National Aeronautics and Space Administration

Enhanced Auditory Alert Systems

Methods and Systems for Enhanced Auditory Alert Perception

Auditory warning systems for human interfaces are often designed around criteria that depend primarily upon signal loudness. It is well understood from the auditory literature that, by making an alert signal substantially louder than the measured background noise level, one can insure that an alert signal will be detectable. Such auditory alert systems have been used in the aviation industry for a number of years in order to raise the awareness of the crew for terrain proximity for example.

However, if an alert signal amplitude is too loud, the alert signal may produce a “startle effect” that hinders performance in some high stress situations.

This invention provides an alternative approach that uses other features, in particular spatial modulation, to improve the detectability of an alert signal, without substantially increasing the amplitude level of the alert signal beyond the background sound level.

This invention provides several different but compatible approaches to enhance the detectability of an alert signal. Binaural communication, using for example stereo earphones or loudspeakers with independent delivery systems, is preferred.

BENEFITS

- **Reduced overall level of alert sounds**
- **Reduced fatigue**
- **Improved detection of alarms**
- **Raised awareness**
- **No “startle effect”**

technology opportunity

In a first approach, an existing auditory alert signal is supplemented with a brief burst of selected spectral components, chosen to exceed an auditory masking threshold and lying in a broader frequency bandwidth, 0.1-10 KHz, than the frequency bandwidth of the alert signal that is at least 3-10 dB above a general background of auditory signals including noise. An alert prefix signal, preceding or contemporaneous with an alert signal, is issued that has one or more selected tones within each of several critical frequency bands, at a prefix signal level at least 3-10 dB above the background; and alert signal detectability is thereby increased. A second approach uses spatial modulation in a binaural signal delivery system to make a signal appear, to the subject, to move from one location to another within a selected time interval.

In a third approach, a microphone for example provides a sound level that would otherwise be present at each of the subject's ears, averages these signals, and delivers the averaged signal to each ear through a pair of stereo earphones, as a more or less homogeneous background signal that the subject's ears interpret as being present in the "center" of the subject's head. A binaurally differentiated signal, such as the spatially modulated, spectrally altered alert signal is then more easily distinguished from this coherent background signal, because the differentiated signal has low coherence relative to the background signal.

APPLICATIONS

- **Aviation**
- **Vehicles with stereo systems**
- **Personal cars or trucks**
- **Naval vessels**
- **Ceramics and composites**
- **Monitoring activities as in**
- **power plants**
- **Games**
- **Headset for visually impaired**
- **Workers in loud environment**

Patents

This technology has been patented (U.S. Patent 7,346,172).
Reference: ARC-14556-1.

Licensing and Partnering Opportunities

NASA's Technology Transfer Program seeks to transfer this technology out of NASA's space program to benefit U.S. industry. NASA Invites companies to inquire about licensing possibilities for this technology for commercial applications.

Learn More
For more information on this technology, and to discuss licensing and partnering opportunities, please contact:
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