the input notation and processing it with pronunciation and musical performance rules. Both solo and choral singing are synthesized. Various effects will be demonstrated, such as timing of pitch changes and consonants, coloratura, markato, timbre, legato, and multiple pitch singing. Also, some effects concerning musical expression will be presented.

Contributed Papers

4:05

L6. Is there a single vibrato waveform? Robert Maher and James Beauchamp (Computer Music Project, School of Music, University of Illinois at Urbana–Champaign, 2136 Music Building, 1114 W. Nevada, Urbana, IL 61801)

High-fidelity singing synthesis requires careful consideration of the properties and character of natural vibrato. In many synthesis methods, a single vibrato waveform is derived and applied equally to all of the partials of the synthesized tone. The research reported here tests the validity of this linear treatment of vibrato using an analysis/synthesis procedure. The singing tone /ah/ is analyzed for bass, tenor, alto, and soprano voices, providing time-variant measurements of amplitude, frequency, and phase for each of the partials. The tones are reconstructed using an additive synthesis procedure. The importance of vibrato waveform similarities and differences between partials is evaluated by resynthesis of the singing tones from modified analysis data. The modifications include the use of the fundamental partial's vibrato waveform for all of the partials, the use of sinusoidal vibrato for all the partials, the elimination of amplitude variations for each partial, and various combinations. The analysis data and examples of the resynthesis will be presented. [Work supported, in part, by an NSF Graduate Fellowship.]

4:20

L7. The jnd's for rate and extent of frequency modulations. Yoshiyuki Horii and Ron Scherer (Campus Box 409, CDSS, The University of Colorado, Boulder, CO 80309 and The Denver Center for the Performing Arts, Denver, CO 80202)

Vocal vibrato samples were spectrographically analyzed to determine ranges of rate and extent of frequency modulations. Subsequently, sinusoidal and pulse signals of 2-s duration at 261 or 522 Hz, modulated within the measured ranges, were used as standard stimuli to derive rate and extent jnd. For the rate jnd, the standard stimuli were sinusoidally modulated at 4, 5, and 6 Hz. For the frequency extent jnd, the standard stimuli were sinusoidally modulated at 5 Hz with frequency extent of 0.25, 0.5, and 0.75 semitones. Subjects were instructed to adjust rate/extent of frequency modulations until the difference between the standard and adjustable signals was just noticeable. The rate jnd was less than 5%, while frequency extent jnd was much smaller especially for the pulse stimuli. A perceptual cue for the frequency extent appeared to be rate of frequency changes rather than the extreme frequency values. A follow-up experiment indicated listeners' inability to match accurately nonmodulated signal frequency to the extreme frequency values of the modulated signals. Implications of these findings to vibrato singing will be discussed. [Work supported by NIH.]

4:35

L8. Analysis, resynthesis, and modification of sound signals with the help of wavelet transforms (i.e., time-and-scale representations). R. Kronland-Martinet (Laboratoire de Mécanique et d'Acoustique, C.N.R.S., 31, chemin J. Alguier, 13402 Marseille Cedex 9, France) and A. Grossmann (Centre de Physique Théorique, C.N.R.S.-Luminy Case 907, 13288 Marseille Cedex 9, France)

An attempt will be made to present an up-to-date survey of results on wavelet transforms of signals, with particular emphasis on examples involving sound. The main feature of a wavelet transform is that it associates to a signal $s(t)$ an appropriate function $S(b,a)$ of two parameters: a time b and a scale parameter a. If it is required that the correspondence $s \rightarrow S$ be linear, the definition of a transform involves an "analyzing wavelet" g, which has to satisfy some conditions, and, given by $S(b,a) = Ka^{-1/2} \times \int s(t) g^{-}[(t-b)/a]dt$, g^{-} is the complex conjugate of g. This correspondence has a stable inverse. A transform $S(b,a)$ is fully determined by its values on a suitable discrete grid of the (b,a) open half-plane. Wavelet transforms are close relatives of time-frequency representations, the frequency being replaced by a scale parameter. The aim will be to describe some of the mathematical background, to give a description of some existing implementations, and to display an appropriate set of examples, involving acoustical signatures in the field of speech and music. There will be auditive examples showing the possibilities of intimate modifications of sound by these methods.

TUESDAY AFTERNOON, 17 MAY 1988 GRAND BALLROOM A, 1:30 TO 4:20 P.M.

Session M. Noise III: Airport Noise Compatibility Planning

Dennis G. Ossenkop, Chairman
Federal Aviation Administration, 17900 Pacific Highway South, Seattle, Washington 98056

Chairman's Introduction—1:30

Invited Papers

1:35

M1. Airport noise compatibility planning perspectives. Steven Starley (Noise Abatement Division, Federal Aviation Administration, 800 Independence Avenue, S. W., Washington, DC 20591)

Air transportation is mass transportation and its continuing growth has spawned a complex set of interrelated noise and capacity problems. Airport proprietors, who are responsible for noise damages, are turning to