Real Time Communication (RTC) Device using Raspberry Pi

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***Abstract*—**In order to fulfil the need of a portable, low cost & compact embedded device to carryout real time voice, video & text transmission over a wireless medium, a Real Time Communication (RTC) module is proposed. This module consists of a Raspberry Pi, which is capable of being used as a notification device in any locally confined organizations like a school, college or even in an office building. The module is made to carryout real time voice, video & text communication over wireless LAN infrastructure. The use of Raspberry Pi is made as it is of low cost, has more functions, portable & has compatibility with many open source software compared to any other embedded device currently available in the market. In the proposed configuration, transmission of text, audio & video has been carried out with the help of IRC, VoIP, SIP protocol & python programming between two Raspberry Pi modules. Proposed configuration is expandable for bigger setups and many-to-many communication paradigm.

***Keywords*—** Raspberry Pi, Protocol, VoIP, Secure Shell (SSH), Internet Relay Chat (IRC), Communication, Local Area Network (LAN), Private Branch Xchange (PBX), Interface

1. INTRODUCTION

1.1 Motivation And Background

In today's schools, colleges & offices of developing countries, communication of notices, updates & announcements are still being done by traditional methods like the use of typed and printed papers. But in developed countries the use of Ethernet technology is being used in place of the traditional methods. In undeveloped and developing countries many organizations as well as individuals don't have enough revenue to establish basic Ethernet communication. So in order to solve the issue of not being able to purchase expensive devices such as mobiles, computers or any smart display devices for communication over Ethernet , the module provides the basic services for communication over wireless LAN which is comparatively cheaper than mobiles, computers or any other smart device so far available in the market.

1.2 Objective

The module replaces the need of traditional P.A. systems with the use of voice communication over IP. Being cheaper it also replaces the use of IP phones for VoIP communication. The module carries out real time

text communication to replace the traditional method of sending notices, announcements etc.. using pen & paper. Transmission of Audio and Video is carried out with the help of VoIP and SIP Protocol in real time from one Raspberry Pi module to another Raspberry Pi module. Open source Linux based OS is used in this project to keep the cost low.

Since we are using a Raspberry Pi which is an embedded system, hence for an embedded VoIP system many factors are taken into design consideration & to carefully weigh among the protocol which suits the best; SIP& RTP protocols are adopted. SIP(Session Initiation Protocol) is one of the most common protocols used in VoIP technology. It is an application layer which works in conjunction with other application layer protocols to control the communication sessions. RTP(Real time Transport Protocol) & SDP(Session Development Protocol) will carry out the voice communication. For Raspberry Pi VoIP consists of server and client. The server handles the forwarding of the calls, hence is available readily on the internet or should be configured on a powerful device such as a computer. The Pi uses a client like browser to access the server to establish voice communication. The server is established on computer.

For the transmission of video from one Raspberry Pi to another the aid of basic programming is taken. The Raspberry Pi is interfaced with a webcam such as the Raspberry Pi's own camera module. We can configure the device to unicast or multicast the video feed via LAN using an IPv4 address. The receiving Raspberry Pi will tune to the Ipv4 address.

Generally, for IRC the user (such as you) runs a program (called a "client") to connect to a server on one of the IRC nets. The server relays information to and from other servers on the same net. Hence enabling network chatting.

The module is capable of providing basic services for communication between its own kind as well as other devices; serves as a temporary/permanent desktop for basic use such as file editing, file transfer (SFTP) & and other basic functions as that of a computer. It is designed for individuals or organizations that cannot afford expensive devices for basic communication purposes.

