From Sampled to Synthesized: An Exploration of Sound Re-Synthesis

1. Overview: The Gap Between Synthesized and Sampled

Much research has been done in the area of computational sound synthesis over the past few decades. Euterpea, developed by Paul Hudak, the Yale Haskell Group, and the Haskell community, is a sound synthesis environment in the Haskell programming language designed for creation of and operation on a limitless variety of sounds. Within Euterpea, one can analyze and reconstruct waveforms to his liking, but as of this moment, there is no way to begin with an instrument sample and from there, build a wide range of related tones.

Research in this area has been done before. SoundFont technology, a popular software sampler, claims to re-synthesize sounds based on pitch and dynamics and has been around for many years. Because of the improved, realistic output, SoundFont files are often used in place of General MIDI in many music sequencers where GM instruments are lacking.

Half of computer music production relies on samples, while another half relies on strict sound synthesis (additive, subtractive, granular, FM, etc). I personally find this area between the two extremely interesting. Is it possible to build a tool that begins with a mere sample and synthesizes the rest of the instrument?

I would like to introduce this functionality (and more!) to Euterpea. I think that Euterpea would greatly benefit from an extension that allows for the creation of sound banks based on samples, and not only fills in the
gaps, such as SoundFont files may, but also investigates the possibilities beyond pitch and dynamics.

2. Project Goals

The goal of this project is to build an interface for Euterpea which can bridge this gap between synthesized and sampled instruments. The overreaching concept is to create a tool with the ability to build entire sound banks of instruments based on a few, simple samples. Based on the input, the tool should be able to output both realistic and less believable, but perhaps more interesting tones.

First, the tool will allow for the introduction of any instrument sound samples to a buffer in Euterpea. From this point, the program would make adjustments to the sample waveforms (based on user guidance) in order to make new, synthesized sounds which are similar to the original, but differ slightly in pitch, velocity, resonance, specifics of timbre such as frequency spectrum and envelope, and as many other aspects of the sound as time allows. When triggered with MIDI data, these sound banks can be used to produce full quality waveform tracks that should sound quite realistic.

At first, the project will focus on instruments with non-predetermined pitches, such as non-tuned, one-hit, percussion instruments. This will be an easy place to begin research, as pitch should cloud the sound. Once the tool is able to make realistic variations in these sampled percussion instruments, the project will move towards the generic scenario of any random instrument sample and a wide range of outputs.

3. Deliverables

Process Deliverables

- Week 1 (Feb 4th) – Project proposal
- Week 4 (First week in March) – Presentation to Advisor of research + findings
- Week 8 (before break) – Midpoint review of software and progress

**Final Deliverables**
- Presentation of software with video demonstration of a song using re-synthesized instruments
- Executable/source code available for download from Project Site and Haskell.org as Euterpea extension