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HEARING AID- A HISTORY & TECHNOLOGY REVIEW

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ABSTRACT

A hearing aid is an electroacoustic device for improving the hearing ability of hearing impaired. It should be designed such that it is able to adjust the magnitude response of arbitrary input frequencies, have low power consumption for reasonable battery life, output should be provided with a low delay and the overall structure should be small in size. This paper gives an overview of the hearing aid staring with the causes for hearing loss, different ways to improve the loss, a brief history of the hearing aid & the technology behind the hearing aid.

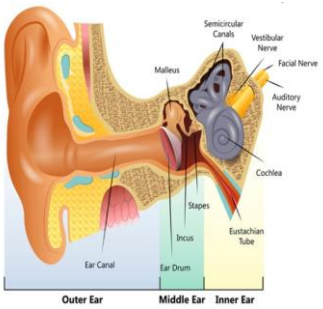
Key Words— Hearing Aid, Hearing loss

I.INTRODUCTION

Every human being are blessed with two ears, an organ which is used to hear the sounds surrounding us. But many people around us have hearing loss. Hearing loss happens when there is a problem with one or more parts of the ear, the nerves coming from the ears, or the part of the brain that controls hearing. About 3 in 1,000 babies are born with hearing loss, making it the most common birth defect. A hearing problem can also develop later in life. Human ear is able to hear within the frequency range of 20-20KHz[1]

How does a human ear work? [2]

The ear is made up of three different sections as shown in fig (1) : the outer ear, the middle ear, and the inner ear. These parts work together. The outer ear, or pinna , picks up sound waves and the waves then travel through the outer ear canal



Fig(1) A human ear

When the sound waves hit the eardrum in the middle ear, the eardrum starts to vibrate. When the eardrum vibrates, it moves three tiny bones in the ear. These bones are called the hammer (or malleus), anvil (or incus), and stirrup (or stapes). They help sound move along on its journey into the inner ear. The vibrations then travel to the cochlea, which is filled with liquid and lined with cells that have thousands of tiny hairs on their surfaces. There are two types of hair cells: the outer and inner cells. The sound vibrations make the tiny hairs move. The outer hair cells take the sound information, amplify it (make it louder), and tune it. The inner hair cells send the sound information to hearing nerve, which then sends it to brain, allowing hear.

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There are a few different types of hearing loss:

conductive, sensorineural, mixed (conductive and sensory combined), neural, and central.

Causes of Hearing Loss

- During birth
- Other problems can happen later because of an injury or illness, including: middle ear fluid; serious infections; head injury; listening to very loud music, especially through headphones; repeated exposure to loud sounds, such as machinery. Lots of kids have ear infections, which also can cause hearing loss. Permanent hearing loss from an ear infection is rare

Methods to improve hearing loss

- Use of hearing aid
- Cochlear Implants
- Implantable Hearing Devices
- Hearing Assistive Technology
- Captions
- Loop technology

The most common devices are **hearing aids**. These range from extremely tiny ones that fit completely in the ear canal, to ones that are placed behind a person's ear and that deliver sound into the ear canal via tubing and an earmold.

Hearing aids help the majority of people with mild-to-moderate hearing loss, for many people who have severe hearing loss. A **cochlea**r implant can be useful which consists of an internal and external component. The internal component is surgically inserted under the skin behind the ear, and a narrow wire is threaded into the inner ear. The external component, which looks somewhat like a behind-the-ear hearing aid, is connected to the internal one through the skin via an external magnetic disk.

There are some types of **conductive hearing** losses that can be surgically corrected or improved with hearing aids depending on the condition of the nerve. If not, hearing can be improved with: an implanted bone-conduction hearing device; a surgically implanted, osseointegrated device (for example, the Baha or Ponto System); Sound Bite Hearing System

Hearing Assistive Technology, or HAT as it is commonly referred to, is a technology that help in various listening situations, such as telephone communication, TV reception, ensure an effective smoke alarm, or listening in various kinds of public venues.

Captions are the written text of the spoken word

A **hearing loop** is a wire that circles a room and is connected to a sound system. The loop transmits the sound electromagnetically. The electromagnetic signal is then picked up by the telecoil in the hearing aid or cochlear implant.

II.THE HISTORY OF HEARING AID [3]

The first hearing aid- Ear Trumpets shown in fig (2)

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was created in the 17th century. Ear trumpets are tubular or funnel-shaped devices which collect sound waves and lead them into the ear. They serve as hearing aids, resulting in a strengthening of the sound energy impact to the eardrum and thus a better hearing for a deaf or hard-of-hearing individual.

Fig(2): Ear Trumpets

Next Frederick C. Rein establishes F.C. Rein and Son in London. It is the earliest firm known to manufacture hearing aids on a commercial basis. Rein's early products were non-electric hearing aids, such as ear trumpets, acoustic urns, and speaking tubes for churches.

Hutchison invented and Akouphone manufactures the first electric hearing device in 1898. Called the "Akoulallion" (from the Greek "to hear" and "to speak"), this model instrument used a carbon microphone and up to three pairs of earphones.

Earl C. Hansen invented and patented the first vacuum tube hearing aid. Called the "Vactuphone," the instrument was battery-powered and employed a single triode.

