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IOT based Smart IR Device using CC3200

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Abstract

Background/Objectives: In day-to-day customs we come across miscellaneous gadgets for instance television, set-top box, home theater, air conditioner, DVD player and many more remote operated devices for our comfort and contentment. Using non-identical gadgets means using different kinds of remote controls which not only makes disconcert but also difficult to conserve. A Smart IR device will control all the IR enabled devices like television, home theater, DVD player using android and iOS applications. **Methods/Statistical Analysis:** To design a device that will control all the IR devices which encompass learning module and operational module. Learning module, a new IR remote bit pattern is learned and stored in the device itself and operational side deals with the android and iOS applications, i.e., the mobile application will communicate with Smart IR device and the Smart IR device control the gadgets like television, set-top box, home theater, air conditioner. **Findings:** As the advancements in the embedded systems and internet-of-things some special hardware is required to design a Smart IR device for controlling the IR based home appliances and this way of implementation leads to low power and cost-effective home automation device.

Keywords: Embedded Systems, Home Appliances, Home Automation, Internet-of-Things, Internet-on-a-Chip, Mobile Applications, Remote Control, Smart Home

1. Introduction

The fundamental chunk of automation is to control Home Appliances remotely[1,2]. There is a great deal of inconvenience in controlling each digital device with its own separate remote. In this paper, we present a Smart IR device which can control the IR enabled digital devices like TV, home theatre, air conditioner etc. This paper gives the design on how to build a Smart IR device and how to turn our smart phone into a true universal remote which will be both versatile and have the ability to learn new devices and new IR protocols. In day-to-day life, various digital devices such as television, set top box, air conditioner, home theatre, DVD player and many other remote operated devices are used for comfort. Different gadgets mean maintaining different remote controls which are not only clumsy but also difficult to manage. Smart IR device simplifies our lives because it help us control any IR devices like TV, air conditioner, home theatre. But, because of many technological complexities it becomes difficult to build a single IR based universal remote which can control all the available IR based electronic gadgets from different manufacturers. The rapid growth in mobile communication system and electronics in the present era is changing people's life and work style. Fast development of mobile technology has brought the world in our grasp. Functionalities of electronic gadgets like computer, iPod, and camera are now made available in a single mobile phone. Smartphones already feature-perfect and can be made to communicate with any other devices in an ad-hoc network with connectivity possibilities like Bluetooth and Wi-Fi[3,4]. Most of the digital devices use Infrared based control systems.

A simple mobile phone cannot be used directly to control any such appliances. Some special hardware is required to design a Smart IR device for controlling the IR based home appliances using mobile phones. Automation

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of the neighboring environment of a contemporary human being escalates increased work efficiency and contentment. There has been a notable development in the area of individual routine tasks and those that can be automated[5]. Therefore designing a Smart IR device is part of home automation.

For designing a Smart IR device a simple link CC3200 WI-FI module is used which acts as the central part of the design. The Wi-Fi modules are the next generation in embedded Wi-Fi. The Internet-on-a-chip can add Wi-Fi and internet to any Microcontroller (MCU). The CC3200 is a programmable Wi-Fi MCU that enables true, integrated internet-of-things (IoT) development[6].

The Wi-Fi network processor sub-system in both Simple link Wi-Fi devices integrates all protocols for Wi-Fi and Internet, greatly minimizing MCU software requirements. With built-in security protocols, Simple link Wi-Fi provides a simple yet robust security experience. The major features of Wi-Fi module that integrates an ARM Cortex-M4 Core at 80 MHz, Wi-Fi network processor subsystem of 802.11b/g/n Radio, Baseband, and Medium access control, 8 Simultaneous TCP, UDP, or RAW Sockets and 2 Simultaneous TLS v1.2 or SSL 3.0 sockets, low power consumption at 3.6 V, 16Mbps UDP application throughput and 13Mbps TCP application throughput, strong crypto engine for fast, secured WLAN connection with 256-bit encryption.

The applications of CC3200MOD are:

- Internet of Things (IoT)
- Cloud connectivity
- Home Automation
- Home Appliances
- Access Control
- Internet Gateway
- Wireless audio
- IP network sensors node

The CC3200MOD also incorporates a wide range of peripherals like2S,SD/MMC, UART, SPI, I2C, and four-channel ADC. The CC3200 family involves flexible embedded RAM for code and data; ROM with external serial flash boot loader and peripheral drivers; and SPI flash for Wi-Fi network processor service packs, Wi-Fi certificates, and credentials. The functional block diagram ofCC3200MOD is shown in the Figure 1 which consists of 32 KHz and 40 KHz crystal, serial flash 8Mbit, RF filter and pull-up resistors[7,8].

