EE210: Signals and Systems

Practical Assignment 1

Virtual Reality with Convolution

Audio processing for Virtual Reality

- To be able to create an “immersive” experience for the remote listener.

I.e. perceiving a source in its specific location in a specific environment. We need cues to (i) source location (ii) cues to the surrounding environment.

- There are two different methods of surround sound simulation. The first one uses numerous loudspeakers placed around a room. The second one uses stereophonic headphones.

Cues to sound source location

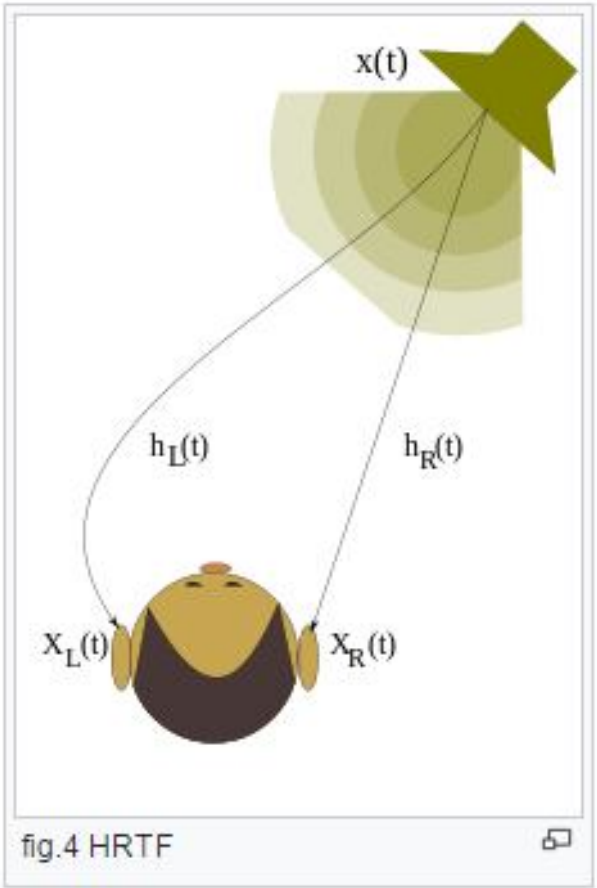
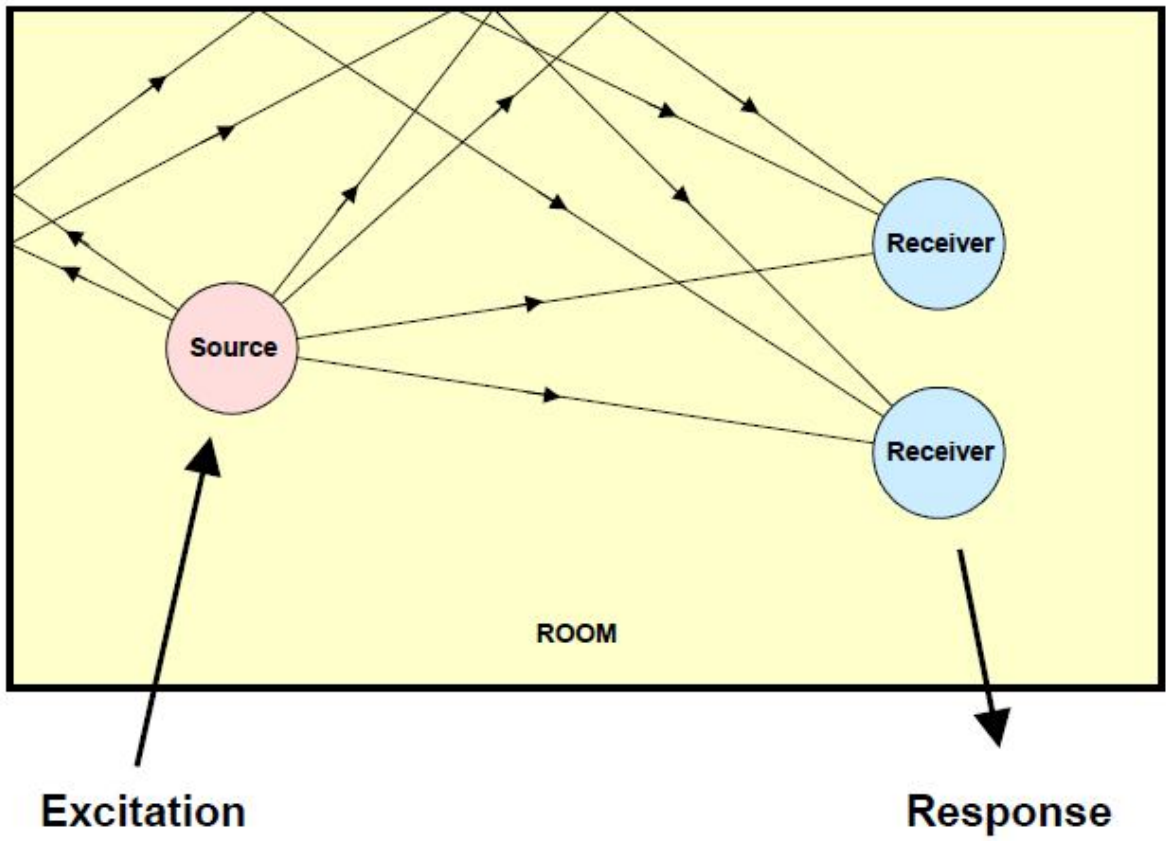


