

MAT 240B Digital Audio Programming

Sound Synthesis and Processing Techniques

F 10-2pm, 4 Units

Elings 2003

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TA: Joseph Tilbian

Lab/TA Office Hours TBA

This course surveys established techniques for audio synthesis and digital signal processing applied to sound. Additive, Subtractive, FM and Granular synthesis will be explored and implemented. Additionally, processing techniques like filtering will be covered. It is a practical course focused on software implementations of the various techniques, and will be permeated by discussions about performance and sound quality.

Theoretical aspects related to the various techniques are discussed, and particular emphasis will be placed on their implementation in computer algorithms. Artistic and practical use of the techniques will also be discussed and tested with the implementations. Different existing implementations will be compared and studied, in particular those found in widespread systems like Csound, Supercollider, Gamma and CSL.

Pre-requisites

Students are expected to have attended MAT 240A, or should have some basic familiarity of C and C++ and of digital audio. This course, however, will cover practical aspects related to building and developing applications, so extensive programming experience is not required.

Topics

- Additive synthesis and oscillators
- Envelopes
- Frequency, Phase and Amplitude modulation
- Waveshaping
- Subtractive synthesis
- Granular synthesis
- Physical modeling

Software

The software used throughout this course will be the C and C++ languages. Examples will be demonstrated using the QtCreator frontend and the Cmake build system for cross-platform compilation.

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

Introduction to required tools and concepts.
Oscillator algorithms and Additive synthesis.

Week 2

Envelopes and their use in practice. Implementation of envelopes.

Week 3*

Designing synthesis algorithms for musical applications.
Triggering and rendering graphs.

Week 4

Amplitude, Frequency and Phase Modulation.

Week 5

Waveshaping.
Wavetables and sampling. Resampling and time shifting. Interpolation.

Week 6

Subtractive synthesis. Band-limited oscillators and resonant filters.

Week 7*

Granular synthesis. Basic techniques.

Week 8

Granular synthesis. More versatile and complex techniques.

Week 9

Physical modeling. Waveguides and stochastic models.

Week 10

Physical modeling and final presentations.

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

50% Final project

10% Attendance and participation

References and Resources

Boulanger and Lazzarini, eds. The Audio Programming Book. MIT Press. 2011.

Roads. The Computer Music Tutorial. MIT Press. 1996.

Dodge and Jerse. Computer Music: Synthesis, Composition, and Performance, 2nd Edition. Schirmer. 1997.

Teaching Unit Generators: <https://sourceforge.net/projects/tugs/?source=directory>