

IoT based Smart Power Extender with Timer Feature Controlled through a Mobile App

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Abstract

The purpose of the task is to construct a prototype of the Smart Power Extender and bridge the distance between the conventional and futuristic extension board. The proposed machine includes a microcontroller-primarily based improvement board that controls this prototype. Also, this prototype presents real-time tracking of the equipment's utilization to a Backend Server that manages the Internet of Things (IoT). This prototype also includes different protection functions provided by app interface, allowing the equipment to run most straightforwardly for a selected time limit. These functions permit the consumer to govern and protect the home equipment linked to it everywhere around the sector with the Internet's assistance.

Keywords: IoT, Power extender, Timer, Touch control

1. Introduction

The Internet of Things (IoT) is a network of physical items known as "Things" that are equipped with electronics, software, sensors, and network connectivity to collect and exchange data. The Internet of Things (IoT) allows things to be sensed and controlled remotely through existing network infrastructure, allowing for more direct integration between the real world and computer-based systems, resulting in increased efficiency, accuracy, and economic benefits [1].

Home appliances monitoring system helps in creating a smart environment which enables the user to switch on/off the devices using an app. It eases the life of physically handicapped and elderly people and also helps in reducing the usage of power and energy.

Another major advantage of this method is that it can operate several appliances at a time and the cost is also less when compared to other mediums.

The aim of this project is to build a prototype of the Smart Power Extender and bridge the gap between the traditional extension board and futuristic extension board. The proposed system consists of a microcontroller-based development board that controls this prototype. This prototype provides real-time monitoring of the appliances usage to a Backend Server which manages the Internet of Things (IoT). Additionally, this prototype consists of other safety features which enables the appliance to run only for a particular time limit [2].

1.1 Problem Statement

Design a system that allows the user to control the appliances connected to it, either physically or remotely with the help of IoT technology. Also, adding a feature of Time Bound usage to enhance the safety, efficiency and reliability of the appliance.

1.2 Motivation

Many motivations led to this project, as it provides convenience to the user helping them to control switches through an app, so that they can make sure that their device doesn't draw unnecessary power. Also, the major focus is to make it reliable by building a product that can be operated by the user without any difficulty. Moreover, it helps users to let them know if any device is connected to the sockets, leading to a safer environment, by developing a more economical product. With regarding to protection, one can imagine or might have gone through many instances where an appliance is kept on power supply more than it's necessity which may lead to unexpected accidents. These kind of scenarios and situations can be handled in a better way with the remotely controllable feature proposed in this study.

2. Related Work

Extension boxes, extension boards, power strips, outlet extenders, and other words are used to describe power extenders. Many experiments and studies have been conducted in this genre of art, resulting in a variety of approaches to tackling comparable challenges [3].

One of the recent trends is touch controls. Most of the extension boxes that are available in the market do not provide individual control switches to the sockets. The switches available are mechanically operated, which does not match with the current trend. And, the most commonly used keyword these days is 'Smart' which is also a missing concept

in the traditional power extenders. Table 1 gives a general review of existing models and their features.

Table 1. Comparison of existing systems [5]

Product→ Features ↓	Wipro Smart extension (DSE2150)	Anchor Electricals Pvt Ltd 4 Way Power Strip with Individual Switch	Electrobot - Programmable Timer Switch with Smart Socket Plug
Timer	No	No	Yes
Ease of access	Single switch to control all the sockets	3 switches to control 4 sockets	1 socket with numerous buttons for different modes/functions
App Provider/Integrator	Through Alexa	N/A	N/A
Control	Push button	Switch	Push button

The proposed prototype is made with the expectation of using an extension box to its at most ability by incorporating the feature of 'Time Bound Usage', which gives any user the freedom to restrict the duration of power usage through any given socket.

3. Proposed Work

The brain of the system consists of a microcontroller, which interfaces with the relays in order to turn on/off a particular power socket based on the signal received from the capacitive touch sensor. NodeMCU consists of Wi-Fi feature which connects to a server (i.e. Firebase) via the Internet. The app which is developed with the help of Flutter helps the user to control the appliances connected to it anywhere around the world with the help of the Internet. The mobile application is used to provide a Graphical User Interface (GUI) to the user.

