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Implementation of FM Transmitter Using Raspberry Pi

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Abstract- FM radio is a more reasonable and significant approach to communicate imperative school or college notices. FM radio presents the new part of utilizing radio for college audience and in addition enables students to showcase their abilities during free periods of the college that causes them in exhibiting their talents and gets supported. Frequency Modulation (FM) broadcasting is one of Very High Frequency (VHF) broadcasting technologies. The cost diminishes to very great extent and permit a stage for web-casting of Radio by Utilizing Raspberry Pi. The credit card size Raspberry Pi appears as single board computer. The Raspberry Pi has on-board equipment that is used to produce spread-spectrum clock signals on the General Purpose Input/output (GPIO) pins to yield FM signal. The implementation is to accomplish a solution that results in having a FM Transmitter made exclusively out of the Raspberry Pi, an optional but recommended passive antenna, and also source code written in the C++ programming language. The FM Transmitter project utilizes the general clock output on a Raspberry Pi to create frequency modulated radio communication. Once the program execution is completed, one can speak through a microphone and broadcast their voice, or pick audio files on their Raspberry Pi and play them. Subsequently making the communication inside a college or institution more simple and quick.

Index Terms- FM Transmitter, Raspberry Pi, GPIO, FSK, A/D converter.

1. INTRODUCTION

The transmission of audio signals is usually accomplished through the frequency modulation strategies. FM transmitter is the sub-system that transmits the data from one place then onto the next place with no wired-connections. It is used to address a large public within the transmission range, for instance to make announcements of college. For a superior quality and proficient communication, digital modulation strategy is employed. The main advantages of the digital modulation are higher noise immunity, bandwidth availability and permissible power. In digital modulation, an analog message signal is changed into digital message, and afterward modulated by using a carrier wave. FM transmitter system comprises of an input signal source i.e., microphone (for speech) or auxiliary cable (for recorded audio), modulator and antenna to transmit the signal over large range. The transmission begins with a sound source (human voice or recorded audio), which makes sound waves (acoustical energy). These waves are recognized by a microphone or auxiliary cable, which converts them in to electrical energy. The signal is then modulated and transmitted at the desired frequency using the antenna. The transmitted signal can be heard by the users through their mobile phones.

In digital system, the sort of the modulation is chosen by the adjustment in the carrier wave parameters like amplitude, phase and frequency. Amplitude Shift Keying (ASK), Phase Shift Keying (PSK) and Frequency Shift Keying (FSK) are key digital modulation procedures. In ASK, the amplitude of the carrier changes in view of the base-band signal, which is in digital form. ASK is sensitive to noise and utilized for low-band necessities. In FSK, the frequency of the carrier is differed for each symbol in the data. It needs larger bandwidths. So PSK changes the carrier phase for each symbol and it is less sensitive to

MIC/AUX CABLE

HEAD PHONES

1.1. *Block Diagram of FM Transmitter*

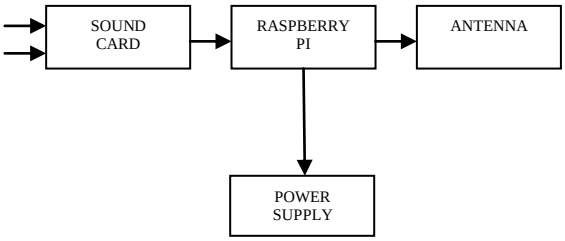


Fig1. Block diagram of FM transmitter

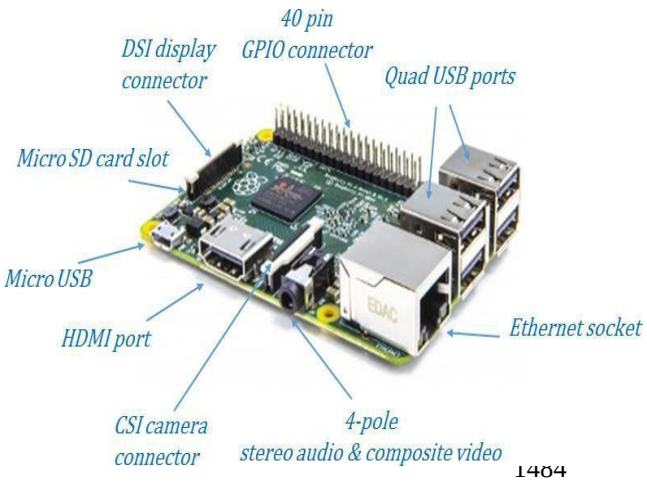
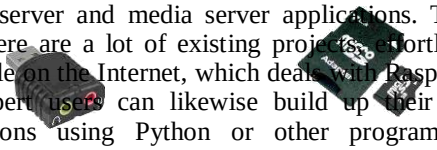