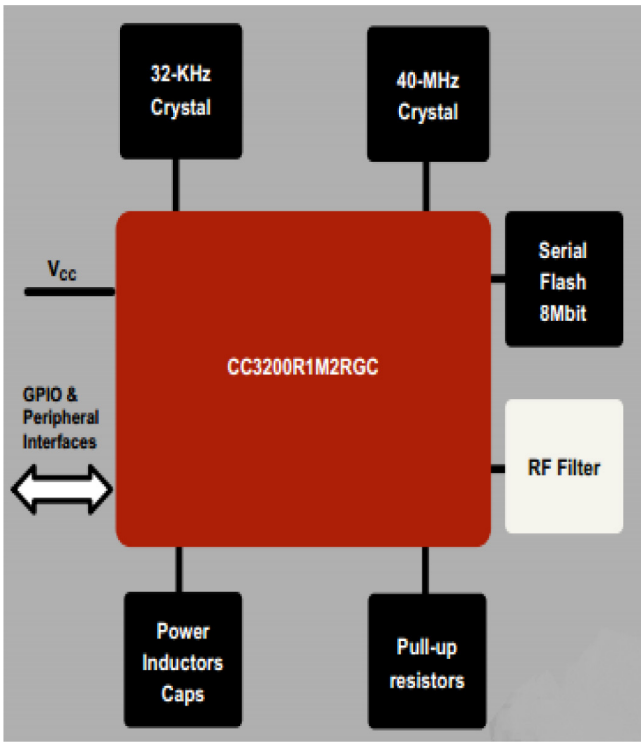

Figure 1. CC3200MOD functional block diagram.

2. The Design of Smart IR Device

2.1 Integral Idea

The Smart IR device incorporates a CC3200 Wi-Fi module which is the central part of the design and it has IR transmitter Led's and IR receiver module. The IR transmitter Led's are placed in a specific pattern to cover the complete 360 degree angle, and IR receiver is used to receive the remote codes i.e., IR bit patterns from different remotes.

The Smart IR device can learn a new IR remote bit pattern quickly. Every button on the remote has the corresponding IR bit pattern which varies from remote to remote for instance LG and Samsung remotes have different IR bit patterns for power on key. The goal is to design a device which can able to learn and store any kind of remote bit patterns. The Figure 2 shows the IR remote learning process[9].

The IR Receiver will receive the remote bit patterns stores in the CC3200 Wi-Fi module, which can be accessed and controlled through android/iOS application.

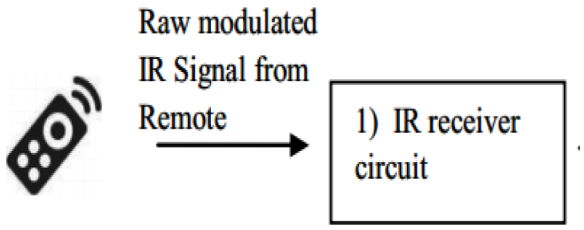

Figure 2. IR remote learning.

2.2 CC3200 Module

CC3200 Wi-Fi module is the internal part of the Smart IR device. In CC320 Wi-Fi processor system contains a diligent ARM microcontroller unit to completely discharge the host microcontroller unit along with an 802.11 b/g/n radio, baseband and MAC with a strong crypto engine for a high speed, secure WLAN and Internet connections with 256-bit encryption. The CC3200 module supports various modes, they are AP mode, Station mode and Wi-Fi direct mode. The module also reinforces WPA2 personal and enterprise security and WPS 2.0. The CC3200 Wi-Fi network processor contains an embedded IPv4 TCP/IP stack[10,11]. The Figure 3 shows the schematic representation of CC3200 module.

The CC3200 module makes substantial use of pin multiplexing to indulge more number of device functions in the simplest possible way.

