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Transmission of Audio Over Wireless Networks Using Raspberry Pi in Real-Time

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ABSTRACT: With increasing demands of Electronics products in the domain of the industrial & Consumer application, it becomes necessary to come up with new ideas of electronic products. In the field of communication, present real-time communication audio transmission uses technologies like WiMax, IEEE 802.11, 3G and Bluetooth. But audio-streaming through Bluetooth or radio waves have drawbacks of range and not secure as intruders can get streamed feed. In this paper a fully-functional embedded device has been proposed which is able to stream or transmit audio in real-time over Wi-Fi (IEEE 802.11). This system uses a small credit card sized single board called Raspberry Pi, display, webcam, Wi-Fi and headphone/speakers. This system is a standalone system and does not require any single PC to take or receive the data from camera and headphone/MIC and send to another user. Operating speed of this platform is in 700MHz and it supports live audio streaming. As it has onboard Audio codec, it is possible to connect to user by just accessing the IP address of another user. SSH (Secure SHell) is used for secure data communication, remote command-line login, remote command execution, and other secure network services between two networked nodes. Open source Linux based OS is used to keep the cost low.

KEYWORDS: Raspberry Pi, Wi-Fi

I. INTRODUCTION

In today's busy world, where even every micro second is considered as very significant, almost all existing systems can be considered as real time systems because time has become a very important factor for execution of any system. The present communication systems such as WiMAX, Bluetooth are also providing real time communication but it has range problem as well as they are not very secure. The wireless technologies have gained lots of importance because of fast speed, security and low-cost. In [5], authors have tried VOIP communication based on Arm 9 platform which adopts SIP and RTP to ensure the low-latency and high quality communication. They have used Linux operating system and ALSA device driver are used for cost control and sound effects and succeeded. While [8] have attempted real-time audio & video transmission system based on visible light communication but it has range limitations of just three meters. [6] have proposed android based platform to use the advantage of Wi-Fi systems, for peer to peer calling and group calling using free resources and standards to keep the cost low. In this paper, we are trying to transmit audio to a remote location. This system can be used to transmit recorded audio to remote computer in real time.

The raspberry pi is a low cost, credit-card sized computer that plugs into into a computer monitor or TV and uses a standard keyboard and mouse. It is capable of doing all those things that a PC can do, right from browsing the internet and playing high definition video, to make spreadsheets, word-processing and playing games[3]. This paper uses model B+ of

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Raspberry Pi. The processor at the heart of the Raspberry Pi system is a Broadcom BCM2835 system-on-chip (SoC) multimedia processor and relies on SD card for booting and storage. This uses Linux and Debian based operating systems. We are using 'Raspbian Wheezy'. This model has 4 USB ports, an HDMI port and a 10/100 Ethernet controller. It uses 5V 1.2 Amp power supply with micro-USB connector.



Fig.1: Raspberry Pi Model B+

II. HARDWARE REQUIREMENT

- 1) Headphone/MIC - Here easily available regular headphones and mics are used for capturing the audio signals.
- 2) IEEE 802.11 - This is IEEE standard used for the wireless network and also referred as Wi-Fi. We are using Edimax - 7811un wireless-802-11b-g-n nano usb-adapter.
- 3) Keyboard/Mouse – Wireless Logitech Keyboard and mouse is used to write system code.
- 4) Ethernet cable – Ethernet cable is used to connect raspberry pi to the computer for programming purpose.

III. IMPLEMENTATION METHODOLOGY

First Raspberry Pi needs to be prepared with the required Operating System and software packages. This is done using Ethernet cable and the image of 'Raspbian Wheezy' is downloaded. For transmission of audio to the remote computer, we need to connect Raspberry Pi to the computer using Secured SHell (SSH) and configure microphone and web camera.

A. Installation of the "Raspbian Wheezy" Operating System

Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. it comes with over 35,000 packages, pre-compiled software for easy installation on Raspberry Pi. A Raspbian image is downloaded onto an SD card which in turn can be used to boot your Raspberry Pi and Via APC into the Raspbian operating system. This image can be downloaded directly from the Raspberry Pi Website Downloads Page. To extract the OS image file into the SD memory card, an image writer application "win32diskimager-v0.9-binary" can be used. 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 can start. After that raspberry Pi is connected to PC using Ethernet cable and it is configured with the static IP address. The SD card is inserted in PC and the static IP address is added to the last line of "cmdline.txt" file of boot folder. The DHCP server obtains IP address automatically when connected to the internet.

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Fig.2: Initial booting of Raspberry Pi

B. SSH protocol and PuTTY installation

To reach to the Raspberry Pi from PC, we need SSH protocol. SSH is cryptographic network protocol used for remote access of machines in a secure way. PuTTY provides SSH connectivity for Windows and emulates an xterm terminal. This allows users to connect Linux machines remotely from Windows environment. PuTTY is installed in the remote PC. In the Session menu in the PuTTY type in the static IP address defined earlier of the Raspberry Pi and leaves the port at 22 for SSH to login. During connection it will ask for the username (“pi”) and password (“raspberrypi”) of Raspberry Pi.

