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RESEARCH ARTICLE

Design and Implementation of Hearing Aid for the Hearing Impaired

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ABSTRACT

Hearing loss, also famously seen as hearing injury is a limited or entirety failure to hear. Hearing aid is an electro-acoustic device designed to amplify sound signal. This research work titled "Design and Implementation of Hearing Aid for the Hearing Impaired"is aimed at amplifying audio signal, to pick up sound that are within the range of 20Hz to 20kHz frequency and take it up to 10meters to balance the audible range damage for individuals with hearing difficulties. This battery-powered digital hearing aid is achieved by the use of high pass and low pass filter which filters unwanted background noise to enable a clear sound. Its integrated circuit possesses a microphone (input transducer) which amplifies the audio signals received and converts it into electrical signals. The electrical signal is then passed through an amplifier which increases the sound capacity and sent it to a receiver (output transducer) which changes back the electrical signal back into sound and directs it to the ear. This work comprehensive design was implemented, tested and its performance substantiated very acceptable.

Keywords: *Digital, Hearing, Microphone, Transducer, Amplification*

1. Introduction

5.3 percent of earth's population suffers from hearing loss and noise is one of the major causes of hearing loss. The human auditory system can generally perceive sounds within the frequency range of 20 Hz and 20 kHz hence the frequency range between 100Hz and 6 kHz contains most information of human voice. The receptiveness of hearing requires sufficient functioning of auditory portion along with proficient ear, however humanoid deafness and hearing loss most commonly occur due to damages in the ear. Hearing loss is usually referred to people who have relative insensitivity to sound in the speech frequency range (Bauer, 2000).

Hearing loss can be defined by the degree and configuration of the loss in hearing. The degree categories include the normal range (0 to 24dB), the mild loss (25 to 45 dB), the moderate loss (46 to 65 dB), severe loss (66 to 85 dB), and profound loss (greater than 86 dB) (Berger, 1997).

However, the three types of hearing losses arethe Sensory Neural Loss, Conductive Loss and Mixed Hearing Loss.Patients suffering from sensory neural loss have some kind of damage to the auditory nerve. Some of the auditory nerves do not properly resonate with their designated frequencies and are not able to send short pulses to the brain. In conductive loss, the middle ear gets damaged and does not receive sound signals appropriately (Goldstein, et al., 2003). The mixed hearing loss is as a result of both conductive and sensory neural loss. The Sensory neural loss could be treated by using hearing aids, which magnifies the sound signals or cochlear implants to stimulate the nerve cells directly (Miller, et al, 1975); Magotra, 2000). The nerve cells convert them to pulses which are then decoded by the brain. In case of conductive loss if the middle ear is not totally damaged hearing aid device would help by amplification of the signal in band of interest. Figure 1 below shows the depictive diagram of the types of hearing loss (Ritwik , 2016).

