MAT 240D Digital Audio Programming
Spatial Audio

Fall 2015, MF 2-4pm
Elings 2003
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Office Hours TBA
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Hearing is inherently spatial in nature, and spatial properties of sound can convey meaning and sensations in ways that no other senses can. Sounds that are close and coming from the back can elicit fear and sounds from all directions can be perceived simultaneously, without the need to turn the head. Producing spatial cues and exploiting the properties of multichannel systems presents interesting technical challenges, and can provide new avenues for artistic and practical exploration. Many techniques to work with spatial audio have been developed for different applications and this course will present a practical introduction to them through their application in software. Emphasis will be placed on using these tools for artistic endeavours.

Pre-requisites

Students are expected to have attended MAT 240A, MAT240B and/or 240C or should have some familiarity of C, C++ and of digital audio. Although practical aspects related to building and developing applications are not covered in this course, extensive programming experience is not required, and guidance in these areas will be available through the TA.

Topics

- Psychoacoustics, localization and spatial audio
- Amplitude and Delay Panning
- Doppler shift
- Sound in rooms, Impulse response, convolution and multichannel reverb
- Vector based amplitude panning
- Interactive and non-interactive spatialization
- Binaural sound and 3D sound simulation
- Standards for multi-channel sound projection
- Object based panning
- Ambisonics
- Pseudo-stereo and decorrelation techniques
- Wavefield synthesis
- Multi-channel DSP and synthesis

Software

The software used throughout this course will be the C and C++ languages. The AlloSystem sound facilities will be used.

You are encouraged to install the software discussed in this course on your own machine, as all of it is cross-platform and free/libre software.

Tentative Schedule

Week 1

Psychoacoustics, localization and spatial audio

Amplitude and delay panning

Week 2

Doppler effect

Sound in rooms and multichannel reverb

Week 3

Vector based amplitude panning

Week 4

Binaural sound, Impulse response, convolution

Week 5

Interactive vs. non-interactive spatialization

Multichannel sound in the Allosphere

Week 6

Standards for multi-channel sound projection

Object based panning

Ambisonics I

Week 7*

Ambisonics II

Week 8

Pseudo-stereo and decorrelation techniques

Wavefield synthesis I

Week 9*

Wavefield synthesis II

Week 10

Final projects

Final project

Students will prepare a final project where they explore some technique studied in the course, or some other related technique to produce a practical or artistic application.

Grading

40% Homeworks

40% Final project

20% Readings/attendance/participation

Every week, randomly selected students will be asked to answer a few questions about the readings. These will make part of the 20% readings grade.

References and Resources

Roads, Curtis. *The computer music tutorial*. The MIT press, 1996.

Boulanger, Richard, and Victor Lazzarini. *The audio programming book*. The MIT Press, 2010.

Zoelzer, Udo, ed. DAFX: Digital Audio Effects. Chapter 5: Spatial Effects. John Wiley and Sons, 2011. Available online from the UCSB Library.