



Individualisation required for high fidelity 3D positional audio

There is a significant, unfulfilled demand for an improved 3D audio experience in the games industry to meet the vision of Next Generation games enabled by new multi-core CPUs. Current 3D audio over headphones for games is a poor imitation of the real “free field” listening experience with problems such as poor externalisation, localisation, sound quality and listener fatigue. As a result, there has been low market penetration and user uptake of 3D audio over headphones.

Personal Audio’s MyEars™ technology provides a significant improvement in the listening experience from current offerings by reproducing the superb listening experience of multichannel audio systems over headphones.

1. What is 3D headphone audio and why is it hard to do?

3D Hearing

Our everyday environment is filled with a multitude of sounds often occurring at the same time. Yet, the human auditory system has the ability to sort these out and extract precise directional and other information from each individual sound, to extract meaning and aid in speech discrimination. It is said that “the purpose of the ears is to point the eyes” – our 3D hearing contributes significantly to our sense of spatial orientation and general environmental awareness.

3D Audio

As humans can hear in 3D in the real world environment using just two ears, it is well known that the same effect can be achieved using loudspeakers in a surround sound system.

A 3D audio system aims to re-produce a realistic sound field and position sounds all around a listener. Although the sounds are presented over headphones or loudspeakers at a specific location, the objective is to generate, for the listener, the perception of sounds from any location in space around them.

On this basis, a variety of 3D audio products have been created over the years, yet each technology has found it challenging to create realistic 3D soundscapes over headphones:

Stereo Widening/Expanded Stereo:

- Uses 2 speakers, each one being monophonic and carrying a separate channel
- Has always been limited by its sound stage or the size of its audio image perceived by the listener
- Techniques using delays or filters were used to widen the stereo sound stage, so that where sounds would normally extend to the locations of the left and right speakers, they were widened to extend beyond the speakers
- **Problems:** Muffled sounds, out of phase signals and a large amount of frequency response loss. Stereo widening does not have the ability to position individual sounds around, behind, above or below.



Binaural Recording:

- Recordings that are made for reproduction/playback over stereo headphones
- Derives the head related transfer functions (HRTFs) for a particular sound source location
- **Problems:** Frontal sounds often appear inside the head or behind the listener. In addition, binaural recordings tend to give a poor stereo effect and the sound source image is broad, and there can be unnatural signal colourations

3D Positional Audio:

- A 3D audio technology available on the market that makes use of generic HRTFs in producing a 3D sound effect.
- **Problems:** Generic HRTFs do not work for most people in producing a 3D sound perception over speakers and headphones.

2. How does 3D Audio work?

Head related transfer functions (HRTFs) – their use and measurement

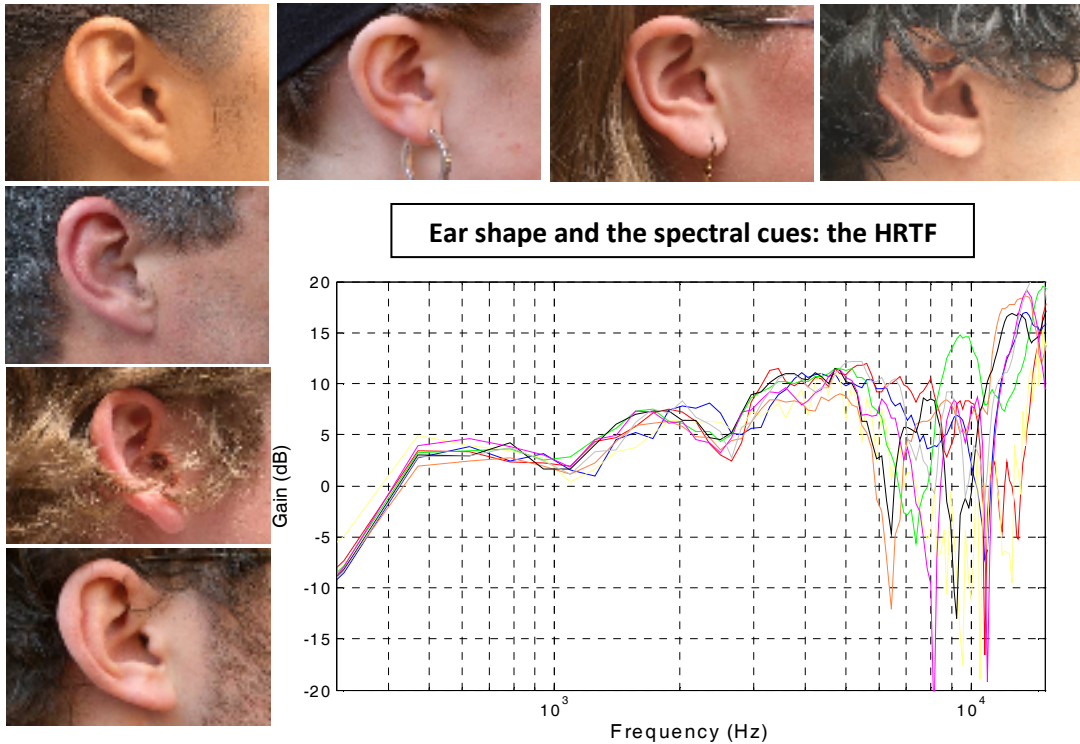
In normal listening, sound is filtered by the outer ear before being encoded by the human auditory system. The way that a sound is filtered is dependent on the precise shape of the listener's ears and the location of the sound source relative to the listener's head. The head related transfer function (HRTF) contains all the listening cues that are applied to a sound as it travels from the sound source, through the environment, to the listener's ears. Depending on the direction from which the sound arrives at the listener's ears, the filter changes accordingly.

