CSE3006 - Embedded System Design

PROJECT REPORT

FM Transmitter using Raspberry Pi

Submitted to

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Slot: A2+TA2

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ABSTRACT

Radio is the technology of using radio waves to transmit information, such as sound, by systematically modulating the properties of electromagnetic energy waves transmitted through space. Although it was invented in 19th century, it is still surprisingly used by many to listen to music or podcasts to pass time. It is very exotic to find people with a radio system, but most people listen to online radio or through phones which have FM chip.

In this project, we build our own radio system to transmit FM using a Raspberry Pi. This system can broadcast waves around 50 feet without any antenna. We can select what songs to play and which frequency to use. Any device with FM capabilities can receive the waves and play the songs.

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- **AIM**

  To make our own radio FM transmitter using Raspberry Pi.

- **OBJECTIVE**

  The transmission is compared to Deluge as simple and lightweight torrent client. On the other hand, although Deluge has more features, it's a bit heavier, but you won't feel any extra strain on your computer, as computers are much faster these days.

- **INTRODUCTION**

  In this project, we use a list of components (hardware and software) to run the program. We also need a laptop with good internet connection.

Hardware:-

i.   Raspberry Pi 3 Model B
ii. Power supply (micro USB cable)
iii. MicroSD card
iv. Ethernet cable
v.   Jumper wire (male-to-female)
vi. [Optional] Raspberry Pi case

Software:-

i.   Raspbian OS (or NOOBS installer)
ii. SD card formatter (to format the microSD card)
iii. Win32 Disk Imager (or any other image file writer)
iv. PuTTY (to configure Raspbian OS in laptop)
v.   VNC Viewer (to run Raspbian OS in laptop)

Raspberry Pi

  The Raspberry Pi is a series of small single - board computers developed in the UK by the Raspberry Pi Foundation to promote computer science education in schools and developing

countries. The original model became far more popular than expected and was sold outside its target market for applications such as robotics. It does not include peripherals (such as keyboards and mice) and enclosures. However, some accessories were included in several official and unofficial packages.

What's the difference between an Arduino and a Raspberry Pi?

An Arduino is a microcontroller motherboard. A microcontroller is a simple computer that can run a program over and over again. It's very easy to use.

A Raspberry Pi is a universal computer, usually with a Linux operating system and the ability to run multiple programs. It's more complicated than an Arduino. Raspberry Pi is best used when you need a full - fledged computer: driving a more complicated robot, performing multiple tasks, performing intensive calculations (like Bitcoin or encryption).

Raspbian OS

Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of single - board computers. Raspbian was founded by Mike Thompson and Peter Green as an independent project. The first construction was completed in June 2012. The operating system is still under development. Raspbian is strongly optimized for the weak ARM CPUs of the Raspberry Pi line.

Since the last update Raspbian uses PIXEL, Pi Improved X-Window Environment, Lightweight as main desktop environment. It consists of a modified LXDE desktop environment and the Openbox Stacking Window Manager with a new design and some other changes. The distribution comes with a copy of the computer algebra program Mathematica and a Minecraft Pi version as well as a lighter Chromium version starting with the newest version.

PuTTY

Putty is a very useful application for connecting serial ports and Secure Shell (SSH) with Raspberry Pi's. It is mainly used with Windows to connect to remote devices, but it can also run on a Raspberry Pi.

VNC Viewer

VNC is a graphical desktop sharing system that allows you to remotely control the desktop interface of a computer (with VNC server) from another computer or mobile device (with VNC Viewer).

VNC Viewer transmits keyboard and mouse or touch events to VNC server and receives screen updates in return. You will see the desktop of the Raspberry Pi in a window on your computer or mobile device. You can control it as if you were working on the Raspberry Pi itself.

VNC Connect from RealVNC is included in Raspbian. It consists of both a VNC server, which allows remote control of your Raspberry Pi, and the VNC viewer, which allows you to remote control desktop computers from your Raspberry Pi if you wish.

