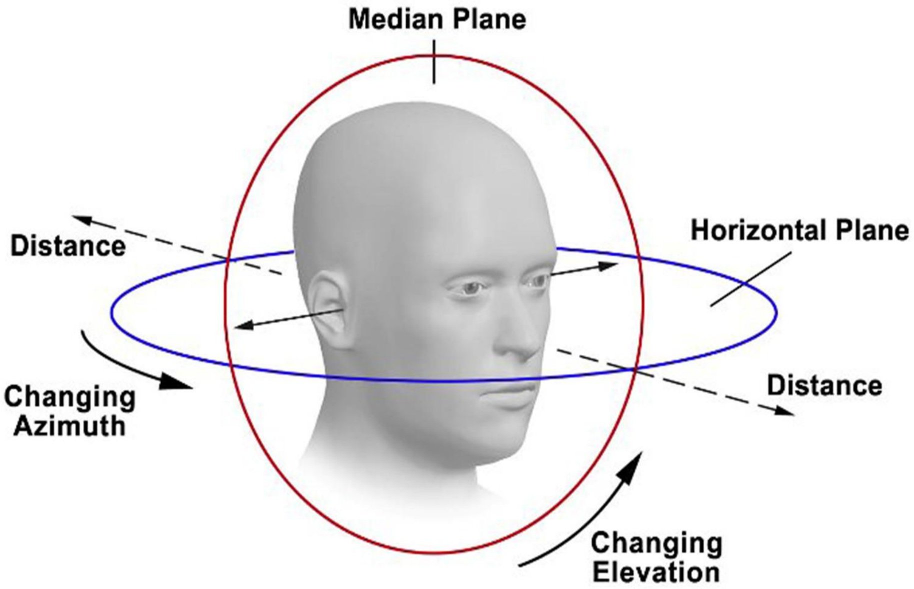
3D Audio

Rosa Saldana

Understanding Azimuth and Elevation

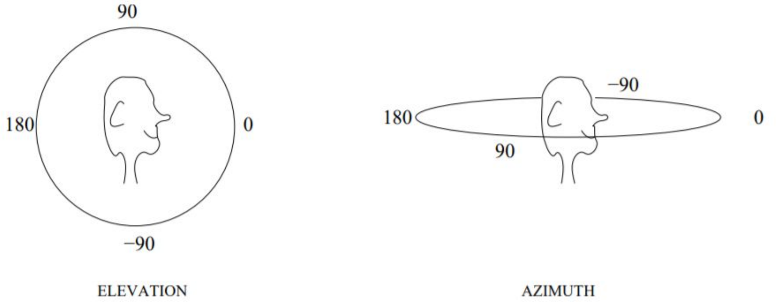


Azimuth

An azimuth is an angular measurement in a spherical coordinate system

Elevation

The elevation angle is the angle between the horizontal plane and the line of sight.



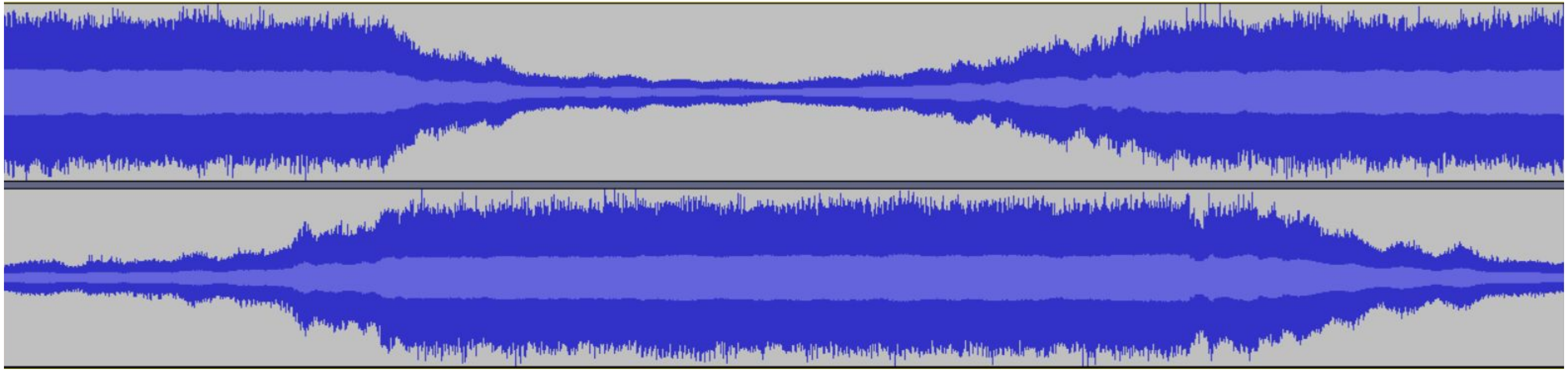
Interaural Time Difference (ITD)

Definition : the difference in arrival time of a sound between two ears.

