The Distance Cues:

Simulation of the Distance in a Binaural Spatialization Algorithm

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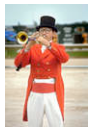
The three Distance Cues and their Simulation
A technique is presented for the binaural simulation of distance

	DISTANCE CUE	SIMULATION OF THE DISTANCE CUE
1	Air Absorption: the attenuation of the air can be approximated as linear in frequency response until about 15 meters of distance, then it has to be considered as a non-linear gain reduction.	Up to 15 meters it can be simulated using a simple gain reduction line that follows the *inverse square law*; above 15 meters, a filtering line that attenuates the high frequencies more than the low ones needs to be implemented.
2	Differences in the HRTF spectrum: mainly related to the *cone of confusion* effect and to the fact that for proximate sound sources the wave-front cannot be approximated as a plane.	5 different HRTFs have been extracted at different distances: 1, 3, 5, 7 and 9 metres. The cue is simulated performing cross-fades between the signal convolved with the HRTFs at different distances.
3	Direct to reflected signal ratio: this cue is not relevant for the simulation of a free-field or anechoic space.	This cue has been simulated splitting the direct, first reflections and reverberant binaural impulse parts, and mixing the differently spatialized signals with different weightings.


LISTENER	1 METER	5 METERS	15 METERS	30 METERS
Air Absorption	No gain reduction No filtering line	Gain reduction of -3dB No filtering line	Gain reduction of -8dB 12dB/Oct filter at 14 kHz	Gain reduction of -15dB 18dB/Oct filter at 6 kHz
HRTF Spectrum	Crossfades between HRTFs extracted at 1, 3, 5, 7 and 9 meters			
Direct/First Reflections/Reverb	80% Anechoic 20% First Reflections	40% Anechoic 40% First Reflections 20% Reverb	30% Anechoic 30% First Reflections 40% Reverb	10% Anechoic 10% First Reflections 80% Reverb

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1st SpACE-Net Workshop
University of York
25th January 2007