Fig2. Raspberry Pi 3 Model B

2. RASPBERRY PI

The Model B of Raspberry Pi3 , which is the Raspberry Pi of 3rd generation model shown in Fig2, is a credit card sized single-board computer equipped with a quad-core Broadcom BCM2837. 4X ARM Cortex-A53, 1.2GHz processor running Despite its minimal cost, in order of 40$, it feature highlights are 1GB RAM, a 4-pole stereo output, a 40 pin GPIO connector, 4 USB ports, composite video port, a CSI connector, a HDMI port, a DSI connector, a micro-SD card slot and an Ethernet socket. It picked up the attention of specialists and professionals particularly for file server and media server applications. These days, there are a lot of existing projects, effortlessly accessible on the Internet, which deals with Raspberry Pis. Expert users can likewise build up their own applications using Python or other programming languages, taking advantage from the accessibility of such a flexible and cheap device to acknowledge customized solutions to their necessities.



(a) External sound card (b) Micro SD card

(c) Whip antenna (d) Microphone

Fig3. Additional Hardware

The Raspberry Pi is a low cost and credit-card sized computer that attaches to a TV or computer screen, and utilizes a standard mouse and keyboard. It is a little capable device that empowers individuals of any age to investigate processing, and to figure out how to program in languages like Python and Scratch. It can do all that you had anticipate that a personal computer to do, from browsing the web and playing superior quality video to creating spreadsheets, word-processing and playing games. Furthermore, the Raspberry Pi can cooperate with the outside world, and has been utilized as a part of a wide cluster of digital maker projects from music machines and parent finders to weather report stations and tweeting aviaries with infra-red cameras. We need to see the Raspberry Pi being utilized by kids everywhere throughout the world to figure out how to program and understand how computer works. The Model B of Raspberry Pi3, of the family of Raspberry Pi is being used as a part of this undertaking to manufacture a FM transmitter.

3. ADDITIONAL HARDWARE

As shown in the Fig3, there is some additional hardware used to implement the FM transmitter. They are

3.1. *External Sound Card*

Prior to the creation of the sound card, a computer could make a beep sound. In spite of the reality the computer could change the beep's duration and frequency; it couldn't change the volume or create other different sounds. Computer information and Sounds are essentially different. Sounds are mostly analog and made of wave that travels through matter. Individuals hear sounds when these waves physically vibrate their eardrums. Computers, nonetheless, communicate digitally, utilizing electrical impulses that represent 1s and 0s. Like a graphics card, a sound card interprets between a computer's digital data and the outside world's analog data.

3.2. *Micro SD Card*

The Micro SD card is a storage device that can store the required files to make Raspberry Pi act as an FM transmitter. The code written to run the raspberry pi as FM transmitter and the required operating system are all stored in this SD card.

3.3. *Whip Antenna*

The most straightforward antenna is the "whip". This is a quarter wavelength wires that stand above a ground plane. The most widely recognized cases are found on automobiles and are utilized for broadcast radio, CB and amateur radio, and even for cellular phones. All antennas, similar to any electronic component, have no less than two connection points. On account of the whip, there must be an association with a ground, regardless of whether the ground plane region is simply circuit follows and a battery. The whip and ground plane consolidate to form a complete circuit. The electromagnetic field is set up between the whip and the ground plane, with current moving through the field, thus completing the circuit. In a

perfect world, a ground plane should spread out no less than a quarter wavelength, or more, around the base of the whip. The ground plane can be made littler, yet it will influence the performance of the whip antenna. The ground plane zone must be considered when designing an antenna. A quarter-wave whip is definitely not a conservative antenna. At 100 MHz, in the FM Broadcast Band, it is nearly 30 inches (75 cm). The length of the antenna ought to be estimated from the point where it leaves close proximity to ground, or from the transmitter output. On the off chance that a a whip is mounted on a box, and associated with the transmitter with plain wire, that wire turns out to be a piece of the antenna.