Importance : It is important in the localization of sounds, as it provides a cue to the direction or angle of the sound source from the head.

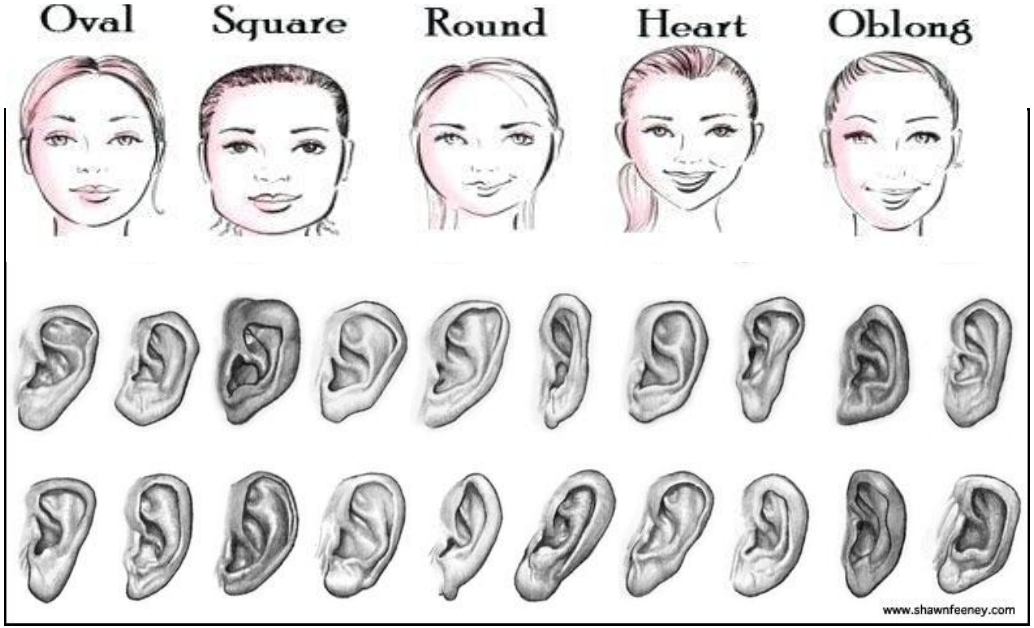
L -›

R-›



Head Related Impulse Responses (HRIR)

A person’s body (pinna, head, shoulders) transforms an incoming sound and it does so in a direction-dependent way.



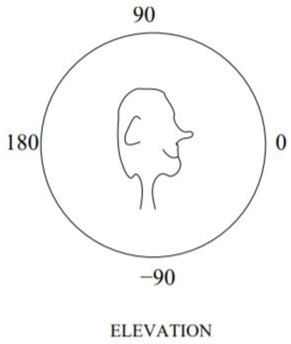
For any direction relative to the head, consider an impulse function which leaves from a position from a distance away at time t0.

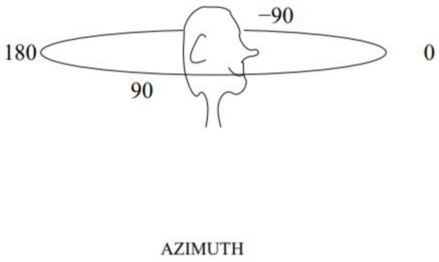
The head, ear, shoulders deform this wave of sound. This deformation is a combination of shadowing and reflections.

Head Related Impulse Responses

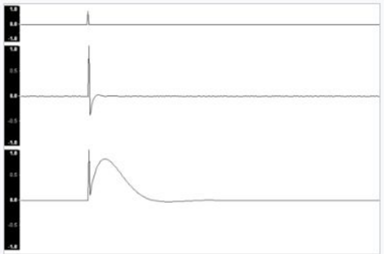
When there is an impulse from direction (ϴ, φ), the sound pressure wave that is measured inside the head is a function h(t; ϴ, φ).

Think of the head as a filter, which transforms an incoming sound wave.





Impulse Response



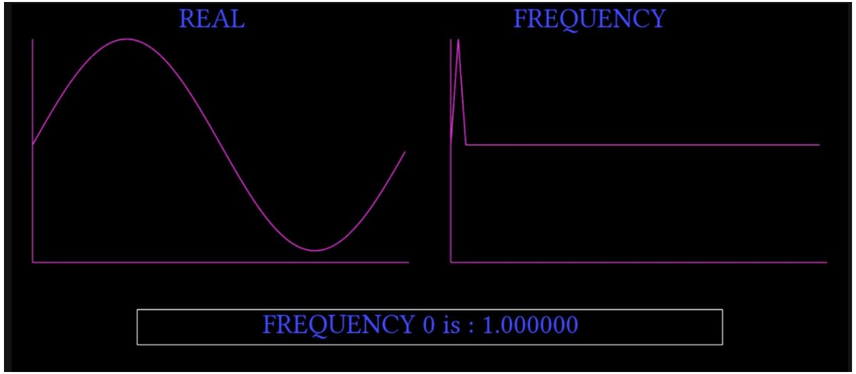
The Impulse response from a simple audio system. Showing, from top to bottom, the original impulse, the response after high frequency boosting, and the response after low frequency boosting.

