Session 2pBV

Bioresponse to Vibration and to Ultrasound: General Topics

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Chair's Introduction—1:25

Contributed Papers

1:30

2pBV1. Exposure guidelines for Navy divers exposed to low-frequency active sonar. F. Michael Pestorius (Appl. Res. Labs., Univ. of Texas, Austin, TX 78713-8029) and Michael D. Curley (Naval Submarine Medical Res. Lab., Groton, CT 06349-5900)

A 30-month experimental and modeling study was conducted into the effects of low-frequency active (LFA) sonars on Navy divers. 453 dives using 87 subjects were completed with one symptomatic event. A variety of dive equipment, depths to five atmospheres, and three signal waveforms were used. Interim guidance for exposure to LFA signals was issued by the U.S. Navy Bureau of Medicine and Surgery. For exposures to nonimpulsive waterborne sound in the frequency range 160–320 Hz, the following set of parameters did not compromise the safety of a highly trained, fit, and informed diver (diver compromise refers to a diver who could become a casualty or burden to others in an operational setting): A maximum overall SPL of 160 dB for no more than 100 s continuous exposure on a 50% duty cycle, with a cumulative exposure limit of 15 min/dive-day, a total of 9 days of exposure in a 2-week period. SPL is measured at the diver's location. This guidance is generalizable only to those populations equivalent in medical health and fitness to U.S. Navy divers. [Work supported by U.S. Navy.]

1:45

2pBV2. A new multifinger tactual display. Hong Z. Tan and William M. Rabinowitz (Res. Lab. of Electron., MIT, Cambridge, MA 02139)

A multifinger positional display, called the Tactuator, was developed to study communication through the kinesthetic and vibrotactile aspects of the tactual sensory system of the hand. The display consists of three independent single-point actuators interfaced (individually) with the fingerpads of the thumb, the index finger, and the middle finger. Each actuator utilizes a disk-drive head-positioning motor augmented with angular position feedback from a precision rotary variable differential transformer (RVDT). A floating-point DSP system provides real-time positional control, using position and derived-velocity feedback. Stimuli from threshold to about 50 dB SL can be delivered throughout the frequency range from near dc to above 300 Hz, thereby encompassing the perceptual range from gross motion to vibration. Actuator frequency and step responses are well modeled as a second-order linear system. Distortion is low allowing delivery of arbitrary stimulus waveforms, e.g., 25-mm low-frequency motion with superimposed high-frequency vibration. System noise and interchannel cross talk are also small. As one example of behavioral performance verification, absolute thresholds measured with the stimulator are in general agreement with reference values. Overall, the Tactuator accurately follows its drive waveforms and is well suited for a variety of multifinger tactual perceptual studies. [Work supported by NIDCD.]

2:00

2pBV3. Information transmission with a multifinger tactual stimulator. Hong Z. Tan, Nathaniel I. Durlach, William M. Rabinowitz, and Charlotte M. Reed (Res. Lab. of Electron., MIT, Cambridge, MA 02139)

The information transmission capabilities of a multifinger positional stimulator, called the Tactuator, were explored in a series of absolute identification experiments. Variations in the frequency of single sinewave stimuli evoked three relatively distinct perceptual attributes: smooth motion (up to about 6 Hz), a rough or fluttering sensation (about 10 to 70 Hz), and smooth vibration (above about 150 Hz). Multicomponent stimuli were formed by summing sinusoids from each of these three regions, with the intent that frequency (and amplitude) variations within each region could be identified independently. Stimulation was applied to either one of three digits (thumb, index, or middle) or to all three digits simultaneously. For stimulus durations of 500 and 250 ms, information transfer (IT) was 6.6 bits (corresponding to perfect identification of 97 stimuli); at 125 ms, IT was 6.0 bits. Estimates of potential IT rates were obtained by sequencing three random stimuli and (a) having the subject identify only the middle stimulus and (b) extrapolating this IT to that for continuous streams. Estimated IT rates were 13 bits/s, and the optimal stimulus presentation rate was approximately 3 items/s regardless of stimulus duration. This IT rate is roughly the same as that achieved by Tadoma users in tactual speech communication. [Work supported by NIDCD.]

2:15

2pBV4. Active noise reduction stethoscopy for lung sounds measurement in loud environments. Samir P. Patel, George R. Wodicka (School of Elec. and Comput. Eng., Purdue Univ., West Lafayette, IN 47907-1285), and Matthew G. Callahan (Univ. Res. Engineers & Assoc., Inc., Acton, MA)

Auscultation of lung sounds in vehicles such as an ambulance or aircraft is unachievable because of high noise levels. Also, the bandwidths of lung sounds and vehicle noise typically have significant overlap, limiting the utility of bandpass filtering. In this study, a passively shielded stethoscope coupler with one microphone to measure the (noise-corrupted) lung sounds and another to measure the ambient noise was constructed. Lung sound measurements were performed on a healthy subject in a simulated USAF C-130 aircraft environment within an acoustic chamber at noise levels ranging from 80 to 100 dB SPL. Adaptive filtering schemes using a least mean squares (lms) and a normalized least mean squares (nlms) approach were employed to extract lung sounds from the corrupted signal. Up to 25 dB of noise reduction over the 100–600 Hz frequency range was achieved with the lms algorithm, with the more complex nlms algorithm providing faster convergence and up to 5 dB of additional noise reduction. These findings indicate that a combination of active and passive noise reduction can be used to measure clinically useful lung sounds in high noise environments. [Work supported by US Air Force.]

2p TUE. PM