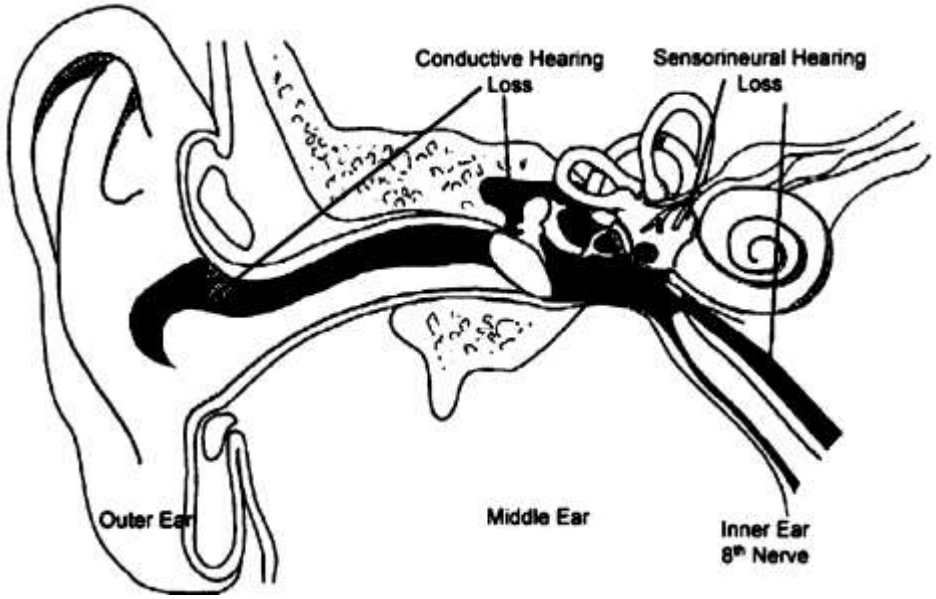

Figure 1: Types of Hearing Loss

The constructed device can improve the quality of sound for people with hearing loss. The circuit is an integrated circuit which amplifies all the signals picked by the condenser microphone and converts them back into sound and sent to the ear. It is a battery-powered electronic device that can amplify sound for people with hearing loss. The amplification function of the hearing aid is made possible with a microphone-input transducer which picks up sound and converts it into electrical signals, an amplifier which increases the volume or the sound, a receiver-output transducer which changes the electrical signal back into sound and sends it to the ear. The hearing aid is an electronic device that makes sounds louder and helps to offset hearing loss.

Block Diagram of the Design

The block and circuit diagram of the hearing device is as shown in figure 2 and figure 3 respectively. It is made up of the power supply (DC9V), input transducer (microphone), pre-amplifier, amplifier and the output transducer (earphone).

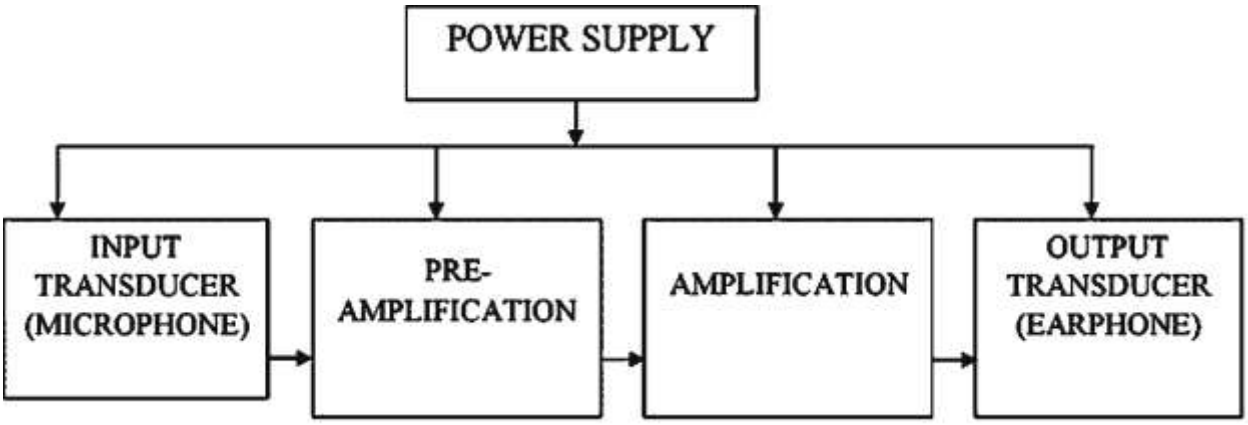

Figure 2: Block Diagram of a Hearing Aid

The 9 volt battery was used for the power supply. The condenser microphone picks up sounds and sends to pre-amplifier for provision for channel into the amplifier section for additional amplification. The pre-amplifier amplifies the signal, controls its volume, and perhaps changes its input impedance. The pre-amplification was designed using an NPN transistor BC547 along with some capacitors and resistors. In the circuit diagram shown in figure 3, transistor Q1 and its associated components form the audio signal pre-amplifier stage.The audio signal is converted into corresponding electrical signals. Resistor R1 biases the internal circuit of the low-voltage condenser microphone for proper operation. The audio output from the pre-amplifier stage is fed to the input of the amplifier circuit via capacitor C3 and volume control V1. The output transducer changes the enhanced signals back into sound waves that the brain can properly perceive. The electrical signals are converted into acoustical output signals or sound waves and are directed into the ear canal. The loudspeaker (LS1) is a 32 ohm earphone which served as the output transducer.

