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Review Article

Assistive Listening Device

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Abstract

Communication difficulties are a negative result of sensorineural hearing loss (SNHL) particularly in noisy and/or reverberant environments. Assistive listening devices(ALD) improve the signal-to-noise ratio (SNR) in different ways: by reducing background noise, minimizing effects of distant sound source, and compensating for poor acoustics as reverberations. ALD refers to any device assist individual hearing aids or cochlear implants to help individuals to detect surrounding sounds. ALDs are used to increase individuals' hearing ability in various conditions, as in the classes, theatres, religious institutions, and airports. They enable greater independence, reduce the stress of daily activities, and improve the quality of life for people with impaired hearing.

Keywords: Assistive listening device, ALD, FM, Electromagnetic transmission.

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Introduction:

Communication difficulties are a negative result of sensorineural hearing loss (SNHL) particularly in noisy and/or reverberant environments . [1] It's been proven that using hearing aids can be effective to compensate for impairment of hearing as regard loudness but not sufficient for difficulties with either temporal resolution or frequency and this is more evident in difficult listening situations. [2] Despite advancements in digital signal processing that try to separate the primary signal from unwanted sounds, the person with hearing loss still has communication challenges.[3]

Definition of ALD:

ALD refers to any device assist individual hearing aids or cochlear implants to help individuals to detect surrounding sounds. [4] some of them are used in large places like theatres, schools, churches, and airports. Some are made for individual use in small places and for private situations.

Who benefit from ALD?

According to (5)the following are circumstances where ALDs could be useful
for:

- Persons technology mild hearing impairment who are not recommended to use hearing aids but can take benefit from ALD in challenging surrounding environment.
- A person who uses hearing aids but suffering in different listening conditions (large spaces with reverberations such as theatres, classes where they cannot discriminate spoken words well)
- A person who is recommended to use hearing aids however he refused to use them as but at the same time he has no problem to utilize an ALD in their homes.
- People who have hearing loss and cannot benefit from hearing aids.
- For people with CAPD assistive listening devices also can be helpful . [6]

Advantages of ALD

As regards to SNR, noise, distance, and reverberation make a triangle of obstacles. ALDs increase SNR in different methods: by reducing background noise, minimizing effects of distant sound sources, and compensating for poor acoustics as reverberations . [7] ALDs approximates the microphone to the subject, so improving the signal-to-noise ratio and speech recognition . [8]

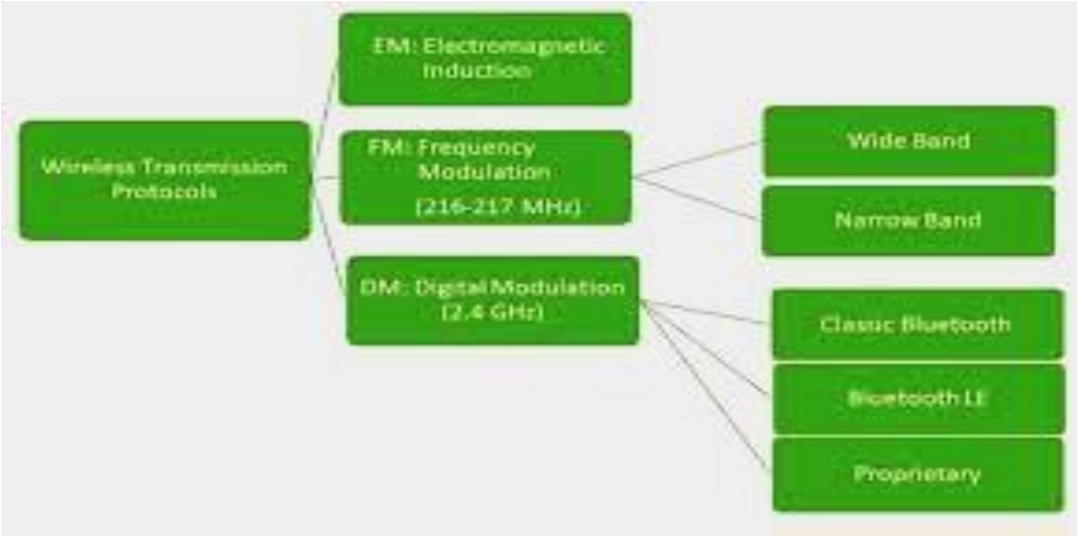
ALDs help to increase the ability of hearing for individuals in different listening conditions; as in classes, theatres, religious institutions, and airports. They enable greater independence, reduce the stress of daily activities, and improve hearing and communication for persons with hearing impairment . [7] In comparison to unaided and/or aided situations, alternative listening devices that include ALD increase behavioral measures of speech intelligibility. [9]

Parts of ALD

Generally, In ALD, the transmitter uses a microphone to capture sound from the source and then transforms it into an electrical signal. The signal is transmitted by wire or wireless transmission to the receiver, which in turn pass the detected signals directly to the hearing aid or transforms it to sound for the wearer. The negative impacts of distance and background noise are removed because the signal is transmitted electronically. The quality of the perceived signals which the user detects is very close to that of the signals coming directly from the source . [10]

