the connected control interface. This is a security feature to disable control remote controlling device is compromised.

### B. Power Supply Unit

The power supply unit supplies power to the WeMos board and the eight relays at 12V dc. Figure 3 shows the circuit diagram of the power supply unit. The terminal T1 connects to terminal T1 in the relay driving circuit of Figure 4.

The source of power for the relay coils are tapped before the 7812-voltage regulator to ensure enough current is supplied to the relay coils.

### C. Switching Relays Unit

The controlled circuits comprise eight direct current relays which are connected independently to the eight output pins of the WeMos D1 R2. The output pins of the WeMos were each connected through a switching transistor circuit to provide enough current to energise the coils of the relays.

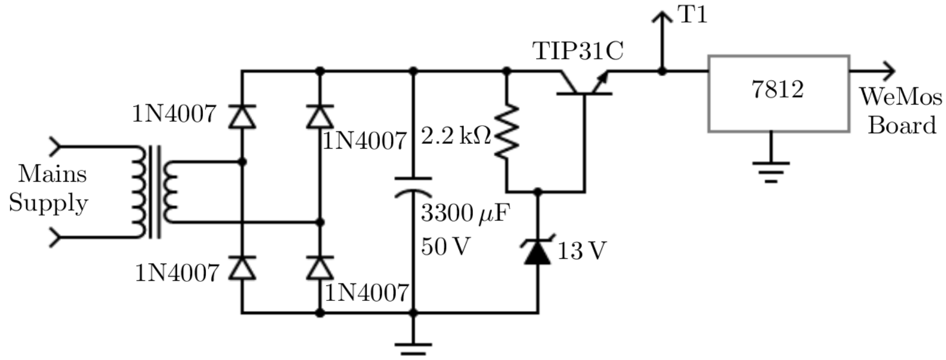


Figure 3: Power supply unit circuit.

### D. Remote Interface

The remote interface is any Wi-Fi-enabled device with web browser application. The WeMos receives/sends command using the Hyper Text Transfer Protocol (HTTP). On successful HTTP request, the WeMos sends an HTML page which is rendered at the web browser. When a button on the webpage is pressed, the WeMos receives the command as HTTP request and turns ON/OFF the circuit represented by the button.

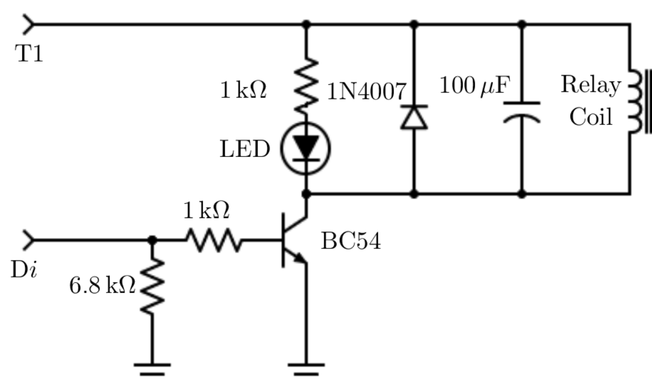


Figure 4: The relay driving circuit.

## 3. IMPLEMENTATION AND TESTING

The final design was temporarily constructed and tested on a bread board. The source code was written in the Arduino IDE and transferred to the microprocessor through board's micro USB interface. After the circuit is confirmed to work, the final circuit was transferred to a permanent board (the Veroboard).

In a test to confirm its interface versatility, a smartphone and a notebook PC was used to connect and control the circuits. The security of the device was also tested by attempting to establish more than one connection. This was impossible as the max connection was limited to one. The device runs at 60W when all the eight relays and LEDs are energized

## 4. Conclusion

A device for remote switching of home devices have been designed and implemented. A web browser is used as the user interface which connects to the device via a secure wireless local network. The module is capable of independently switching eight circuits. When all switching circuits are in operation, the device only consumes about 60W of power. Consistent accurate results confirmed the accuracy of the design. This design has the potential of being connected to a cloud service for data storage and processing.

## REFERENCES


Arul, B. S. (2014). Wireless Home Automation System Using Zigbee. *International Journal of Scientific & Engineering Research*, *5*(12), 133–138.

Babu, K. N., Lakshmi, K. V, Bhargavi, K. S., Ravi, A., & Sasidhar, K. (2018). IOT Based Home Automation System Using Raspberry Pi with Web Server. *International Journal of Innovative Research in Science, Engineering and Technology*, *7*(3), 3037–3043.

Bhaskar, P. R., & Uma, S. K. (2015). Raspberry Pi Home Automation with Wireless Sensors Using Smart Phone. *International Journal of Computer Science and Mobile Computing*, *4*(5), 797–803.

da Costa, C. A., Pasluosta, C. F., Eskofier, B., da Silva, D. B., & Righi, R. da R. (2018). Internet of Health Things: Toward Intelligent Vital Signs Monitoring in Hospital Wards. *Aritificial Intelligence Medicine*, *89*, 61–39.

Demiris, G., & Hensel, B. K. (2008). Technologies for an aging society: a systematic review of “smart home” applications. *Yearbook of Medical Informatics*, 33–40.

Dhiman, K., Sharma, A., Chaudhary, A., Fatima, F., & Rajput, D. S. (2016). Zigbee Based Home Automation and Security System. *International Journal of Engineering Science and Computing*, *6*(4), 3921–3925.

Hill, J. (2015). The smart home: a glossary guide for the perplexed. Retrieved March 19, 2020, from https://www.t3.com/features/the-smart-home-guide

ITU-T. (2012). Overview of the Internet of things. Retrieved March 19, 2020, from http://handle.itu.int/11.1002/1000/11559%0A

Khan, N. R., & Hasan, R. (2017). Designing A Home Automation System by Using RF Receivers. *International Journal Of Advance Research And Innovative Ideas In Education*, *3*(4), 2395–4396.

Kumar, A. (2016). *Home Automation Via Bluetooth Using the Arduino Uno Microcontroller*. California State University, Long Beach.

Panigrahi, A., Ranjan, R., Subhasish, B., & Kumari, N. (2017). DTMF Based Home Automation System. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, *6*(3).

Prashant, R., Khizaruddin, S., Kotian, R., & Shubham, L. (2017). Raspberry Pi Based Home Automation Using Wi-Fi, IOT & Android for Live Monitoring. *International Journal of*

*Computer Science Trends and Technology*, *5*(2), 363–368.

Ramlee, R. A., Leong, M. H., Singh, R. S. S., Ismail, M. M., Othman, M. A., Sulaiman, H. A., Meor Said, M. A. (2013). Bluetooth Remote Home Automation System Using Android Application. *The International Journal of Engineering and Science*, *2*(1), 149–153.

RhydoLabs. (2019). WeMos D1 (R2) ESP8266 Development Board (Arduino Compatible). Retrieved March 20, 2020, from https://www.rhydolabz.com/arduino-arduino-boards-c-152_123/wemos-d1-r2-wifi-esp8266-development-board-arduino-compatible-2431.html

Ruhidas, D., Ghosh, R., Ghosh, A., & Sengupta, A. (2018). *DTMF Based Home Automation*. Maulana Abul Kalam Azad University of Technology, West Bengal. Retrieved from https://www.rcciit.org/students_projects/projects/ece/2018/GR12.pdf

ZigBee. (2003). ZigBee Alliance. Retrieved March 20, 2020, from https://zigbeealliance.org