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Remote Controlling and Monitoring of Electrical Appliances with IoT

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Abstract - From toiling away in caves to somehow striving to survive in the huts, we managed to discover amicable homes for ourselves with the support of science and technology. Now, with the tremendous growth in technology, we have smart homes at our service. The major deviation of smart homes from the traditional homes is that it basically functions as a sort of digital butler to you, and automatically adjusts your home to your own personal preferences. So there comes the biggest leverage in our living standards. This paper covers one way of getting our electrical appliances under our control. These myriads of electrical appliances are connected to the internet, which makes them smart.; squarely to what the internet of things(IoT) suggests. These smart devices - devices that don't necessarily function by themselves need to be controlled. Now, control as in being able to remotely monitor the status of our electrical appliances and also change their status with the use of a mobile app. Further, it aims to show the convenience of using cloud storage to help in the functioning of the app. This system guarantees to save both time and energy to a large extent thereby providing ease and convenience to everyday activities in the home by remotely monitoring and controlling our devices making our home a better place to live in.

Key Words: IoT, Remote Monitoring and Controlling, Wifi, NodeMCU, WiFi manager, Firebase

1. INTRODUCTION

The Internet of Things (IoT) has breakneck advancements in wireless technology. Many of the fledging domain applications have been expanded to remote monitoring and control systems (M&C). The paper proposes a methodical application for the Internet of Things used for controlling and monitoring heterogeneous home appliances through a cloud and mobile app. The primary objective of our proposed work is to design and implement an energy-saving and efficient model to control our appliances remotely having a handy and user-friendly mobile application.

2. Existing Systems

Remote Monitoring and Controlling System Based on ZigBee:

Zigbee is an open protocol, It has been used for M&C systems largely because it addressed the unique requirements of most remote monitoring and control and sensory network applications. The range of this system is barely 30-40 feet and it is capable of powering only battery-powered devices. Being an open protocol it is vulnerable to hackers and also requires a smart hub to control it.

Remote Monitoring and Controlling System Based on Bluetooth:

The Bluetooth is an open wireless technology which revolutionized the connectivity by providing freedom from wired connections. Just like Zigbee, even Bluetooth requires a smart hub and the range is 100m which is extremely short to connect more number of devices together.

Remote Monitoring and Controlling System Based on GSM:

GSM network is a medium for transmitting the remote signal. The system includes two parts which are the monitoring center and the remote monitoring station. The major drawbacks of using this system are delays in mobile networks and the Need for a mobile phone entirely dedicated to this system.

3. Proposed System

IoT based Remote Monitoring and Controlling of electrical appliances aims to overcome all the shortcomings of these existing systems. This system basically uses the wifi module of the nodeMCU to connect to the internet to fetch and upload the status of the connected devices to the firebase cloud. A user-friendly mobile app is used to remotely monitor, update and control the status of the connected appliances and devices.

The leverage obtained by preferring this system over the similar kinds of existing systems is that the alerts and the status sent by the wifi connected microcontroller managed system can be received by the user on his phone from any distance irrespective of whether his mobile phone is connected to the internet. The microcontroller used in the current prototype is the nodeMCU ESP8266 which comes with an embedded micro-controller and an onboard Wi-Fi shield. Another major aspect is how the smartphone is able to connect and communicate with other devices. This system also comes with extremely beneficial embedded security features.

Fig: Monitoring and controlling electrical appliances through a mobile app

4. Methodology

The proposed system consists of the following components:

1. Interfacing the Relay module with the nodeMCU
2. Firebase Realtime Database
3. Mobile application

The first step is to interface a relay module to NodeMCU **ESP8266**. Then you can control your appliances with NodeMCU wirelessly. It is done by powering the nodeMCU and then connecting the relay module GND to GND. Further, connect the relay module to NodeMCU 3.3v. Lastly, the relay module signal to NodeMCU D1.

