Towards a Radio Acoustical Virtual Environment

Currently, good hearing protection is achieved at the cost of decreased communication while good communication is achieved at the cost of jeopardizing good hearing protection. It is vital to provide workers with satisfactory hearing protection and communication. We propose a new distance sensitive protocol that provides intelligible speech to workers wearing hearing protection. Using changes in acoustical features of speech the vocal effort will be coded and the speech signal will be sent in a way that mimics a natural acoustical environment. The "Radio Acoustical Virtual Environment" discussed will allow workers to communicate without the need to remove their HPDs. Somewhat undisturbed speech from inside the ear canal will be captured and transmitted over wireless radio to the remote listener. The transmitted signal will only be received by listeners within a given spatial range, this range depending on the user’s vocal effort and background noise level. RAVE is not only useful for workers in noisy environments but for anyone in a noisy environment that wants to communicate. We anticipate that RAVE will promote the use of HPDs and encourage people to want to protect their hearing.

III. Conclusions

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I. Motivation

About 9 million North American workers are exposed to occupational noise levels that put them at risk of Noise Induced Hearing Loss (NIHL). One of the ways to protect workers’ hearing health is the use of Hearing Protection Devices (HPD). However, depending on the type of HPD worn, as well as the spectrum of the noise and the wearer’s hearing ability, wearing HPDs often limits communication. Good communication in a work environment is vital. In a recent survey, workers identified communication as the number one reason for abandoning the use of their HPDs. Workers in noisy environments must be provided with both adequate hearing protection and good communication. Unfortunately, current communication in noise compromises one factor for the other. There is a need for a device that provides intelligible communication for persons wearing hearing protection in noisy environments. Current methods of communication in noise are listed below.

Current Methods of Communication in Noise

Remove the HPD:

Use passively filtered HPD

Flat attenuation HPDs could be beneficial for speech communication. However, they do not provide sufficient attenuation in very loud environments (> 100dB). In quiet, they also decrease speech intelligibility, which would compel the wearer to remove the HPD for communication.

Use of a communication headset

Although they are the best alternative, they are difficult to wear with other personal protection equipment such as helmets. Also using any kind of radio transmitter does not distinguish a receiver and all communication is sent to everyone on the same radio channel. This can be annoying and contributes to the noise dose.

II. Methodology

We propose a new concept called “Radio Acoustical Virtual Environment” (RAVE) in which workers in noisy environments can achieve intelligible communication without hindering their hearing protection. RAVE intends to mimic a natural acoustical environment by transmitting intelligible speech only to an “intended” radius of listeners based on the vocal effort of the speaker and the level of background noise. RAVE uses an advanced intra-aural instantly custom molded HPD, equipped with an In-Ear Microphone (IEM), a miniature loudspeaker, a Digital Signal Processor (DSP), an Outer-Ear Microphone (OEM) and Wireless Radio (WR) capabilities. The custom molded HPD does not only provide good hearing protection, but also permits us to pick up a speech signal that is minimally affected by background noise. As speech is produced the vibrations from the vocal chords propagate through bone conduction and are then picked up by the IEM. Because the signal captured originates from bone conducted vibrations, it lacks some high frequency content, and therefore must be enhanced. It is then coded and sent to an appropriate radius of listeners based on the acoustical features of the produced speech and the level of background noise.