fig.4 HRTF

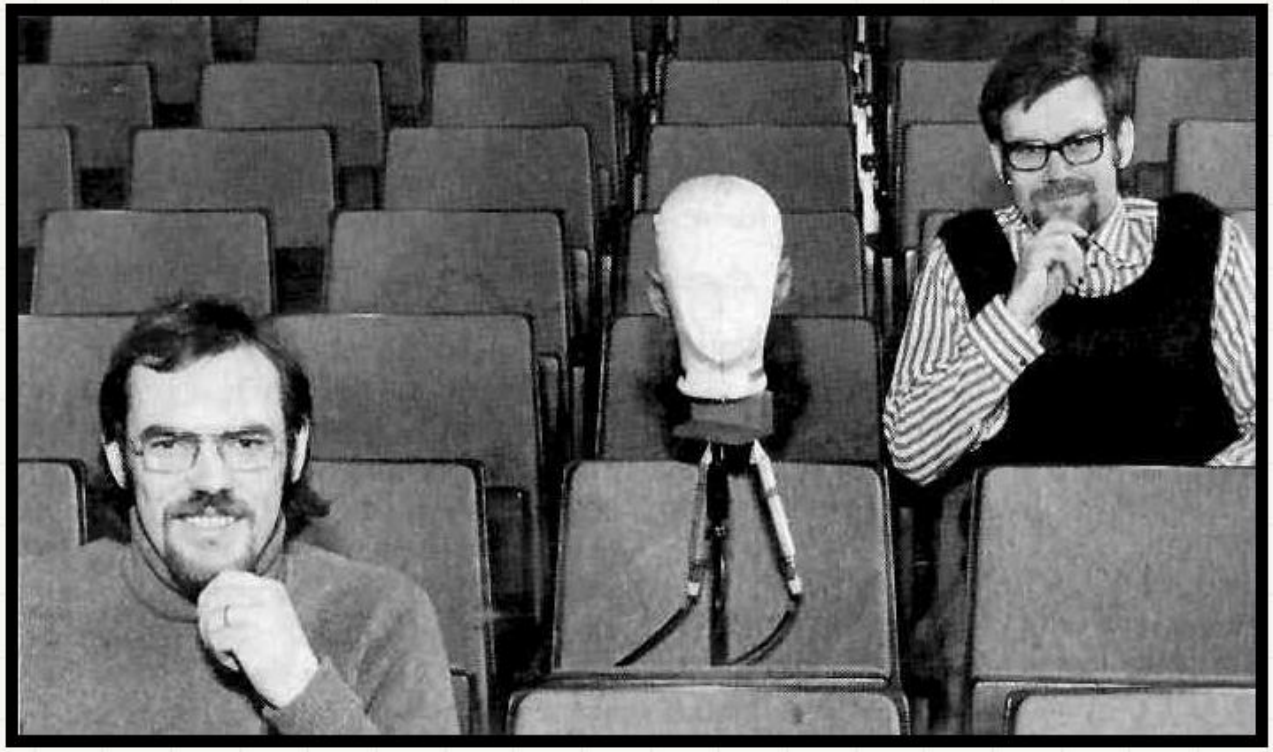
https://commons.wikimedia.org/w/index.php?curid=3848567

Cues to the source-listener environment



So how do we create the “immersive experience” for a remote listener?

