

Amazon Alexa Enabled Smart Wi-Fi Switch

Shubham Jain

B. Tech student, ECE Department, Bharati Vidyapeeth College of Engineering, New Delhi.
jainshubham0403@gmail.com

Abstract: Voice Assistance is expanding rapidly and so as the IoT components that can be governed by the voice assistance is now taking over market, creating a "WOW" factor among the customers. The IoT industry has made some investments in the home automation sector in recent years because of its increasing demand. Devices such as Google Home, Samsung Smart Things, Amazon Echo, etc has led to a boom in the Smart Home Space in the world. In this paper, we focus on developing Amazon Alexa enabled smart Wi-Fi switches in an inexpensive way and that will be easier to connect and setup for the users. We will be using Internet of Things as the developing platform and Amazon Echo Dot as the personal assistant for listening to voice commands. The Wi-Fi switch comprises of NodeMCU ESP8266 module as its major component and relays, bi-directional logic shifter as its minor components. Our system works effectively to switch on/off any electrical appliance used at our homes, offices, etc through voice commands and also through the Amazon Alexa App. It will be a step towards developing smart homes in the future and a boom to the IoT sector in our country and all around the world. Detailed discussion regarding this project has been discussed in this paper.

Keywords: Amazon Alexa, Arduino ESP8266, Bi-Directional Logic Shifter, Home Automation, IoT (Internet of Things), Relays, Wi-Fi

1. INTRODUCTION

Since many years we have been using electrical appliances at our homes to run daily errands and fulfill our needs. From the beginning, we have operated these appliances with the help of switches and plugs, that we need to switch on/off manually. Who ever had thought at the beginning that technology will become so modern in the future that it will even allow us to control these appliances over voice with our own virtual personal assistant. Amazon has developed a personal assistant in the form of voice enabled speaker called the Amazon Echo. It becomes active to do any task whenever the user says 'Alexa' as a trigger word. The device can do voice interaction, music playback, make to-do lists, set alarms, stream podcasts, provide other real-time information [1]. It is also capable of controlling home appliances over voice by using

the Wi-Fi plugs that can be integrated with it. Home automation is trending in today's world. Although people especially in our country don't buy the Wi-Fi plugs because they are expensive. The aim of the project is to build Amazon Echo Dot enabled smart Wi-Fi plugs in an inexpensive way. We can say turn on/off appliance to Amazon Device whenever we want to control it. The paper is unique from the other papers because here we have discussed how to make an Amazon Alexa Enabled Wi-Fi Plug at home without the need of purchasing the costly plugs from the market. The Smart Wi-Fi plugs reduces a user's time and effort by helping them to control any electrical appliance at their homes over voice. The paper is sectioned as follows:

Section-II includes the work related to this paper that has been done or on going in the real world.

Section-III describes the technology stack of the project and brief details about the various components used in development.

Section-IV contains the system designing and the inside working of the project.

Section-V includes the working methodology of the project briefing us about how to operate it. It also tells us about the advantages of this Wi-Fi smart switch over the existing switches in the market.

Section-VI concludes the project and tells us about its future scope followed by references.

2. RELATED WORK

In this section, we will present the various systems available in the market and the recent advancements in the research working in this area. Many systems that have been developed are based on IFTTT [2] i.e. If This Than That. It is used to create applets that are chains of conditional statements. It is a free web based service that can provide a robust solution in the field of IoT [3]. Following are some of the

successful smart Wi-Fi plugs available in the market:

Smarteefi Wi-Fi Smart Switch, a Wi-Fi enabled smart switch that works with Amazon Alexa using Smarteefi mobile app costing approximately ₹2,500.

Sonoff Wi-Fi Smart Dual Switch, it allows to control appliances of your home using voice. It ranges from ₹900 to ₹1,200.

Yi&Mi Xiaomi Yeelight RGBW E27 Smart LED Bulb, The device is easy to use and install. The user needs to download the app and connect bulb to network and then enjoy smart lighting.

Hence, various kinds of brands are selling their own devices in the market that can save us time and human effort. These devices will allow us to get off the couch less often and will turn our “normal” or otherwise “dumb” home into a smarter one. Although most smart plugs and devices are available at expensive rates in the market because of which many people still hesitate to dip their toes in the field of smart home sector.

On the other hand, there are devices where the user faces trouble while using the app. Belkin WeMo Insight Smart Plug is considered as one of the good smart plugs available in the market yet it becomes annoying when sometimes users find it difficult to remove devices from the app.

Yet there has been an increasing demand of such devices over the recent years, thus ensuring a brighter future of the smart home sector all over the world.

