Multi Channel Audio Sample Rate Conversion on Embedded Platform

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***Abstract*: The main objective of this project is to provide cost effective transmission of audio channels from one region to another region. The Project makes use of Raspberry Pi 2 technology with Linux Operating system as the platform. Generally, in Satellite Televisions the transmission of channels is initially transmitted to a broadcasting satellite which in turn sends the signal to the corresponding receiver. In the existing system, when a large amount of data is to be converted it requires many numbers of converters and in reality the number of channels broadcasted is multiple and the conversion of data is enormous. This requires a vast amount of time and is a costly procedure. In order to overcome this, a Raspberry pi 2 model is used. It is equipped with Sample rate converter and audio CODEC's. The advantages of this project are that it is cost-effective and makes use of real time embedded system concepts and designs.**

Keyword: Raspberry pi 2, matlab, broadcasting system, audio channel frequency, src.

I. INTRODUCTION

The broadcasting industry has developed drastically in the past decade. In the 19th century, the Radio and Television were the main sources of entertainment. Nowadays, it has been replaced by varying technologies. Likewise, the broadcasting industry has also developed. Let us consider the evolution of Television and the technology used for transmitting channels. Television was connected to local networks and local channels were only broadcasted. In the 21st century, International channels are being broadcasted. Each technology is invented to provide a better life and also to overcome the difficulties in the present day technology. Hence Satellite Television was invented to overcome the disadvantages of a cable television. Most existing DTH systems have been used as deliver systems for existing programs, for example, broadening the market exposure of existing programming or delivering the program with improved quality or convenience. As a delivery or rebroadcast system, a substantial portion of programming typically arrives at the DTH broadcasting or uplink facility via other backhaul satellites or terrestrial fiber. Programming, such as theatrical films, arrives at the facility as prerecorded digital tapes. In a limited number of systems, the broadcasting facility also includes studios for the creation of unique programming. The broadcasting facility provides a number of functions common to any broadcasting facility, such as incoming signal monitoring, adjustment, and resynchronization, signal routing within the facility, and for prerecorded material, quality control, cloning, and playback. For playback, broadcast-quality tape players are utilized or, more recently, the material is stored on and played from video file servers using redundant arrays of independent disks (RAID) technology.

The paper arranged of follow: section II describes the operation principle of sample rate conversion. In Section III, explain about the structure of raspberry pi 2 and the technique of multi-channel audio conversion is proposed. In Section IV, simulation results are analyzed.

II. SAMPLE RATE CONVERSION

Sample rate conversion (SRC) is a process of converting a discrete time signal at a given rate to a different rate. Multi rate signal processing requires to up sample the incoming data to a very high rate and to down sample when the data should be resent to the receiver. When the output sample and the input sample are not of the same size, the output sample is conditioned to bring it back to the original size. Sometimes, the input sample is refined so as to bring the desired output. This, in technical terms is stated as band limiting the input sample. The SRC also determines the ratio between the output and the input sample rates. It is designed in such a way so that if there is any discrepancy in the sampling it does not affect the performance of the Sample Rate Converter. The re-sampling of a signal involves the conversion from the initial sampling rate to a new and different one. This is often necessary in practical applications because the sampling rate is often fixed while the desired sampling rate may depend on the application used. Although re sampling algorithms have been developed and implemented in commercial software libraries, these algorithms have certain limitations.

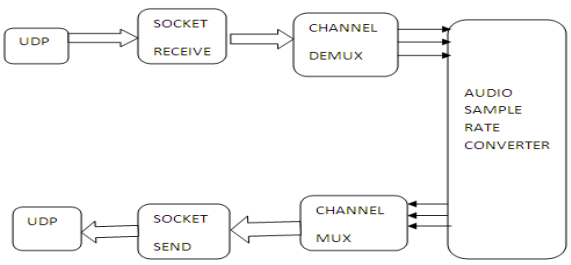

Fig. 1. SRC Structure.

A. Audio Sample Rate Algorithm

Let us consider a random noise, which has a "flat" spectrum (constant energy at all frequencies), and a sequence of sine waves spaced at 500 Hz, which allows a much better feel for the shape of filter distortions and also more readily shows the presence of aliasing artifacts (*aliasing* is the presence of energy from high frequency regions in low frequency regions due to the removal or insertion of samples). The signal source is originally at 8 KHz sampling rate, and written to a 16-bit, single channel .WAV file (PCM encoding).The Sample rate is converted to 44.1 KHz using each of the sample-rate conversion algorithms. Each of the resulting up-sampled files is loaded into MATLAB using a function that reads the binary format into memory, and then a 64k-point FFT is performed. The resulting spectrum is plotted in dB against the new sampling rate.

[1]. B. Linear Interpolation and Random Noise

The following figure shows the performance of linear interpolation on random noise, up sampling from 8 kHz to 44.1 kHz.