The Sound of Music

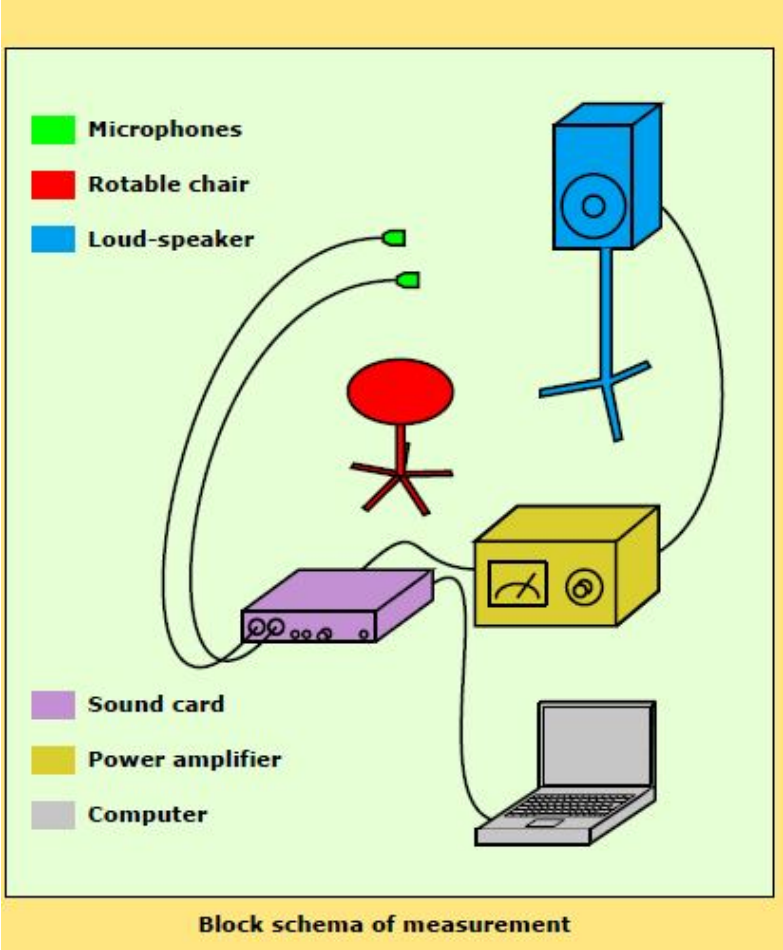


Manfred Schroeder's collaborators K F Siebrasse (left) and D Gottlob (right) and the dummy head through which they recorded the sounds of 20 European concert halls.

How about modeling?

- Our physical system takes the source-emitted sound signal as input and outputs the left- and right-ear received signals.
- Modeling the physical system would allow us to recreate the experience for a remote listener with *any* source signal.
- Physical modeling needs details of room dimensions and physical characteristics of walls, etc.
- An attractive option for the (assumed LTI) system is…

