Program package for the analysis and synthesis of animal vocalizations

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A set of programs has been developed to manipulate the acoustic structure of animal vocalizations. The programs, originally developed on Digital Equipment Corporation (DEC) PDP-11/45 and -11/10 computers (Zoloth, Dooling, Miller, & Peters, 1980), have now been modified for both the PDP-11/23 and -11/24 processors. While useful for editing any complex acoustic signal, these programs have been used primarily for analyzing and synthesizing bird vocalizations.

Environment

These programs are written in FORTRAN and PDP-11 assembly language and operate under RT-11 Version 4. Two versions of the programs exist, allowing graphics display on either a DEC VT-105/125 or a Tektronix 4006 graphics terminal.

Programs

The programs can be broken down into six groups according to function. The underlying principle in the creation and editing of acoustic signals involves the fast Fourier transform (FFT) (Cooley & Tukey, 1965).

SN DIN. This program samples an analog (amplitude vs. time) waveform and converts it into a digitized pulse code modulation (PCM) representation. Conversions are done using one of two schemes, either an AR11 (10-bit) or an ADV11A (12-bit) A/D converter, sampling at the rate of 20 kHz. Digitized values are stored on either double-density floppy disk (RX02) or one of two hard disks (RK05 or RP02).

EDPCM. This program allows cursor editing of the PCM waveform prior to spectral conversion. The beginning and the end of the sound segment of interest is defined by cursor position, and a new PCM file is created containing only those parts of the original signal needed for further analysis.

PCMFFT. This program transforms the PCM waveform (digitized amplitude vs. time signal) into a spectral (frequency vs. time) representation. A disk file is pro-

duced with the amplitude-frequency and phase-frequency information interleaved for each FFT computed.

EDFFT. This program modifies the signal spectrum in the graphics mode. There are four different display modes: frequency vs. time (frequency spectrum), amplitude vs. frequency (power spectrum), phase vs. time, and amplitude vs. time. Editing changes include (1) modification of signal phase, amplitude, and frequency, (2) mixing of two sound segments, and (3) deletion, insertion, or replication of selected signal segments.

FTPCM. This program converts the altered FFT file back to PCM data using the inverse discrete Fourier transform.

SN DOUT. This program sends PCM data out through a D/A converter at the sample rate of 20 kHz. Two versions exist: one for the 10-bit AR-11 module and one for the 12-bit AAV11-A module.

System Requirements

Two versions of these programs are available. One is operating on a PDP-11/23 processor with a VT125 graphics terminal and RX02 floppy disk drives. This version has limited storage capacity but uses a 12-bit A/D and D/A conversion scheme for better signal-to-noise ratio. The other version is operating on a PDP-11/24 with a Tektronix 4006 graphics terminal and storage facilities consisting of an RX01, and RK05, and an RP02. This system uses DEC's AR11 module and a 10-bit conversion scheme.

Availability

Source code listings for the first version (PDP-11/23, VT125, and RX02) are available from Robert J. Dooling, Psychology Department, University of Maryland, College Park, Maryland 20742. Source code listings for the second version may be obtained from Christopher Clark, Rockefeller University Field Research Center, Tyrrel Road, Millbrook, New York 12545. There is a \$5 charge for copying. Users interested in obtaining the software should send a floppy diskette (RX01 compatible, single sided, single density) to the appropriate address above. We request that publications resulting from this software formally acknowledge this source.

REFERENCES

- COOLEY, J. W., & TUKEY, J. A. An algorithm for the machine computation of complex Fourier series. *Mathematical Computing*, 1965, 19, 297-301.
- ZOLOTH, S. R., DOOLING, R. J., MILLER, R. C., & PETERS, S. A. A minicomputer system for the synthesis of animal vocalizations. *Zeitschrift für Tierpsychologie*, 1980, 54, 151-162.

(Accepted for publication August 24, 1982.)