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Portable FFT Analyser Using Raspberry Pi

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ABSTRACT

In this project we present an extremely efficient FFT based spectrum analyzer. Real-time spectrum analyzer is a hot instrument for signal analysis and spectrum monitoring. It has wide applications in wireless communication and high potential for smart reading. However, it is characterized with a high cost. Hence, a designed light version based on already available lab instruments is constructed for use in school lab. In this project, a Raspberry-Pi and a TFT were used in the process. Both instruments communicated through cable and OPEN-CV software is used for the processing tasks. In order to test the designed one, a simple signal generator is used. The signal is analyzed in both time domain and frequency domain. Then measurements of the signal over time were updated to a matrix of FFT and are plotted in 3D, showing spectrum variation over time.

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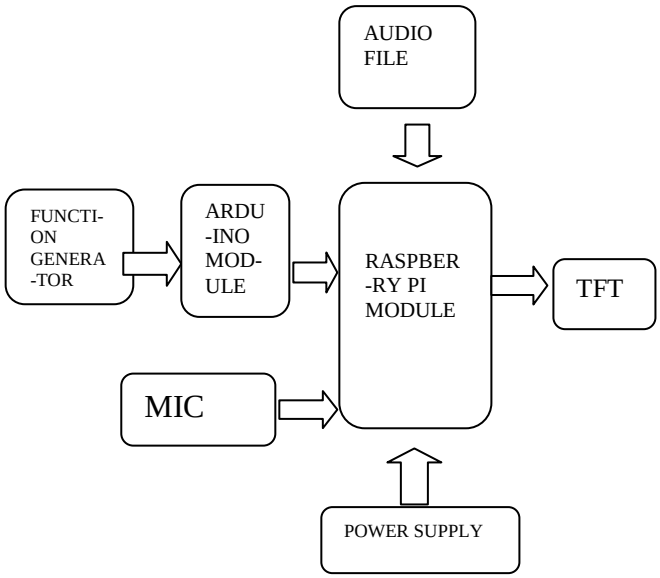
I. INTRODUCTION

This project is to build a simple real-time spectrum analyzer using RASP-PI, function generator or MIC. The function generator transmits the sine wave signal to the RASP-PI and the RASP-PI captures the signal and uses the analog to-digital convertor (ADC) inside it to transform the analog data into digital format. Finally, RASP-PI uses the FFT function to transform the time-domain signal into frequency domain. Then the spectrum of signal with one frequency is displayed on the screen. Furthermore, the frequency is changed manually and a 3D spectrum figure is plotted using TFT Module. It is easy and achievable. Spectrum analyzers for communication systems commonly use Fourier transform for implementing a narrowband filter bank. The extreme efficiency of the FFT algorithm is the main attraction of such a structure. For spectrum analyzers that process communication systems, a bank of narrowband filters with equally spaced center frequencies and equal bandwidths spanning the frequency range of interest performs this decomposition.. Finally, RASP-PI uses the FFT function to transform the time-domain signal into frequency domain. Then the spectrum of signal with one frequency is displayed on the screen. Furthermore, the frequency is changed manually and a 3D spectrum figure is plotted using TFT Module.

II. BLOCK DIAGRAM



Block diagram description:

Power supply: Power is an electronic device that provide electric power to the circuit. This system uses power supply to provide 5V to the circuit.

Function generator:*:* A function generator is a signal source that has the capability of producing different types of waveforms as its output signal. The most common output waveforms are sine-waves, triangular waves, square waves, and sawtooth waves. The frequencies of such waveforms may be adjusted from a fraction of a hertz to several hundred kHz.The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. Here we are using four input devices. They are function generator, mic, arduino and audio files.

The Raspberry Pi 3 features a 1.2 GHz quad-core 64-bit Arm Cortex A53 processor, Chip antenna, 4 USB ports, an Ethernet Port, a GPIO, HDMI, 3.5mm Audio Output, WIFI chip, 1GB LPDDR2 for RAM Memory, and a Micro SD slot. The Micro SD card contains the Pi3's operating system and it can also be used for file storage.

Features:

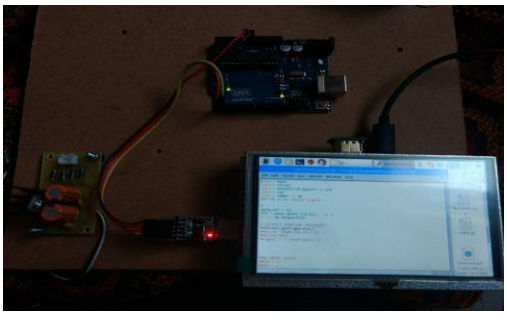
- CPU: Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz.
- GPU: 400MHz Video Core IV multimedia.
- Memory: 1GB LPDDR2-900 SDRAM (i.e. 900MHz)
- USB ports: 4.
- Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack. Network: 10/100Mbps Ethernet and 802.11n Wireless LAN

The USB microphone is used in this project. A normal microphone is connected to a microphone input which has a built in microphone preamp which then can send an analog signal to a mixer or an amplifier, or to a computer. The USB Microphone has everything built in. Any USB microphone has a built in preamp and an analog to digital converter. This means you can simply get the best quality from a USB microphone because it can be directly connected to a computer, Mac, PC, iPad, tablet or laptop. Getting a direct connection without added noise.

A thin-film-transistor liquid-crystal **display** (**TFT LCD**) is a variant of a liquid-crystal **display** (**LCD**) that uses thin-film-transistor (**TFT**) technology to improve image qualities such as addressability and contrast.

