Canadian Audiologist
The Official Publication of the Canadian Academy of Audiology

An Overview of Hearing Instrument Wireless Technology

Samidha Joglekar, ReSound In-House Audiologist

Published January 21, 2016

Wireless technology for individuals with hearing loss began with limited potential body worn devices and has since evolved into miniature ear level systems, capable of quickly transmitting a myriad of complex digital signals. We have come a long way; to a point where wireless technology is extensive in our industry. Patient demands are likely to increase faster than the industry can keep up, and thus a push towards convenient and flexible wireless technology solutions for hearing instrument users is continually relevant. The purpose of this article is to provide a basic overview of wireless technology in hearing instruments, and to touch upon some of the research areas being examined with the implementation of this wireless technology.

The application of wireless technology in hearing instruments has generally served two broad purposes: to improve the signal-to-noise ratio (SNR) in specific conditions, and to improve the overall experience and convenience for the hearing instrument user.[1,2–4] In terms of SNR improvement an area of development is wireless technology that allows bilaterally worn hearing instruments to share information and coordinate digital signal processing (DSP) to enhance algorithms like directionality and noise reduction.[2–4] Another ambitious focus is to have coordinated DSP between hearing instruments that will emulate binaural auditory processing, to mimic phenomena like binaural squelch and binaural redundancy, hopefully leading to improvements in SNR and spatial hearing.[3,4] A study published by Ibrahim et al evaluated the benefits of wireless communication between hearing instruments, specifically for speech intelligibility and sound localization.[3] Twelve participants with symmetrical SNHL and fit with hearing instruments that had wireless synchronization of multichannel Wide Dynamic Range Compression (WDRC) were compared with normal hearing listeners on hearing-in-noise (HINT) and sound localization tests. The findings indicated no significant benefit of this technology for speech in noise. However, it was suggested that binaural wireless technology in hearing instruments could improve localization abilities after some period of adaptation.[3] The authors suggest that more research will be needed to investigate to what extent the synchronization of active DSP features impacts overall auditory performance after individuals have been fit with and have acclimatized to hearing instruments.[3,6]

Wireless technology to facilitate connectivity has had the largest immediate impact on the hearing instrument user in terms of user experience and convenience. Connectivity in a hearing system allows the user to interface with other electronic devices, such as cell phones, and receive sound directly into the hearing instruments. Current wireless hearing instrument systems use one of two main methods for this kind of connectivity: 1) Near-field magnetic induction (NFMI) combined with BluetoothTM or proprietary radio frequency (RF) transmission or 2) proprietary radio frequency transmission alone.[1,2,4] NFMI involves a body worn streamer, or gateway device, with inductive neck loop as the centre of the system.[2,4] NFMI-based systems incorporate a “far-field” wireless technology (e.g., BluetoothTM) to stream from an audio source to the body worn gateway device, which then relays the signal to the hearing instruments via magnetic induction.[1,2,4] NFMI is easily implemented in hearing instruments because it is similar to the long existing telecoil and introduces minimal current drain.[2] However, NFMI systems have the disadvantage of a short transmission distance, which means that the gateway device must be worn on the body and in the right orientation to the magnetic field, which usually means around the neck. [1,2]

Wireless technology that uses radio frequency (RF) transmission places the hearing instruments at the centre of the system and allows for direct communication between a streamer device and the hearing instruments [1,2] Current approaches to proprietary RF transmission are either via the 2.4 GHz license-free ISM (Industry Science Medical) band or the 900 MHz band.[2,4]

The 2.4 GHz system functions by transmitting data in very small packets quickly across multiple channels, using time division and frequency hopping to effectively avoid interference with other wireless devices operating in the same band [1,4]. Transmitted signals go directly to specially designed antennae in the hearing instruments where the signal is decoded, digitized, treated by the hearing instruments, and sent to the ear.[1,2,4] The immediate advantage of this system is that it can transmit over long ranges and conveniently eliminates the need for a body worn device.[2,4] In addition, these systems have markedly improved sound quality as they do not have the latent audio transmission that is associated with Bluetooth.[1,2,4]