3.4. *Microphone*

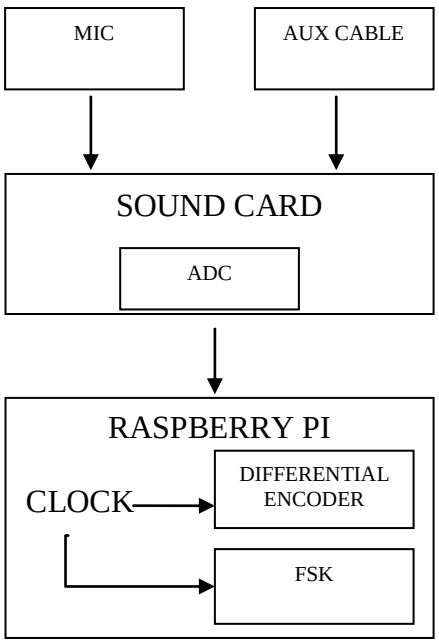
The input to the sound card can be fed from the MIC or from auxiliary cable which can be connected to the device storing the recorded audio file like Mobile phone or a computer. The mic we are using in this project is the iball over-ear headphones with mic. The power supply to the Raspberry Pi can be given from the 5v adapter.

4. IMPLEMENTING THE FM TRANSMITTER

The below is the discussion about implementing the FM transmitter using Raspberry PI.

4.1. *Inputs*

The microphone acts as a transducer converting the voice signal (sound energy) into analog electrical signal (electrical energy). The recorded audio connected through aux cable from PC or mobile phone is already in electrical signal and need not require any transducer.



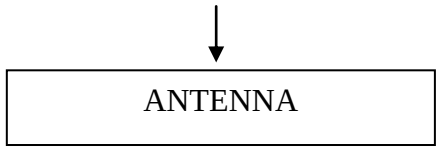


Fig4. Flowchart of implementing FM transmitter

4.2. *A/D Conversion*

These input signal sources mic and aux cable are connected to the 3D sound card. The main function of the sound card is to the input analog signal into the digital signal. It acts as an A/D converter. The ADC interprets the one's voice analog waves into digital information that the computer device can get it. To do this, it requires sampling and digitization of the sound by considering exact measurements of the wave at persistent intervals.

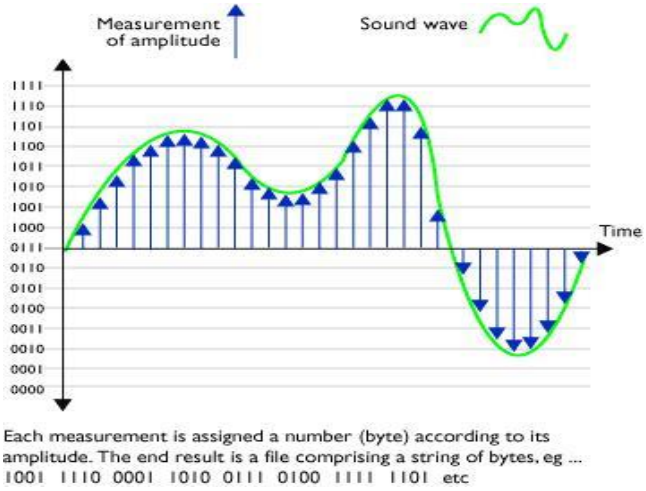


Fig5. Digitized audio signal

Thus the output of the sound card is the digital signal and is plugged in to the raspberry pi for further processing of the signal.

4.3. *Raspberry Pi*

The Operating system and the necessary compiler to compile the C++ code are installed on to the raspberry Pi with a memory card plugged in. The digitized data from the sound card is connected to the raspberry pi. Now the input digitized data should be modulated and transmitted on air at the desired frequency. But the bit streams adhering to the numerous communications circuits in the channel can be un-purposefully altered. Most signal processing circuits cannot tell if the entire stream is inverted. This is additionally called as phase uncertainty. To avoid this we go for differential encoding.