- In 1912 the first volume control for an electric hearing aid was introduced by the Globe Ear-Phone Company.
- In 1948 the first hearing aid with a printed circuit, the Solo-Pak from Allen-Howe Electronics Corp., was introduced.
- In early 1950's Transistor hearing aids were introduced and began replacing vacuum tube hearing aids.
- First, all-transistor hearing aid was introduced by Microtone, in January 1953
- Then the German company Akumed and the American company Otarion were the first to market electronic hearing aid eyeglasses.
- In 1955 Dahlberg, Inc. introduced the first so-called "in-the-ear" hearing aid, the D-10 Miracle-Ear for mild hearing loss. All the hearing aid components were concealed in a shell which was actually worn at the ear rather than in the ear.
- The first BTE (Behind the Ear) hearing aid with an integrated circuit, was introduced by Zenith in 1964
- In 1987 - The first digital hearing instrument, the Phoenix, was introduced by Nicolet.
- Later in 1991 Oticon in Denmark presented the first fully automatic hearing aid without a volume control. Called MultiFocus, it had two channel non-linear sound processing.
- In 2006 ELI was introduced by Starkey, enabling hearing aids to be compatible with Bluetooth-enabled mobile phones.
- InSound introduced Lyric, the first completely invisible deep-canal hearing aid in the year 2008.
- In 2009 Ginger Labs introduces soundAMP, an assistive software application that transforms the iPhone into an interactive hearing device.
- Siemens launched, Aquaris, a waterproof, dustproof and shock-proof hearing aid in 2011.

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III.TECHNOLOGY BEHIND HEARING AID

Hearing Aids are available in two types - analogue and digital.

Analog hearing aids simply convert sound into electric currents, boost the currents, and turn them back into louder sounds.

Digital hearing aids are more sophisticated. They convert the sound into a numerically coded signal and, depending on how they are designed, process and refine the signal before turning it back into a sound. Digital hearing aids can be tuned so they emphasize sounds of particular frequency or block out unwanted noise more effectively, whereas analog hearing aids tend to amplify everything (background noises as much as important sounds) by the same amount.

There are different types of hearing solutions available, but they all have the same five key components:

3.1. Mircrophone

The microphone on the outside of the hearing aid picks up sound from the air as it enters the ear and converts sound waves into digital signals

3.2. Microchip

A microchip - a miniature computer enables the expert Audiologists to customise the hearing solution

3.3. Amplifier

The amplifier strengthens the digital signals.

3.4. Battery

A tiny battery powers the hearing aid.

3.5. Receiver

The speaker converts the digital signals into vibrations that then pass through the inner ear to the brain.

How an analog hearing aid works? [7]Sound waves travel-1 toward ear (pink) and the hearing aid wearing behind it (blue). A small microphone-2 picks up the sounds and turns them into an electric current.

An amplifier circuit-3 (containing one or more transistors) increases the strength of the current. A small button battery-4 powers the amplifier circuit and other components. The amplified current-5 drives a small loudspeaker. The loudspeaker-6 plays its sound into a tube called the ear hook. The ear hook-7 plays the sound through the ear mold into ear canal

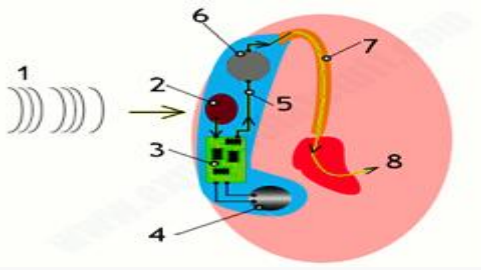

Fig (3) working of analog hearing aid.

Sound waves-8 of greatly increased volume travel to inner ear.A digital hearing aid works in much the same way, except that the amplifier chip digitizes the sound signals from the microphone, then processes and filters them before it amplifies them—producing much clearer sounds. It can be much more closely tuned to particular hearing difficulties and it automatically adjusts itself to different environments. Digital hearing aids analyze incoming sounds intelligently, do their best to figure out which sounds and sound frequencies you want to hear, and boost those selectively. Digital hearing aids use a combination of different techniques very broadly referred to as DSP (digital signal processing), including Gain adjustment, Compression, Sound classification, Speech enhancement, Feedback reduction, Noise reduction.Following are some of the features that are usually included in basic hearing aid technology. Channels; Directional microphone systems; Digital noise reduction; Impulse noise reduction; Feedback management systems; Telecoil ; FM compatibilityIn addition to the basic hearing aid technology, each major hearing aid manufacturer offers several levels of advanced digital technology such as Bluetooth compatibility; Wind noise reduction ; Data logging; Learning features ; Binaural processing;

IV.CONCLUSION

There have been significant improvements in hearing aids over the past few years. These improvements have allowed audiologists to provide amplification to patients who previously may not have been able to use hearing aids. Recent improvements also allow for greater ease and flexibility in the fitting process.. With the progression of microelectronics, the future of hearing aids looks quite promising. As the processing speed and memory in hearing aids

increase, the algorithms will become more sophisticated . Future developments in hearing aids will become more complex and will require combined efforts of psychoacoustics, signal processing, and clinical research conducted by audiologists. These improvements will attempt to better mirror the complex nature of hearing loss and use patient feedback to help achieve goals of providing improved devices for the population with hearing impairment. This paper is provided with a brief history of hearing aid & the technology review of the hearing aid.

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