Fastcomcorp Research

White Paper

Fastcomcorp Digital Audio

Public Version

Introduction

Thru 2007 and 2009 Fastcomcorp's founder with the help of others researched and developed a virtual audio distribution system made up of 77 virtual loud speakers that covered a target by utilizing Head Related Impulse Response (HRIR) measurements and image coordinates. FDA prototype extended binaural technology 3D dimension plane to its own adaptation of a unique 7D sound system thus to make way in time to enhance virtual reality. The prototype consisted of the processing of the audio taking place in Matlab, a custom decoder, and HRTF filters running on a MacBook Pro.

The base of Fastcomcorp Digital Audio can be described as a ball in a box. The ball represents the directional plane in which sound comes from in all angles. These angles are right, left, up, and down. The box represents the environment in which the ball is stored. Environment plays a major role in sound because of temperature, reflecting objects (that produce echo), tone manipulation through materials, and quality.

Original Purpose of the Research and Development of FDA

Develop an audio system that is able to replicate our living environment that we hear with our ears and to enhance the experience of an audience.

The Virtual Loudspeaker Setup

Fifty-seven of Fastcomcorp's Digital Audio (FDA) virtual loudspeakers are placed around today's 3D audio sphere set that is widely used. In FDA's spherical speaker arrangement there are seven planes filled with speakers. In each plane there are eight speakers which are separated one half of a quadrant, 45 degrees around a circular plane.

Within the seven planes and eight speakers, one on each panel; there is a total of fifty-six virtual loud speakers. There is also a center speaker set in place. This center speaker handles low end sounds such as the bass. Each of the speaker's sound volume is aligned through the support of the (HRIR) measurements.

(0 °, 0 °) corresponds to a point directly on the ahead

(0°, 90°) corresponds to a point directly overhead

(0°, 180°) corresponds to a point directly behind

(0°, 270°) corresponds to a point below

(90°, 0°) corresponds to a point directly to the right

(-90°, 0°) corresponds to a point directly to the left

The Interneural-polar coordinate system

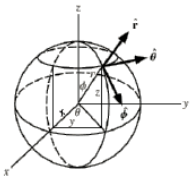
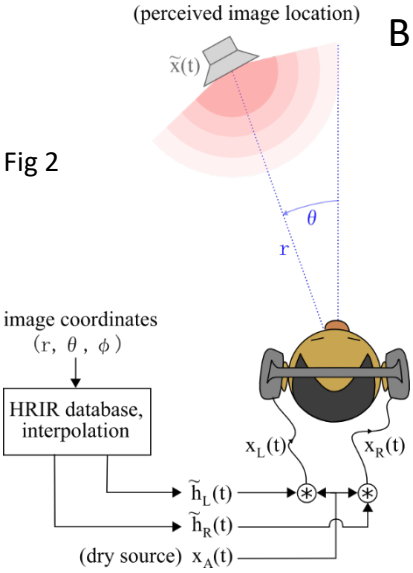


Figure 1

The head related sound impulse responses being described are functions of azimuth, elevation, and time. Which are naz(azimuth), nel(elevation), and nt(time). 25 x 50 x 200 3-Dimensional array. The following HRIR values are given for twenty five different azimuths, fifty different elevations, and 200 instants in time.

Binaural Technology – How Sound is Transferred

Fig 2

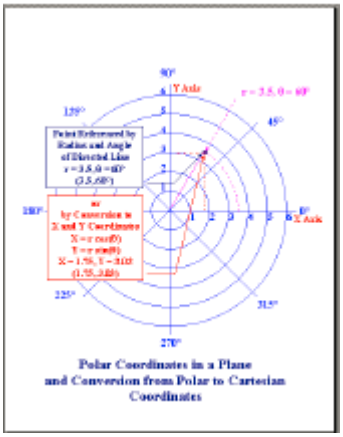


Binaural technology takes HRIR database and interpolates in where the sound it should be mimicked. Fastcomcorp took the same approach as binaural technology has done through the image coordinates and HRIR database. FDA's interpolation process is more advance and complex. Before we go further one must understand the Cartesian coordinate system, points (X,Y,Z). Because it will help one adapt the following information.

