10:20

GG6. Comprehensive study of analysis and synthesis of tones by spectral interpolation. Roger Dannenberg, Marie-Helene Serra, and Dean Rubin (Center for Art and Technology, Carnegie Mellon University, Pittsburgh, PA 15213)

A new approach to the real-time generation of digital sounds uses a completely automated analysis/synthesis technique for natural sounds. This approach leads to a more efficient implementation than classical additive synthesis; moreover it allows dynamic spectral variations to be controlled with only a few high-level parameters. Additive synthesis devices require a large number of oscillators (one for each partial). This technique gives excellent results; however, it requires a large amount of computation, and a large amount of control data. On the other hand, fixed-waveform synthesis uses only one oscillator, but the results are of poor musical quality since there is no dynamic evolution of the spectrum. A new technique has been investigated in which spectral variation is achieved through spectral interpolation. The research shows that spectral interpolation provides high-quality synthesis including controlled timbral variation at little more than the cost of a table-lookup oscillator. The task of analyzing different kinds of instrumental sounds to produce control information for this technique has been automated.

10:35

GG7. Nonuniformity in timbre of string instruments. Asbjørn Krokstad (Division of Telecommunications, The Norwegian Institute of Technology, N-7034 Trondheim, Norway)

Mechanical musical instruments, may show great variation of all physical properties that correlate to timbre, even over intervals of a semitone. To examine preferences and limits of acceptability, timbre variations have been studied in a melodic context. A short melody of 13 tones covering a decime was played by two professional musicians on three violins and a viola, and recorded at two microphone positions in an anechoic room. Each tone was processed digitally to reduce differences in loudness and in transients. In the first of two listening tests, dissimilarities in timbre between pairs of successive tones were evaluated. From these differences, integrated differences for different versions of the whole melody are calculated, and differences between versions. The possibility of identifying a certain player, a certain instrument or a certain microphone position may be given as relative numbers. The dissimilarity data are used for the synthesis of new versions of the melody with a range of nonuniformity in timbre. In the second listening test, acceptability of nonuniformity were evaluated. To study the dimensions and physical variabilities of timbre by sustained tones, multidimensional analysis of the subjective differences are performed and several spectral variables for describing the differences are tested.

10:50

GG8. Theoretical relationship between bow pressure and vibration amplitude, derived from a sticking–sliding force-velocity characteristic. Xavier Boutillon and Gabriel Weinreich (Randall Laboratory of Physics, University of Michigan, Ann Arbor, MI 48109)

The Helmholtz motion for bowed strings may be described with the help of a characteristic between the bow's frictional force and the string velocity at the bowing point. Although this characteristic has never been dependably measured, some of its features are implied by players' common experience. In general, the vibration amplitude changes with bow pressure or bow velocity. The relationships between these changes and the local evolution of the characteristic will be established and discussed. The case of perfect stickiness, in which the amplitude becomes independent of bow pressure, follows as a special case. [Work supported in part by NSF and the French Ministry of Culture.]

11:05

GG9. Impedance characteristics above cutoff for clarinet-like structures. William J. Strong (Department of Physics and Astronomy, Brigham Young University, Provo, UT 84602)

The cutoff frequency determined by the open tone holes on a clarinet-like structure is a useful means for characterizing the structure's musical properties. [See, for example, the discussion and data in A. H. Benade, *Fundamentals of Musical Acoustics* (Oxford U.P., London, 1976), Chaps. 21–22; note Sec. 22.5 in particular.] When impedance peaks above the cutoff frequency have amplitudes that are significant fractions of those below cutoff, they may influence the clarinet reed vibration. The input impedance of a clarinet-like structure (a cylindrical tube in the present case) is influenced by its input and output terminations. Three input terminations are considered: (1) rigid cap, (2) rigid taper, and (3) rigid taper with reed. Several output terminations are considered including (1) open end, (2) "infinite" tone hole lattice, (3) "short" tone hole lattice, and (4) short lattice plus bell. Input impedances are calculated for various combinations of the input and output terminations to demonstrate their effects on the amplitudes of the input impedance peaks both above and below the cutoff frequency.

11:20

GG10. Spectral characteristics of the Helmholtz resonator driven by an air jet. Roset Khosropour and Peter Millet (Department of Physics, Hamilton College, Clinton, NY 13323)

Motivated by an interest in the action of air jets on resonant systems in woodwinds, preliminary measurements have been made on the frequency spectra of several air jet driven Helmholtz resonators. Over the range of air jet velocities examined, stable oscillations dominated by a single frequency (under certain conditions harmonics are in evidence) occur in several intervals of jet velocity. Within each such interval the dominant frequency increases with increasing jet velocity. The span of frequencies associated with each interval includes the calculated Helmholtz frequency and, depending on the resonator and the interval, can be as much as an octave. The spectrum of the zone between the intervals is formed from an overlap of the extrapolated spectra of the adjacent intervals, i.e., it is marked by the appearance of two frequencies, where one is above the maximum frequency from the lower interval and the other is below the minimum frequency from the higher interval.

11:35

GG11. Acoustical behavior of a bass drum. Thomas D. Rossing (Department of Physics, Northern Illinois University, DeKalb, IL 60115)

The bass drum is one of the loudest instruments in the orchestra. Its two large membranes may be set to equal tension, but more often the batter head is tuned to a higher tension. The sound spectrum contains many peaks that can be related to the vibration modes of a membrane. The low tension of the heads plus the strong coupling via the enclosed air lead to a large frequency difference (about $1\frac{1}{2}$ octave) between the two (01) modes associated with in-phase and out-of-phase motion of the heads. Sound decay rates for most modes are slightly greater when the two heads are at the same tension.