3. TECHNOLOGY STACK

We have used many technical components and established a seamless functionality among them. The details are as follows:

A. Layers of the Project

1. Physical Layer: It comprises of the hardware components that we have used to develop the Wi-Fi plug. The details are as follows:

Amazon Echo Dot: A Smart Personal Assistant developed by Amazon present with the user to handle the electrical appliances.

ESP8266 NodeMCU CP2102 Board: We can prototype our IoT product using this

open source firmware development kit within a few Lua script lines [4].

Single Channel 5V Relay Module: This module is used to control high voltage electrical appliances using 5V input voltage.

Bi-Directional Logic Level Converter: This module is used to convert low voltage signal to high voltage signal supplied with external voltage.

2. Programming Layer: The source code of the project is written in the Arduino IDE.

3. Application Layer It consists of the mobile application (Android/IOS) that will allow us to control the appliances and setting up the switch with Echo Dot.

B. The Physical Layer and components involved

Amazon Echo is a device that is cylindrical in shape and its height is around 9.25 inches (23.5 centimeters) and 3.27 inches (8.3 centimeters) in diameter. It has a small board having speaker drivers and Texas Instruments (TI) power [5]. Amazon also provides a cheaper to boot Amazon Echo Dot as well that takes lesser space than the original and is around 3.3 inches wide and 1.3 inches tall. Amazon Echo has T1 DM3725 ARM Cortex-A8 Core Digital Media Processor, 256 MB of LPDDR1 RAM with an inbuilt Wi-Fi module as its major configuration. Its image can be seen in Figure 1 below:



Figure 1: Amazon Echo and Echo Dot [6]

ESP8266 NodeMCU CP2102 is a board consisting of ESP8266 Wi-Fi chip along with ESP-12 SMD footprint that provides self

contained and complete Wi-Fi networking solutions [7]. This board has all the components necessary to program and upload code to ESP8266. We can upload codes by using the built-in USB. It has a logic level converter circuit and a 3.3V regulator as well. Its image can be seen in Figure 2 below:

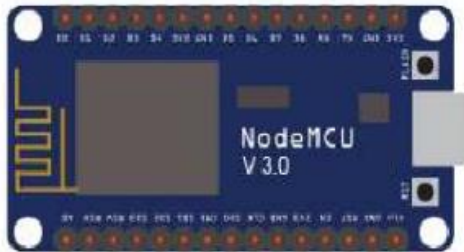


Figure 2: ESP8266 NodeMCU [8]

A 5V Relay module is an electrically operated device that has a control system and works on NO (normally open) and NC (normally closed) contacts. It is an automatic switch where a low-current signal can control a high current circuit. It can handle high load currents up to 240V, 10 A. Its image can be seen in Figure 3 below:



Figure 3: Relay Module [9]

Bi-Directional Logic Level Converter module requires both the lower voltage level and the higher voltage level power supply. Here the “HV” pin is connected to the higher voltage source and “GND” pin to its ground near the “HV” pin. Similarly, the “LV” pin is connected to the lower voltage source and pin “GND” to its ground near the “LV” pin [10]. Its image can be seen in Figure 4 below:

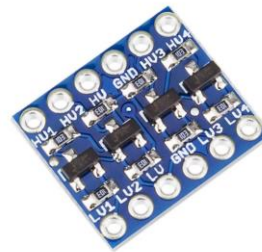


Figure 4: Bi-Directional Logic Level Shifter [11]

C. The Programming Layer

The programming is done in the software named Arduino IDE which helps us to upload sketch on microcontrollers like Arduino UNO, NodeMCU 8266, etc. Arduino IDE is a platform that allows us to write code and upload it to microcontrollers like Arduino UNO, ESP8266 NodeMCU and many more. It supports languages like C and C++ using special rules of code structuring. Its structure includes two functions i.e. “setup()” that is executed once for the first time when the code is uploaded to the microcontroller. The other function is “loop()” that keeps on executing its statements continuously.