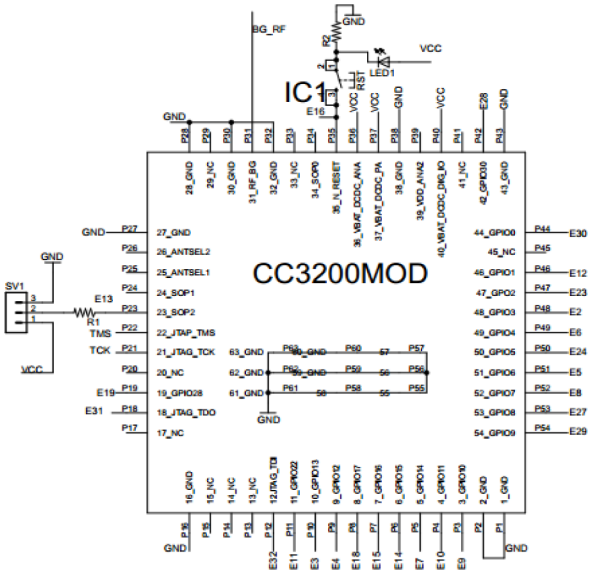

Figure 3. CC3200 Module.

2.3 IR Circuit

IR circuit consists of both IR transmitter and receiver.

2.3.1 IR Receiver

The schematic representation of the IR receiver is shown in the Figure 4. Generally carrier frequencies are between 30 KHz to 40 KHz and the most commonly used carrier frequency in consumer electronics is 38 KHz. The IR receiver is used to learn the remote bit patterns, and those bit patterns are stored in SFLASH of CC3200. Different remotes have different bit patterns, for instance Sony uses SIRC protocol. The Figure 5 represents the pulse train of 12 –bit SIRC protocol in which LSB bit is transmitted first, the start pulse is about 2.4ms wide followed by 0.6ms standard space. Usually 'space' is represented as high and 'mark' is represented as low[12].

When button is pressed the processor wakes up to transmit the appropriate IR command and the command is stored in CC3200.

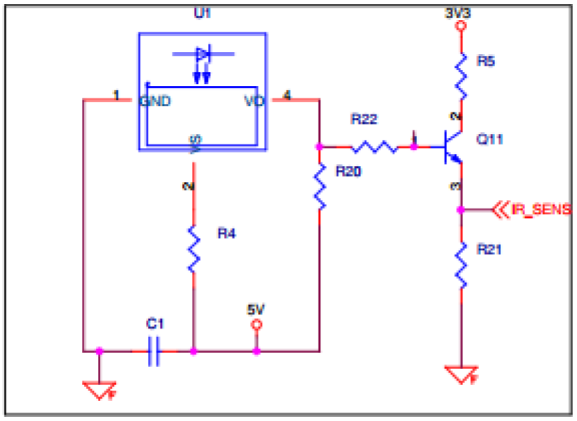

Figure 4. Basic IR Receiver.

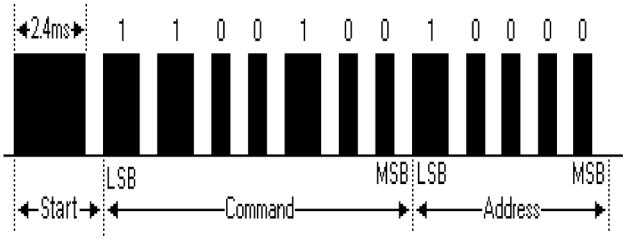

Figure 5. Typical pulse train of the 12-bit SIRC protocol.

2.3.2 IR Transmitter

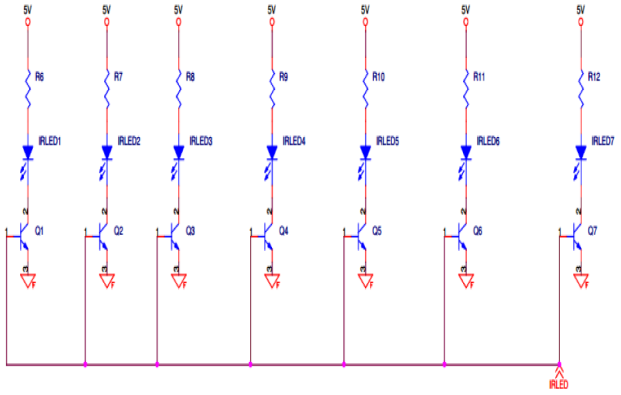

Figure 6. IR Transmitter circuit.

Simple transistors are used to drive the LED's[13]. The schematic representation of IR transmitter LED's are shown in Figure 6. In Smart IR device the entire seven IR transmitters led's placed in a circular manner so that it can transmit in 360 degrees direction. When the button is pressed on the Smart IR mobile application the IR receiver will send the equivalent IR command, through IR transmitter LED's and the corresponding device will work.

