3-D SOUND SYNTHESIS SYSTEM

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Introduction

With the increasing popularity of 3-D movies and games, people are seeking more ways to enrich the effects of entertainment.
Our project is a prototype of 3-D sound synthesis system. After putting on headphones, the users can specify direction and distance of the sound they would like to hear from by sliding the potentiometers. We will also show a demo from the movie "The Matrix". The direction and distance of each note is pre-processed by our device.

Motivation

•Head Related Transfer Function (HRTF)
HRTF is a response that characterizes how an ear receives a sound from a point in space. By using a pair of HRTFs for two ears, we can synthesize a binaural sound with 3-D effect.

•Games
Compared With mono sound, 3-D audio effect will make the games more vivid and enjoyable.

•Cane
Smart canes will tell the direction and distance of the obstacles, thus helping the blind people.

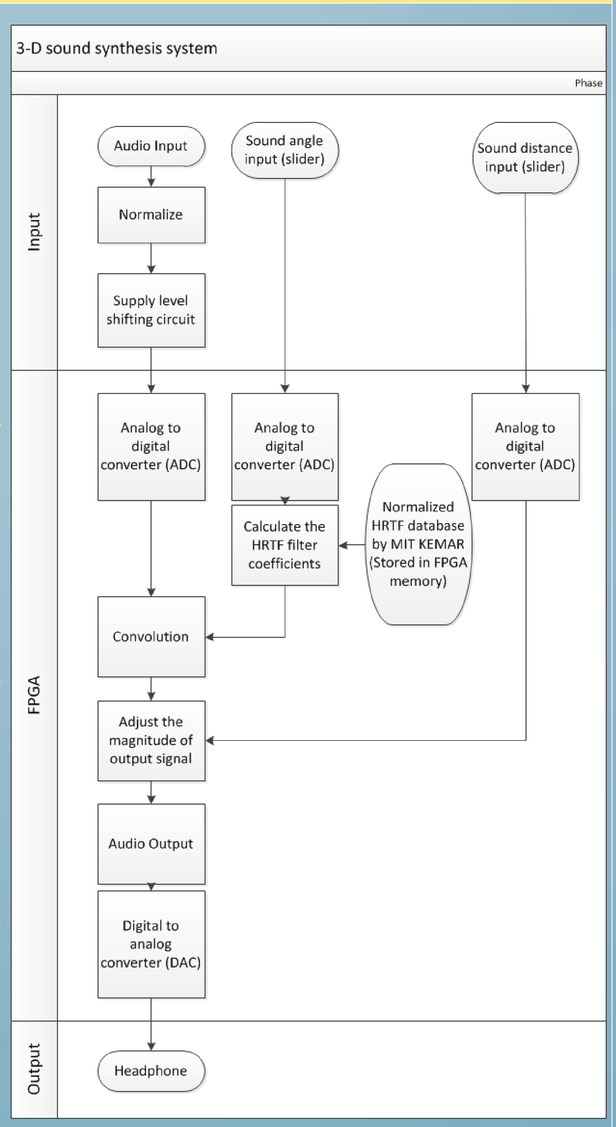
Implementation: Synthesis

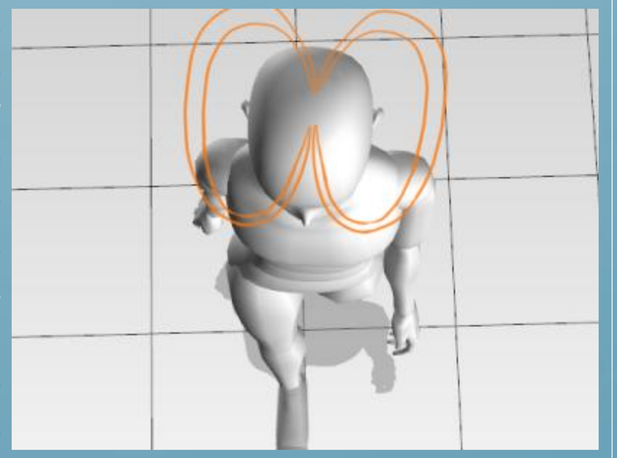
We first used Matlab to design and test the algorism of the system. Then, we implement the whole system on FPGA, which can be divided into two parts, the Input / Output (I/O) and FPGA Filter Implementation.

As for the I/O part, We used the analog to digital converters (ADC) as the input ports. The audio input will first pass the supply level shifting circuit to make all inputs value positive to avoid overflows given the criteria of the ADC. The angle and distance inputs controlled by sliders can be connected to the ADC directly. We also used a digital to analog converter (DAC) as the output port. The output analog signal, which is actually the sound, can be listened to directly by a headphone.

The FPGA Filter Implementation part did the signal processing tasks. It first generate the HRTF filter according to the input elevation and azimuth of the sound. We use triangular interpolation algorithm to calculate the HRTF for a certain point from the HRTF database by MIT KEMAR Lab. Next, we let the input signal passes through the HRTF filter and adjust the magnitude of the output signal based on the distance input. Finally, the output is transformed into analog signal by DAC and outputted.

The orange area in the right figure showed the area with most obvious 3-D sound effect.





Implementation: Recording

We used dummy head model and implanted two microphones to left and right ears. After recording with the model and process the audio, we will get sound with 3-D effect.

Future Work

•Blind Spot
Currently, the existing technology has some limitations of distinguishing the front and the back. We will do some research and try to reduce the blind spot area.

•Cane
By placing ultrasound devices around the tip of the cane, we can detect the direction and distance of the obstacles. We will use our designed system to make low cost smart cane.

Contact Information

If you have any questions or would like information about this project, please feel free to email us at umeecs452.3dsound@gmail.com

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