D. The Application Layer

The Amazon Alexa app is a mobile application for android and iOS devices. It is a companion to Amazon Show, Echo Dot and Echo. This app is used to setup these Amazon devices and connect them to the Wi-Fi. It also lets us know the status of appliances and control them by tapping on the on/off button in the app. Our interactions with the devices can be automatically seen on the Alexa app as well. It can also manage alarms, music, shopping lists and more. It can be downloaded from the Google PlayStore (for android devices) or AppStore (for IOS devices). Its image can be seen in Figure 5 below:

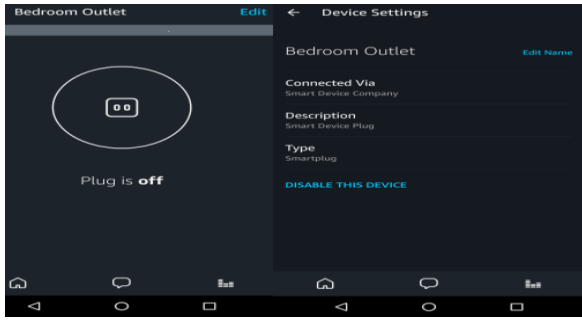


Figure 5: The Smart Plug Screen in the Alexa app

4. SYSTEM DESIGN AND WORKING

E. The System Overview

Our system as shown in Figure 6 consists of Amazon Echo Dot, NodeMCU, Relay module and level shifter. We will discuss about each component's role in the system to make it function [12]. Its image can be seen in Figure 6 below:

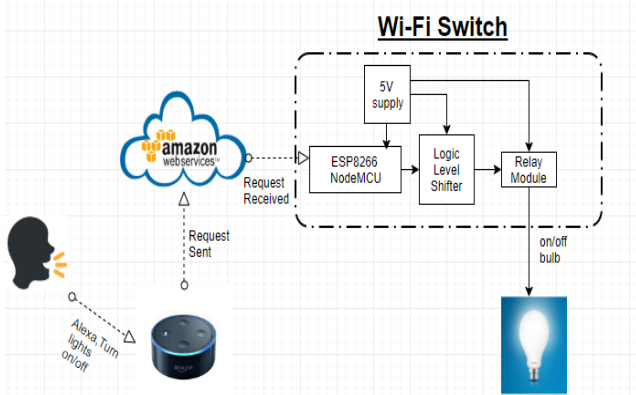


Figure 6: System Overview

F. Inside of Working

Firstly, the ESP8266 NodeMCU module acts as a hotspot whenever the user presses the reset button on the Wi-Fi switch so that it can be connected to the same Wi-Fi to which Amazon Echo Dot is connected. It can be connected to the Wi-Fi by entering the Wi-Fi credentials as shown in the Figure 7 through mobile by connecting mobile phone to the hotspot named 'ESP8266'. The NodeMCU requires 5V input

supply. Since, NodeMCU does not have 5V output voltage pin unlike Arduino UNO thus it is connected to the Bi-Directional Logic Shifter that can be used to convert low voltage to high voltage so that NodeMCU can send a 5V control signal to the relay module through the shifter in order to switch on/off the electrical appliance as per our command.

After configuring the switch to the Wi-Fi, the user needs to go to the Amazon Alexa app and tap on 'Smart Home' tab and then select 'Add Device option' after which the Echo Dot starts scanning for the nearby Alexa enabled Wi-Fi switches. After the scanning is completed a plug named 'christmas lights' appears on the screen. And finally the setup is complete and Wi-Fi switch is ready to operate. The user can edit the name of plug as per his/her convenience. The voice sent by the user is received by the Amazon Echo Dot that sends the received command to the Amazon console. The command in turn is received by the NodeMCU module which sends the control signal to the electrical appliance as per our request.

The user should reset the Wi-Fi switch only for the first time and need not do it again and again as the Wi-Fi switch gets automatically connected to the same Wi-Fi to which it was connected earlier using the previously saved Wi-Fi credentials. The image of the AutoConnectAP can be seen in Figure 7 below:

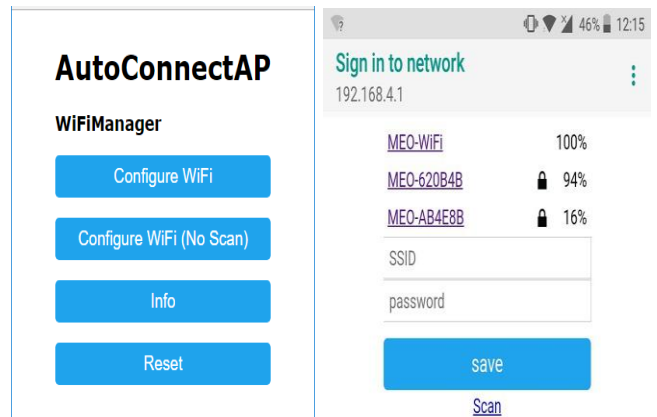


Figure 7: Connecting Wi-Fi switch to Wi-Fi

5. SIMULATION RESULTS AND DISCUSSION

G. Platform and Language Used

- IoT Platform: An IoT platform helps in communication and data flow between the different layers used in an IoT system. An IoT system is a system having hardware and software that are connected with each other. An IoT system needs a user interface to become complete. Our project is based on IoT platform.
- Arduino language and Arduino IDE: As discussed in the earlier section, Arduino IDE is used to write and upload code to the microcontrollers. The language used is Arduino Language. We have used the Arduino IDE and language to compile and upload the code to our main microcontroller i.e. NodeMCU ESP8266.
- Amazon Alexa android application: As discussed earlier, Amazon Alexa android app is an app developed by Amazon itself and it is available for both android and iOS devices. We have used this app to connect our smart Wi-Fi switch to the Amazon Alexa so that it can be governed over voice through the app or through the Amazon Echo. We can also control the switch by tapping the button inside the app.