Figure 1 shows the Block diagram which depicts the basic functionality of the proposed model

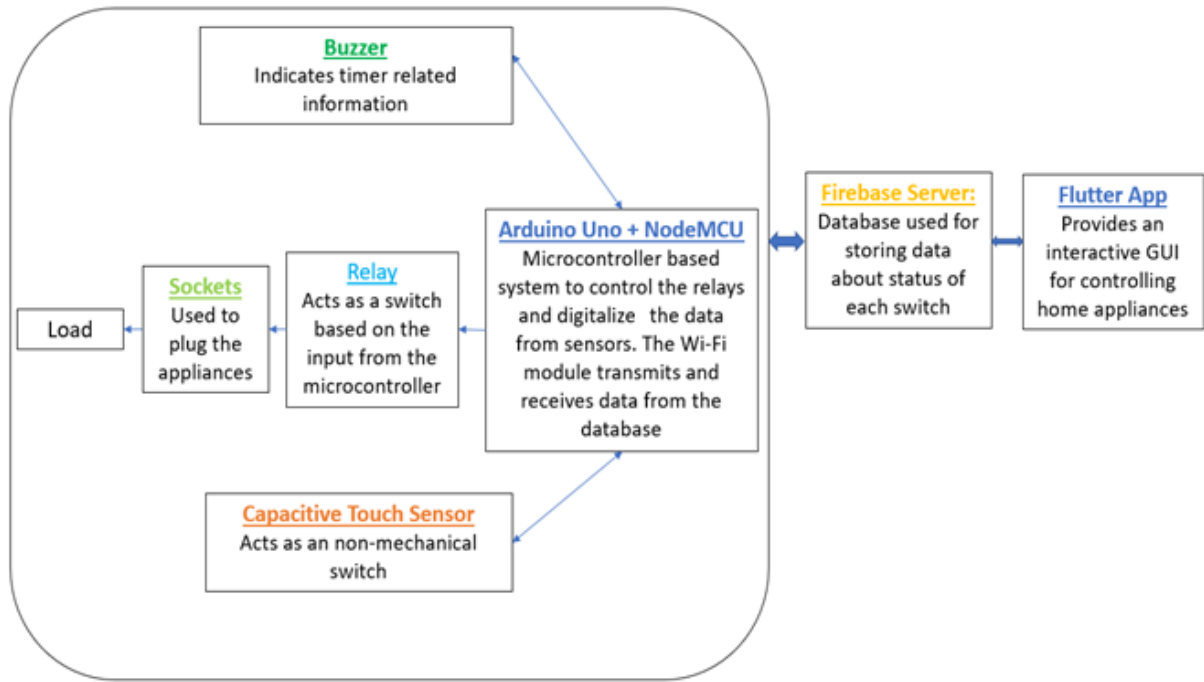


Figure 1. Block Diagram of the Project

The following hardware and software have been utilized in building the proposed system:

3.1 Arduino UNO



Figure 2. Arduino UNO

Arduino is a platform for electronics projects which has a simple hardware and software. Arduino UNO shown in Figure 2 is a board that comes with a microcontroller on the chip used for projects on Arduino platform [10].

3.2 NodeMCU

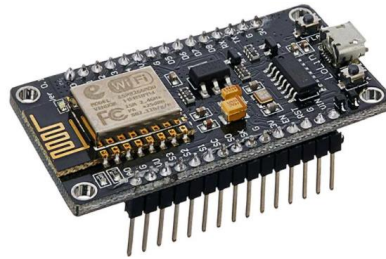


Figure 3. NodeMCU

It is a platform for projects related to Internet of Things. NodeMCU is popular for its Wi-Fi module on-board. It comes with ESP8266 Wi-Fi System on Chip. The firmware for the Wi-Fi module comes included with the whole unit as shown in Figure 3 [8].

3.3 Relay module

Relay is basically a circuit that acts like a switch. A typical relay circuit consists of 3 terminals out of which 2 terminals are connected at any given point of time. This connection can be controlled through signals. One of the terminals is flicked to make a connection with the open terminal by applying input signal to the relay. Figure 4 depicts a relay module which is nothing but 4 (or more) relays which comes as a single unit [9].