X = r cos (phi) cos (theta)

Y – r cos (phi) sin (theta)

Z = r sin (phi)



As we look back at Fig. 2 we can discern where the direction of sound interpolates with that mathematical formula that binaural sound is produced. The letter h stands for hemisphere, t for time, and x is the plane. Four of the 23 new equations which are htp(t) for the top hemisphere, hb(t) for the bottom hemisphere, Xtp(t) the output for the top, and Xb(t) the output for the bottom.

The top hemisphere [redacted] which outputs to [redacted] and the bottom hemisphere outputs to Xb(t) work together to achieve equilibrium with the other hemispheres to output sound coming from the top and the bottom without clashing to each other waves. There is also little sound

wave interference because it has a set volume and distance. The virtual speaker has a sound range of 1.5 ft virtually. so it would not interfere with the other waves. This prevents future problems.

The rest of twenty virtual speakers are set around a 4 dimensional cube outside the 3 dimensional system which is in the inside the inner square in figure 3.

The purpose of the 3 dimensional system is to provide support for the background effects in a recording and enhance the user experience. Such as capturing a recording of someone talking outside a room when the listener is inside a room could listen. Another advantage is that it can reproduce those low end sounds that we hear.

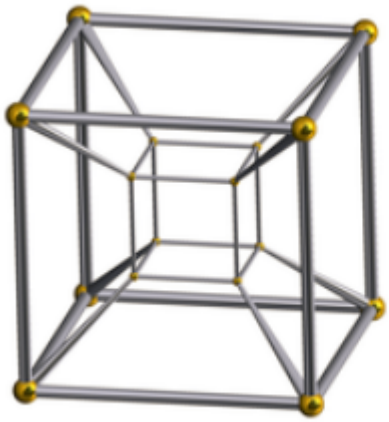


Figure 3
The 4 Dimensions

The outer cube equations are [redacted] which outputs to [redacted] which outputs to [redacted], [redacted] which outputs to [redacted], [redacted] outputs to [redacted].

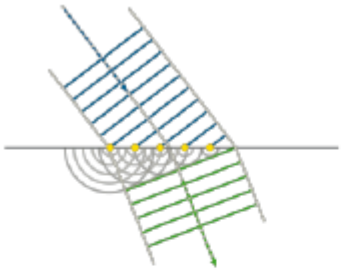
Live Concert Concept

Let's say that we are watching on television this live concert and we are viewing it from this angle. We can hear the crowd that is around us singing, talking, and people shouting, including the band playing. Remember those load speakers in the concert auditorium that are too loud? Or those annoying sounds that prevent you from enjoying the concert?

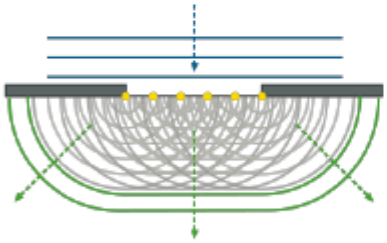
FDA can take care of that during the editing process by putting into the sound mix controller crowd sound environment. One would start mixing with the 4 dimensional system. The dimension system would play back the edited version of the crowd around the angle it was recorded shouting and singing with a little low end sound. It would be perfectly mixed along with the people next to one from the angle shouting or singing along. The two main advantages to a system such as this are the enhancement of the user experience and giving the sound engineer room to be creative with little limitations.

The Principles of Fastcomcorp Digital Audio

The **Hudgens-Fresnel Principle** named after a Dutch physicist's Christiaan Huygens and French physicist Austin-Jean Fresnel who both came to the conclusion that one can produce an acoustical field within a volume that can be expressed as an integral. (One can apply this into wave propagation in **Far Field Limit** and in **Near Filed Diffraction**).



Wave Refraction - Huygens.