H. Working Methodology

- Before proceeding, make sure that your Amazon Echo Dot is connected to the Wi-Fi. If not configured, you can follow the steps as given in the Amazon Alexa app to setup the Amazon Echo.
- Press the reset button on the Wi-Fi switch for 10 seconds. Pressing the reset button will turn NodeMCU Esp8266 into a hotspot.
- Connect the mobile Wi-Fi to the hotspot named 'ESP8266'. It is just like connecting mobile phone to any Wi-Fi.
- Enter your Wi-Fi credentials as shown in Figure 8 and make sure to connect it to the same Wi-Fi to which Echo Dot is connected.

- After that, open Amazon Alexa app and scan for 'Alexa Devices' in the 'Smart Home' tab. Now your associated Amazon Echo will start scanning for the nearby devices if any.
- Within few seconds, a plug named 'christmas lights' will be shown on the screen. It means that Amazon Echo has scanned a plug named 'christmas lights' within its range. If not shown, again press the reset button on the WiFi switch for 10 seconds and repeat the whole process.
- Connect any suitable electrical appliance with the two terminals of the Wi-Fi switch that you want to control using your voice. It can be any electrical appliance operating at 230-240 V like TVs, Coffee Makers, Water Purifiers, etc.
- Finally, the device setup is complete and you are ready to go!
- You can also edit the name of the plug within the app as per your convenience by tapping on to the 'Edit Name' option in the 'Device Settings' Tab.
- Just say 'Alexa, turn on/off <switch name>' or tap on the plug icon created in the app to control your appliance.

I. What makes it Better?

- *Low Cost*

The overall cost of the Wi-Fi switch will be much lesser than the other Wi-Fi switches present currently in the market that are comparatively expensive as discussed in the Section II above. The cost of the switch will be ranging from ₹400₹500.

- *Only one App*

The switches available in the market require the users to download a separate app for configuring their switches with the Amazon Alexa like IFTTT, SmartLife App for Count_on sockets, etc. But for using our switches, the user will require to download only one app developed originally by Amazon i.e. 'Amazon Alexa' mobile app.

- *Compatible*

This Wi-Fi switch can be used to control any electrical appliance in our home, office, etc with maximum input voltage of 240V.

- *Easy to connect and setup*

It is easy to connect by connecting the terminals of the switch with that of the electrical appliance. The process of configuring and setting up this switch will be much simpler unlike the switch developed in [2] where the user needs to check the Serial Monitor logs to check if the Wi-Fi connection has been established successfully or not.

6. CONCLUSION

Our product makes it viable for the market since it is easy to setup and can be used with any appliance. The Amazon Alexa enabled smart Wi-Fi switches will be a boom to the Home Automation sector of IoT especially in our country because these switches will be available to the customers at an inexpensive cost which was not the case till now. It will also increase the demand of Amazon Voice Assistant Devices like Amazon Echo/Dot/Show. We used one of the latest smart devices available today in the market and integrated with NodeMCU ESP8266 module. On testing and debugging, this module performed satisfactorily and promising results were obtained in real-time. It is a step towards cost-effective smart homes. We aim to develop similar applications in the future for Google Home/Assistant and many other assistants as well using simple voice commands to provide an inexpensive way to convert non-smart homes to smarter ones. Figure 9 below shows the final switch:

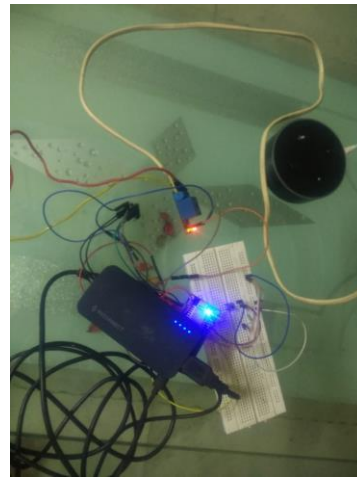


Figure 9: The Amazon Alexa Enabled Smart Wi-Fi Switch

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