Advanced Topics in Computer Music (MARE 502)

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Outline

1. Recapitulation
2. Csound at the Command Line
3. Spatialisation with Csound
4. Conclusion
Recapitulation: Physical Modelling

Question

Which physical modelling approaches do you know?
Csound at the Command Line
UNIX Command Line

- Textual interface to operating system
- **Advantages**: programmable interface (e.g., for automatic complex or repetitive tasks)
- **Disadvantage**: harder to learn and use than graphical interface
- Recent MS Windows equivalent: PowerShell
Environment Variables I

- OS-wide settings
- Important example: PATH variable contains list of directories with executables
  - Try executing shell command `echo $PATH`
- Environment variables commonly set in shell initialisation file (e.g., ~/.profile)
Environment Variables II

Important Csound environment variables with example settings

Directory for resulting sound files

```bash
export SFDIR=~/csound/Output/
```

Directory for input sound files

```bash
export SSDIR=~/csound/Samples/
```

Directory for analysis files

```bash
export SADIR=~/csound/Analysis/
```
Csound on Command Line I

General syntax

Traditional format with orchestra and score files

csound [-flags] file.orc file.sco

Unified file format

csound [-flags] file.csd

Example (Outputting named AIFF file (non-realtime))

csound -A -o Chowning-Stria Chowning-Stria.csd
Csound on Command Line II

Documentation

- Start of doc section on Csound command

- Csound command line flags
Using the Graphical Interface of QuteCsound

- Setting environment variables
- Rendering files in realtime and non-realtime
• Spatialisation with Csound
Amplitude Panning Exercise

Exercise

Program a stereo instrument that plays a mono soundfile. Implement stereo panning by modulating the amplitude (linear amplitude panning).
Amplitude Panning I

Problem of linear panning

Hole in the middle!
Amplitude Panning II

Constant power panning

Instead of straight line use square root (constant power panning).

AmplitudePanning.csd

\[ \frac{\sqrt{x}}{\sqrt{1 - x}} \]
\[ \sin \left( \frac{x}{2} \right) \]
\[ \cos \left( \frac{x - \pi}{2} \right) \]

\[ x \]
\[ 1 - x \]

\[ x \]

\[ 0 \]
\[ 0.2 \]
\[ 0.4 \]
\[ 0.5 \]
\[ 0.6 \]
\[ 0.8 \]
\[ 1 \]

\[ 0 \]
\[ 0.2 \]
\[ 0.4 \]
\[ 0.6 \]
\[ 0.8 \]

\[ a \]

Source: http://csounds.com/ezine/autumn1999/beginners/
Amplitude Panning III

Generalisation to circular panning

Provides control for left-right and front-back dimensions

CircularPan.csd
Using Delays I

Exercise

Program a stereo instrument that plays a mono soundfile. Play the soundfile on one channel with a little delay compared to the other channel.
Use different delay times (0 msec to 100 msec): what is the perceptual effect of these different delay times?
Different delay times: different perception

- Direction (Precedence Effect)
- Spaciousness
- Echo
Processing a Stereo Signal I

**Rotation of a stereo signal**

Translates stereo signal to MS stereo, rotates that and translates back
RotateStereo.csd

**Distance ”Fade”**

Simultaneously applies multiple processings to emulate moving a stereo scene away into distance
- Lowpass filter
- Highpass filter
- Reverb
DistanceEmulator.csd
Binaural Panning

- Panning for headphones
- Dummy head recordings used for obtaining head-related transfer functions (HRTF)
  - Processes amplitude, delay times and spectrum

Example (Binaural panning)

BinauralPanning.csd
Multi-Channel Approaches

- Multi-channel spatialisation is key to turning presentation of sound from loudspeakers into something special.

**Vector base amplitude panning (VBAP)**

Generalisation of amplitude panning for arbitrary 2-D or 3-D setups.

**Ambisonics**

Recording and replay technique that encodes arbitrary (2-D) 3-D setups into a (3-channel) 4-channel format called B-format (first-order Ambisonics).

**Modelling techniques that also model room acoustics**
Spatialisation Opcodes in Csound Manual

- Panning and Spatialization:
- Reverberation:
Summary

- Csound at command line
- Spatialisation with Csound
Could you please fill in the questionnaire?