2. Review Of Literature

2.1 Live Audio and Video Transmission System using Raspberry Pi

Vaibhav A. Vyavahare proposed a new fully-functional embedded system which was able to transmit voice in real-time over WI-FI with an acceptable video facility. The credit-card sized single-board and low price, Raspberry Pi model is the most appropriate as a portable device for live audio and video transmission. In his project, the Raspberry Pi was intended to have capability of gathering audio from an USB microphone connected to it and image is captured via camera connected to USB port. Transmission of Audio and Video was carried out with the help of VOIP and SIP Protocol in real time from one Raspberry Pi module to another Raspberry Pi module. The transmission was carried out using "Linphone" freeware. Open source Linux based OS was used in his project to keep the cost low.

In his project, a secure connection, with the help of VOIP and SIP protocol, was established between two Raspberry Pi devices with a Wi-Fi connection. With the help of this connection, voice was recorded, played and streamed on and from one Raspberry Pi to another Raspberry Pi module using a Python based GUI successfully. The attempt to live video and audio transmission between two Raspberry Pi modules was successfully achieved through VOIP server/client implementation maintaining operation of Raspberry Pi as a headless embedded system. The usage of open source, freeware programs and OS kept the project cost low.

2.2 Proposed System for Placing Free Call Over Wi-Fi Network Using VoIP and SIP

Bhushan R. Jichkar proposed a system that allows peer to peer calling and an additional feature of group calling. For supporting group calling feature we are using SIP (Session Initiation Protocol). This technology helps us to find a way for free calling and thus ultimately helps to private organization for reducing bills over communication.

He presented the design and implementation details of an application based on Wi-Fi technology for Wi-Fi enable devices (i.e.: mobiles, laptop, PDA's, tablets) supporting calling, community interactive services and also provides secured Wi-Fi network, based on open technologies such as android programming, MySQL database and SIP. His goal was to create an easy to use, mobile, interactive, flexible and extensible system for calling using free resources and standards. The cost involved is only the initial set up cost and all calls within the network are free. This model would be very useful to solve the communication problems in large organizations, by making free voice calls through Wi-Fi.

2.3 A Taxonomy of Internet Instant Messaging and Chat Protocols

The IBM team had done an analysis on Network chat and Instant Messaging, providing an overview of the system architectures, protocol specifications and available features of several network chat protocols. They presented a survey of several popular systems: AOL Instant Messenger, Yahoo! Messenger, Microsoft Messenger, and Internet Relay Chat describing the common features across these systems and highlighting distinctions between them. They discussed possible advantages and disadvantages of different approaches, particularly with respect to security.

3. Design And Methodology

3.1 Block Diagram

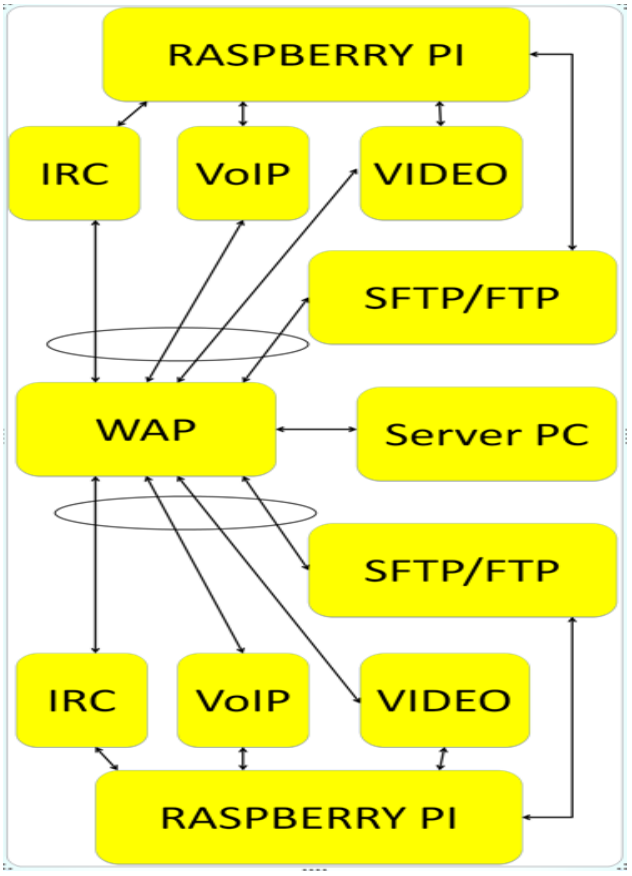

Fig. 1 Block Diagram

3.2 Description of Components

Raspberry Pi 3:

The Raspberry Pi 3 is the third-generation Raspberry Pi. It replaced the Raspberry Pi2 Model B in February 2016. Its specifications are a Quad Core 1.2GHz Broadcom BCM2837 64bit CPU, 1GBRAM, BCM43438 wireless LAN and Bluetooth Low Energy (BLE) on board, 40-pinextended GPIO, 4 USB 2.0 ports, 4 Pole stereo output and composite video port, full size HDMI, CSI camera port for connecting a Raspberry Pi camera, DSI display port for connecting a Raspberry Pi touch screen display, Micro SD port for loading your OS and storing data, upgraded switched Micro USB power source up to 2.5A.

Raspberry Pi Camera:

The Raspberry Pi Camera Module v2 replaced the original Camera Module in April2016. The v2 Camera Module has a Sony IMX219 8-megapixel sensor (compared to the 5-megapixel OmniVision OV5647 sensor of the original camera). The Camera Module can be used to take high-definition video, as well as stills photographs. It's easy to use for beginners, but has plenty to offer advanced users if you're looking to expand your knowledge. It supports 1080p30, 720p60 and VGA90 video modes, as well as still capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. The camera works with all models of Raspberry Pi 1, 2, and 3. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Pi camera Python library.

3.3 Flowchart

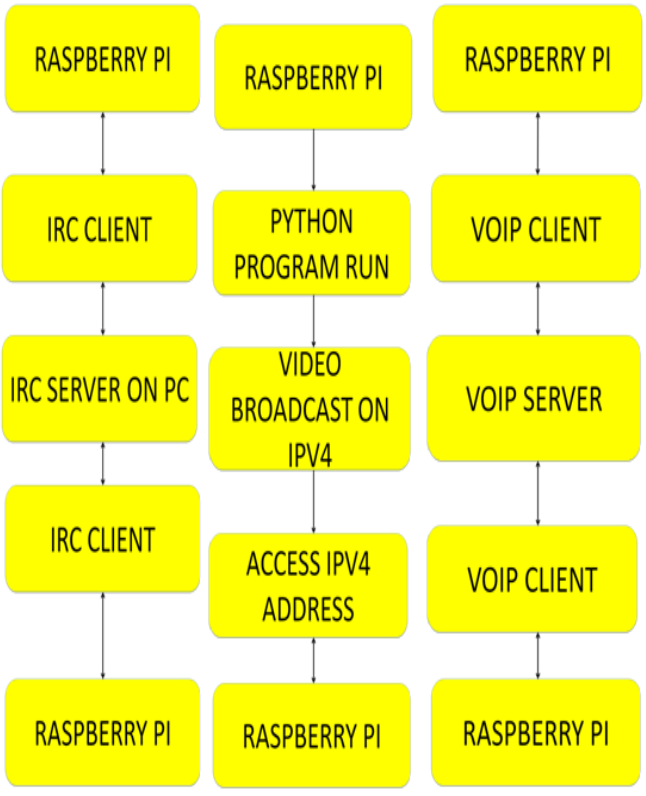

Fig. 2 (a) IRC, (b) Video, (c) VoIP

4. IMPLEMENTATION

4.1 Installation of the "Raspbian" OS

Raspbian is a Debian-derived free OS optimizing specially for the Raspberry Pi hardware. Raspbian mostly uses a Linux kernel also popular as the Debian GNU/Linux distribution. The "jessie-raspbian.Zip"OS file can be directly downloaded from Raspberry Pi's official website. After downloading this ZIP file it is necessary to extract the OS image file into the SD memory card, for that purpose an image writer application "Etcher-1.0.0-win32- x64"can be used. This software is used to write a raw disk image to a removable memory device. It is a free of cost and the program for it is open source. It is useful for any embedded development because of the source code can be branched and modified as per the requirement. After writing to SD card is finished, it is put in the SD card slot of Raspberry Pi and switch it on so that initial booting of Raspberry Pi can start.

