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Web Controlled Home Automation Using Raspberry Pi

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***Abstract*—Having access to high speed mobile networks like 3G and 4G coupled with very cheap and accessible Smart phones, Mobile industry has seen massive growth in terms of providing its services even to the most remote areas on the planet[1] Thus these networks can be put to use for one of the most significant tasks which is home automation. Web based home automation has one agenda, that is to control the real-time home appliances from anywhere around the world. By implementing trending software like Node-red and Ngrok, we are able to implement the same in a very simple way so that any average citizen with a smart phone can control the home appliances they have. This project is extremely helpful for people who are in constant travel and don't want to compromise the routine works that has to be done at home. With the help of evolving networks as well as the need to control the appliances without physically being present is the prime motivation of this project.**

I. INTRODUCTION

The home automation is nothing but interconnection of physical devices embedded with sensors and software. Data is collected and used using the networks. Automation of home means we are automatically controlling the appliances at home. Various control systems are utilized in this residential extension of building automation. Home automation means just this all the devices that are there in the home are connected to a common source. This common source or gateway acts like a interface between the users as well as the appliances that are there in the home[5]. Through this gateway we can control all kinds of home appliances like doors, lights, watering gardens, main gate control etc. Home automation system can be realized by using the technology available to control the devices and appliances at home[2-3].

This paper presents a simple but very elegant way to implement the home automation system. Here we are implementing a webpage, which is compatible with any electronic device having access to a web browser, making it very flexible to implement. We are implementing a simple 'ON" and "OFF" button in our webpage to control a home appliance like a light bulb. The approach that we are using here has many benefits which includes security integration, ease of building a webpage and hosting it very comfortably.

II. BACKGROUND STUDY

A. Home automation system based on Bluetooth Technology

The scheme used here uses Bluetooth technology to control the real time home appliances. To control the on and off of the home appliances it uses HC-05 Bluetooth module and a Bluetooth controller. To demonstrate the working system Relay and Load are used.[3][8]

B. Smart home based on Zigbee

ZIGBEE has made controlling home appliances using wireless a technical hotspot. To the ZIGBEE node there are various sensors and home appliance controller that are connected to it. Through this ZIGBEE wireless module we are able to connect to different appliances that are present in the home[3].

C. Touch screen and remote control based home automation system

Modern technology has to be put to use to implement home automation systems. This work is done to enhance the user interaction through touch screen, remote controller etc. [3] The issue of controlling the devices has been solved in this implementation. Different attractive features are implemented here for automating the home which is nowhere found in other implementations[7].

III. PROPOSED SYSTEM

We are using Raspberry pi 4, which is the latest version. We use this Raspberry pi for couple of reasons, they are:

1. Its Wi-Fi enabled, we can connect our raspberry pi to local Wi-Fi or a mobile hotspot to implement the project
2. As we extend the project to multiple home appliances we want an efficient gateway to control these devices which is why we preferred Raspberry pi 4.

We have used "Debian Buster" Operating system of 32-bit is used for the Raspberry pi.

Compared to other operating systems that are available in open source "Debian Buster" operating system show significantly

less no of bugs and is very compatible for Wi-Fi based applications.

The following steps are followed to implement this home automation system.

1. The Micro-SD card used for has this operating system(Debian Buster) with an empty ssh file init also, necessary component file to connect to the Wi-Fi or hotspot available.
2. We recognize the Raspberry pi using “Advanced IP Scanner”, and once we have the IP address of the Raspberry pi. We use VNC software as an interface to interact with Raspberry Pi’s operating system.
3. We then install an extensively used framework for we applications which is Node-red. We use Node-red for following reasons
   a. Building a web application using Node-red is extremely simple.
   b. Node has a very powerful user authentication system and is very easy to implement.
   c. Hosting web applications that are developed using Node-red can be very easily hosted.
4. After installation of Node-RED framework we implement the workflow.(Simple switch).