The brain uses the HRTF information to generate the perception of sounds coming from outside the head and to also locate the source of the sound. Similar to a fingerprint, every individual has a unique set of HRTFs.

Measurement

To date, the only successful method of measuring an individual's HRTF is to place small microphones inside a listener's left and right ears, place a speaker at a known location relative to the listener, play a known signal through that speaker, and record the microphone signals.

By comparing the resulting impulse response with the original signal, this will provide a single filter in the HRTF set. The speaker can then be moved around to various locations and provide an individual's HRTF set.



The right ears of 7 people and the acoustic recordings of the HRTF from each ear

Generic HRTFs

The procedure of measuring HRTFs as described above, is a technical process that requires a specialised laboratory setting and time invested by the listener. The majority of 3D audio technologies on the market are based on the concept of using HRTFs to some degree, but these are generic HRTFs that have been measured using a physical model of the average human ear or averaged from a number of HRTFs. They operate on the hypothesis that HRTFs are interchangeable and the HRTFs of someone who can localise well in a real world environment can be used by others to allow them to localise in a simulated world.

The ability of these generic HRTFs to create the illusion of 3D realistic hearing is, however, dependent on how well an individual's HRTFs matches the generic HRTFs. A mismatch between an individual's HRTFs and the generic HRTFs can also produce colouration of sound, where sounds will appear mechanical or synthesised. In addition, a mismatch will lead to mislocalisation, where the sound source appears in the wrong location and it can also fail to externalise the sound (i.e. they hear it inside their head, like normal stereo headphones)

3. Personal Audio's solution to the current state of 3D Audio

Why is it important to do 3D Audio properly?

The recent development in videogames consoles and multi-core processor PCs has resulted in the birth of Next Generation (Next Gen) games. An aim of Next Gen audio is to create a realistic listening experience including rendering sounds in 3D with direction, depth and ambience, which will create a sense of presence in the virtual worlds created by the games. While some spatial enhancements have been captured via the use of generic HRTFs, there is still a large gap in the experience for each listener of 3D audio in these games.



MyEars™ Technology

With the use of Personal Audio's patented digital signal processing (DSP) and statistical techniques, Personal Audio has developed the MyEars™ engine that enables the prediction of an individual's HRTFs. Personal Audio's value proposition provides a significant improvement in the 3D audio listening experience from current offerings, via the MyEars™ solution, which enables a stunning listening experience over headphones, including an accurate rendering of elevation, hence raising the bar of 3D audio, in general, for the games industry.



Competitor Technology

There are many companies that have 3D audio based technology, such as Dolby, Creative, Gen Audio and QSound - most of these competitor companies use generic HRTFs. The use of individualised HRTFs is the uniquely differentiating feature of Personal Audio's MyEars™ technology. This approach sets Personal Audio apart in an exclusive and compelling way.

Summary

The goal of achieving high fidelity 3D audio and a natural listening experience over headphones is an issue directly associated with individualisation. The sense of immersion sought by virtual worlds in games is significantly increased by high fidelity 3D audio and in a growing games market, it is a shortfall that needs to be addressed. Personal Audio's MyEars™ technology is a powerful solution that closes the gap between free field listening and headphone listening, provides a competitive advantage for the player and generates a very compelling sense of presence.

For more information on MyEars™ and Personal Audio's range of products and services, please visit www.personalaudio.com.au or contact us on contact@personalaudio.com.au .