UNIVERSITY OF MIAMI
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Engineering Acoustics, EEN502/MMI361

Project No. 2

Framework
Human listeners can locate acoustic signal sources in 3-D open space. This is achieved in the way the brain processes the interaural time or phase differences (ITD/IPD), interaural intensity differences (IID) and the location of spectral zeros which depend on the angle the plane waves impinges upon the irregular surface external ear (pinna). All such effects may be captured by careful laboratory measurements of the Head-Related Transfer Functions (hrtf). The hrtf are usually provided as location-depended (azimuth-θ & elevation-φ angles) impulse responses, h(t, θ, φ). Typical hrtf data have been placed in the public domain by the MIT media Lab at http://sound.media.mit.edu/resources/KEMAR.html

Use the Matlab scripts available at that site to read the appropriate data. The hrtf data are in the zip file, organized in files with names of the format "HEEeAAAa.dat", where EE is the elevation angle of the source in degrees (0 for the azimuth plane), and AAA is the azimuth angle of the source in degrees (in this case 0 to 180 in steps of 5 degrees.) Zero azimuth angle is the direction looking straight ahead, and positive angles are in the right hemisphere. Each file contains a stereo pair of 128 point impulse responses corresponding to the left and right ear responses for the given source position. For instance, the file ``H0e090a.dat'' contains the left and right ear impulse responses for a source directly to the right of the listener. (The effects of the interaural distance are included in the hrtf measurements.) The data is stored as 16-bit integers and the stereo samples are stored in (left, right) interleaved order. The sampling rate is 44.1 kHz. The program 'testhrtf2' is an example of how the data can be read and used.

Project Requirements

1. A sound source emits a broadband signal and moves a circular orbit with the head in the center of the circle. The source moves on the azimuth plane (the elevation angle is zero), with constant speed. Assume that Doppler effects are negligible.
   a. A single source moving clockwise at constant speed makes a full rotation in 2 sec. Synthesize 4 sec of the signal received by each ear using the overlap-add convolution method.
   b. A second source moves anti-clockwise at constant speed making a full rotation in 1 sec. Synthesize 2 sec of the received binaural signal.
   c. Synthesize 4 sec of the received binaural signal when both sources described in (a) and (b) are in operation.

2. For Audio and Graduate students only:

   A source moves at a straight-line at steady speed in front of the observer (as in Project 1). Include Doppler, HRTF and distance fading effects to synthesize the binaurally received sound. Use (i) a multi- tone signal, and (ii) broadband noise.

Submit a web presentation and report including your methodology, code and observations, and audio samples of your results.

Date due: **10/26/2009**

Bonus Part (20%):

In question 1 let the source move on the azimuth plane on a circle of 1 meter radius making one clockwise revolution every 8 sec. Produce a 3-dimensional plot of the air particle displacement pattern produced by the source as the source moves around the circle. Let this plot cover a 4x4 meters rectangle.

You may consider using Matlab functions such as: `meshgrid`, `surf` and `view.`

Examples of such patterns for displacements resulting from loudspeaker arrays have been posted on BB.