4.2 Interfacing

With a display:

Many types of display devices can be interfaced with the Raspberry Pi 3.The basic is interfacing the Pi with a HDMI screen for the display and using USB mouse & keyboard directly connected to the Pi for the configuration. It is then powered "ON" and then connected to the private network on which it will carry out the communication of Text, Voice ,Video & Data.

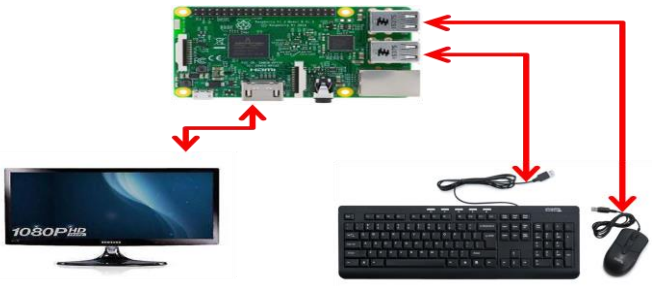

Fig. 3 Interfacing with HDMI Display

With a Phone:

The second type of interfacing is using a touch screen display which removes the need of a USB mouse & keyboard. The last type of interfacing is using a computer or smart phone as a display via SSH protocol. This protocol provides security of the network by encrypting data. The interfacing of smart phone is done by having both Raspberry Pi and the phone in the same network. Learning the Ipv4 address of the Pi is crucial for SSH to be successfully established. Using an android app "Connectbot" enables you to configure the Raspberry Pi remotely and also do the necessary configuration to

enable display over SSH. In the case of the displaying via SSH on Smartphone "VNCserver" ; "VNCviewer" need to be installed on Pi & amp; phone respectively.

Fig. 4 Interfacing with Smartphone

With a Laptop/PC:

Similarly, the computer can also be used to remotely control the Raspberry Pi using SSH. For displaying via SSH on computer "Xming server" is needed to be installed on the computer & "putty" in which SSH connection can be established should be configured to forward "X11".

Fig. 5 Interfacing Laptop/PC with Raspberry Pi

4.3 IRC (Internet Relay Chat)

First a server is created on a PC/Laptop as the Raspberry Pi isn't capable of heavy duty work for a server purpose. "JoinMe" is installed on Windows OS laptop for the server and the IP of the laptop on the LAN(for windows OS, in CMD type-in "ipconfig") it is connected is noted down as it will represent the server IP for the IRC clients to connect.

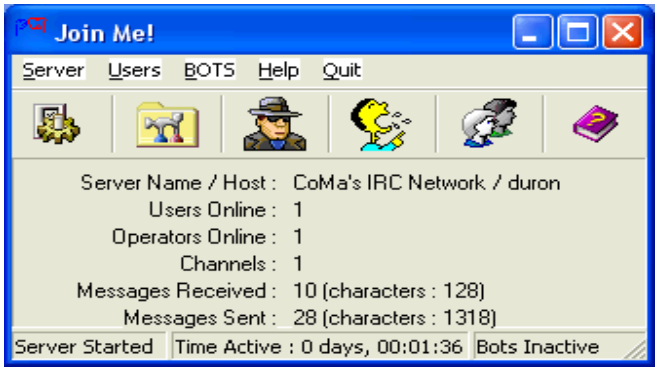

Fig. 6 IRC Server

Once IPv4 of the server is known, the Raspberry Pi(s) are started & general configuration is done using commands:

"sudo apt-get update"

"sudo apt-get upgrade"

The IRC client is installed for IRC purpose using command:

"sudo apt-get install irssi"

Irssi is the IRC client used in Raspberry Pi. After installation in the terminal window, type-in

"irssi"

Connect to the server using,

"/connect ip.address.of.server"

This will then connect the IRC client to the Server. Once in, nicknames can be changed using,

"/nick Name"

A new channel can then be created/joined using,

"/join #channelname"

Once in the channel normal network chatting is carried out. Hence text communication is carried out.

