Cooking with Csound: Wavetable Synthesis Recipes for Woodwind and Brass Instruments

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ABSTRACT: This demonstration will give an overview of our upcoming book, Cooking with Csound: Wavetable Synthesis Recipes for Woodwind and Brass Instruments. We have matched the parameters for 18 woodwind and brass instruments using a genetic algorithm, and built Csound instruments using the parameters. For the demonstration of each of the instruments, we will play Csound scores of well-known orchestral excerpts such as the opening of Stravinsky's The Rite of Spring.

1 Brief Synopsis of the Book

Cooking with Csound contains a collection of ready-to-use software synthesis designs for the woodwinds and brass. The designs are in the Csound software synthesis language. We have included a tutorial on Csound which shows the reader the basics of Csound and how to implement wavetable synthesis. Our prototype Csound wavetable synthesis design implements expressive performance nuances like vibrato, melodic stresses and phrasing.

Using wavetable synthesis to simulate acoustic instruments is an ongoing research problem. We used an effective genetic algorithm procedure for finding the wavetable synthesis parameters to match a particular acoustic instrument tone (Horner et al. 1993). We can combined the matched parameters from different pitch angles of the instrument into a single design.

The main section of the book describes the derived wavetable synthesis parameters for each of the woodwinds and brass instruments. For each design, we describe the general acoustic features of the instrument and the matching parameters, and then give a short musical excerpt from the instrument's repertoire. We then give some effects for customizing the instrument designs.

Instruments and their excerpts include:
1. piccolo (Stravinsky - Rite of Spring)
2. flute (Debussy - Prélude à l'Aprés-midi d'un Faune)
3. oboe (Stravinsky - Rite of Spring)
4. English horn (Dvorak - New World Symphony, second movement)
5. clarinet (Mahler - Symphony #4, last movement)
6. bass clarinet (Stravinsky - Rite of Spring)
7. bassoon (Stravinsky - Rite of Spring)
8. contrabassoon (Dukas - La Sorcière's Apprentice)
9. saxophone (Kenny G - Wedding Song)
10. trumpet cup-muted (Bach - Brandenburg Concerto #2)
11. trumpet harmon-muted (Bach - Brandenburg Concerto #2)
12. horn open (R. Strauss - Till Eulenspiegel's Merry Pranks)
13. horn stopped (R. Strauss - Till Eulenspiegel's Merry Pranks)
14. trombone open (Brahms - Symphony #2, ending)
15. trombone cup-muted (Brahms - Symphony #2, ending)
16. tuba (Berlioz - Symphonie Fantastique)
17. tuba (Opening to Stravinsky's Rite of Spring)

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2 Who should use the book?

The designs are very efficient, providing real-time composers with a collection of source sounds for their DSPs that require only a minimal amount of precious on-board wavetable memory and computation. The books gives synthesizer, sound card and music workstation designers a set of instrument designs that can run on simple and cheap wavetable synthesis hardware. Wavetable synthesis is more powerful than most people currently realize.

For instrument design researchers, the book provides a solid model to build upon. For example, the wavetable model is an excellent base harmonic model for texturing noise models, which gives psychoacoustic researchers a set of complex sources more interesting than static waveforms, and less data- and computation-intensive than additive synthesis. The instrument designs can be used to test the effects of attack and decay times, brightness, envelope shapes, frequency deviations and vibrato.

The book also provides computer music novices with a way to bootstrap their knowledge by learning from the examples. For MIDI users wishing to branch into synthesis, the book is a good way to bridge the gap. It gives a complete set of working designs which you can modify as you gradually become more proficient in Csound and synthesis.

3 Additional Features

We have also designed some effects to use with our instrument designs including echo, chorus, flanging, custom comb filtering, ring modulation and a multi-effect processor. We will play some of the highlights of the sound examples during our demo.

The book also includes a chapter on alternate pitch representation. The demonstration will show how these work, and give examples where each representation is especially useful. Examples include excerpts using just and 1/4-comma mean-tone tunings, and 26-tone-per-octave equal temperament.

Finally, we have composed several short musical examples using the instruments and effects from our book. We will play these examples and show how they use the various effects and other tricks for making the synthetic performance more expressive. Appetite is a one-minute piece in the Indonesian alendro tuning system using multiple effects on the flute; Ginger Gypsy Soup simmers some of the example fragments using the woodwind and brass designs so that their flavors begin to merge in unexpected ways; Brassouffle bakes a brass chorale in a tonality of 19; and Porcini Tortellini uses most of the wind instrument designs in orchestrating cyclic patterns that bubble up from the texture.

4 Conclusion

Current instrument design is an art of trial and error as composers and researchers create new sounds and compositions. Cooking with Csound explains some of the mystery, and gives a collection of designs as a departure point. The synthetic designs allow them to be used without regard for physical and economic limitations of acoustic instruments, such as range breaks and fingerings. You can also combine features of separate instrument designs to create hybrid instruments.

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References