

Binaural rendering using HRTF

Introduction

When we are listening to music using headphones, the source is panned in 180 degrees. Using Head Related Transfer Functions(HRTF) this mini-project construct a program to listen to music in 360 degree. The input of the program will be samples of music and the user will be able to place the source in function of the distance and direction of the listener. The program will then simulate the overall music by into taking in account where they come from. The result of the project is a web -application that is written in JavaScript.

Description of the Problem

From the input sound, which is a music, we will render two output audio signal, one for each ear. The output will simulate a sound in a free-field space. The source is determined by the direction and the distance from the listener so that the simulation will lead to a localisation of the source.

The challenge that is posed by this problem is multiples: First, Localization of the sound is done by the ears and the head movements. The latter one is used to resolve the cone of confusion. Thus, using the head-phones, we won't be unable to use the head movements. Second, with the various shape of the ears that the human has, the impulse response that represent them are numerous and this leads to a resolution of the problem that is experimental. It means that the solution might not work for some and for other it can work perfectly.

Resolution Technics

HRTF's are the Fourier transform of the impulse responses of dummy-head measure in anechoic rooms. Several Database are present freely in the web which allow us to produce the simulation digitally. For this project, The CIPIC Database was used. With measures of 50 subjects in 12500 different angles, it offers a broad range of datapoint.

As the number of impulse responses is finite, the panning in 360 degrees is done using the lineally weighted interpolation technics. The idea is that for any angle, we select the two closest angles for which there is an impulse response present in the database. Then, we compute the distance between the angle and the selected one. Using the computed values, we compute the impulse response that is a distance-weighted combination of the selected angle impulse response. The validity of the interpolation technic lies on the linearity of the convolution operation.

Implementation

As a preliminary work, Matlab code was written to test the CIPIC database. Then, the final project is a web application written in JavaScript, therefore, data processing tools were applied to the database in order to convert the mat format file into JavaScript readable ones.

The choice of doing the project in JavaScript as a web-application is justified by the existence of the Web Audio API. This JavaScript library simplify digital signal processing task and has an intuitive implementation properties.