The second step is to set up Firebase Realtime Database. Firebase Realtime Database is a cloud-hosted database that supports Android. The data is stored in JSON format and any changes in data are reflected immediately by performing sync across all the platforms & devices. This allows us to build more flexible real-time applications easily with minimal effort. The Firebase Realtime Database should be added to the Andriod app.

Lastly, the MIT app inventor is used to build a fully functional Andriod app for this system. It is a blocks-based programming tool that helps everyone, even beginners, to start programming and build fully functional apps for Andriod devices.

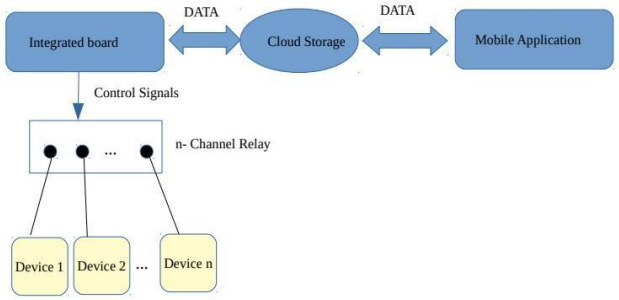


Fig. Block Diagram

The above block diagram describes the brief working of this system. The devices are connected to the relay which acts as a switch and controlled by the nodeMCU ESP8266, this nodemcu has a wifi module. The nodeMCU can be preprogrammed to store and fetch the ON/OFF status of devices from the firebase cloud storage. The Status data of the devices are updated in realtime in the firebase cloud storage and the same is conveyed to the mobile app, Using which the users can remotely monitor and control the connected devices. The changes made to the status of the devices are reflected in the firebase realtime database and this data is fetched immediately by the nodemcu. The relay operates based on the nodemcu control signals to change the state of the device.

4.1 Functionality

Integrated board

Input: Status of each electrical device to be set on/off from the cloud.

Output: Control signals to relay channels via nodeMCU. If a device is to be set ON, a low voltage is sent to the relay channel as the relay is a low enabled device. And a high voltage is sent to the relay to set the device OFF. Uploads default set values of each device to the cloud at the initial setup.

Functions of the integrated board:

- Connect devices to the board.
- Facilitate transfer and bring set status into effect.
- Connectivity to cloud for data transfer.
- It provides secured internet connectivity.
- Data encryption

Cloud Storage:

Input: Device status, set commands, user credentials from NodeMCU board, and mobile application, from authorized users only.

Output: Device status and set commands to the integrated board. Sends results to the mobile application.

Functions of the cloud storage:

- Provides interactivity between boards and application via cloud database and APIs.
- Server sided data encryption and hashing.
- Administration of flow of data and control.
- User access management
- Stores voltage status of the devices.
- Updated device status is forwarded accordingly to take into effect.

Mobile Application

Input: User input for login (only authorized users). The command from the user to set the device on or off.
Output: Display the status of each device. Red-colored room button if all devices are powered off otherwise green in color. User input sent to cloud storage and updated.

Functions of the mobile application:

- It provides interactivity with the end-user.
- Monitor and control devices of each room.
- Provides user login portal.
- Authentication check for *Forgot Password*

Relay

Input: Control signals from nodeMCU board as follow:
The low input signal to power on the attached device.
The high input signal to power off the attached device.
Output: Device is powered on/off for low/high voltage signal respectively as it is a low enabled device.

Functions of the relay:

To connect and control 230V operable electrical devices using control signals from the nodeMCU board.

5. Advantages of the Proposed System

1. Security Features :

Wifi Manager: Hardcoding the Wifi credentials can pose security threats to the entire System. However, The major disadvantage was to configure the network credentials in the esp8266 nodeMCU without requiring to modify and uploading the code again.

WiFiManager allows connecting the ESP8266 nodeMCU to different Access Points (AP) without having to hard-code the credentials and upload new code to the board time and again. Additionally, it manages multiple SSID connections to prevent network failure.