4.4. *Clock*

The Raspberry Pi could generate the clock signal frequency ranging from 5 KHz to 1500MHz. The C++ code is written in such a way to generate the desired radio frequency; here we are using 93.5MHz FM frequency. (While Anantapur radio station is operating at 101.7MHz)So the clock signal of 93.5MHz frequency is generated and is used in modulation.

4.5. *Differential Encoder*

Differential Encoding is utilized to secure against this possibility. It is one of the least complex type of error protection coding done on a baseband sequence before regulation. A system of Differential Coding comprises of a modulo2 adder operation as demonstrated as follows.

d_{in} = Data sequence in

e_n = Differentially Encoded data sequence out

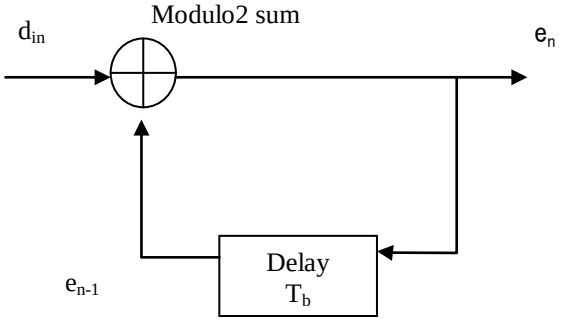


Fig6. Differential Encoder

Accordingly after differential encoder stage, the data is indicated by changes instead of the levels. Now this differential encoded data is modulated with the clock signal that is generated in the raspberry pi. The C++ code is written to modulate the differential encoded data using the Frequency Shift Keying.

4.6. *Frequency Shift Keying (FSK)*

FSK is a modulation technique where digital data is transmitted through discrete frequency changes of a carrier (clock) signal. The FSK wave's output is usually high in frequency for a high binary input data and low in frequency for a low binary input data. The binary 0s and 1s are called Mark and Space frequencies. The mark and space frequencies are the frequencies slightly altering based on the carrier signal (fc = 93.5MHz) and the message signal (fm).

Mark frequency: fc + fm
Space frequency: fc - fm

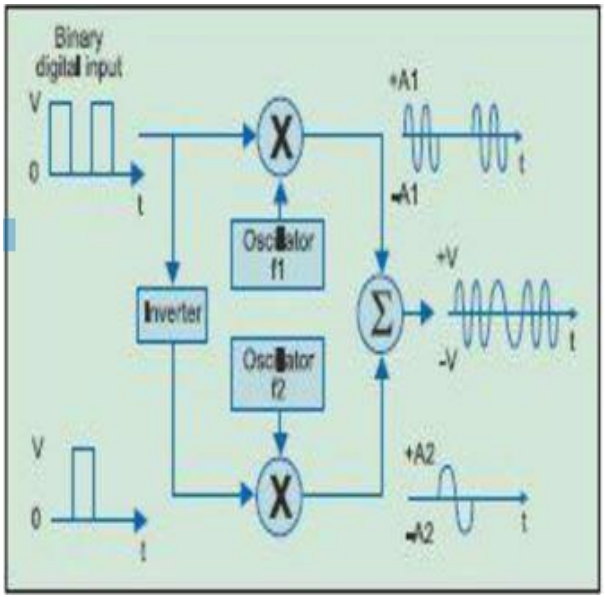


Fig7. FSK transmitter

The above block diagram is implemented through the C++ code in raspberry pi to generate the frequency modulated signal. The frequency modulated signal is thus generated using the above logic.

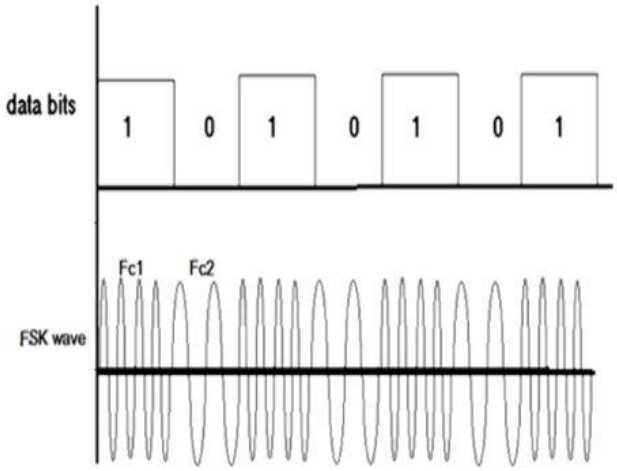


Fig8. FSK output

4.7. *Antenna*

The FM signal generated at the frequency of 93.5 MHz is transmitted on air through the GPIO 4 (pin 7). The height of whip antenna is chosen to be 1.260mtrs for covering the large transmission region. The Whip antenna is connected to the GPIO 4 through the male pin for the transmission of the signal.