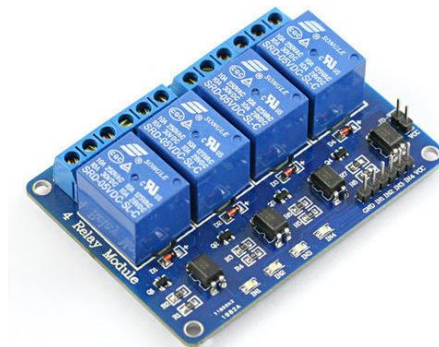


Figure 4. Relay module

3.4 Capacitive Touch Sensor

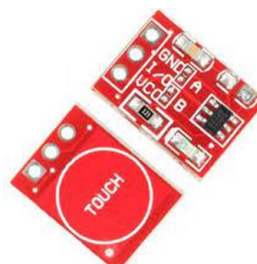


Figure 5. Capacitive Touch Sensor (TTP223)

Capacitive touch sensor shown in Figure 5 is a simple circuit that generates a signal when it comes in physical contact with the human skin/finger. It consists of two conductor plates which acts like a capacitor. When a human finger comes in contact with these plates it creates a change in the capacitance, which is sensed by this circuit/sensor. This way it produces one kind of signal when it is touched and a different kind of signal when it is not. This makes it the best replacement to a mechanical switch [6].

3.5 Current Sensor

Current Sensor is used to measure the current which flows in a wire. It uses the principle of Hall Effect to measure current in a circuit. It can be used to measure both AC and DC currents. Figure 6 below is a ACS712 current sensor which comes in 5A, 20A and 30A variants.

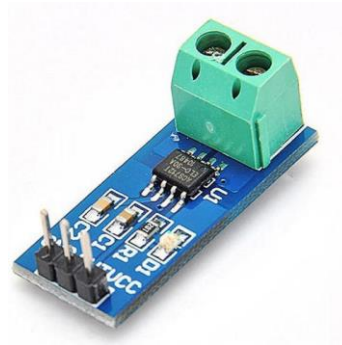


Figure 6. Current Sensor (ACS712)

3.5 E-mail Automation

E-mail automation is a way where emails are created in order to send it to the right person. It helps in reducing the man power, because automation overcomes the difficulty of a person typing the emails again and again. This comes very handy in various fields. Having email automation as an extension to this prototype gives rise to a new future scope. Aim of this comes into picture when the power extender is put forward for commercial usage at public places where a user, after his/her utilization of the extender, will have to pay an amount based on their usage. Sole purpose of email automation is to generate a bill which would be mailed to the user for the payment (this feature has been added for prospective commercial use). The payment can either be instant or on a monthly basis.

Despite the advantages of automatic email, several businesses have nonetheless to embrace it. The good news is that launching an imaginative, targeted automatic email campaign and seeing tangible results is easy [10].

3.6 Firebase

Firebase is a google product used as database to store data for mobile and desktop operation. Internally, Firebase is used to shoot and admit drive announcements in mobile apps [12]. Figure 7 shows website of Firebase server and its simple user interface.