The **impulse response**, of a dynamic system is its output when presented with a brief input signal, called an impulse.

Head Related Transfer Function (HRTF)

Taking the Fourier transform and applying the convolution theorem gives us the head related transfer function.

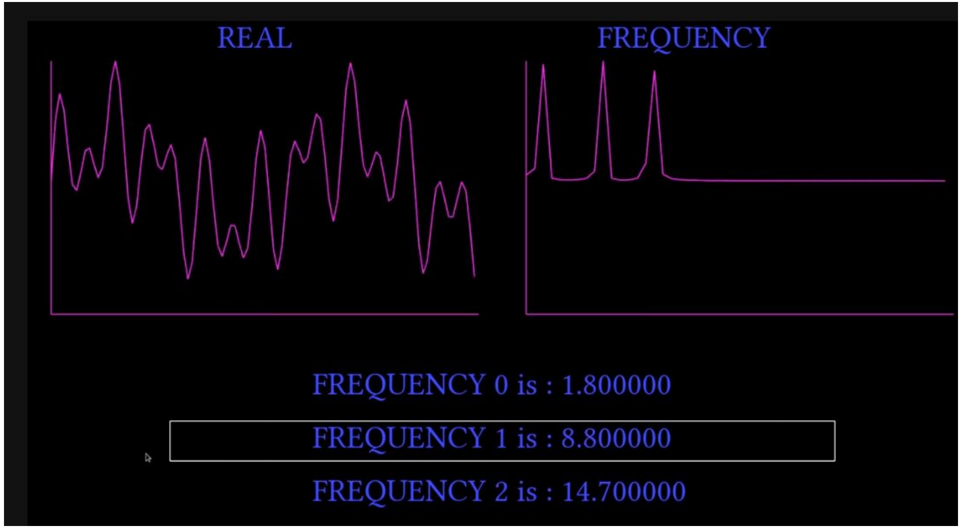
Fourier Transform:



The **Fourier transform** (**FT**) decomposes a function of time (a *signal*) into the frequencies that make it up, in a way similar to how a musical chord can be expressed as the frequencies (or pitches) of its constituent notes.

Convolution: is a mathematical operation on two functions (*f* and *g*) to produce a third function that expresses how the shape of one is modified by the other. http://iub.edu/~emusic/etext/synthesis/chapter4_convolution.shtml

Fourier Transform



We can now see three distinct peaks for each individual wave in real space.

The Fourier Transform allows us to flip back and forth between real and frequency space.

Head Related Transfer Functions

Why Important?

Decomposes the incoming sound which is arriving from just one direction into its frequency components and looking at how each component is affected by the head.

