Hearing Aided Device using Bone Conduction

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Abstract— Hearing is the process of receiving acoustic stimuli via the auditory system and converting them into auditory sensations. The auditory system consists of two ears and an associated neural network. The stimuli arriving at the ears are converted into mechanical vibrations and then they are converted into neural impulses There are two transmission pathways by which physical sound waves can be transformed into mechanical vibrations that stimulate the inner ear: air conduction and bone conduction.

Key words: Bone Conduction, Mechanical vibrations, neural impulses

I. Introduction

Hearing through bone conduction is the process of transmitting sound energy through vibrations of the skull or neighbouring parts of the body, which results in an auditory sensation. It is a secondary auditory pathway enhancing air conduction process. The sound waves impinging on the human skull from the surrounding environment and direct mechanical stimulation of the skull by a vibratory source can result in auditory sensation. So, the people who are hearing impaired can use the secondary auditory pathway as their primary pathway of hearing by hearing aided devices. The Bone conduction device uses magnets, axle, and few coils of copper for the transmission of sound vibrations to brain. The stimuli or audio from surroundings can be received by the mobile phones.

II. Construction of Bone Conduction Device

The Device mainly produces vibrations to the teeth of the person. The bone conduction device has been passing on the vibrations over bone with the sufficient power for music, which is to be on the frequency range of 20- 20,000 Hz. Bluetooth receiver is used to receive the signals from the transmitter of the mobile phone or audio jack is used for connecting the device and the mobile phone. The device consists of a set of magnets, rotor, copper brushes and bearings. The audio waves are transferred to the device by either Bluetooth or audio jack from the mobile phone. The device requires a minimum of 0.2 – 0.5Volts of direct current to work efficiently.

The energy is either can be obtained from separate battery or directly from the mobile phone that is connected to the device. The device consists of only copper wires and copper rotors as it is the good conductor. The copper wires are insulated with a thin layer called enamel. A specially designed application is required to run the device without any noise ambiance. The application can be developed based on the operating system of the mobile phone. The device basically consists of a metal rod. The copper rotor is fixed to the rod and the rotor is covered with the set of magnets. These magnets create a magnetic flux around the rotor. This rotor is attached with a pair of copper brushes in which the current is passed. When the audio waves are transferred to the device the current is passed to the copper brushes and it creates the vibrations in the rod.

III. Working of Bone Conduction Device

The device is connected with the mobile phone with Bluetooth or with audio jack which acts the audio input for the device. The device is placed on the teeth of a hearing impaired person. The application in the mobile phone catches the clear audio from the surrounding and it transfers it to the device. The application also records the audio from the surroundings and saves it locally on the device. The application not only catches the audio from surrounding it also plays the music and songs saved on the device. The application is specially designed for the bone conduction device which cancels the noise distortion from surroundings. The device consists of metal rod which is placed in between the teeth of the hearing impaired person. When the audio signals are sent to the device the current from the copper brush is transferred to rotor inside the device and due to electromagnetic repulsion the rod starts to vibrate. This vibration makes bone conduction and makes the person to hear the audio through their teeth. The vibrations can be controlled by the user by the application which is developed for the device.

The vibrations of the teeth coming from various directions vibrate the fluids in the cochlea. Neural impulses produced within the cochlea are sent to the brain to be interpreted as sound. The fact that recordings of our own voices made through an air microphone sound very different than the voice we hear while we are talking is because the microphone recordings do not account for what we hear through bone conduction. However the voice can be adjusted with help of the specially designed application. The device basically vibrates the maxilla and mandible bones which connects to the temporal and sphenoid bone where cochlea is located. The device produces vibrations in compressional mode, in which the skull is divided into a number of parts that vibrate in opposite directions, creating pulsating movements of the bony structure. Compressional inner ear mechanism, by which compressional vibrations of the temporal bones move cochlear fluids within their chambers (osseous pathways), is the result of the alternate compression and expansion of the cochlear shell in synchrony with positive and negative polarities of the impinging sound waves. It results from the fact that the cochlear fluid is incompressible and must yield under the influence of the opposite movements of the cochlear shell. The device requires additional power source for powerful performance this can be achieved by connecting additional batteries to it.

IV. ADVANTAGES OF BONE CONDUCTION DEVICE

Bone conduction device consists of metal rod which is made up of surgical steel so it doesn't cause infections to the person. The sound transmission through bone conduction has a precipitation of noise caused in the surroundings. The application designed for the bone conduction device allows the person to adjust the audio quality based on their comfort. The bone conduction device can also be used in communication systems. It can be used for military forces for information exchange. The device can be used in the environments when the listener does not want to have his or her ears covered, when the listener does not want someone to know that she/he is listening to something. In these situations, listening through bone conduction allows for stimulation to the ears without interfering with the pinnae. Another main advantage of this bone conduction device is it is highly cost efficient.

V. APPLICATIONS OF BONE CONDUCTION DEVICE:

The Bone Conduction device consists of several applications such as:

A. Communication:

This device was designed to provide audio information through bone conduction; the application designed for device allows the people with normal and impaired hearing to use the same mobile phone. As this device is connected to a mobile phone it allows people to make or receive phone calls through the application of the bone conduction device.

B. Entertainment:

This device can be used for entertainment purpose such as it can be used for listening music. The application designed for bone conduction device allows the user to play both video and audio through mobile phone, where the audio signals are passed to the bone conduction device.

C. Assistive Device for Skydivers:

As the bone conduction device cancels the noise ambiance of the surroundings it can be used by the skydivers for the communication between other divers. The device is kept in the mouth of the person for the transmission of audio signals to brain.

D. Hearing Assistive:

The bone conduction device is placed in the teeth of the hearing impaired person. The audio signals are transferred to the brain through vibrations of the teeth. The mobile phone is used as the audio receiver from the environment. So this device can be used as a hearing assistive device by the hearing impaired person.

VI. LIMITATIONS OF BONE CONDUCTION DEVICE

One of the primary disadvantages of the use of bone conduction device in quiet environments is that vibrators can demonstrate undesirable amounts of aerial leakage. This sound, depending on its intensity, can be heard by listeners in the immediate vicinity of the person receiving the message. As the device is placed in the teeth of the user he/she cannot speak while he/she is listening.

VII. CONCLUSION

Audiologists have long felt that the phenomenon of hearing through bone conduction was well understood. Simply put, the bones of the skull are set into motion, which vibrates the cochleae that are surrounded in bone, and these vibrations are translated into neural impulses that are perceived in the brain as sound. The more technologically oriented society becomes, the more receptive people are to explore new ways to sense the world and communicate during adverse listening conditions. There are many potential future applications of bone conduction as a method of sound transmission.

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