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- **RELATED WORKS OR LITERATURE SURVEY**

Project title	Abstract
Raspberry Pi FM Radio Transmission Station - Rhythm Kr Dasgupta	The FM Transmitter project uses the general clock output on a Raspberry Pi to produce frequency modulated radio communication. The Raspberry Pi is a very useful computer that can be used for many different things. PiFM station is one of useful device. PiFM Transmitter play the sound over the air. This device normally works like real radio station. We can use this device in real life, suppose in an area where our phone network as well as internet is not working to communicate, in those area we can install this device for communication purpose on the other hand it's

	a low-cost device we can used in our daily life to communicate in locality.
FM Transmitter for Raspberry Pi on Secure Unix Systems - Kyle Daniel Martin	Frequency Modulation (FM) broadcasting is a Very High Frequency (VHF) broadcasting technology which began with Edwin Howard Armstrong. Armstrong made use of FM to provide high quality sound broadcasts over radio. The term FM band directly dictates the frequency band which is dedicated for FM transmission. Note that the term equates a FM method within a range of frequencies. The Raspberry Pi is a credit card–sized, single-board computer. The Raspberry Pi has on-board hardware that is used to generate spread-spectrum clock signals on the General Purpose Input/output (GPIO) pins to output FM signal. My proposal is that we will achieve a solution that results in having a FM Transmitter composed solely of the Raspberry Pi, an optional but recommended passive antenna, as well as source code written in the C programming language.
Cognitive Radio Communication Using Raspberry Pi - T.Rohitha Raj, B.Chakradhar, Vandana khare M.Tech Embedded Systems, Assistant Professor, Associate Professor	Raspberry Pi FM Transmitter similarly as Software-defined radio (SDR) is a radio communication system where components that have been typically implemented in hardware like amplifiers modulators, demodulators etc. are instead implemented by means of software on a personal computer or embedded systems. Here I am implementing SDR in Raspberry pi which enables transmission/Receiver of signals with the help of General purpose-input-output pins and with the help of software. While the concept of SDR is not new, the rapidly evolving capabilities of digital electronics render practical many processes which used to be only theoretically possible. We can establish a FM station with the help of Raspberry Pi based on Cognitive Radio communication in which user can easily block other user's Spectrum.

	By blocking Spectrum, we can easily transmit our signal without any disturbances. Both Transmission and Receiving is possible with raspberry which helps to setup our own communication channel with Cognitive frequency by allocating random frequency
Low Cost and Power Software Defined Radio Using Raspberry Pi for Disaster Effected Regions - Vijendra SinghTomarVimalBhatia	Radio communication is extremely critical for public safety, national safety, and emergency communication systems. During emergency situations like natural disasters, terrorist attacks and plane crashes, inter-operability problems are faced by military and civil safety officials where different aid agencies have radios working in different frequency bands, waveforms and protocols. At the same time, these radios need to be low cost, small size, portable, and require low power to operate. Software defined radio (SDR) technology helps to solve the above problems by implementing radios that can operate on multiple frequency bands and multiple protocols by software control. In this paper, we describe a novel SDR system that we have developed using Raspberry Pi, and a low cost front end solution. The system is low cost, small size, consumes low power and is portable, hence can be quickly deployed in disaster affected areas to save life and resources.

- **EXISTING AND PROPOSED SYSTEM**

In our proposed system we give songs as input to the Raspberry Pi. These songs are sent to the media via the antenna, and the selected song on the Raspberry Pi is received via the FM phone at the desired frequency set in Raspberry Pi.