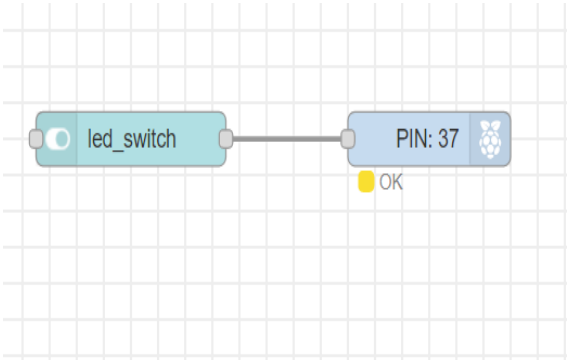


Fig. 1. Workflow of Node-RED Framework.

5. Deploy the workflow and check if connections are working fine by performing an LED test.
6. We extend the same to real time home appliance.
7. We implement user authentication system.

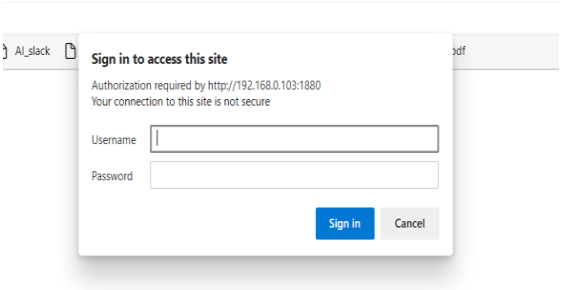


Fig. 2. Dashboard Authentication.

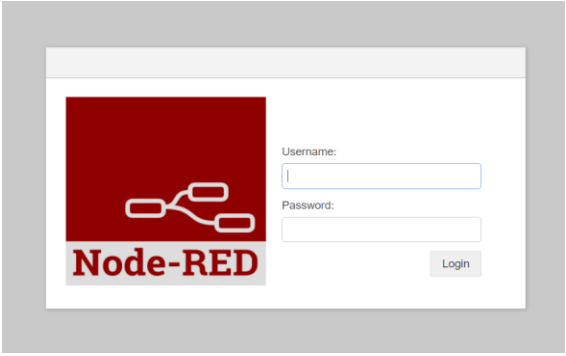


Fig. 3. Work-Flow Authentication.

8. We deploy it using another software known as Ngrok. We used Ngrok for following reasons:
   a. Hosted webpage has “https” protocol.
   b. Simple to host the web application created using node RED.
   c. Available for free of cost for immediate implementation.

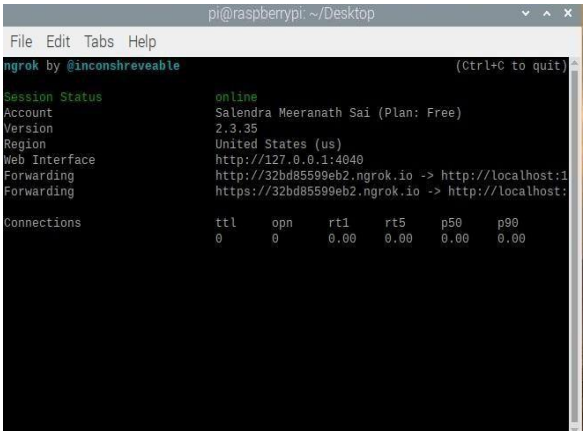


Fig. 4. Ngrok Execution.

IV. Hardware Requirements

A. *Raspberry Pi 4*

The Raspberry Pi 4 Model- B is the latest version of Raspberry Pi. The size of the Raspberry Pi is similar to a credit-card. It is less cost effective; it can also be plugged into a computer monitor and used with a standard keyboard and mouse. The latest version of Pi is energy- efficient and uses less power when compared to other computers.