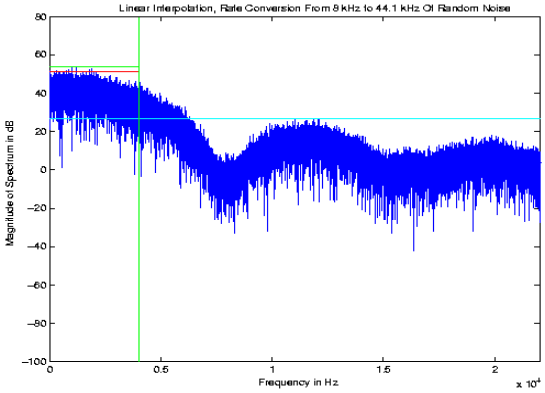

Fig 2 Graphical diagram of Linear Interpolation

This shape is very characteristic and can be derived mathematically, since we use it to give an insight of interpolation techniques the graphical diagram is only needed. The main things to note are that signal degradation starts almost immediately and that a large "hump" of energy appears around 12 kHz, which will sound like a quiet high-pitched noise. As it is only 25 dB down from the maximum signal energy, this is significant.

[2]. C Band Limited Interpolation and Random Noise

The following figure shows the performance of band-limited interpolation on random noise, up sampling from 8 kHz to 44.1 kHz.

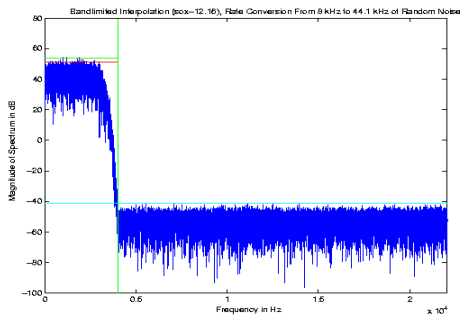

Fig 3 Graphical diagram of Band limited interpolation

The result shows extremely low noise in the stop band (4 kHz - 22 kHz) and an acceptable low pass cut off starting at 3 kHz.

III. BASICS OF RASPBERRY PI 2

The Raspberry pi 2 is the advanced model of Raspberry pi model B+. There are no major differences between the previous model and its upgrade except for 2 features. Though the difference is small, it has a huge impact on the performance. The Raspberry pi 2 has a 900 MHZ quad-core ARM Processor and extended memory of 1GB RAM. The common Characteristics are as follows:

- USB Ports (4)
- GPIO Pins (40)
- HDMI Port
- Ethernet Port
- Audio Jack
- Camera Interface (CSI)
- Display Interface (DSI)
- Micro SD Card Slot
- Graphics Core

Raspberry pi was initially produced for educational purpose; since it was a huge hit the improved version has removed some of the bugs and performance issues.

The original Raspberry pi has a memory of 256 MB only. It is made compatible to Linux/Windows. In order to make it easy for Raspberry Pi users Windows has created a modified OS, termed as Windows 10 embedded.

It can help in building a super computer. Coding techniques are made easy by using Raspberry pi 2. Everyone can code by following the systematic procedures of using the embedded system. Despite the advantages of using Raspberry pi 2. There are few flaws such as Photographing a Raspberry pi 2 causes it to shut down. To be precise, a key component of the Raspberry pi 2 is Photosensitive. The effects are caused only due to the flash and if the camera is at a close range.

The advantages of using Raspberry Pi 2 are listed as follows:

- The processing speed is higher compared to single board chip computers.
- It is of low cost.
- It is specifically designed for educational purpose, and hence it is compatible with the most of the latest software applications.

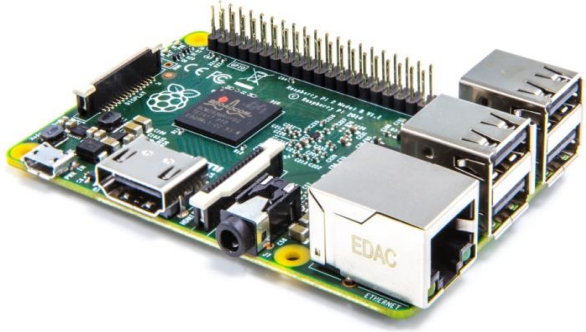

Fig. 4. Raspberry Pi 2 Board

V. SIMULATION RESULTS AND DISCUSSION

The simulation result has provided the proof that it is possible to convert the sampling frequency in a cost effective method. It reduces complexity in programming and easy to use. The range of conversion can be modified according to the users concern. The basic conversion of sampling frequency requires up sampling and down sampling.

VI. CONCLUSION

The basic conversion of sampling rate enables an audio/ video channel to be transmitted without any complex operations required, and it plays a pivotal role in the broadcasting industry. In this study, the application of Sample Rate Conversion (SRC) implemented in the Raspberry Pi 2 provides a whole new dimension to the broadcasting industry and the applications do not limit to this. As the Raspberry Pi 2 is just a circuit board perform the instructions given to it. The Raspberry Pi 2 can be Re-programmed accordingly. This proves that Raspberry Pi 2 is versatile to this industry.

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