CHAPTER-3

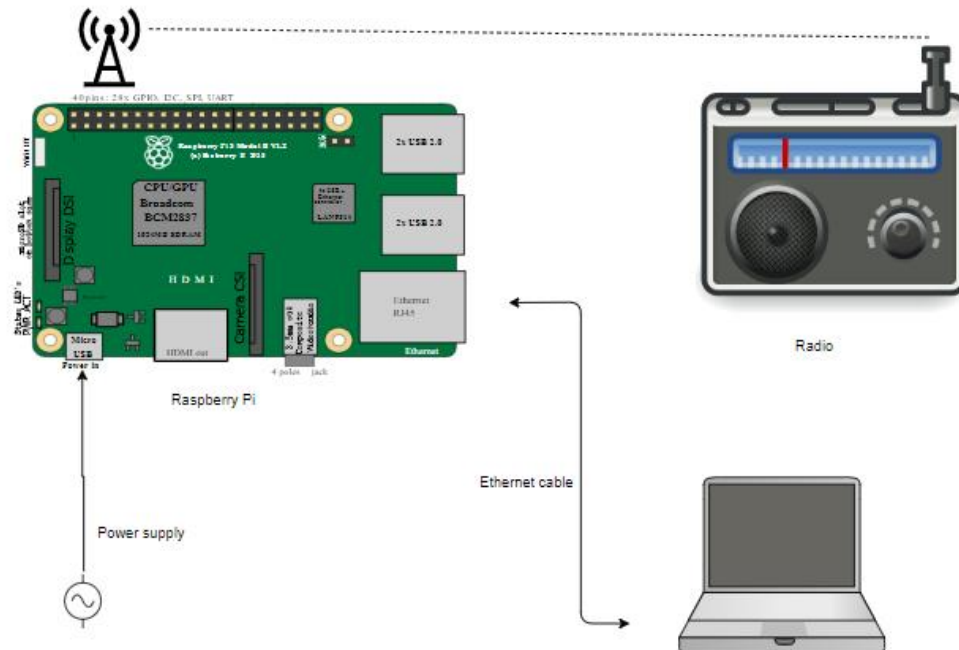- ## PROPOSED SYSTEM DESIGN ARCHITECTURE

Fig 1. Block diagram of the system

- ## ARCHITECTURE EXPLANATION

  i. Download Raspbian OS from the official Raspberry Pi website.

 ii. Format the microSD card and write the Raspbian OS image file to it.

iii. Create an SSH file and copy it to boot drive (microSD) with the OS.

 iv. Insert the microSD card in Raspberry Pi, connect the Ethernet cable and supply power.

  v. Run command prompt in laptop and type the following

  ping raspberrypi.mshome.net

 vi. Copy the IP address for Raspberry Pi.

vii. Open PuTTY and use the same IP address.

viii. Login as "**pi**" with password "**raspberry**".

 ix. Follow the commands to enable SSH and VNC

Enter "**sudo raspi-config**" → **Interfacing options** → **SSH** and **VNC** → **Enable**

    x.   Reboot the system.

   xi.   Open VNC Viewer and start new connection with same IP address.

  xii.   Start the connection and run the Raspbian OS.

- **ALGORITHMS AND PSEUDOCODE**

In the Raspbian OS, we need to do the following:-

    i.   Update all libraries and packages.

<div align="center">

sudo apt-get update

sudo apt-get upgrade

</div>

   ii.   Install the required library for FM transmitter software.

<div align="center">

sudo apt-get install -y sox make gcc g++ git libmp3lame-dev

</div>

  iii.   Compile the software.

<div align="center">

cd ~/fm_transmitter

make

</div>

  iv.   Download an audio file (preferably wav file) in the same folder.

   v.   Play the audio file via the GPIO pin.

sox [filename] -r 22050 -c 1 -b 16 -t wav - | sudo ./fm_transmitter -f [frequency] -

