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Article Summary:

"Modeling Piano Tones with Group Synthesis"
by Kathy Lee and Andrew Horner
(Journal of the Audio Engineering Society, March 1999, pgs. 101-11)

This article served as an overview of the physical modeling techniques for recreating piano sounds and also introduced an new method, known as group synthesis, capable of a more accurate reproduction of piano tonalities while requiring less computational power. The piano was chosen as the instrument after which to model this new type of synthesis since traditionally, "the piano is one of the most challenging instruments to synthesize." Contemporary common methods of recreating piano sounds include sampling, additive synthesis, and wavetable synthesis. All of these methods are bound by limitations which can be overcome by group synthesis practices.

The drawbacks of using current synthesis procedures are usually linked to quality of sound and computational power. Usually, the realtionship between these two factors is an inverse one. It is the balance of these two requirements that continuously challenges engineers. Sampling, for example, requires a large amount of memory storage capability; also, sampling does not allow for time scaling and is thus a rather inflexible method of reproducing sound. Additive synthesis, while allowing more flexibility with the time scaling of the sounds, does not allow the user much control over the amplitude and frequency envelopes; as well, additive synthesis requires lots of memory and computation time for the calculation of these envelopes. Finally, wavetable synthesis uses about one order less computational power than additive synthesis but, while a good solution for the quasi-periodic sustain portions of many instruments, has trouble reproducing the attack and decay envelopes convincingly.

A solution to these problems is proposed using group synthesis techniques. The basic idea of group synthesis is that partials can be divided into distinct groups, where each group has a common amplitude and frequency envelope. During resynthesis, these envelopes are scaled to the appropriate magnitude and used to generate partials that approximate the originals. Computationally, group synthesis is about twice as fast as additive synthesis. Also, by using "frequency stretch factors", partial stretching can be simulated.

Listening tests were also conducted to determine the accuracy of the group synthesis method in modeling piano tones. Listeners had a much more difficult time distinguishing between the actual piano recorded sound and the group synthesis examples as compared to the additive synthesis examples. Especially, higher notes were much more difficult to separate from the original sound. Lower tones did not have the clarity of attack that real piano sounds possessed, but the listeners commented that the results were acceptable.

I would like to see this group synthesis method applied to other instruments. For example, bells, plucked string sounds, and mallet percussion are all good cases to discern problems with the model. While these intial results of group synthesis tests may be encouraging, many more types of sound that single piano tones need to be created by an average synthesizer. Before the success of such a method is accepted, therefore, more tests that include the modeling of a wide range of sound sources needs to be undertaken.