Project Applications

UCDAVIS ELECTRICAL AND COMPUTER ENGINEERING

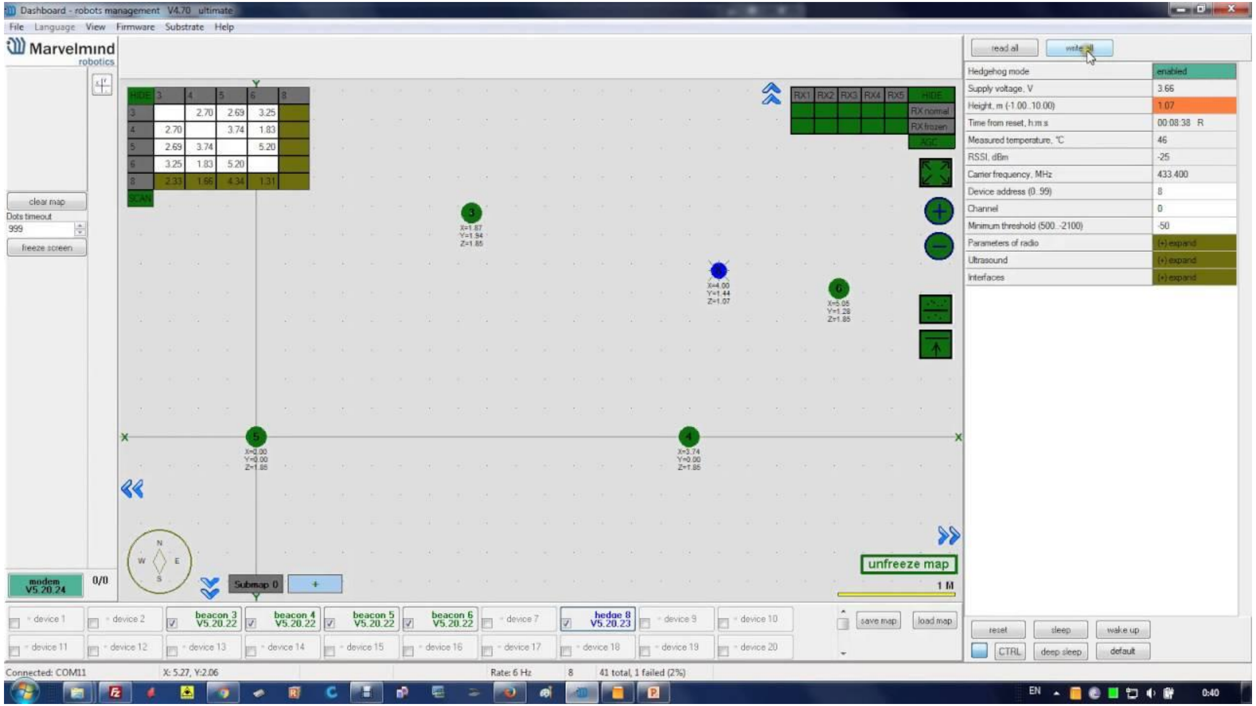
SoundPad Lab used UCDavis' CIPIC HRTF Database which is a high-spatial-resolution HRTF measurements for 45 different subjects. Their database includes 2,500 measurements of head-related impulse response for each subject. These measurements were recorded at 25 different azimuths (-80 through 80) and 50 different elevations. (0-180)

SoundPab Lab

For the 3D Audio for Museum Exhibits project, we are utilizing 3D audio to help precisely guide guests through museum exhibits in Library East.

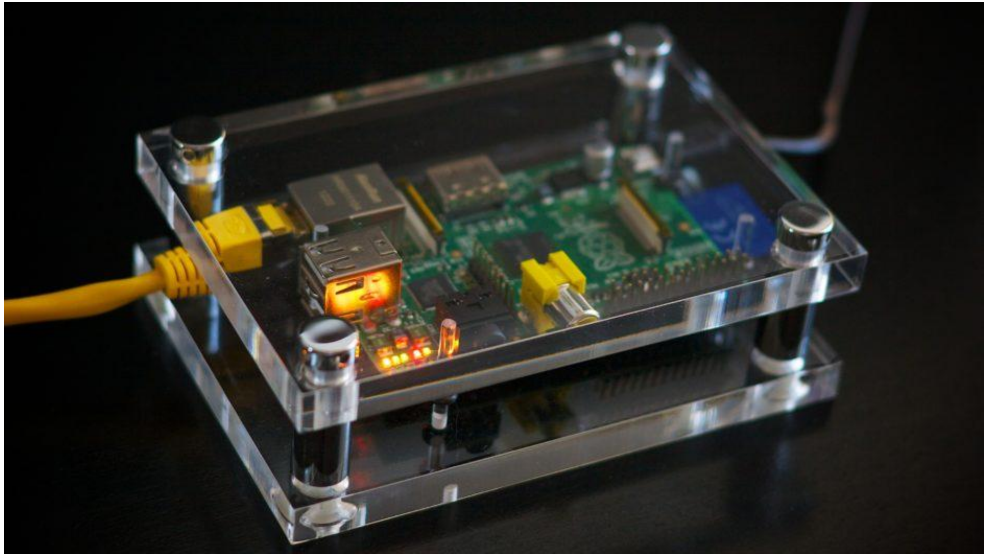
To help guide people, beacons will be placed in front of every museum exhibit of Library East. Individuals will then walk through the simulated museum, while listening to the 3D audio streamed over the Bluetooth headphones. After pursuing the museum exhibits, an individual’s quantitative feedback is recorded and analyzed.

Tracking User Positions



A beacon is an "indoor" GPS that tracks the user's movements.

Raspberry Pi



Goal:

Render the 3D audio on the raspberry Pi

Challenges:

Optimizing code so that the audio does not lag.

UC Davis' CIPIC Database

Azimuths: -80, -65, -55, -45, 40, -35, 30, -25, -20, -15, -10, -5, 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 55, 65, 80

Group Accomplishments

1. Retrieved and stabilized coordinates
2. GUI
3. 3D Audio almost finished

Future Tasks

1. Cross Fading
2. Rendering 3D Audio on Raspberry Pi
3. Integrating the 3D Audio with GUI
4. Integrating the Coordinates with the GUI