-r sample rate sox converts the file

-c number of channels

-b bit rate of sampled output

-t type/extension of file

-f desired frequency

CHAPTER-4

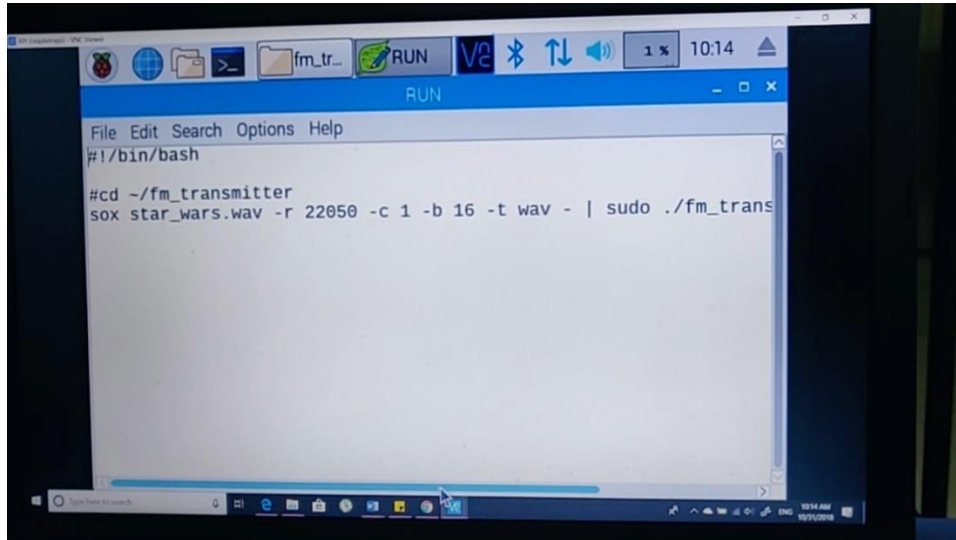- **RESULTS AND DISCUSSIONS**

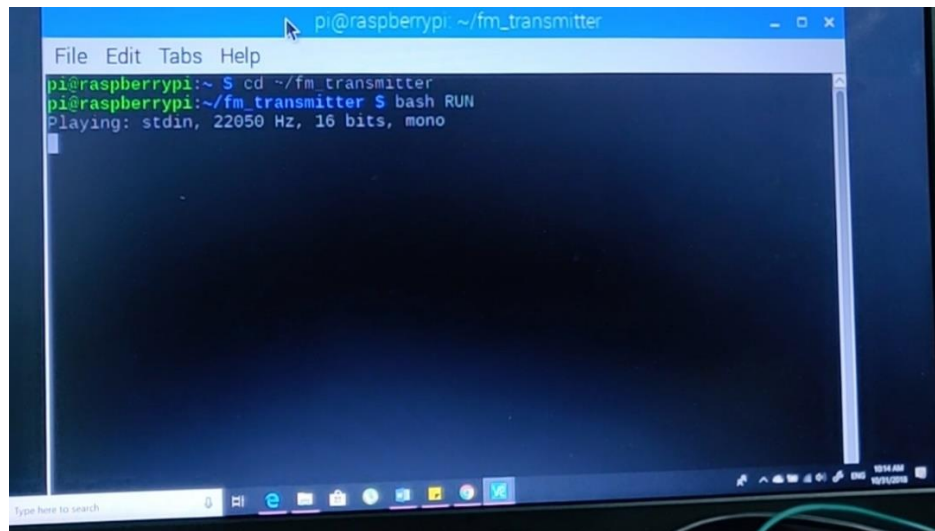*Fig 2. Bash file to run the program*
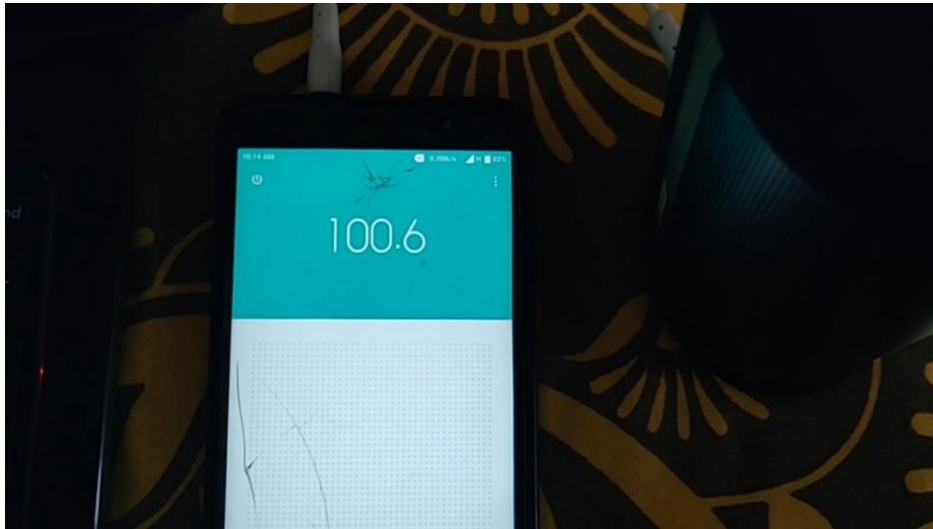

Fig 3. Execution of the program

Fig 4. Radio working!!

This is an experimental program designed for experimentation only. It is in no way intended to become a personal media center or a tool to operate a radio station, or even send sound to one's own stereo system.

In most countries, the transmission of radio waves without a government license for the transmission modalities (frequency, power, bandwidth, etc.) is illegal. Always connect a shielded transmission line from the Raspberry Pi directly to a radio receiver in order not to emit any radio waves. Never use an antenna.

Even if you are a licensed amateur radio operator, using this system to transmit radio waves to amateur radio frequencies without filtering between the Raspberry Pi and an antenna is most likely illegal because the square wave carrier has very harmonic frequencies, so the bandwidth requirements are unlikely to be met.

- ## CONCLUSION AND FUTURE WORK

This is an extremely simple hack that turns your Raspberry Pi into a powerful FM transmitter. This hack requires absolute minimum requirements: an SD card, a piece of wire and a power source.

This FM station has a powerful assortment to comfortably cover your home and office. If you are planning outdoor activities such as organized mountain hikes, excursions or other activities, you can take your FM radio station with you.

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