International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com, Volume 5, Issue 3 (May-June, 2017), PP. 31-34

IOT HOME AUTOMATION

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***Abstract* — Automation is a system or technique of controlling a process through electronic devices thus reducing human involvement to minimum. Our main motive is to provide an easy control over appliances for disabled persons, which will provide convenience to their daily life and they can control appliances even when they are away from home. The user gets monthly electricity usage and can set the time span after which a device has to be turned on/off using the timer option which in turn saves energy and money. This system is implemented using "Android Things" and "Firebase" by Google, the latest technology in the field of IoT (Internet of Things). Android Things makes development of apps for embedded devices easier by providing the same development environment as Android. Firebase is a powerful platform for android apps which offers real-time database, cloud notifications and synchronization to all connected devices and handling of user authentication.**

***Index Terms* — Rpi3 (Raspberry Pi), Dataplicity, Android Things, Firebase, FCM (Firebase Cloud Messaging), Firebase Functions.**

I. INTRODUCTION

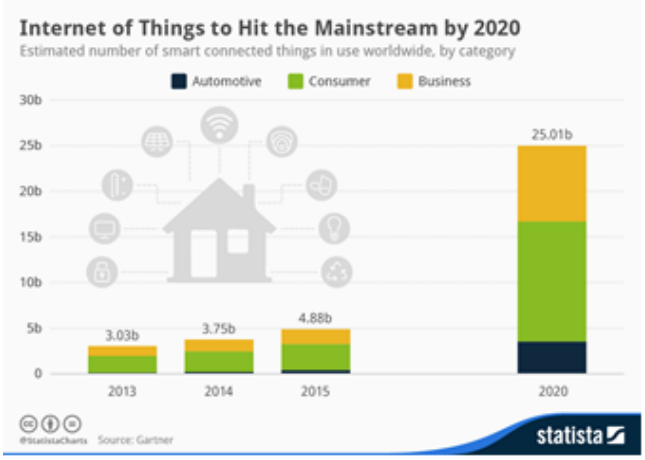
Home Automation is the process of controlling home appliances automatically and remotely using various control system techniques. Traditionally, the appliances at home such as lights, fans, fire alarm, coffee maker, etc, used to be controlled by using DTMF, SMS, Bluetooth and RF technologies whereas presently they are controlled using WiFi and Cloud Computing technologies. The perks of the current system is that it is more secure and reliable than the traditional approach.

There are various techniques to control home appliances such as IoT based home automation over the cloud, home automation under WiFi through android apps from any smartphone, Arduino based home automation, home automation by android application based remote control, home automation using digital control, RF based home automation system and touch screen based home automation.

Wireless home automation using IoT is an innovative application of internet of things developed to control home appliances remotely over the cloud.

Networking giant Cisco (NASDAQ:CSCO) estimates that the number of connected devices worldwide will rise from 15 billion today to 50 billion by 2020. Intel is even more bullish, claiming that over 200 billion devices will be connected by then. [2]

According to Statista, the number of IoT-connected devices is expected to top more than 25 billion by 2020. Also, currently the majority of the usage is domestic, but later IoT will have a significant impact on business, agriculture and other sectors as well, where the devices would range from printers to irrigation systems. The possibilities really are endless.[1]

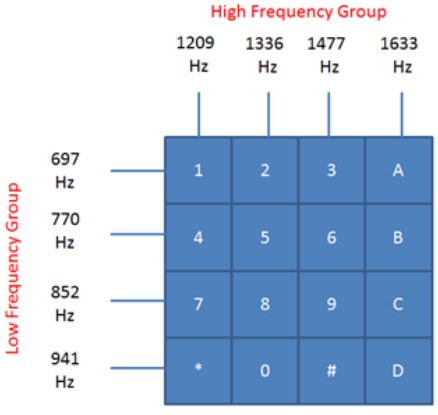


source:[1]

II. LITERATURE SURVEY

A. Existing Systems

DTMF (Dual Tone Multiple Frequency) : This technology is used by network operators for the functioning of their customer care system. In the figure given below we can see two groups of different frequencies. When one upper and one lower frequencies are mixed, a tone is created which is termed as Dual Tone Multiple Frequency.[4] Home Automation using DTMF is an old approach since the mobile phone has just 12 keys which in turn can control just 12 appliances. The drawback of using DTMF is that it limits the user to control 12 appliances only.[5]



source:[4]

SMS(Short Message Service) : It can be used to control the appliances remotely. The dire disadvantage previously was the cost of the sms [6], but today this approach also lacks the UI for user- friendly interaction with the system.

WiFi : Using Wifi technology, any individual can control the appliances via LAN as well as WAN. This approach is more secure than DTMF and SMS based home automation[7].

B. Proposed System.

Attempt 1: In our previous attempt, we tried to adopt the traditional approach for developing the system i.e. installing a Linux (Raspbian OS) on Raspberry Pi inside which an Apache web server is hosted. In order to access the web server remotely, we implemented Port Forwarding and bought a static IP address for raspberry pi. The GPIO Library provided by python is used to create a script. When this script is executed, the GPIO pins of the RPi which are connected to a 5V relay are set/reset which in turn switches the relay on/off. We used MySQL Database to store the data collected from the appliances/sensors.

In this process if we need to access raspberry pi through Internet, then we have to deal with a lot of stuff such as:

i. To allow the remote request to raspberry pi we need to configure our router for Port Forwarding (thus increasing vulnerability).
ii. The IP address from which we will connect to raspberry is Public IP which is Dynamic so we need a Static IP.
iii. Now with Static IP and Port Forwarding setup, we can access the web server [Apache] remotely.

