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IMPLEMENTATION OF COST EFFECTIVE SMART HOME CONTROLLER WITH ANDROID APPLICATION USING NODE MCU AND INTERNET OF THINGS (IOT)

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Abstract- This paper presents the design and implementation of Smart Home Controller wherein the user can control their devices using the Android Application running on a Smart Phone. The system employs client server architecture and Internet of Things (IOT) for communication. The controller is designed with the Arduino microcontroller (Node MCU) at the consumer end and is connected to the internet through Wi-Fi. In this system, every device is connected to the internet through the IOT protocol and controlling is done through HTTP requests sent from the Android mobile application. The API (Application Programming Interface) connects the server and android application and allows it to interact and exchange data with the server. Whenever the user sends requests from android application, the API connects to the server and it sends request to the controller, further to which the controller performs ON/OFF function of the device based on the request received. Using this method, controlling home appliances is discussed in this paper.

Keywords— Home Controller, Android application, Node MCU, Internet of things.

I.INTRODUCTION

The concept of smart homes is getting more attention in the present Indian power system scenario, which possesses the ability to turn ON/OFF the devices remotely. The smart phones add the advantage of making this process simpler and cheaper. The main purpose of doing this is to convert present devices into smart devices by connecting them to internet. There are numerous smart home controllers developed which work on Bluetooth technologies [2], GSM (mobile) based [3] and Internet based [4]-[6] technologies. But they all have their inherent drawbacks in terms of the cost, range of operation and number of devices that they can be connected to. Internet of Things (IOT) is a new Information and Communication Technology (ICT) evolution which connects any number of devices to the internet, and makes it highly scalable. Among the various applications of IOT, a smart home is a very important application. IOT provides the necessary communication infrastructure through which information exchange is done at a faster rate. The objective of this work is to implement an IOT based smart home controller and control it through the smart phones. Figure1 depicts the smart home controller where the loads are connected to internet through microcontroller and IOT. The android application running in the

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smart phones connects to the internet through Wi-Fi or by using wired internet connection from service providers; similarly, the microcontroller is connected to the internet through LAN or home Wi-Fi. The controlling request is sent from android app by using API commands to the server. The server in return sends the request to the client (microcontroller), further to which the microcontroller turns ON/OFF the particular device.

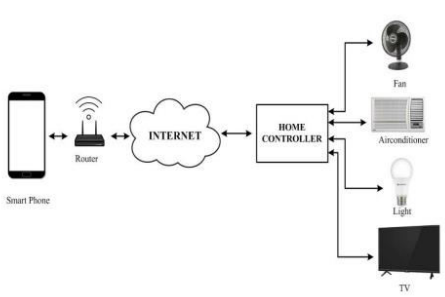

Fig1: Overview of Smart Home Controller

This kind of system creates a smart environment for controlling devices through IOT. In case the user forgets to turn off his/her devices it can be done remotely from any part of the world, once connected to internet. The system referred to in this paper provides easy controllability of devices for elderly and physically challenged people as well. It has also been made cost effective enabling its real time implementation. The cost of the controller is reduced with the use of node MCU's and less complicated hardware. The said system is built for a cost of 900 Indian rupees and can control up to 8 devices. The cost can further be scaled down if mass production is done.

II. SYSTEM ARCHITECTURE AND WORKING

The architecture of the system developed is based on the client server model. Here, the devices including smart phones and microcontrollers are treated as clients which are connected to central server. Figure 2 shows the broad client server architecture implemented. The architecture can be divided into 4 layers namely- Home appliance layer, control unit layer, server layer and client layer. The communication between the home appliance layer and control unit layer is through wired medium and that between the control unit and the server is either by LAN or Wi-Fi. The server is basically HTTP based and communicates with clients through API requests.

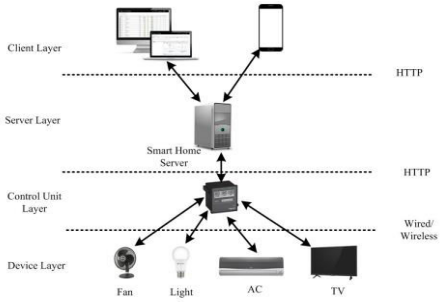

Fig 2: Client server architecture

There are four kinds of request methods used to communicate with HTTP server, which are as below:

A. GET request: used to retrieve data stored in the server.

B. PUT request: used to replace a data with the new value.

C. POST request: used to add multiple data in the same database below the priveous data.

D. DELETE request: used to delete a data from the database.

The working of the client server architecture is given as algorithmic steps:

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Step1: Initialize the clients; connect to the internet and server. Step2: Stand-by and wait for the HTTP requests.