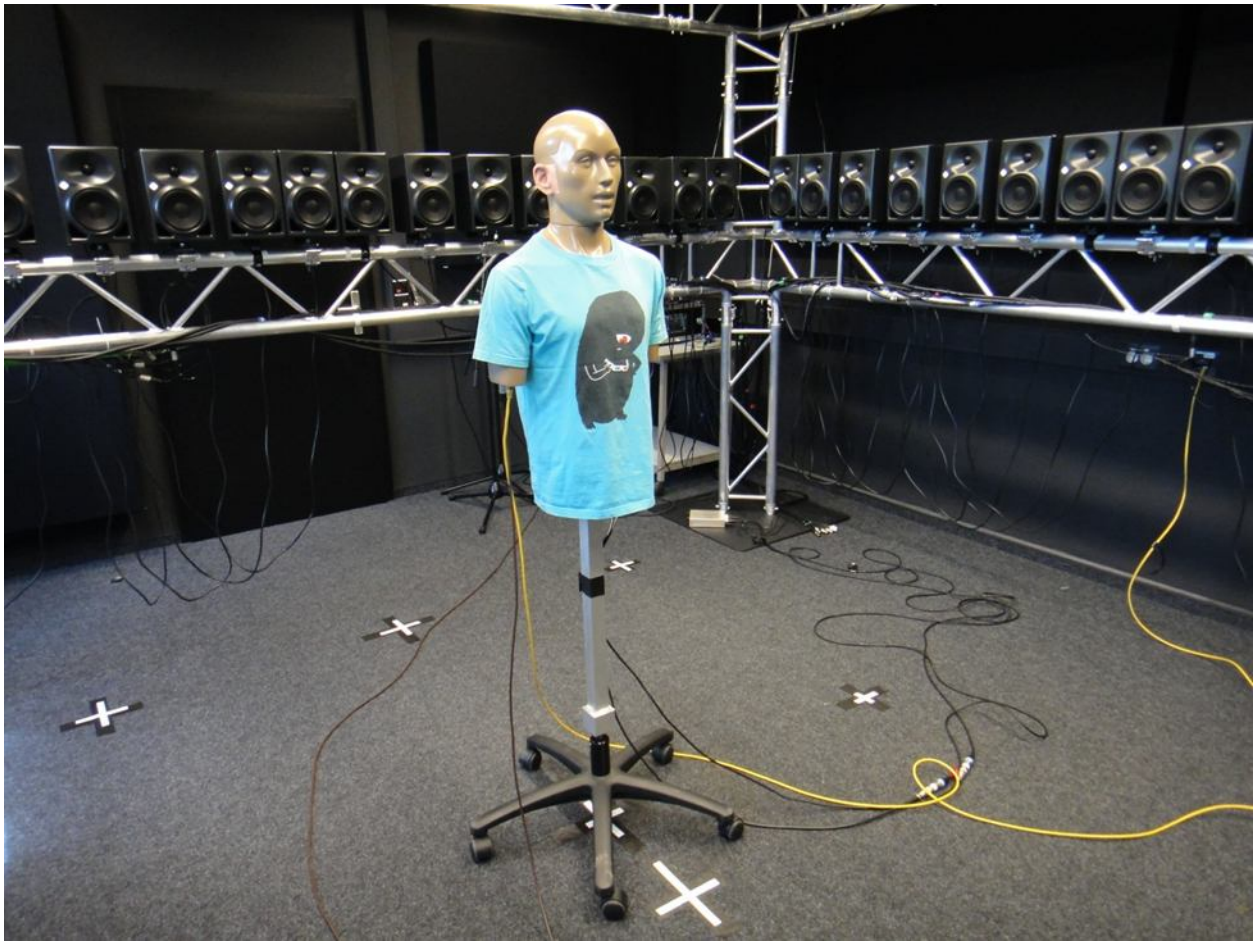
Impulse response measurement



Block schema of measurement

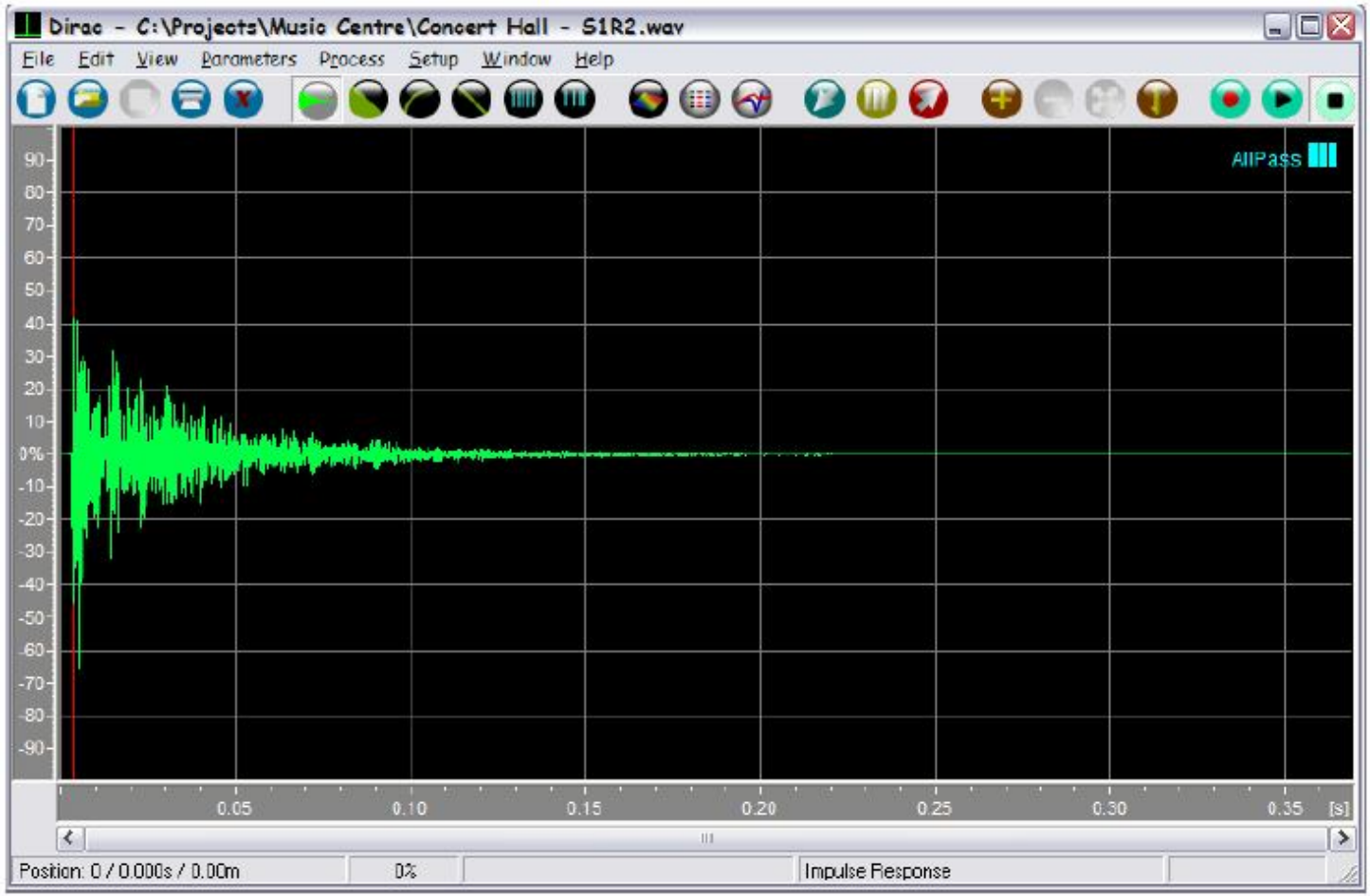
Bernhauer and Hardrava, 17th Conference of Slovak and Czech Physicists, Žilina, Slovakia, 2011