III. RESULTS

Fig shown below shows the assembly of the project.



The TFT display is placed on the raspberry pi module. The input signal from the signal generator i.e. analog in nature is get converted into digital form by the aurdino uno module which can be seen in the fig. The aurdino module is capable of converting signals from 30 Hz up to 125 KHz. In the fig given below we can observe how the input signal data from aurdino or mic is fetched by raspberry pi module.

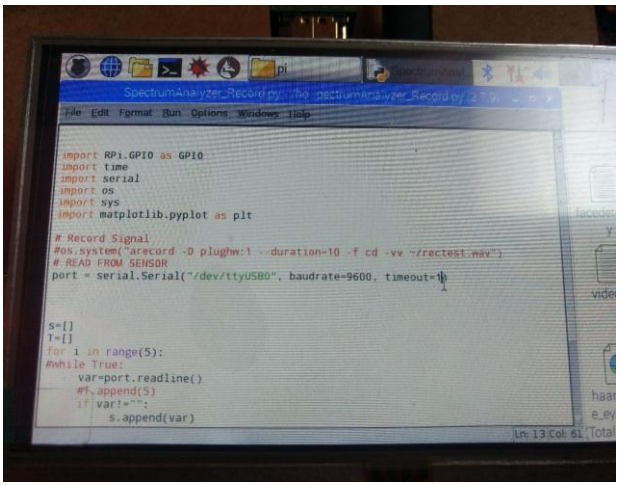


Fig. fetching input from input device to raspberry pi

This digitised signal is displayed on the TFT screen in following manner.

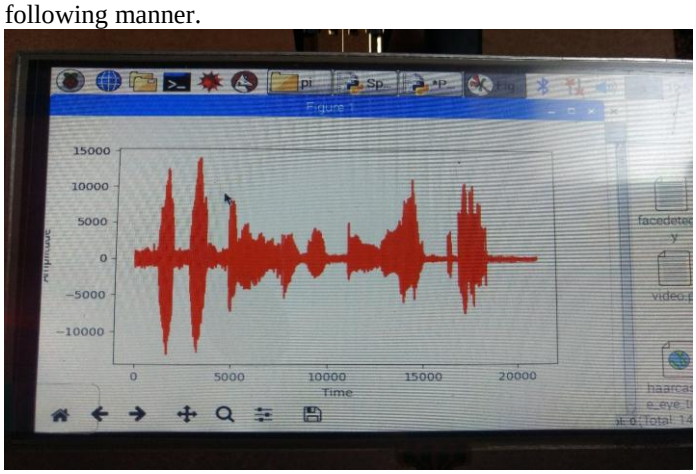


Fig displaying the input signal on TFT diplay

The FFT is performed by raspberry pi module by using hanning window and the desired spectrum is displayed on the TFT display as shown in following fig.

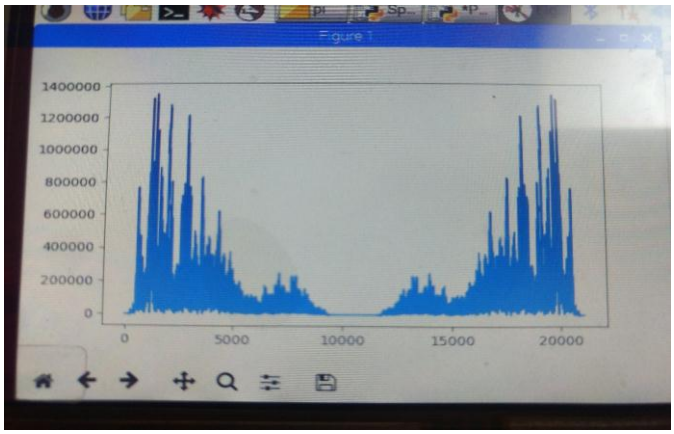


Fig. displaying the spectrum on FFT display

IV. ADVANTAGES

This project is to build a real-time spectrum analyzer and use it to plot the spectrum of the Changing frequencies in 3D, so the advantages and disadvantages will be discussed based on the functionality the light version of RTSA.

1) The light version can adjust the time duration between each measurement. Therefore,
The look of the out coming 3D plotting of the spectrum is flexible.

2)Even though the Time duration can be set to be very small, the light version is still incapable to achieve Seamless measurement of the signal, which the real RTSA is capable.

V. DISADVANTAGES

1) The result of the 3D spectrum plotting is colorful and is added with the color bar to
Show the power distribution, which gives a better explanation of the spectrum.
However, it is not as smooth as the plot of the real RTSA.

VI. APPLICATIONS

1.A **spectrum** analyzer is used to determine, by direct observation, the bandwidth of a digital or analog signal.
2.A **spectrum** analyzer interface is a device that connects to a wireless receiver or a personal computer to allow visual detection and **analysis** of electromagnetic signals over a defined band of frequencies.
3.Filtering algorithms, solving difference equations.

VII.CONCLUSION

In this project, the methods were good due to the following reasons. Firstly, the function Generator or audio file were chosen. They are very common in laboratory and easy to handle so that the communication between the operator and the equipment's and the data transmission between the equipment's was successful.

Secondly, choosing the software OPEN-CV as a tool to communicate with the RASP-PI was a good method. In this work, an abundant data needed to be processed and complicated spectrum analyzing needed to be calculated. OPEN-CV accomplished them easily and precisely.

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