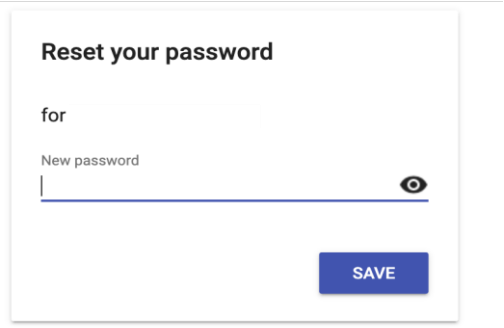
Fig: Wifi Manager with nodeMCU ESP8266

Here's a brief explanation of how it works for our system: Soon after the nodeMCU boots, it tries to connect to the previously saved access point (a known SSID and password combination);. If this process fails, then Using any Wi-Fi enabled device with a browser, connect to the newly created Access Point (default name AutoConnectAP); After connection with the AutoConnectAP, configure the SSID and password through a web page by going to the default IP address 192.168.4.1. Once a new SSID and password are set, the ESP reboots and tries to connect; This establishes a connection, the process is completed successfully.

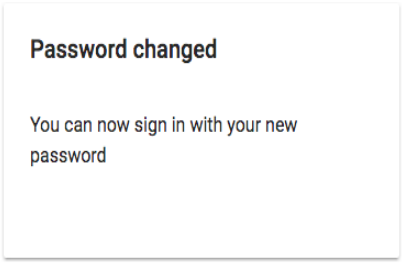
Authentication of authorized users: The authorized users are added by the admin in the firebase Realtime database. Their credentials are stored in the database which they can use to login to the app. This enables the security of the system by not allowing unauthorized users to operate the system. In Case the user forgets his registered password, the ***forget password*** option helps the users to change their password immediately.

Fig: Login Page with Option to Change password

Here's a quick explanation of how it works: The firebase provides API to change the password by sending a *password reset email*. It is sent by issuing an HTTP post request to the Firebase AUTH. The password resetting email is sent after verifying authorized users (ie., users registered by the admin in the firebase Database).



The changed password can then be used to access the system using the app. This process guarantees complete security from unauthorized users.



2. Cost Efficiency

The budget of this Proposed system per unit is very affordable as it requires one nodeMCU and relay for the setup. The life expectancy of any electronic product can be extended by keeping it cool.

By and large, there are certain factors to consider regarding the life of an IoT product. Factors such as heat, vibration, dust, moisture, chemical-fumes, exposure to sunlight, rail apart from the mode in which device is powered, power source (it's own resilience to heat, vibration, dust, moisture, etc.), quality of primary power, etc. The reliability is a function of the above factors given that the components used, PCB fabrication material. However, the system is well protected in a portable plug-in case, which will protect it from the above factors.

3. Portability

The entire system has a small form factor. All the boards and connecting devices are sealed in a case which makes it extremely portable. This guarantees a better look and feels of the system after installation and also protects it from factors affecting its life efficiency.

4. Scalability

This system can easily be expanded to support any number of devices in multiple rooms. The use of scalable components such as the relay module which can support up to 8 devices at once and the network extension of wifi makes this system highly scalable.

5. Manual Switching

The Proposed system has an additional feature of changing the state of the connected devices manually. The manual status change happens as smoothly as when done by the app. This feature is useful in situations when the switch needs to be operated manually or when the system shuts down due to network failure at very rare instances.

6. CONCLUSION

This system can be further upgraded by using different sensors and different home appliances. Since smartphones are widely used nowadays, this user-friendly system can be used for benefitting the current trends and lifestyle. The cost of the system is also very affordable. Not just the old-age groups or physically challenged people can be benefitted using this, but any person with a smartphone can monitor and control the electronic devices without much difficulty. As awareness grows, the adoption rate is likely to increase for IoT-based solutions for our comfort.

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