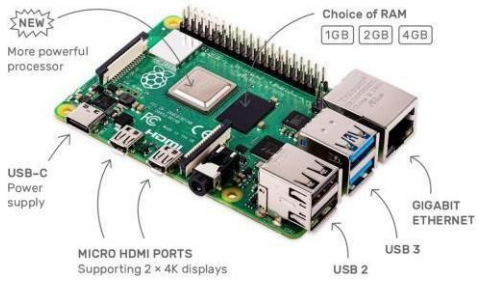


Fig. 5. Raspberry Pi 4 Model-B

Raspberry Pi 4 Technical Specifications

- The Raspberry Pi 4 Model-B is integrated with Broadcom 2711, 64-bit quad-core Cortex-A72 processor and 2GB RAM.
- It features true gigabit Ethernet port, 2 x USB 3.0 "Super-Speed" ports.
- 802.11b/g/n/ac wireless LAN (2.5 GHz & 5GHz) Bluetooth 5.0 Dual micro-HDMI ports, 4K UHD video H.265 decode (4kp60)H.264 decode (1080p60)
- OpenGL ES 1.1, 2.0, 3.0 graphics PoE capable 5V3A USB-C power supply required
- It is completely upgraded, re-engineered, faster, more powerful, Dual displays 4K output along and is silent, energy-efficient can transfer data up to ten times faster.

B. 5V Relay Circuit

A 5V Relay is mostly used in an automatic control circuit. It is capable of controlling a high-current circuit with a low-current signal. The range of input voltage for a 5V Relay lies between 0-5 V.

Fig. 6. 5V Relay

C. Jumper Wires

Jumper wires consist of connector pins at each end of the wires. These wires can be used to connect two points to each other without soldering. The jumper wires are mostly used along with breadboard and other prototyping tools to make required changes in a circuit easily.

Fig. 7. Jumper Wires

D. Micro-SD card

A 16 GB Micro-SD card is taken to load the Raspberry Pi Debian Buster Operating System into the SD card and also used for storage.

V. SOFTWARE REQUIREMENTS

A. Node-RED

The Node-RED framework a flow-based development as well as a programming tool which is generally used to wire APIs , hardware devices and online services together. The framework provides a browser-based editor which makes it convenient to wire the flow together using a wide range of nodes in the palette. It can be deployed to its runtime easily in a single-click.

B. Ngrok

Ngrok can be defined as a cross-platform application which helps developers to expose a local development server to the Internet with minimal effort. The public IP or domain name on the local machine is not required. It allows you to expose a web server running on your local machine to the internet. It takes port 80 as default for HTTP.

C. Virtual Network Computing (VNC) Software

The Virtual Network Computing software is used to view the desktop interface of Raspberry Pi 4 which we have loaded into the SD card. This software allows us to remotely control the desktop interface of one computer (running VNC sever) from another computer (running VNC viewer). We can easily control the Raspberry Pi through VNC software in a way just like how we use our personal computer manually.

D. Advanced IP Scanner

An Advanced IP Scanner is a free and fastest software that can be used for network scanning. It allows us to quickly detect all network computers and helps us to obtain access to them. We can also turn a remote PC on and off by connecting it to any reliable remote accessing software products with a single-click.

VI. Results and Discussion

The circuit has 3 main parts: Raspberry Pi, 5V Relay and a Real-time Home Appliance. Once the power is given to the appliance it starts working, this connection is shorted when the 5V relay is given power from the Raspberry Pi. Once the Node-RED framework starts working, we can have access to the web application that we have built. Using this web application we will be able to control the home appliance. The input commands from the user is directed to the relay through raspberry pi and the relay will implement the same by giving signals to the connected home appliance.