5. RESULTS AND DISCUSSION

The below is the Fig9 showing the raspberry pi connected with the sound card. The Raspberry Pi is booted so that it acts as an FM transmitter as soon as it

is switched on. The FM signal is detected at 93.5MHz as soon as it is on though no input connected.

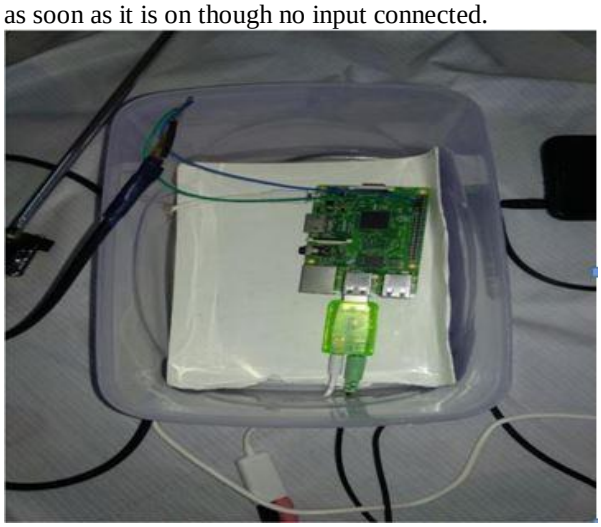


Fig9. Raspberry working as FM transmitter

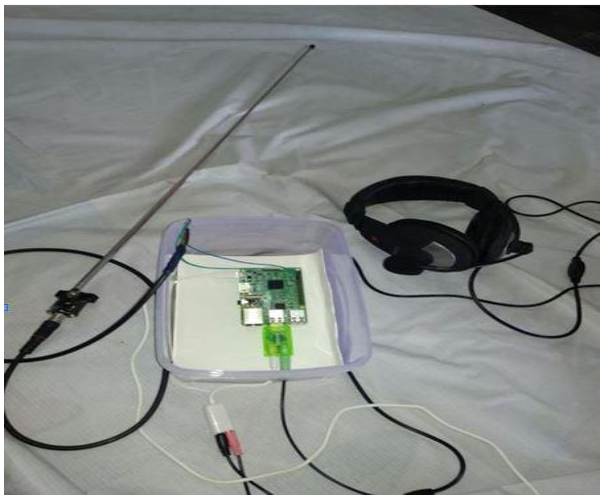


Fig10. Raspberry Pi transmitting voice signals

In the above Fig10, the raspberry pi is connected with sound card which is connected to the microphone to transmit the voice signals at 93.5MHz.

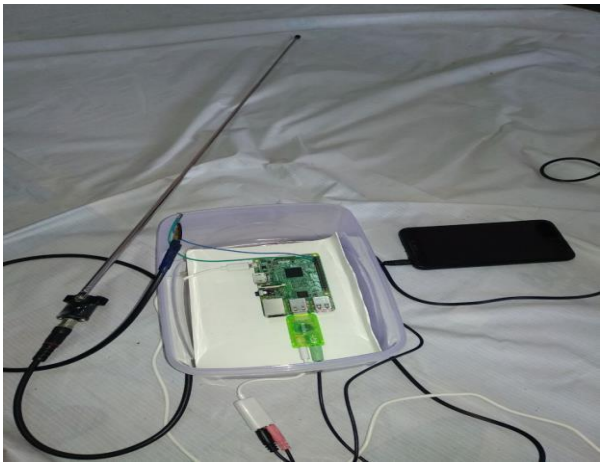


Fig11. Raspberry Pi transmitting audio signal

In the above Fig11, the raspberry pi is connected with sound card which turn connected to the mobile phone is storing the required audio filed need to be transmitted at 93.5MHz.