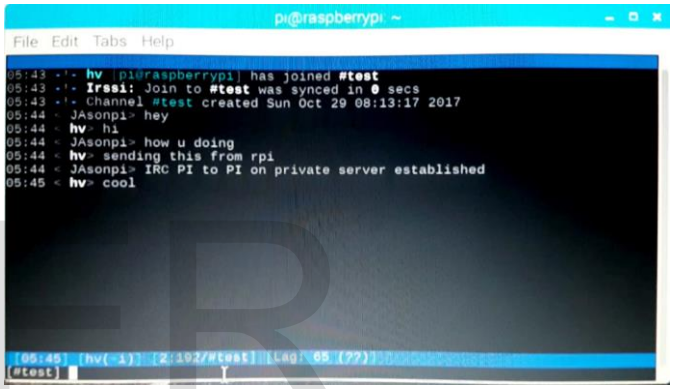

Fig.7 IRC Chat Room On Private Server

4.4 Video Communication

Video communication is carried out on the basis of IPv4 broadcasting. Python programming is used to configure the Raspberry Pi Camera to broadcast on the IPv4 of the LAN the Raspberry Pi is connected to with the a specific port number. This IPv4 address can be streamed using a HTTP browser of any device connected on the same LAN. This can also be carried out in full duplex from Raspberry Pi to Raspberry Pi only.

The python program can be referred from the website named "Random Nerd Tutorials" .

Fig. 8 Video Transmission Over IPv4

4.5 Voice Communication

In VoIP communication a PBX is used to handle calls between the clients. Clients are given an extension number by the PBX which they can use to communicate with each other specifically.

Hence, voice communication is carried out using "RasPBX" which involves the creation of a PBX server on your Raspberry Pi. RasPBX is first installed on the Raspberry Pi. It is then configured to have a static IP address for ease of access on the network.

The following configuration is done before assigning a static IPv4,

"root@raspbx:~# ip addr show dev eth0 | grep inet"
"inet 192.168.15.69/24 brd 192.168.15.255 scope global eth0"
"root@raspbx:~# ip route | grep default"
"default via 192.168.15.1 dev eth0"
"root@raspbx:~# cat /etc/resolv.conf"
"nameserver 127.0.0.1"

"nameserver 8.8.8.8"
"nameserver 8.8.8.4"

Static IP (dhcp config) is now configured using,
"iface eth0 inet static"
"address 192.168.15.69"
"netmask 255.255.255.0"
"network 192.168.15.0"
"broadcast 192.168.15.255"
"gateway 192.168.15.1"

We have to first go into /etc/network/interfaces in an editor and change the line,
"iface eth0 inet dhcp"
to the configuration as above.

Then you can load the new configured network using,
"sudo /etc/init.d/networking restart" in the terminal window.

Once the static IPv4 is configured we can now through a browser on the same network access the GUI using the IPv4. In the GUI extensions can be configured for various devices on your network. Another Raspberry Pi can also be used as a client device by using "Linphone" to access the server Raspberry Pi. For android devices we can use "CSipSimple" as VoIP client.

5. Result

The module being cheaper in cost, portable & capable of providing basic services such as voice, video & data for communication between its own kind as well as other devices, serves as a temporary/permanent desktop for basic use for individuals or organizations that cannot afford expensive devices for basic communication purposes. It can be used with different interfacing ;via HDMI/Touch screen/Mobile or Laptop. Delays & drops can be expected depending on various factors such as bandwidth of the network connections, quality of the hardware used in the network, etc.

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