3. Analysis

Firstly, to control any IR device in the home, the Smart IR device should connect to the router. The procedure of connecting to the router and giving the necessary credentials like router SSID and password termed as smart config. The Figure 7 shows the flow of Smart IR device.

The Smart IR device doesn't require any internet connection within the Wi-Fi router range. As the advancements in the mobile communications it is possible to connect with the smart IR device using smart phones from any place using 3G and 4G. After performing the smart config the device is ready to gain access, open the mobile application and learn the corresponding remote button, the remote button data will be stored in the SFLASH of CC3200. Whenever the button on the mobile application is pressed the Smart IR device retrieve

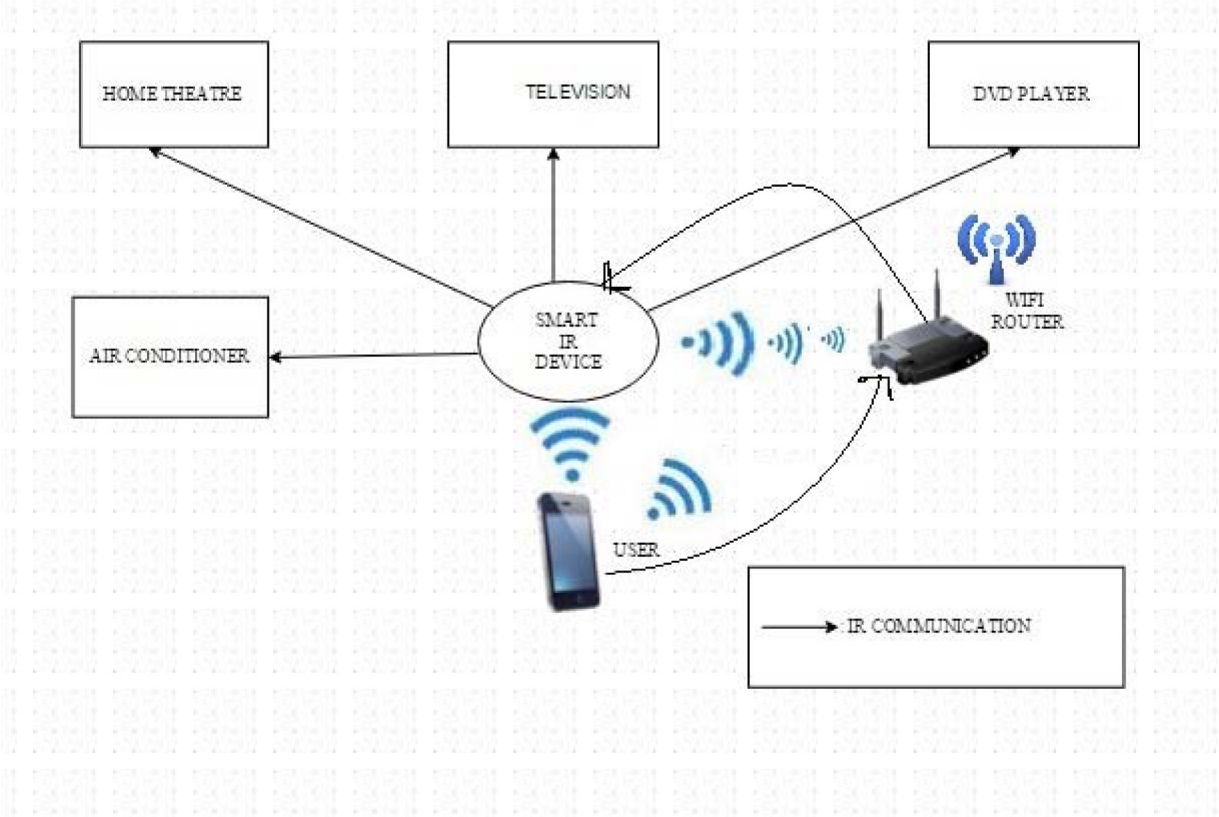

Figure 7. Smart IR device working.

the corresponding button code from SFLASH and mediate through IR transmitter LED's to the devices like T.V, A.C etc.

4. Conclusion

Predominantly universal IR remote devices maintain a server for storing complete protocol data and remote data, which is a heuristic task and that will increase the maintenance and cost of the product.

As the advancements in the embedded systems and internet-of-things some special hardware is required to design a Smart IR device for controlling the IR based home appliances. In this paper a novel idea is presented to store the remote data in the device flash which is independent of the remote protocols. This reduces the maintenance and server cost, and this way of design leads to low power and cost-effective home automation product.

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