Low Cost Skin Sensory Hearing Assisted Device for Profoundly Deaf Individual

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Abstract— An individual with profound deafness or total hearing loss has a hearing threshold of 80dB or more. The ineffectiveness of hearing aids, surging costs and complex surgeries for cochlear implants have discouraged many to opt for these types of treatments. Hence, this project focuses on providing assistance for deaf individuals through a multi-faceted approach. The system utilizes a sound sensor to detect environmental sounds, which are then translated into vibrations using a vibration sensor, allowing users to perceive auditory information through tactile feedback. Additionally, Python's vibration-to-text conversion is employed to convert spoken words into text, enabling seamless communication. The textual data is transmitted to an Arduino Uno via serial communication, enhancing accessibility and facilitating a more inclusive environment for the deaf community by bridging the gap between auditory information and tactile or visual feedback.

Keywords: Profound deaf, Sound Sensor, Hearing device, Vibration pattern, Skin sensory, Stimulation, ArduinoUno

1.INTRODUCTION

The World Health Organization (WHO) has adopted a grading system based on audiometric measurements to standardize the way in which severity of hearing loss of a person is reported. According to WHO, a profound deafness is defined as a person who has a hearing threshold of 80 to 95 decibels (dB). A person with complete or total hearing loss has a threshold of 95dB or more. On the other hand, a normal hearing person has a hearing threshold of less than 20dB.Furthermore, they stated that almost 30 million people worldwide have profound or complete hearing loss in both ears. Based on their reported statistics on number of people with moderate or higher levels of hearing loss, 80% are from low income and middle-income countries as opposed to 20% that are from high-income countries.

A hearing aid[1] or a cochlear implant is the common solution for individual that are profoundly or severely deaf. The purpose of hearing aid is sound amplification; therefore, it is more suitable for mild hearing impairment. This is due to the fact that a mild hearing impairment person can hear sound to a certain loudness but soft sound is hard to hear. On the other hand, a profound hearing lost person would not be able to hear anything. Besides that, the treatment based on cochlear implant is too costly and involves complex and risky surgery. In addition, hearing-impaired users still encounter substantial practical and social challenges with the use of this aid. At present, sign language and speech-reading are commonly applied in schools for the deaf.

These devices send perceptual signals in the forms of forces or through electrical inputs to the user's skin and body as skin plays an important role in perceiving and interacting with the environment. The aim of this project was to develop a hearing aid that stimulates "hearing" through skin sensory which is more affordable and accessible for the profoundly deaf or total hearing loss community. Hence, we embarked into this project on hearing through skin sensory seems to be a promising area for the beneficial of the society of profound hearing people in terms of safety and affordability.

II. EXISTING METHODOLOGIES

Hearing aids are primarily useful in improving the hearing and speech comprehension of people who have hearing loss that results from damage to the small sensory cells in the inner ear, called hair cells. This type of hearing loss is called sensorineural hearing loss. The damage can occur as a result of disease, aging, or injury from noise or certain medicine.

A hearing assisted device magnifies sound vibrations entering the ear. Surviving hair cells detect the larger vibrations and convert them into neural signals that are passed along to the brain. The greater the damage to a person's hair cells, the more severe the hearing loss, and the greater the hearing aid amplification needed to make up the difference. However, there are practical limits to the amount of amplification a hearing device can provide. In addition, if the inner ear is too damaged, even large vibrations will not be converted into neural signals. In this situation, a hearing assisted device would be ineffective.

ADVANTAGES OF SKIN SENSORY ASSISTED DEVICE

A skin sensory hearing device is a type of hearing aid that uses bone conduction technology to transmit sound vibrations through the skin and bones of the skull directly to the inner ear, by passing the outer and middle ear. Here's an expanded explanation of the provided advantages:

- Discreet design:

Skin sensory hearing assisted devices[5] typically designed to be discreet and less noticeable than traditional hearing aids, making them a more aesthetically pleasing option for those who are self- conscious about wearing hearing aids.

- Comfort:

Since skin sensory hearing devices do not require insertion into the ear canal, they can be more comfortable to wear for long periods of time.

- Improved speech understanding:

Skin sensory hearing assisted devices can help improve speech understanding in noisy environments by transmitting sound vibrations directly to the inner ear, bypassing any interference from background noise.

- Accessibility:

Skin sensory hearing assisted devices may be a good option for individuals who have difficulty wearing traditional hearing aids due to ear canal issues or other physical limitations.

- Customizable settings:

Skin sensory hearing assisted devices offer customizable settings and adjustments to suit the individual's specific hearing needs and preferences.