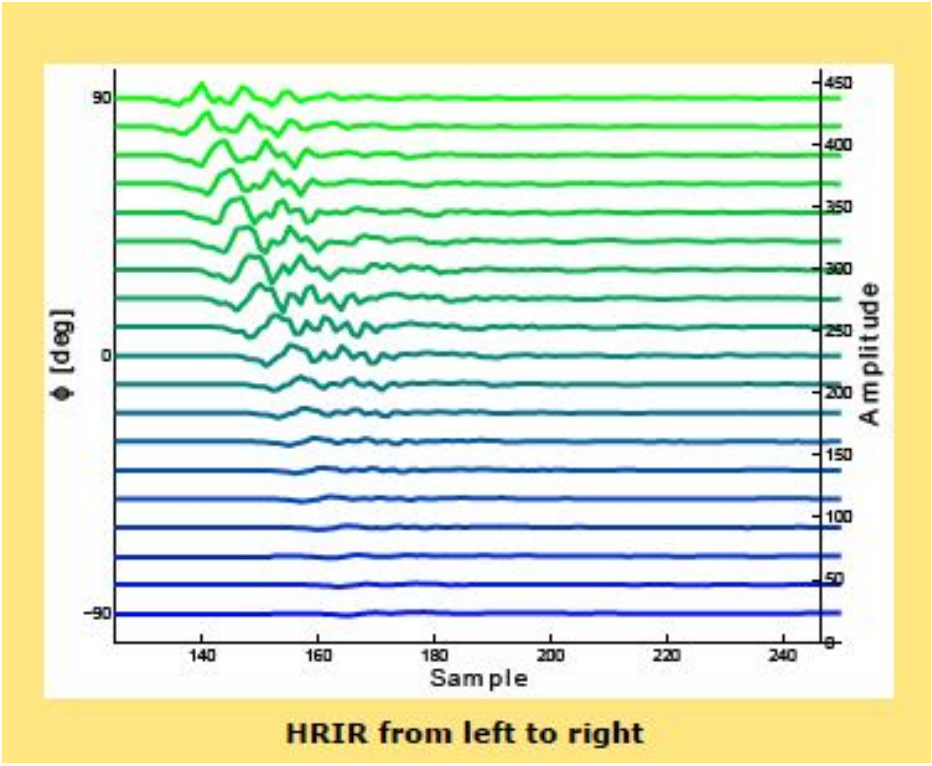
Impulse response measurement



http://spatialaudio.net/free-database-of-single-channel-and-binaural-room-impulse-responses-of-a-64-channel-loudspeaker-array-for-different-room-con%EF%AC%81gurations/

Source to left-ear response in a hall





HRIR from left to right

Binaural room impulse response (BRIR) databases

http://www.voxengo.com/impulses/

http://recherche.ircam.fr/equipes/salles/listen/index.html

http://www.iks.rwth-aachen.de/en/research/tools-downloads/aachen-impulse-response-database/

Computing assignment

- Provided are: an audio signal (part of a solo song), 3 different BRIR (2-channel impulse responses) from different “rooms” and fixed source-listener configuration.

- Use convolution to obtain binaural signals that you can listen to over headphones.
- Code fragments provided for Scilab.