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Review Article

Impact of Artificial Intelligence on Hearing Aids and Auditory Implants

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Abstract

Artificial Intelligence has transformed the hearing aid experience by enhancing the device's ability to analyze and adapt to different sound environments. Traditional hearing aids often struggled in complex listening situations, such as crowded restaurants or noisy offices, as they amplified all sounds equally, making it challenging for users to understand speech. With AI-powered hearing aids, this problem is addressed. These devices utilize advanced algorithms to analyze and distinguish various sound environments, automatically adjusting settings to optimize speech understanding and reduce background noise. Instead of a one-size-fits-all approach, AI allows for personalized sound processing, ensuring that users can effortlessly communicate in different settings. Furthermore, AI-powered hearing aids can identify and differentiate between different voices, enhancing speech clarity and making conversations more effortless and enjoyable. This capability is especially beneficial in scenarios where multiple people are speaking simultaneously, as the device can focus on the target speaker while suppressing irrelevant noise. Furthermore, AI-powered hearing aids often come with companion apps that allow users to fine-tune settings, track usage data, and provide feedback to further enhance the personalized experience. These apps provide a user-friendly interface for individuals to have more control over their hearing aids and customize their listening experiences according to their preferences.

Keywords: Artificial Intelligence; Hearing Aids; Cochlear Implants; Brain-Controlled Aids; Idiopathic Sudden Sensorineural Hearing Loss (ISSNHL); Digital Signal Processing (DSP)

Introduction

Artificial intelligence (AI), which is frequently used interchangeably with machine learning, is the ability of computers to mimic human intelligence in the context of solving complicated problems and applying logic to reasoning. Artificial intelligence (AI) has advanced recently, and this has led to creative new healthcare solutions [1]. Although AI has been around for a while, hearing aids were not one of the areas in which it gained prominence until 2004. Even though artificial intelligence wasn't yet used in hearing aids, technological advancements caused AI to gradually become more prevalent. AI features included cochlear implants and hearing aids with wind noise management, trainable aids, own voice analyzing, brain-controlled aids, and techniques to enhance speech perception in noisy environments [2]. Artificial Intelligence is the term for computer algorithms that can automate thought processes. Fundamentally, artificial intelligence (AI) uses sophisticated programming and computation to handle large amounts of data and carry out operations like word and object recognition, visual perception, and complicated decision-making, which includes driving autonomous vehicles. Artificial Intelligence is being used across many industries. AI's usefulness in medicine has advanced diagnosis—such as distinguishing malignant tumors from benign tumors and identifying diabetic retinopathy—and guided clinical decision-making—such as determining the best course of treatment for infections [3-5].

Artificial Intelligence is a technical innovation that has enhanced users' lives and their ability to hear [6,7]. AI technologies now include own voice processing, which allows a hearing aid to be automatically programmed based on its surroundings, and trainable hearing aids. With the use of AI algorithms like CNN and DNN (deep neural networks), future technologies will consist of brain-controlled hearing aids (convoluted neural network) [8]. A sudden start of hearing loss at > 30 dB for at least three consecutive frequencies within 72 hours is referred to as idiopathic sudden sensorineural hearing loss (ISSNHL). Vertigo, aural fullness, and tinnitus may accompany it. There are five to twenty cases of this prevalent otologic emergency for every 100,000 people per year. The pathophysiology of the disease is still unknown, and the majority of cases are idiopathic. The main reasons for intracochlear membrane breaches, vascular blockage, viral infection, and autoimmunity [9,10].

The basic mechanisms underlying ISSNHL are not well known, which leads to controversy on its management. On the other hand, the most commonly recognized course of treatment is now steroid therapy, which can be systemic, intratympanic, or both [11,12]. Furthermore, because ISSNHL progresses in an unpredictable manner, a number of factors that seem to affect the disease's prognosis have been found. These include age, the form of the audiogram, the degree of vertigo, and the extent of hearing loss [13-17]. In any area of medicine, using optimization models to forecast a prognosis by utilizing artificial intelligence to analyze multiple variables and choose crucial ones might be a creative approach. In audiology, intelligent technology has been used extensively. For instance, it was used to forecast the eventual outcome of ISSNHL and hearing impairment in workers in industries exposed to noise [18-20]. According to a publication, 1220 patient outcomes from ISSNHL were used to create prediction models based on four machine learning techniques: deep belief network (DBN), logistic regression (LR), support vector machine (SVM), and multilayer perceptron (MLP). Out of all these models, the DBN model had the highest predictive capacity [21].

