2IN5060 – Audio Signal Processing

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Department: DÉPARTEMENT SIGNAL, INFORMATION, COMMUNICATION
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description
Audio signal processing has numerous applications : source separation, source localization, acoustic imaging, study of reverberation room, compression...
Besides, experiments with audio signal have the advantages of being quite simple : the audio sources can easily be controlled (for instance using PC and loudspeakers) and the data are usually acquired using microphones.

Prerequisites (in terms of CS courses)
Signal Processing, Statistics and Learning

Syllabus
Three workshops will be addressed during this course.

Room acoustics, reverberation
The sound perceived in a room is significantly different from the sound emitted because of reverberations on the objects and walls of the room. The reverberation effect can be modeled as the convolution of the emitted signal with the impulse response of the room.
The objective of this workshop is to perform experimental measurements and implement the processing to identify the impulse response of different rooms in order to characterize the acoustic environment (e.g. estimation of the reverberation time) and to synthesize realistic signals as they would be heard in the room.

Source separation
Mixing an audio recording consists of mixing different audio tracks to produce one mono track, two stereo tracks, or more (5.1, etc.). Conversely, source separation aims to find these sources, without knowing the gains used to generate the audio tracks, and with more sources than tracks. This type of technique can be used to unmix a music recording or separate speakers in a room.

Detection of noisy points (acoustic imaging)

Acoustic imaging consists of mapping the sound scene in order to obtain an image where each pixel corresponds to the sound intensity emitted by the acoustic sources. With acoustic imaging, we can accurately detect the position of noisy points on an object or in any acoustic scene.

This type of method requires a microphone array of significant size in order to have a sufficient resolution. A network of 32 microphones will be available for measurements.

Class components (lecture, labs, etc.)

Most of the time will be dedicated to practical work.

The theoretical contributions necessary to the understanding of the physical phenomena and treatments will be carried out in the form of short oral interventions of the teachers.

Grading

The work done will be evaluated during a defense in a group of three students.

Resources

The acquisition systems will be made available to the students, and software lib in python will also be provided for the most standard processing.

Learning outcomes covered on the course

For each of the workshops, students will design a measurement protocol, to carry it out and to process the signals. The goal is to develop a methodology to validate the experimental results and evaluate the performance of the proposed processing.

Description of the skills acquired at the end of the course

C1. Analyze, design, and build complex systems with scientific, technological, human, and economic components

C2. Acquire and develop broad skills in a scientific or academic field and applied professional areas

C6. Advance and innovate in the digital world