- Safety:

Skin sensory hearing assisted device is more safety and very affordability

- PROPOSED METHOD

The proposed method involves the integration of hardware and software components to create a comprehensive assistive technology system for individuals with hearing impairment. Firstly, a sound sensor is employed to capture environmental sounds, and the obtained data is processed using an Arduino microcontroller. Subsequently, a vibration sensor is utilized to convert the processed sound data into tactile feedback. In parallel, Python's voice-to-text conversion is implemented to transcribe spoken language into text format. The textual information is then transmitted to the Arduino through serial communication. The Arduino microcontroller processes the incoming data and triggers the vibration sensor accordingly, allowing users to feel and interpret auditory information through tactile cues. This combined hardware and software approach aims to provide a real-time and effective communication tool for the deaf community, enhancing their interaction with the surrounding auditory environment.

HARDWARE COMPONENTS

- ARDUINO UNO

The spectrum analyser measures and displays the amplitude of a given input signal to a full frequency ranges with led matrix indicators. Its main purpose is to measure the strength of the spectrum of both known and unknown signals. This audio spectrum analyser enables us to see the frequencies present in audio or sound spectrum and produces the graph of all the frequencies that are present in a sound source in real time. The Arduino is a microcontroller board that contains everything needed to support the microcontroller to create a led audio spectrum matrix. The board is equipped with sets of digital and analogue input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

The microphone captures external sounds and converts them into electrical signals that are processed by the device. The microphone plays a crucial role in picking up sounds from the environment and transmitting them to the processor for amplification.

C.SOUND TO VIBRATION ACTUATOR DRIVER

An electret microphone preamplifier will pick-up the audible signal from the surrounding and amplifies it through a first stage operational amplifier to a process able signal. The signal will then pass through a second stage amplifier comparator to increase the voltage level high enough to drive the vibrator or actuator. A transistor interface is used to drive the vibrator or actuator in accordance with the sound received from the electret microphone.

- BATTERIES

Skin sensory hearing assist devices are typically powered by rechargeable or disposable batteries. The battery provides the necessary power to operate the device and ensure continuous functionality throughout the day.

- PREAMPLIFIER

Preamplifier is a crucial component responsible for amplifying the incoming sound signals captured by the microphone before they are processed and transmitted to the transducer for bone conduction. The preamplifier boosts the weak electrical signals generated by the microphone to a level that can be effectively processed by the device's signal processing algorithms and transmitted through the skin to the inner ear

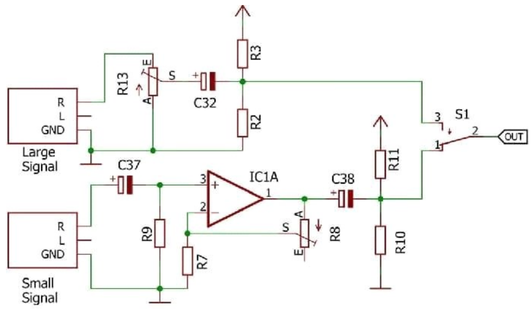

Figure 1. Schematic diagram for preamplifier

- CONTROL BUTTONS

Skin sensory hearing assist device come with control buttons that allow users to adjust volume levels, switch between listening modes, and activate additional features. These buttons provide users with flexibility and control over their listening experience.

Figure 5. Control Buttons

- PROJECT IMPLEMENTATION

A sound transducer uses electrical energy to produce mechanical vibrations to disturb the surrounding air to produce sound regardless of whether the frequency is audible or inaudible. Audio Sound Transducer includes an input sensor that transforms sound into an electrical signal such as a microphone, and an output actuator that transforms the electrical signals back into sound, such as a loudspeaker.A preamplifier converts a weak electrical signal into an output signal, which is powerful enough to be noise tolerant. Absence of this will cause the output signal to be noisy or misleading. Due to this, the preamplifier is frequently located near to the sensor which reduces the effects of noise and other interference. A frequency filter is an electrical circuit that either stops or passes frequency from electrical signal with respect to specific frequency needed for further process. There are two types of filters, passive filter which uses passive components, and active filter that uses active components. Audio spectrum analysers are commonly used by sound engineers for various applications. Measuring the frequency response and analysing distortion characteristics of different types of audio tools are some of these applications. Micro actuators are active devices proficient of producing mechanical motion of solids or fluids. Hand phone coin vibrator is taken from the concept of cell phone vibration motor. We developed a simple single audio signal vibration array, which is based on the LM3915 Dot/Bar Display Driver and an electret microphone.

III.CONCLUSION

Despite the advancement of various hearing devices that improve the life of profoundly deaf people around the globe, there are still many limitations and drawbacks, which emphasizes the need to further improve such technologies. Device have developed four initial vibrating transducers with single spectrum, which were strapped to a belt. Upon wearing the belt, the profoundly deaf persons are able to feel the vibrating stimulation on their skin and accurately stated the directions of the sounds. The results from this study have been promising for the first phase of the design, development and tests. This serves as a motivation for further development to the second phase of this hearing aid which is currently on going. The study of "hearing through the skin" is very promising and leads to affordable and safe solutions for the profoundly deaf people. As far as we are aware, adopting the concept of audio spectrum analyser for developing hearing aid has not been previously studied. Future studies should investigate and address how various types of sound stimulated through theskin by devices such as the belt used in this study, can be interpreted and identified by the profoundly deaf individual.

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