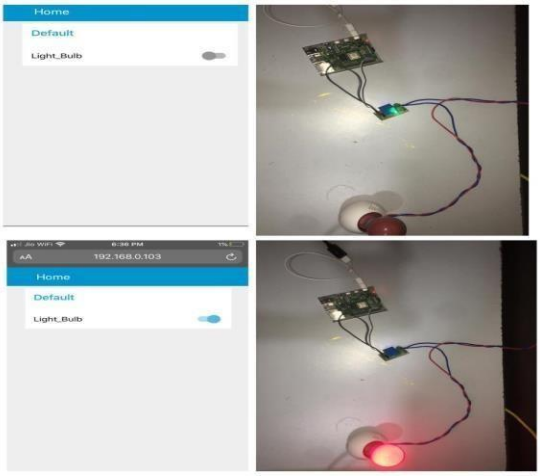
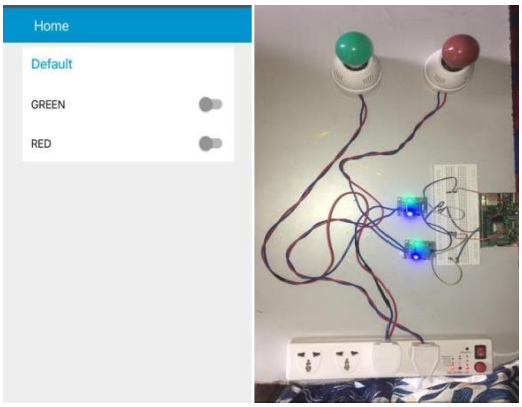


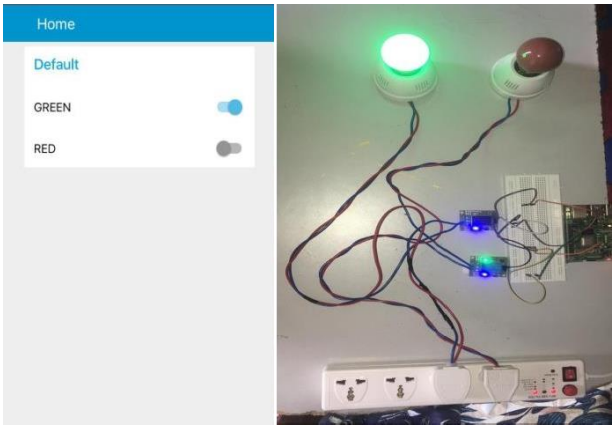
Fig. 8. Controlling Real-Time Home Appliances

For further implementation of this project we can extend the same to other appliances to simply bifurcate the difference in the appliances, we have used two different light bulbs.

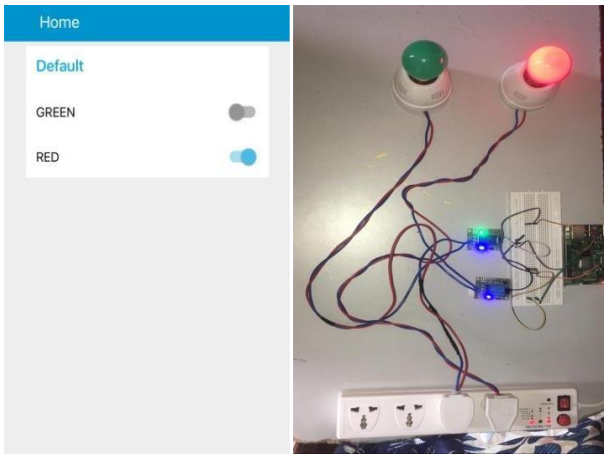
This use of using different light bulbs is essentially to see the difference between which appliances we are using.
The below image is an extension of the same, but with two different appliances.



This is the initial state of the project and now start controlling the light bulbs.



As we can see it clearly that we have given the right input to control the appliance. Here the green switch is on and the corresponding green light is turned on.



Again accordingly the red light is turned on when the red switch in the webpage is turned on. Thus this giving the facility to control various appliances at home. This simple elegant way we can control the home appliances and the title is exactly justified as said.

VII. Conclusion& Future Work

In this work, a web-based home automation system has been successfully implemented which is quite effective in terms of performance and security. This saves the time and efforts of the users because they can control their appliance anywhere round the globe without being physically present near the appliance[6]. As home automation is the current trend, this work can further evolve into by generating a log sheet of user behavior by applying this to machine learning through which the system will learn how the user operates the appliances in his house. According to the results provided by the ML, the system can automatically change the state of the appliances based on the behavior of the user, Also implementing the same in secure gate system, water level management, controlling the main door, controlling the Garage for car parking. etc.[4]

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