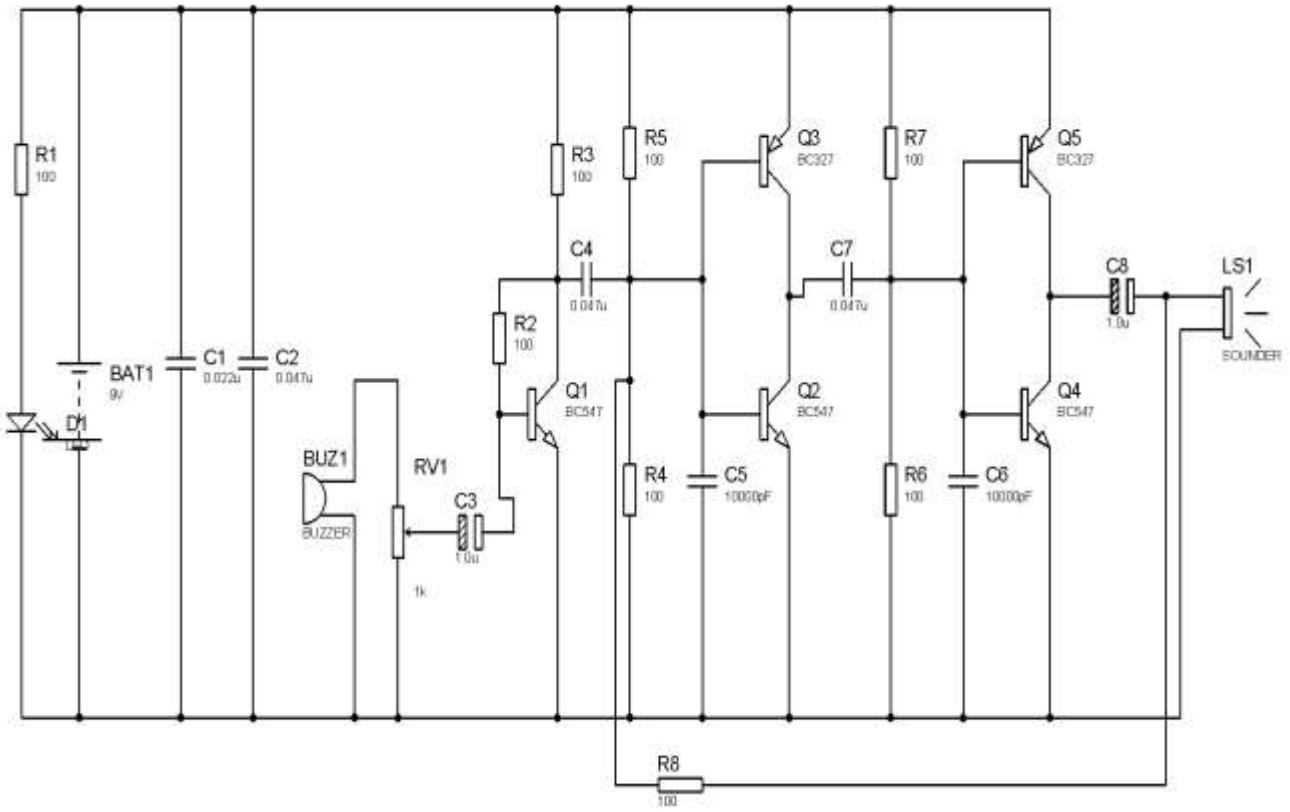

Figure 3: Circuit diagram of Hearing aid

System Testing and Integration

After the design and implementation phase, the system built has to be tested for durability, efficiency, and effectiveness and ascertain that the design is working properly. The system was first assembled using a breadboard. All components were properly inserted into the breadboard from where some tests were carried out at various stages.

To ensure proper functioning of components, the components were tested using a digital millimeter. Resistors were tested to ensure that they were within the tolerance value. Faulty resistors were discarded. The BC547 transistors were also tested, the resulting output was 5.02V which is just a deviation of 0.20v from the expected result of 5.00v. The LED was tested to ensure that they were all working properly.

Result

The results obtained from the various test performed show that the system units and the system as a whole work effectively and efficiently as amplified sound was produced by the output transducer (earphone). However, a noisy output is produced when the hearing aid is close to an electrical wave signal and when close to noisy environment. This is because the diaphragm of the microphone is very sensitive to noise and to electrical waves.

Conclusion

The Hearing Aid designed and constructed is for amplifying sound that will be audible for easy hearing, most especially for the impaired people. It also filters background noise and increases speech signal from afar like a distance of 20KHZ to be heard clearly.

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