COM-415

Audio signal processing and virtual acoustics

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Cursus	Sem.	Type
Computer science	MA1, MA3	Opt.
Digital Humanities	MA1	Opt.
SC master EPFL	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The objective of the course is to introduce theory, methods, and basic psychoacoustics that is needed to understand state-of-the-art techniques used in pro audio and consumer audio, including microphones, surround sound, auralization, virtual acoustics, mixing, and audio coding.

Content

Acoustics and audio is covered and the manipulation and processing of audio signals. It is shown how Fourier analysis of the soundfield yields to the representation of a soundfield with plane waves. These and other acoustic insights are used to explain microphone techniques and reproduction of the soundfield.
Spatial hearing is covered in detail and used to motivate stereo and surround mixing and audio playback. In addition, insights on the principles of auralization and virtual acoustics are given, and the simulation of sound propagation in rooms will be further discussed.
The short-time Fourier transform is introduced as a tool for flexible manipulation of audio signals, suchs as filtering, delaying and other spectral modification. Matrix surround, audio coding, and beamforming are also treated.

Keywords

acoustics, virtual acoustics, microphones, surround sound, matrix surround, audio coding, audio processing, 3d sound reproduction, spatialization, psychoacoustics, human hearing, binaural hearing, dummy head recordings, wave propagation, simulation techniques, geometrical acoustics, auralization, sonification, audio, signal processing

Learning Prerequisites

Recommended courses

Fourier transform, signal processing basics (sampling, filtering, discrete Fourier transform).

Learning Outcomes

By the end of the course, the student must be able to:

- Apply Basics of Acoustics, Signal Processing, Reproduction, Simulation Techniques
- Implement Basics of Audio Signal Processing, Filtering, Multi-Channel Loudspeaker Setups
- Operate Room acoustics simulation programs

Teaching methods

Class + exercise sessions

Assessment methods

Midterm exam + Final exam

Resources

Bibliography

* C. Faller, "Signal Processing for Audio and Acoustics" complete lecture notes in book form.
* J. Blauert, "Spatial Hearing : The Psychophysics of Human Sound Localization", MIT Press, 2001.
* F. Rumsey, "Spatial Audio", Focal Press, 2001.
* M. Vorländer, "Auralization - Fundamentals of Acoustics, Modelling, Simulation, Algorithms and Acoustic Virtual Reality", 2010

Ressources en bibliothèque

- Signal Processing for Audio and Acoustics / Faller
- Spatial Hearing / Blauert
- Auralization / Vorländer
- Spatial Audio / Rumsey