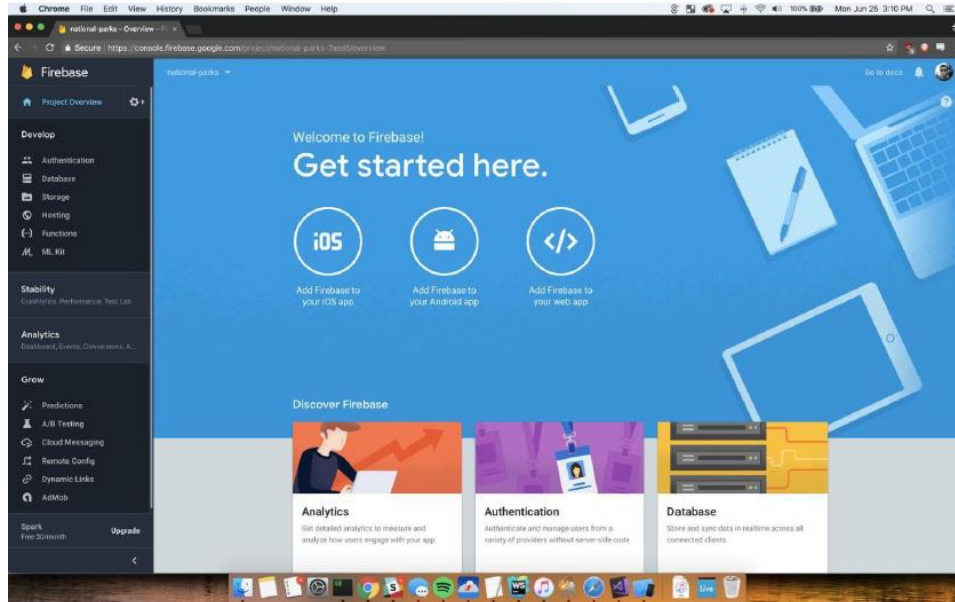


Figure 7. Firebase UI

3.7 Selenium

In order to carry out automation, it is required to integrate with Selenium. Selenium is an open source tool for testing web application. It is used to test desktop application or mobile application. The reason why selenium IDE is gaining its popularity because, any type of test scripts like Java, Ruby, C or python may be used but python is preferred over other languages. It could be tested on any platform like Mac, Windows, Linux or any other platform. This could be tested in any search engines as shown in Figure 8 [11].



Figure 8. Features of Selenium

4. Results and Discussion

Any updation made on capacitive touch will be reflected in Firebase. Microcontroller is integrated with the Firebase so that, any updation made is updated in Firebase. The timer feature enables the switch to cut off by itself once it gets timed out. So, it helps electronic devices from overcharging. Unlike other power extenders where a single switch is used to control all the sockets, individual switches for all the sockets have been used in this work. In contrast, this prototype controls each socket through individual capacitive touch.

To extend this project and implement this public domain, the user is charged based on usage. A web API has been created to generate the bill, where a mail is sent to the user with all the usage details with the help of email automation. Since each device has different power consumption, the current sensor sockets are incorporated in order to generate appropriate bill amount.

Following are some snaps of the result:

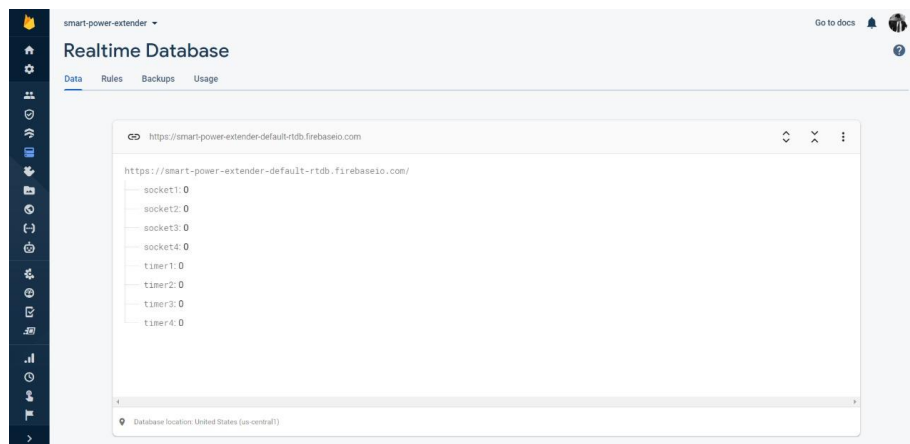


Figure 9. Skeleton of Firebase

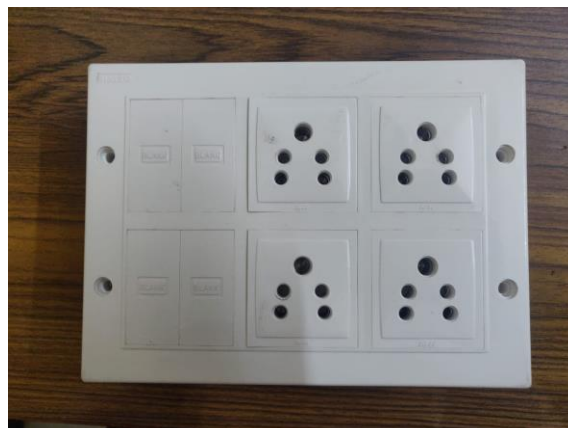


Figure 10. Overview of the power strip

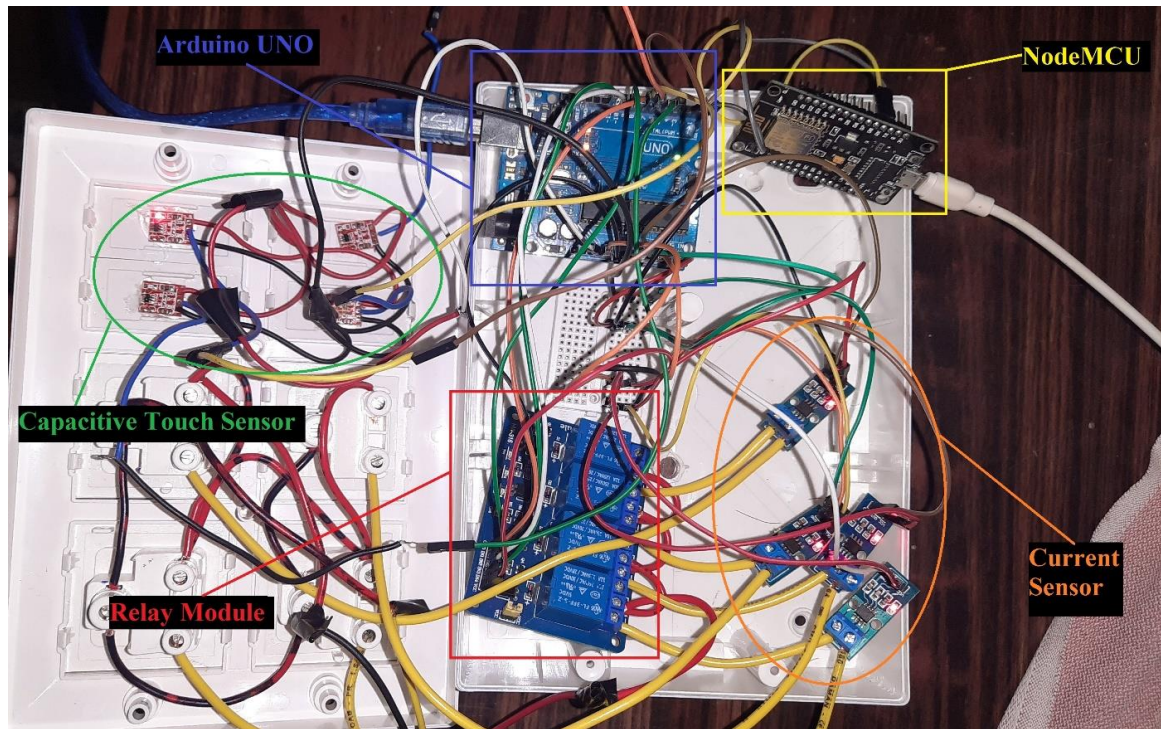


Figure 11. Connection made inside the power strip extender

Capacitive touch sensors are used as the physical control system of this prototype. The input signals from the user are sent to the Arduino Uno which acts as the brain of the prototype which is shown in Figure 11. The Arduino Uno sends the decision signals to the relay module on which socket should get the power supply. Meanwhile, the status of every socket is also updated in the Realtime server (Firebase) as shown in Figure 9 through the Internet via the Wi-Fi module in the NodeMCU. The developed app (Figure 12) also lets the user to control the power sockets remotely through the same method but it works just the other way around. In addition to this, a timer feature is also available in the app where the user can set the amount of time till which a socket should be ON. Current sensors are connected in series to the main supply and the socket, with the help of which the amount of current used up by a socket is measured. This value is further used in the calculation of bill amount as shown in Figure 13.

In other models [19], it is observed that mechanical switches were used; while this prototype uses capacitive touch sensors and since there are no mechanical components present in a capacitive switch, it results in giving a longer lifespan when compared to these mechanical switches. Also, it's compatible and can be easily integrated with a server based system because of its working principle. Additionally, capacitive switches can withstand some of the harshest environments, including outdoor environments. Presence of dirt, dust or

moisture is not a concern, which is why capacitive touch is a better alternative for an electrical switch.