The Fig12 showing the signal is detected in mobile phone at 93.5MHz. The signal is transmitted using the whip antenna to a coverage area of radius 400 meters.

6. CONCLUSION

Thus the FM transmitter is implemented using the Raspberry Pi to transmit the voice signals using mic and the required audio files using the aux cable connected to the sound card. The FM transmitter is implemented to transmit signals at the frequency of 93.5MHz covering area of radius 400 meters.

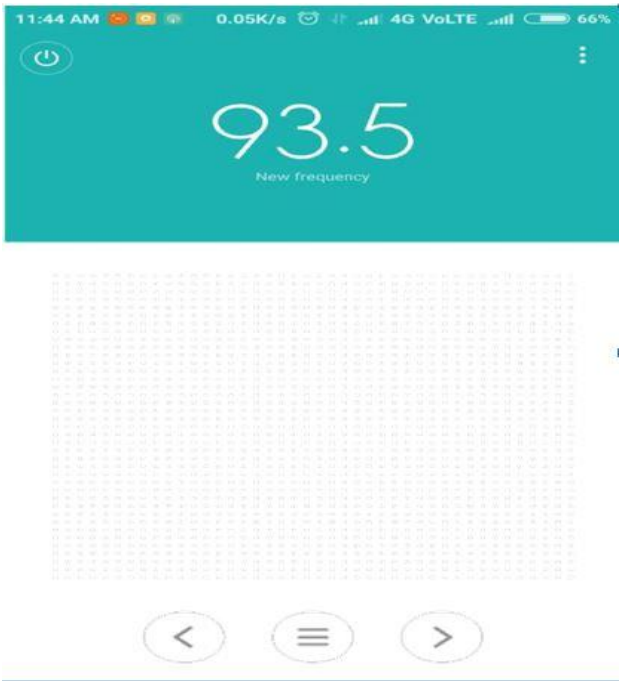


Fig12. Signal detected in mobile phone

7. FUTURE SCOPE

The FM transmitter implemented will not be able to play audio files from multiple inputs at a given moment directly, but cables from mic and aux cable should be altered for transmitting voice or recorded audio signals from various storage devices. The audio files stored in memory card, pendrive, DVD or from any other memory peripherals can be transmitted through this system by installing some modules. The call transmission from distant place to the phone connected to the sound card can also be transmitted using this FM transmitter.

REFERENCES

[1] Richardson, M., Wallace, S., "Getting Started with Raspberry Pi" O'Reilly Media, Inc., 2012.
[2] Liguo, Yu., Stephen, RS., Kai, C., Gillian, Z., and Jeff, O., "Maintainability of the kernels of open-source operating systems: A comparison of linux with freebsd, netbsd, and openbsd." Journal of Systems and Software, 79(6):807–815, 2006.
[3] John, MC., "The synthesis of complex audio spectra by means of frequency modulation." Journal of the Audio Engineering Society, 21(7):526–534, 1973.
[4] Eben, U., and Gareth, H., "Raspberry Pi user guide." John Wiley & Sons, 2014.
[5] Ranjana, S., and Nidhi., "DESIGN AND WORKING OF FM TRANSMITTER." in International Journal Of Advance Research In Science And Engineering, Vol. No.2., Issue No.10., Oct 2013.
[6] Ogbuanya, TC., Abu, S., and Bakare, J., "The Design and Construction of a Frequency Modulated (FM) Transmitter with Output Capacity of 10 Watts and Range above 4km" in International Journal of Applied Engineering Research, Vol.12., No.18., pp.7516-7523., 2017.
[7] Pritish, S., and Shrutik, K., "A Review Paper on Raspberry Pi." in International Journal of Current Engineering and Technology., Vol.4., No.6., Dec 2014.
[8] Sejal, VG., Prashant, RD., "Raspberry Pi Technology." in International Journal of Advanced Research in Computer Science and Software Engineering., Vol.5., Issue.4, Apr 2015.
[9] Nisarg, S., Pradeep, K., Amit, D., and Sarika, NP., "IOT Based Home Automation system using Raspberry Pi-3" in International Research Journal of Engineering and Technology., Vol.4., Issue.5., May 2017.