C. FFserver server (*ffserver*)

FFserver is free software used as streaming server for both audio and video. It supports many live feeds, streaming from files. FFserver receives prerecorded files or FFM streams from some ffmpeg instance as input, then streams them over RTP/RTSP/HTTP. We can manage ffserver via a configuration file which is read at startup or at /etc/ffserver.conf. An ffserver will listen on some port which is specified in the configuration file. You can launch instance of ffmpeg and send FFM stream to the port where ffserver is expecting to receive it.

D. Configuration of Microphone

The Raspberry Pi doesn't have socket for microphone. To record audio, we need to use soundcard. Here we have used regular and easily available inexpensive headphones with mic for this purpose. To check if Raspberry pi can read headphone, “lsusb” command is given in terminal window. This command displays all the devices those are connected to the respective USB ports. For headphone settings, ALSA (Advanced Linux Sound Architecture) is used. The ALSA provides audio and MIDI functionality to the Linux operating system. ALSA supports upto 8 sound cards, numbering from 0 to 7, each card is capable of input and output. Some useful commands are alsamixer, amixer, alsactl, arecord and aplay.

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Raspberry Pi image has already `alsa-utils` for sound. We can set up headphone port by opening `alsamixer` GUI. We can set the desired settings there.

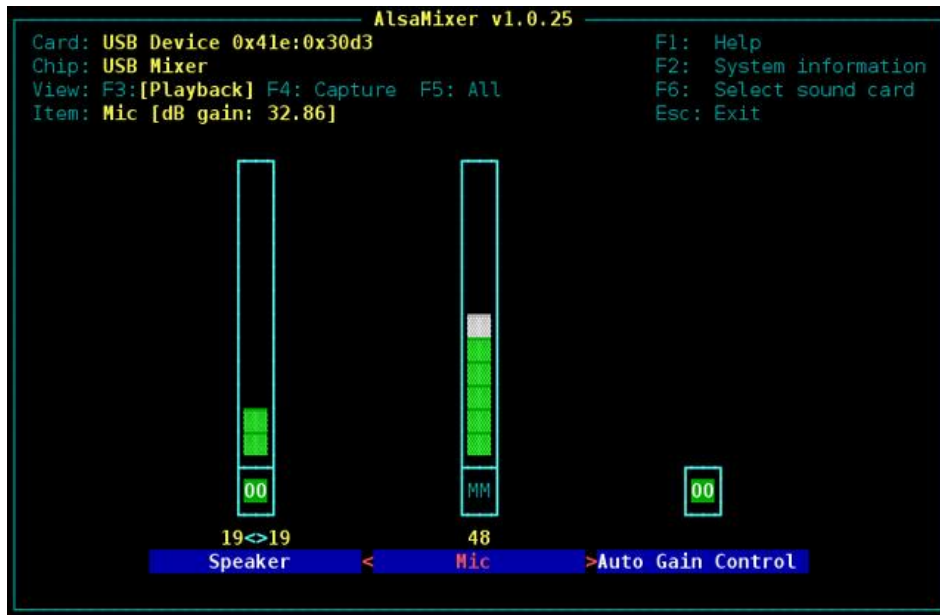


Fig.3: ALSAmixer GUI

E. Wi-Fi Configuration

We are using Edimax Wi-Fi adapter for connecting Wi-Fi to Raspberry Pi. For this purpose we need to change some settings in Raspberry Pi's network interface folder. All the interfaces are defined inside network directory and we can change the settings using nano editor and then changing desired settings and saving them. Generally Wi-Fi network has a DHCP server which gives away IP address randomly. We can as well define static IP address with matching netmask and gateway of the network. Or we can change these Wi-Fi settings using GUI of Raspberry Pi. For this, type 'startx' in terminal window and it takes to the GUI.

F. Streaming and playing voice with commands in terminal

For streaming and playing audio from raspberry pi to the remote PC in the network, certain commands are given from the SSH terminal of raspberry pi. Here these two nodes are recognized by their respective IP addresses. Let IP address of raspberry pi be 192.168.0.2 and that of remote PC be 192.168.0.5. Then the command for audio streaming in real-time will be

```
$ sudo arecord -f cd -D plughw:1 | ffmpeg -i - -acodec mp2 -ab 64k -ac 1 -f rtp rtp://192.168.0.5:8090
```

To listen the stream on remote PC, we need to open the rtp window in the VLC server and type the url, `rtp://192.168.0.5:8090`

Here, we have used RTP protocol for real time transmission of voice.

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IV. MAKING GUI USING PYTHON SCRIPT

For the ease of Recording, storing, playing and streaming voice a GUI is programmed using Python language. It is a common practice to use Visual Basic, #.NET, Eclipse using C, C++ or java platform to design graphical interfaces, but the programming becomes a tedious task with lots of memory management. Python is a widely used general-purpose, high-level programming language. Python is open source. Python is a highly readable language. It is designed to have simple visual layout with a smaller number of syntactic exceptions and special cases than C/C++. Python has a large collection of library or predefined modules for GUI designing, internet connectivity and e-mail, which satisfies all requirements in this project. The following diagram shows GUI for transmission of audio.