Mechanism of earing aids

Every hearing aid ish made up of a few basic parts, each of which is essential to the operation of the device. The microphone is where it all starts. A microphone is a small but mighty device that records sound waves from its surroundings. It works similarly to your ears, only it transmits electrical impulses into the hearing device as opposed to sending sound waves to the brain. Amplifier: Electrical signals are routed to the amplifier after the microphone has completed its task. This is the point at which amplification works its magic. The electrical impulses are strengthened or amplified by the amplifier, which increases their loudness and audibility. Digital signal processing (DSP) in contemporary digital hearing aids takes things a step further. Here, sophisticated algorithms are used by a microprocessor to process the increased signals. Similar to fine-tuning, this processing improves speech clarity, lowers noise from the surroundings, and applies personalized settings according to the wearer's unique hearing requirements. Your hearing aid functions like to having an own sound engineer within. The electric signals are now prepared to be converted back to sound waves by the receiver after processing. The receiver, often known as the speaker, is involved in this. It transforms the signals after processing them into audible sound waves. Transferring auditory waves to reach the wearer's ear is the last stage. Depending on the form of hearing aid, the earpiece is made to fit securely in the canal of the ear or behind the ear. It guarantees that the sound travels as close to the ear as feasible. In the years since its invention, hearing aids have come a long way. The most sophisticated digital hearing aids available today use state-of-the-art technology to provide users an unparalleled hearing experience. Digital signal processing integration makes it possible to significantly customize and improve sound [22].

Methods of AI in enhancing hearing

We searched the following databases for articles published in peer-reviewed journals: Medline/PubMed Central, Researchgate, Google Scholar, and an individual Google search. Machine learning has several uses, including brain-controlled hearing aids that monitor a listener's brainwaves and determine which speaker to focus on by drawing a parallel with the source of sound in the surrounding area among order to make the attended speaker easier to hear among a crowd, the device will then magnify that speaker in relation to the others. This process of automatically identifying the speaker's voice from a mixed audio source is known as auditory attention decoding, or AAD. But speaker-independent speech separation is extremely difficult, and finding a solution is tough. Improved performance has been the subject of framework proposals; hopefully, this is about to happen. Therefore, neural network representations of the auditory cortex and auditory attention are the next area of emphasis for improving speech detection.

A instantaneous fashion low-latency speech-separation method built around deep neural network models is an essential part of such a system. These models have shown to be incredibly successful in numerous applications of machine learning, and they approximate the computation carried out by biological neurons. The goal of this field's continuing study is to improve our knowledge of auditory attention and the neurological markers associated with it in the individual's auditory cortex. The goal is to eliminate the technological obstacles to AAD in order to enhance speech intelligibility and lessen the amount of time that those who have hearing loss must spend listening [23].

Bringing attention to yet another effective application of AI, artificial intelligence has made it possible for hearing aids to track mental and physical health, detect falls, and recognize speech. It is feasible to recognize speech and deliver an enhanced interpretation to the listener in real time by using predictions made from stored data. Motion sensors have the ability to identify falls and notify caregivers or family members by sending warnings and GPS positions. Even more sophisticated than that, these hearing aids can log geographical locations and keep track of them. Subsequently, it can utilize GPS to track the user's return visits to certain locations and notify them if they wish to modify or automatically switch preferred settings. Improved perception of speech based on the physical sounds available is achieved by automatic preference modification in both calm and noisy environments [24].

Voice priority processing (VPP), which uses AI parallel processing, is a feature of the new Syncro hearing aid from Oticon. Because it does not compare multiple outcomes, sequential processing—while potentially faster and more capable of selecting the preferred processing option—may lead to a less-than-ideal answer because of the unpredictable nature of communication in noisy environments. Conversely, parallel processing enables the optimal answer by processing and differentiating among results. Three techniques are used by the VPP to maximize speech production and noise reduction. TriState Noise Management divides noisy environments into several listening modes; voice aligned compression offers compression across an extended frequency based on 8 independent channels; and multi-band adaptive directionality offers a polar pattern for every frequency band. The user's signal is optimized via these several channels. Essentially, VPP uses the AI concurrently processing the system's decision-making capabilities to deliver the optimal voice-to-noise ratio [25].

Intelligent technology is able to recall configurations and applications from many contexts. It can accurately deliver the best hearing impression by scanning the surroundings and selecting the preferable options. The interface for Advanced Bionics Auto-Sound OS with high-quality Sound, which intelligently and automatically adjusts to every listening situation, has been made possible by a variety of sound combinations, including listening to music, lyrics, speech, and other sounds in quiet [26].

Conclusion

It is evident that innovative health care solutions are required as the general population aging and long-term diseases take centre stage in the healthcare system. Recent developments in AI have made it possible to develop novel, data-driven strategies for improving a range of medical applications, from improved diagnostic procedures to cutting-edge new gadgets. The usefulness of the different methods of machine learning employed in hearing aids has been made clear by this brief review. Machine learning algorithms should be incorporated into hearing aids because they facilitate automation, enhance speech recognition in noisy environments, speed up information processing, make audiologists' jobs easier, and increase user comfort. Its usefulness also extends to intra-operative monitoring and surgery, where it lowers mistakes. The research has also demonstrated that using these techniques improves performance. While some people may not be able to purchase hearing aids with cutting-edge capabilities at this time, these devices will soon become more inexpensive and enhance quality of life. AI-powered systems have a tremendous deal of potential to influence the way healthcare systems function in the future, despite the fact that there are still many obstacles to overcome in their implementation.