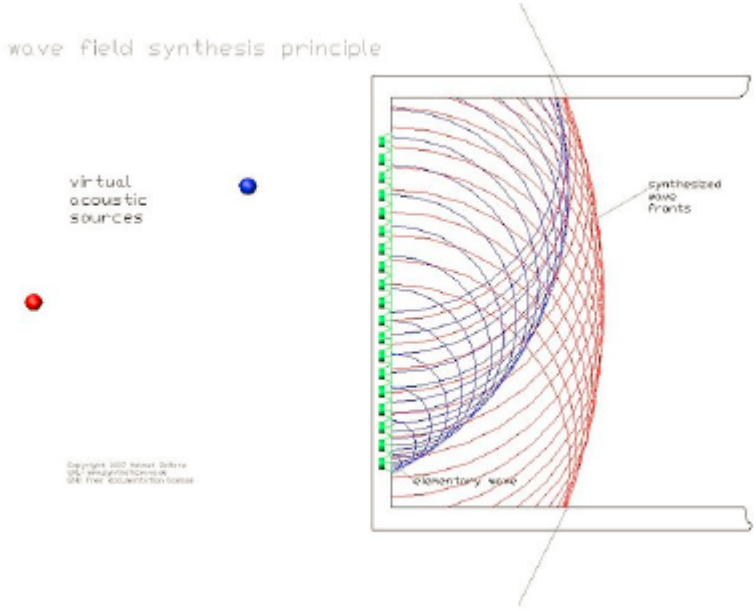
Wave Diffraction - Huygens.

The Kirchhoff-Helmholtz Integral Theorem

$$p(\mathbf{x}) = p_{incident}(\mathbf{x}) - \frac{1}{4\pi}\iint_{Surface}\left(G(|\mathbf{x}-\mathbf{y}|, f)\hat{\mathbf{n}}.\mathbf{v}(\mathbf{y}) - p(\mathbf{y})\hat{\mathbf{n}}.\nabla' G(|\mathbf{x}-\mathbf{y}|, f)\right)d\mathbf{y}$$

It states that the sound pressure is completely determined within a volume free of sources, if sound pressure and velocity are determined in all points on its surface. Therefore any sound field can be constructed, if sound pressure and acoustic velocity are restored on all points of the surface of its volume. Which is the underlining.

Wave Field Synthesis



It is based on **Huygens 'Principle** which states that any wave front can be regarded as a superposition of elementary spherical waves. Which can be synthesized from such elementary waves, this is backed by **The KIrchhoff-Helmholtz Integral**. WFS is a spatial audio rendering technique, characterized by creation of virtual acoustic environments.

It produces artificial wave fronts synthesized by a large number of individually driven speakers. Such wave fronts seem to originate from virtual starting point, the virtual source or notional source. Contrary to traditional specialization techniques such as stereo, the localization of virtual sources in WFS does not depend on or change with the listener's position.

Development of a Theory

There are 7 dimensions of sound in our living environment, not three. The seventh dimension defines the rest. But it could be that there is more than 7 dimensions or an undiscovered equation.

Support

1. Environment plays a major role in acoustics.
2. The speed of sound is variable and it depends on the temperature and the properties of the substance of which the wave is traveling through.
3. Direction of sound is taken care of but what about the sounds that we hear with our ears outside an enclosed room that are dimmed.
4. There are 7 major notes and notes in music C, D, E, F, G, A, B.

5. Aristotle states, “Air motion is generated by a source, thrusting forward in like manner the adjoining air, to that the sound travels unaltered in quality as far as the disturbance of the air manages to reach.”
6. Sound travels in finite speed, meaning that it can bend.
7. There are neural discharges codes for frequency that help the brain discern the output product. Possibly there is a set of instructions already in place.

Audio Processing Thru Tube and Solid-State Amplifiers + FLAC

As we were testing audio formats to append the Fastcomcorp Digital Audio Format. We got into old school amps. We built one and discovered that the magnetic resonance of an amp tube is what makes the sound coming out of it powerful and great specially the bass sound. Chad Pierce went from building one to three. On the solid-state amplifiers when sound travels thru it, it is not the same. FLAC audio and tube amp was a beautiful combination. We possibly figured out a way in theory how to get those missing harmonics. We also made a decision to choose FLAC as our format of delivery instead of wave due to the fact we discovered also that one can play very loud music in FLAC and it does not hurt ones ears compared to the other lossless audio formats.

The Future of Fastcomcorp Digital Audio

To further develop this audio codec into a product. It will take major capital and came to the conclusion we need to conduct studies on the latest development of sound traveling through light and research on the human ear and senses. We are planning to compete in Alabama Launchpad to get the funding.

Special Thanks

Dr. Paul Helminger on guiding us and introducing us to “May the Net Force Be With You.” As well as the math professors, and both Dr. Russ.

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