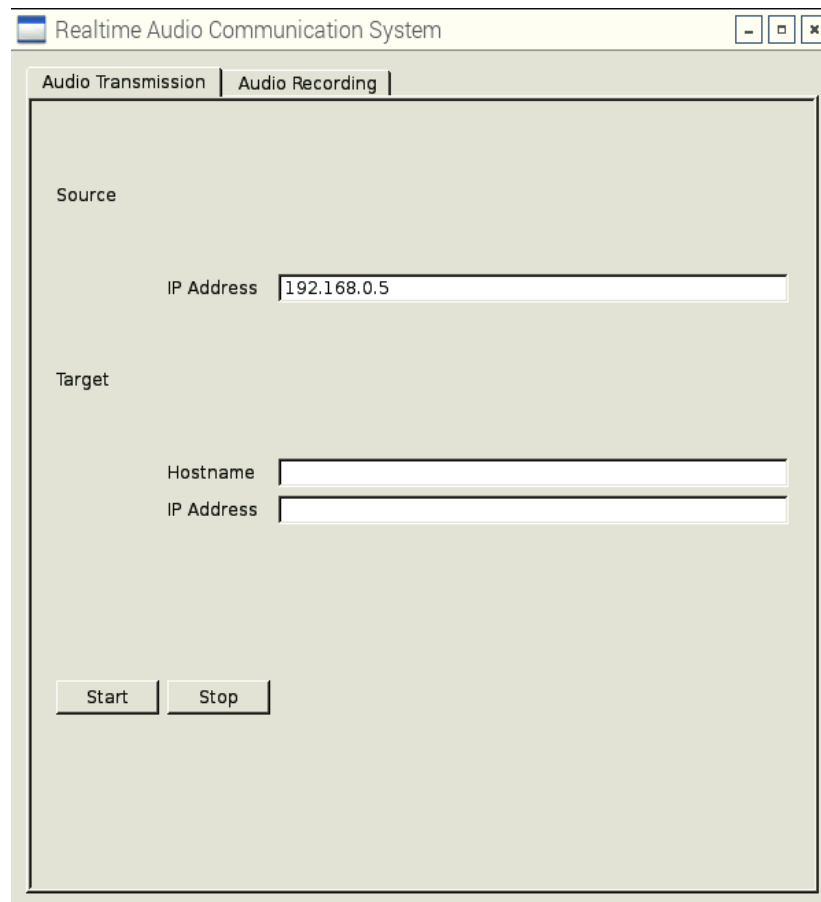


Fig.4: GUI for audio transmission

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V. RESULTS AND CONCLUSION

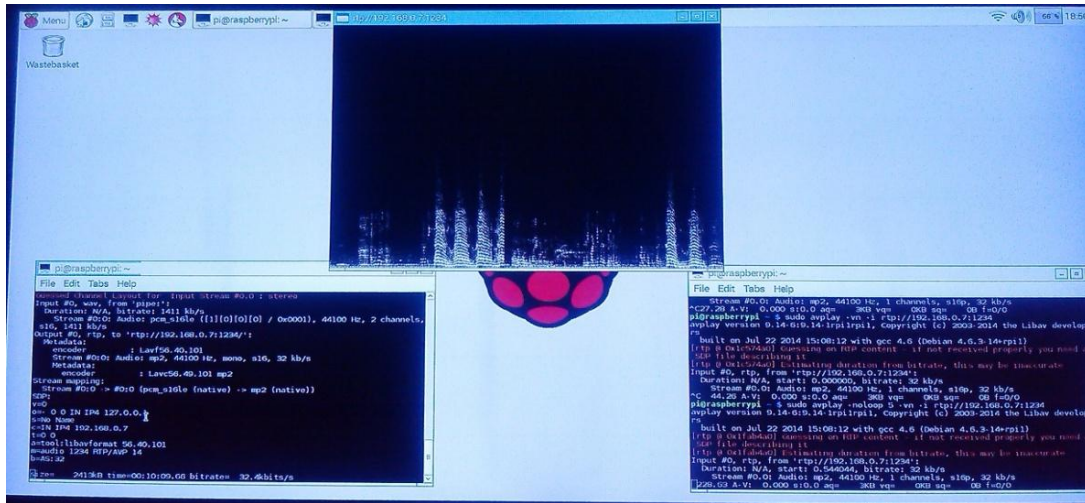


Fig.5: Graphical display of transmission of voice

Here, with the help of SSH protocol using PuTTY, we were able to connect Raspberry Pi and PC with Wi-Fi connection. With the help of this connection audio was streamed successfully from raspberry pi to remote PC in real time with the delay of 1 second and recorded audio can also be transmitted to remote PC. Using Wireless LAN, we can access these transmissions from any part of world, without caring for distance between the two nodes.

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