Efficacy of a Parametric Assistive Listening System to Enhance the Audibility and Intelligibility of Speech

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Introduction

Elderly individuals with or without a significant hearing loss require increased signal-to-noise ratio (SNR) during various listening activities including television viewing. The majority of these individuals achieve this by raising the volume of the television, causing discomfort to the rest of the listeners. A television assistive listening system can play an important role in alleviating this situation.

In this study we have evaluated the efficacy of a Parametric Assistive Listening System (PALS) that was designed and built by our NTU team. The technology employed utilizes ultrasonic emitters alongside a traditional transducer. Since ultrasounds have a very short wave length, as they demodulate in the air, a narrow beam of sound is formed. A listener seated with in this beam receives enhanced sound compared to the rest of the individuals on either side. We have studied the efficacy of this system in improving the listening experience of the individuals with normal hearing and mild hearing loss in noisy situations.

Methods

PALS was constructed such that the ultrasonic emitter can be enabled, referred to as Parametric condition (PAC); or disabled referred to as Non-Parametric condition (NPAC). Under NPAC, the sound system functions as a traditional free-field transducer. Subjects were seated in a height adjustable chair placed two meters directly in front of the system (figure1). The height of the chair was adjusted for each of the patients to ensure that every subject’s ear level was at a standard height from the ground.

the better ear. The perceived increase in sound volume between the two conditions was quantified by comparing the subjective hearing threshold differences between these two speaker conditions (PAC and NPAC). Differences in Speech discrimination scores (SD) in +10dB signal-to-noise ratio (SNR) were obtained under PAC and NPAC conditions to measure the superiority of one speaker condition over the other. SD were administered using NAL-AB words at 50dB SPL with multi-talker babble at 40dB SPL. The order of test conditions were randomized such that both the subject and the tester were blinded to the condition being tested.

Results

Audibility was better in PAC when compared to NPAC in both the groups tested. Overall improvement was greatest at 2kHz (18dB) followed by 8kHz (16.2dB), 4kHz (14dB), 1kHz (12.2dB), 6kHz (9.7dB), and 500Hz (9.5dB). Mean improvement in PAC across frequencies was 16dB for NH group and 10.6dB for MHL group (figure2). Wilcoxon matched pairs signed rank test revealed a statistically significant overall improvement in audibility (mean = 13.4dB, Z = -3.93, p < .0001) in PAC when compared to NPAC.

Figure 2
SD was scored better in PAC than in NPAC for all the subjects studied. Group wise improvement in SD in PAC as shown in figure3, was very similar between NH (28.9%) and MHL (31.3%) groups. Wilcoxon matched pairs signed rank test revealed a statistically significant overall improvement in SD(mean = 30.1%, Z = -3.92, p < 0.0001) in PAC when compared to NPAC.

Conclusion

Difficulties in understanding speech by older adults in everyday situations are a consequence of auditory decline (Schneider et al., 2002). Comparatively better audibility of high frequencies by 0 - 15dB with well audible low frequencies is known to be advantageous to speech recognition (Skinner, 1980). Hearing deficits often demand good audibility as well as SNR in daily listening situations such as television and music listening. A good balance of volume is also required for a comfortable group listening experience. Individuals with hearing deficits tend to turn up the volume at the expense of discomfort to co-listeners. PALS appears to be a promising solution for such situations as evidenced by superior performance under PAC by both individuals with normal hearing and mild hearing loss.

References

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