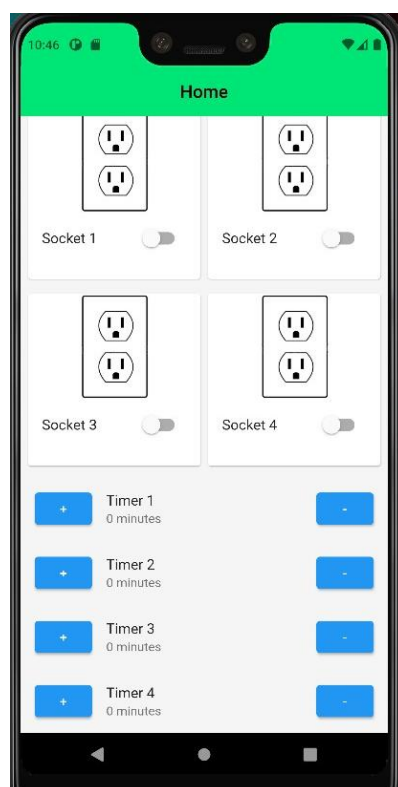


Figure 12. App UI

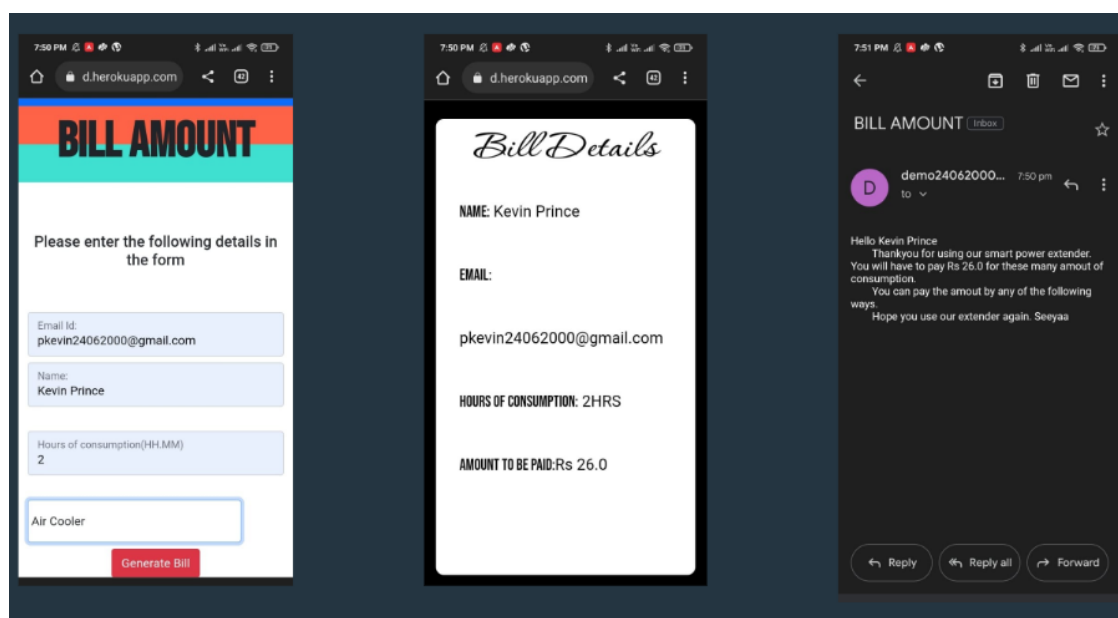


Figure 13. E-mail Automation

Wi-Fi based control is better suited for operating at a faster rate and with better range. In fact Wi-Fi lets people control the system remotely from a completely different location

with the help of internet unlike Bluetooth. With respect to security concerns, Wi-Fi is more secure than Bluetooth. Therefore, an app is built based on flutter which has features to control the sockets.

5. Conclusion

In today's world, most of the things from a smart watch to vehicles, use electricity as their fuel, which is drawn from a power socket. While rest of the world is getting smarter, the power sockets just has the conventional features. With features such as touch controls over mechanical switches, remote as well as physically controlled over just physically controlled sockets, and time scheduled power supply through the sockets, this proposed prototype called as the Smart Power Extender, clearly bridges the gap between the conventional and the futuristic power extender.

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