The implementation of 2.4 GHz in hearing instruments is particularly noteworthy as it was the result of a systematic analysis of both clinician and user needs and careful consideration of how these needs could be satisfied.[1,2,4] This technology offers convenience, mobility, superior sound quality, and can be used safely worldwide unlike the 900 MHz band, which is limited to specific geographical areas.[1,2] The operation of 2.4 GHz wireless technology in hearing instruments is an important achievement that has led to exciting possibilities. For example, this technology in hearing instruments is what has allowed for direct communication with iPhones® and iPads® that use protocols which also operate on the 2.4 GHz ISM band.

The robust design and convenience of 2.4 GHz wireless technology has now been extended to cochlear implants (CIs), opening up a realm of possibilities never before offered to this cohort of hearing technology users. Direct and potentially binaural streaming for CI users opens up several research possibilities. For example, Wolfe et al were among the first to investigate the potential benefits of a digital wireless remote-microphone audio-streaming accessory designed to deliver audio signals directly to a CI sound processor.[7] They evaluated sixteen CI users using AZBIO sentences with CI processor alone versus CI processor with a remote microphone accessory. Test conditions were in quiet and in competing noise ranging in level from 50–70 dBA. Their findings indicated that speech recognition in quiet and almost all competing noise levels was significantly better with use of the remote-microphone accessory compared with performance with the CI sound processor alone[7]. This study illustrates the potential that wireless technology has to improve communication for individuals with severe to profound hearing impairment. 2.4 GHz wireless technology also allows CI users for the first time the ability to stream from multiple external sounds sources such as cell phones and televisions with no need for a body worn device. Further research will be needed to ascertain the overall, no doubt positive, health and social impacts that this kind of technology will have on this population.[4]

Overall, wireless technology is ubiquitous in our society, and several methodologies are used for its implementation. Within the hearing industry the 2.4 GHz RF band offers several important advantages compared with other forms of wireless technology for hearing instruments. Further research is needed to ascertain how the synchronization of hearing aid processing through wireless technology influences aspects of binaural hearing and overall behavioural performance. There is no doubt in terms of the positive impact this technology has had on improving SNR, as well as convenience and flexibility, by providing the ability for direct sound streaming from multiple sources. Further inquiry and innovation will certainly bring about new technologies to move the industry forward.

References

1. Groth J and Dam Pedersen, B. How user requirements affect technology choice for wireless hearing instruments. ReSound white paper. 2010. Available at: http://www.resound.com/~/media/DownloadLibrary/ReSound/White%20papers/user-requirements-affects-choices-wireless-white-paper.
2. Groth J. 2010. Five myths about digital wireless hearing aid technology. The Hearing Review (online); 2010. Available at: http://www.hearingreview.com/2010/12/five-myths-about-digital-wireless-hearing-aid-technology/.
3. Ibrahim I, Parsa V, Macpherson E, Cheesman M. Evaluation of speech intelligibility and sound localization abilities with hearing aids using binaural wireless technology. Audiol Res 2012;3(1).
4. Jesperson CT. A review of wireless hearing aid advantages. Hearing Rev (online). 2012. Available at: http://www.hearingreview.com/2012/02/a-review-of-wireless-hearing-aid-advantages.
5. Rodemerk K, Galster JA. The benefit of remote microphones using four wireless protocols. J Am Acad Audiol 2015;26(8):724–31.
6. Thibodeau L, Schaper L. Benefits of digital wireless technology for persons with hearing aids. Semin Hear 2014;35(03):168–76.
7. Wolfe J, Morais M, Schafer E. Improving hearing performance for cochlear implant recipients with use of a digital, wireless, remote-microphone, audio-streaming accessory. J Am Acad Audiol 2015;26(6):532–39.