Step3: If request is received, then forward it to the microcontroller.

Step4: Process the response received and update the General Purpose Input-Output (GPIO) pin of Node MCU.

Step5: Turn ON/OFF the device connected to the GPIO through relay, based on the request received.

III. IMPLEMENTATION DETAILS AND RESULTS

The implementation of this work is divided into two parts- hardware development and software development. In the hardware part, the home controller is designed by using Node MCU and in software part an android application is developed whose details are as given below.

A. Software design

A.1. Android application

An android application is designed using android Studio software with the minimum android support of 4.4 ice-cream sandwich (API 23). The app consists of splash screen activity and the device controlling activity as shown in figure 3. The software uses SDK's (software development tool kit) for development. It uses XML language for Front End design and derived Java as back end language.

The app is coded in JAVA to send http 'put' request to the server on button press. An API key is added in the code so that the app could connect to the server. Figure 3(a)-3(d) shows the screen shots of the developed app.

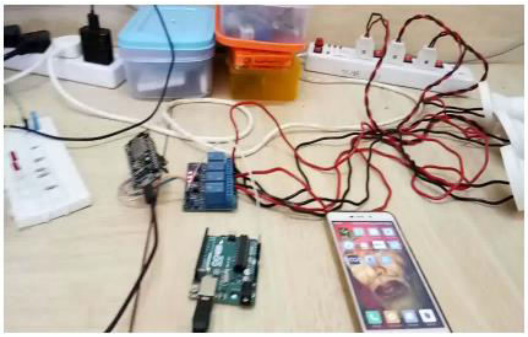
A.2. Web server

Thingspeak is a web server which is used to implement the prototype system. It is easy to configure IOT analytical server through which IOT devices can be controlled, monitored and automated. Figure 5 shows the desktop view of Thingspeak server where in 'talkback' refers to the devices connected.

IV. Implementation

A smart home controller prototype is developed and is been tested with the android application for checking its proper working. Figure 8 (a)-(c) shows the snapshots of the hardware controlled by the android application. The devices can be controlled from any part of the world once they become web interactive and they can further be monitored.

Whenever the application is opened in the mobile phone/Web browser, the app connects to the server and then if the user presses the ON/OFF buttons, a HTTP request corresponding to that device is sent to server. Server updates its values and thereby the controller continuously fetches the data from the server. Based on the data received by the server (here we have used string as the value) like if value is LEDON then corresponding devices GPIO pin is made HIGH or else it will be LOW state. As it was already mentioned, this entire microcontroller set-up costed us about 900 Indian Rupees.



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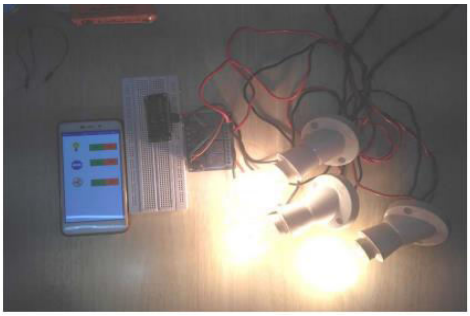

V.CHALLENGES

The hardware demonstrates the smart home controller through android application using IOT. This is an economic, robust and secure method of controlling the devices remotely. IOT providing the necessary communication infrastructure promising the implementation of this controller in large scale. The challenge that we faced is in terms of the speed of controlling. Each request takes 4 to 6 seconds to either turn ON/OFF. This is because of using open source web server. If one has dedicated web server, the speed of the response could be faster and additional security features may be further implemented.

VI.CONCLUSION AND FUTURE WORK

This paper presents a cost effective and secure prototype of Smart Home Controller which can control the web-interactive Home appliances through the android mobile application. As an extension, the web server can be replaced by dedicated local server wherein features like monitoring of loads and automatic controlling of loads may be realized along with the controlling. This paper tries to implement the fast building new information and communication technology, i.e., IOT whose applications can further be explored in building smart home controllers.

VII.ACKNOWLEDGMENT

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