Attempt 2: An improved approach towards remote connectivity is using Dataplicity. All the overhead from the traditional approach is removed and security is upgraded.

Source: Dataplicity.com

Attempt 3 (Final): While we were exploring the Linux and Android connectivity issues, Google launched "Android Things", a platform for embedded devices to implement IoT. It supports Raspberry Pi 3 and it supports Java. So we decided to switch paths, i.e. installing Android Things into RPi.

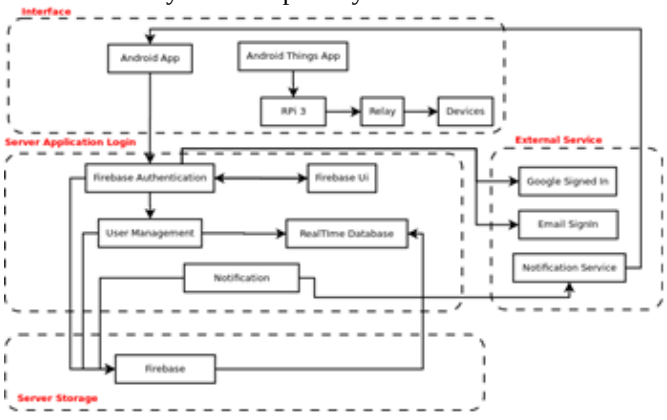
Pros after Switching to Android Things are:

i. No more connectivity issues.

ii. Programming language is same for RPi and Android app.

iii. Since it is Google-owned, the security is more secure, reliable and always up-to-date.

And for backend, Firebase is the relevant option for us, because of its real time database, cloud services, analytics, cloud notifications and integration with Android Studio(IDE) which makes it easy to develop the system.



System Architecture

Modules:

1. Control Appliances: Since the data stored is in real time on firebase database, we created a key called 'light' and a boolean value, here now if we change the value to true/false

then the respective value will be reflected to all the devices which are synchronized with firebase.

data structure used:

```
myAppfirebase{
  "lightHall" : true,
  "lightKitchen" : false,
  "lightBed" : true}
```

2. Login: Authentication service is also handled by firebase platform. We are implementing Email-Authentication method in this system.

3. Timer: For this module, the user will be able to set the timespan after which the appliance should be switched on/off. As soon as the timespan allocated to particular device expires, the device will be switched on/off automatically.

Here if a user sets the timer for, let's say device1 and after some time other user sets some timer for the same device1 then the second user is prompted with the message that a timer has already been set for device1.

4. Notification: Recently Google Cloud Messaging (GCM) merged with Firebase creating Firebase Cloud Messaging (FCM) and introduced "Firebase Functions".

"Firebase Functions" runs on firebase as a server-side code which monitors the events inside the database. Here if any event is invoked i.e. we switch an appliance on/off then this function calls FCM to send notifications. FCM is a cross-platform messaging solution that lets you reliably deliver messages at no cost. Using FCM, we can notify a client that an appliance has been switched on/off along with the username of the client.

When a new user is registered to the system, all the members of the system gets notified with a message that says "user_name" is welcomed in our family.

5. Logs: As auditing is the most important aspect in any system, we have implemented auditing by storing logs of all operations such as:

After signing up to the system an entry is made inside the log with all the essential information of the user.

When any user switches any appliance on/off, an entry is made with the information such as username, timestamp, devices_name and value.

At the time of setting the timer, tthe timestamp, username, device_name, value is been recorded for calculating the usage (total time used).

```
"log" : {
   "admin" : {    ←username
    "light1" : {          ←device_name
     "_comment":"date timestamp value",
     "-KgAU31" : "2017-03-26 22:09:05.008 true",
     "-KgAU41" : "2017-03-26 22:09:07.598 false",
     "-KgAW32" : "2017-03-26 22:18:03.675 true",
      } } }
```

6. Bill Consumption: This module will in general give the approximate cost of the power consumed by an appliance on the basis of total time used and the total usage will be retrieved from the log entries of usage:

```
"usage" : {
   "Light" : {
    "_comment":"time(secs) date",
    "-KgAanJ0Y9u8DnTIh4I5" : "5 26-Mar-2017",
    "-KgAeWPTwn-JP7GqUSv4" : "4 26-Mar-2017",
    "-KgEXUG92I_Qy_vd4swG" : "2 27-Mar-2017"
}}
```

To represent the datasets into charts this system is using a library called MPAndroidCharts.

7. Rpi Offline Notification: When there is a network issue and the system is not connected to firebase or any person has intentionally cut the power source to Raspberry pi, then the legitimate user needs to get notified that there is some problem with Rpi3 and check the further issue manually.

Firebase function isConnected will listen for Rpi value at /.info/connected location. If the value is set to false then the function will notify all the users for the same.

LIMITATIONS

a. This system is not yet compatible to work in offline mode i.e. without internet connection a user cannot control an appliance.

b. Manual hardware switch: If any appliance is connected to relay than that appliance cannot be manually controlled.

CONCLUSION

The objective of this system is to provide a convenient way to control home appliances "remotely" and save energy as well as time. Hence, we can say that the system has been successfully built and in future this system will overcome its limitations.

ACKNOWLEDGMENT

We express our deepest sense of gratitude towards our respected and noble guide Mrs. Asha Rawat madam for spending her valuable time on several occasions to impart us the gains of her knowledge. It was our privilege to have worked under her guidance. We shall always remain indebted to her.

We also wish to express our earnest thanks to the Industrial adepts for providing us the opportunity to explore the feasible options that were available to us.

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