Categories of ALD

- Hardwired These devices need wires to be connected with the microphone, amplifier, and receiver in the stethoscope earphone or ear mold. This type is designed for individual use and for use by physicians or health care providers to offer solutions to hearing-impaired individuals. In public situations, the selected seats are provided with the needed wires with the device and some types of the receiver such as a headset or an earphone can also be used [7] Hard-wired systems are also used in some TV listening devices.
- Wireless Current Wireless ALSs use one of these three technologies(figure1)



Fig(1)Types of categories of wireless communication between a talker and a listener. [3]

1- Electromagnetic transmission

In 1938, the Multitone VPM became the first wearable hearing aid incorporating a telecoil, or induction receiver . [11] An induction loop uses a microphone connected to an amplifier and wire loop to pick up a talker's voice, creating an electromagnetic field that replicates the original signal's frequency and strength. [3]

A current flows through the aid's amplifier when the individual who is listening wears a hearing aid with a telecoil that moves inside that electromagnetic field. The telecoil is sensitive to variations in the magnetic field surrounding the loop. It is therefore easier to hear speech over long distances, in reverberant environments, and when background noise is present since the signal from the speaker is received at a higher intensity than when it arrives at the hearing aid microphone . [3]

All manufacturers can use this kind of wireless connection, which is its primary advantage. There is no need to match the "channel" between the transmitter and the receiver because the transmission is direct rather than reliant on a carrier signal, making it easy to fit the induction receiver (a hearing aid with a telecoil) within the induction loop.Therefore, induction system technology is affordable and enables speaker-listener communication without the need for extra parts over long distances, in environments that reverberate, and when background noise is present . [3]

Electromagnetic transmission has drawbacks, such as the signal from near-room loops spilling over and power lines picking up stray electromagnetic energy, monitors for computers and certain smart watches. Moreover, compared to the original signal, telecoil signals are typically noisy, have less low-frequency energy, and fluctuate in strength as the head moves . [3]

2-Frequency Modulation (FM) transmission

From single-channel, body-worn transmitters and receivers in the 1980s to small, multichannel FM receivers integrated into behind-the-ear hearing aids in the 1990s, this technology has come a long way (12).The initial broadcasting applications for FM systems were in classrooms for children with hearing impairments. [10]

In most cases, FM overcomes the limitations of electromagnetic conduction. A carrier frequency, such as 72 to 76 MHz or 216 to 217 MHz, is used in FM systems to transmit the signal from the talker's microphone to the listener's receiver.FM systems can use a narrow-band or wide-band frequency spectrum to function. A radio-frequency carrier wave receives the frequency modulation of the sound signal. A transmitter sends the wave to a receiver that has the same frequency set. After that, the receiver recovered the original sound signal by demodulating the carrier wave. The user can receive the original sound signal by headphones, earphones,

or a digital audio input (DAI) connector or neck loop on a hearing aid. [10]

3- Digital modulation

The 2.4 GHz frequency spectrum, initially approved for public use by the Communications Commission, is where the DM protocols for wireless communication with ALD operate. It was made available to people with ALD in 2011. These two broad categories of digital streaming methods are proprietary and standardized. [3]

Compared to FM transmission, there is less chance of interference because the transmission operates inside the 2.4-GHz range. Bluetooth Classic version 4.0 and Bluetooth Low Energy are the two most widely utilized Bluetooth protocols with hearing aids. To use a Bluetooth connection, a device needs to be compatible with one or more of the subsets of Bluetooth profiles in order to use a Bluetooth connection. Bluetooth LE has lower power consumption and it has a smaller range and a slower data transmission rate than Bluetooth Classic . [10]

Other types:

Listening devices for telephones: For many years, people with hearing loss have been able to write messages using telecommunication devices for the deaf (TDD). The advent of sophisticated electronic communication devices, such as cell phones and personal computers (PCs), has essentially rendered this equipment obsolete. These technologies that enable TDD users to send messages in the correct format and make calls to regular phones are still in use to some extent . [7]

- **Television Listening Systems**

Television viewing can be done via wireless devices like FM, infrared and audio loop systems. Furthermore, basic amplifiers can be connected straight to televisions via earbuds or headphones. Another excellent option is closed captioning. Because most applications include background music or other noise that can readily interfere with amplified messages, the ability to read spoken words significantly improves understanding on this media [7]

- **Alarm/warning system**

Alerting or alarm devices alert users when a certain event takes place by using sound, light, vibrations, or a combination of these. Sound signals can be converted by the devices into horns, bed vibrators, flashing lights, or a light shaking for wake-up alarm systems and clocks. [7]

Limitations of ALD

However, ALDs have many advantages. ALDs also have a number of drawbacks. Many consumers find the physical appearance of ALDs to be undesirable. The majority of ALDs are larger and more visible than conventional hearing aids. Some people reject assistive listening devices because they believe they bring more attention to hearing loss than hearing aids. In particular, for older persons, the regular use and maintenance of assistive equipment can become exhausting. [13]

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