Bibliography

1. Copeland J. "Artificial Intelligence: A philosophical introduction". John Wiley and Sons; (2015).
2. Copeland BJ and Proudfoot D. "Artificial intelligence: history, foundations, and philosophical issues". In: Philosophy of Psychology and Cognitive Science. North-Holland; (2007): 429-82.
3. Esteva A., *et al*. "Dermatologist-level classification of skin cancer with deep neural networks". *Nature* 542 (2017): 115-118.
4. Gulshan V., *et al*. "Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs". *JAMA* 316 (2016): 2402-2410.
5. Komorowski M., *et al*. "The artificial intelligence clinician learns optimal treatment strategies for sepsis in intensive care". *Nature Medicine* 24 (2018): 1716-1720.
6. Wolfgang K. "Artificial intelligence and machine learning: pushing new boundaries in hearing technology". *Heart Journal* 72.3 (2019): 26-27.
7. Park G., *et al*. "Speech enhancement for hearing aids with deep learning on environmental noises". *Applied Sciences* 10 (2020): 6077.
8. Lee YC., *et al*. "A 2.17mW acoustic DSP processor with CNN-FFT accelerators for intelligent hearing aided devices". IEEE International Conference on Artificial Intelligence Circuits and Systems (AICAS) (2019): 97-101.
9. Chandrasekhar S S., *et al*. "Clinical practice guideline: Sudden hearing loss (update)". *Otolaryngology–Head and Neck Surgery* 161 (2019): S1-S45.
10. Byl F M Jr. "Sudden hearing loss: Eight years' experience and suggested prognostic table". *Laryngoscope* 94 (1984): 647-661.
11. Kuhn M., *et al*. "Sudden sensorineural hearing loss: A review of diagnosis, treatment, and prognosis". *Trends Amplifier* 15 (2011): 91-105.
12. Han X., *et al*. "Combined intratympanic and systemic use of steroids as a first-line treatment for sudden sensorineural hearing loss: A meta-analysis of randomized, controlled trials". *Otolaryngology and Neurotology* 38 (2017): 487-495.
13. Chang N C., *et al*. "Audiometric patterns and prognosis in sudden sensorineural hearing loss in southern Taiwan". *Otolaryngology–Head and Neck Surgery* 133 (2005): 916-922.
14. Fetterman B L., *et al*. "Prognosis and treatment of sudden sensorineural hearing loss". *American Journal of Otology* 17 (1996): 529-536.
15. Laird N and Wilson WR. "Predicting recovery from idiopathic sudden hearing loss". *American Journal of Otolaryngology* 4 (1983): 161-164.
16. Jun H J., *et al*. "Analysis of frequency loss as a prognostic factor in idiopathic sensorineural hearing loss. *Acta Otolaryngology* 132 (2012): 590-596.
17. Lim K H., *et al.* "Comparisons among vestibular examinations and symptoms of vertigo in sudden sensorineural hearing loss patients". *American Journal of Otolaryngology* 41 (2020): 102503.
18. Zhao Y., *et al*. "Machine learning models for the hearing impairment prediction in workers exposed to complex industrial noise: A pilot study". *Ear Heart* 40 (2019): 690-699.
19. Farhadian M., *et al*. "Empirical estimation of the grades of hearing impairment among industrial workers based on new artificial neural networks and classical regression methods". *Indian Journal of Occupational and Environmental Medicine* 19 (2015): 84-89.
20. Aliabadi M., *et al*. "Prediction of hearing loss among the noise-exposed workers in a steel factory using artificial intelligence approach". *International Archives of Occupational and Environmental Health* 88 (2015): 779-787.
21. Bing D., *et al*. "Predicting the hearing outcome in sudden sensorineural hearing loss via machine learning models". *Clinical Otolaryngology* 43 (2018): 868-874.

22. Uhm T., *et al*. "Predicting hearing recovery following treatment of idiopathic sudden sensorineural hearing loss with machine learning models". *American Journal of Otolaryngology* 42 (2021): 102858.

23. Mesgarani N. "Brain-controlled hearing aids for better speech perception in noisy settings". *Heart Journal* 72.9 (2019): 10-12.

24. Park G., *et al*. "Speech enhancement for hearing aids with deep learning on environmental noises". *Applied Sciences* 10 (2020): 6077.

25. Flynn MC. "Maximizing the voice-to-noise ratio (VNR) via voice priority processing". *Heart Review* 11.4 (2004): 54-59.

26. Hazama M., *et al*. "Efficacy of speech in noise using Naida Q90 CI, benefit of speech perception in noise with the latest noise reduction algorithm". *Journal of Heart Science* 8.2 (2018): 174.