HEARING AID FOR IMPAIRED PEOPLE

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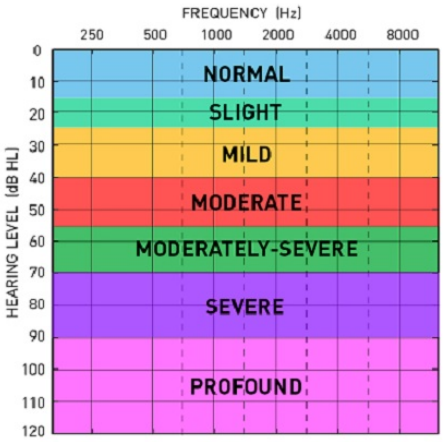
Abstract - Hearing Aids are sound amplifying devices designed to aid people who have hearing impairment. Traditional analog hearing aids essentially amplify all sounds (speech and noise) in the same way. Hearing deficiency can increase sensitivity to certain sounds and diminish sensitivity to other sounds. Whereas digital hearing aids can distinguish between the actual speech and the background noises thus amplifying the required sound and filtering out the other .They also have greater flexibility in hearing aid programming so that the sound they transmit can be matched to the needs for a specific pattern of hearing loss. With the help of digital signal processing, Digital hearing aids perform better than analog hearing aid. We can achieve better signal to noise enhancement, flexible gain , feedback cancellation, noise reduction etc. Through this project we have simulated a simple digital hearing aid using MATLAB programming language. Noise reduction filter, Frequency shaper function and amplitude compression function are used in this project. The project is designed for different levels of hearing losses.

Introduction

Hearing loss is partial or total inability to hear. Hearing loss may be present at birth or acquired at any time afterwards. Hearing loss normally happen because of aging.The severity of hearing loss is categorized according to the increase in intensity of sound above the usual level required for the listener to detect it. In total deafness, no sounds at all, regardless of amplification or method of production, can be heard. Speech perception is another aspect of hearing which involves the perceived clarity of a word rather than the intensity of sound made by the word.Human hearing extends in frequency from 20 to 20,000 Hz, and in intensity from 0 dB to 120 dB HL or more. 0 dB does not represent absence of sound, but rather the softest sound an average unimpaired human ear can hear; some people can hear down to −5 or even −10 dB. Sound is generally uncomfortably loud above 90 dB and 115 dB represents the threshold of pain. Hearing loss can b e identified using spectrograms and audiograms.An audiogram is a graph that shows the audible threshold for standardized frequencies as measured by an audiometer. The Y axis represents intensity measured in decibels and the X axis represents frequency measured in hertz.



Spectrogram is a visual representation of the spectrum of frequencies of a signal as it varies with time. The threshold for different types of hearing are:

Classification hearing loss	Hearing level
Normal Hearing	-10 db to 26db
Mild hearing loss	27db to 40db
Moderate hearing loss	40db to 70db
Severe hearing loss	70db to 90db
Profound hearing loss	Greater than 90db

Hearing aids are sound-amplifying devices designed to aid people who have a hearing impairment.Most hearing aids share several similar electronic components, including a microphone that picks up sound; amplifier circuitry that makes the sound louder; a miniature loudspeaker (receiver) that delivers the amplified sound into the ear canal; and batteries that power the electronic parts.Hearing aids differ by:

1. design
2. Technology used to achieve amplification (i.e., analog vs. digital)
3. special features

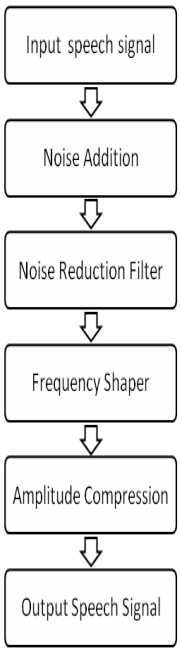
Some hearing aids also have earmolds or earpieces to direct the flow of sound into the ear and enhance sound quality. The selection of hearing aids is based on the type and severity of hearing loss, listening needs, and lifestyle.

Digital hearing aids are preferred over analog aids as they are programmable and they convert sound waves into digital signals and produce an exact duplication of sound. Computer chips in digital hearing aids analyze speech and other environmental sounds. The digital hearing aids allow for more complex processing of sound during the amplification process which may improve their performance in certain situations (for example, background noise and whistle reduction). They also have greater flexibility in hearing aid programming so that the sound they transmit can be matched to the needs for a specific pattern of hearing loss. Digital

hearing aids also provide multiple program memories. Most individuals who seek hearing help are offered a choice of only digital technology these days.

Methodology

Flowchart



The above block diagram is implemented using MATLAB. The implementation can be done using the Digital Signal Processing and Audio Tool Boxes available in MATLAB. The input speech signal goes through a process where noise addition, Noise filtering, Frequency Shaping, Amplitude Compression functions are implemented after which we get the final output speech audible to hearing impaired people. The detailed description of process is as follows:

1. **Noise Addition-** To simulate real situation some noise is added to the clean input signal.

Using MATLAB function, adaptive noise gaussian function (AWGN) is added to input along with random noise. Noise (AWGN) has a continuous and uniform frequency spectrum over a specified frequency band and has equal power per Hertz of this band. It consists of all frequencies at equal intensity and has a normal (Gaussian) probability density function.

2. **Noise Reduction-** Noise is reduced using wavelet filter function in MATLAB. Since the major requirement of hearing aid is to differentiate between Actual signal and noise. So noise is removed using reduction filter function.
3. **Frequency Shaper-** Most people face difficulty hearing high frequencies. Hearing aid amplifies all signal rather than the required signal. So frequency shaper is used to correct hearing loss at certain frequencies. Higher gain is applied for higher frequencies. The signal is shaped according to the transfer function as the gain coefficient is added to incoming signal from gain vector table after application of frequency shaper function.
4. **Amplitude Compression-** Amplitude compression function is for the gain control of the signal. The amplified signal should be less than the saturation power else the sound signal disrupts comfort.

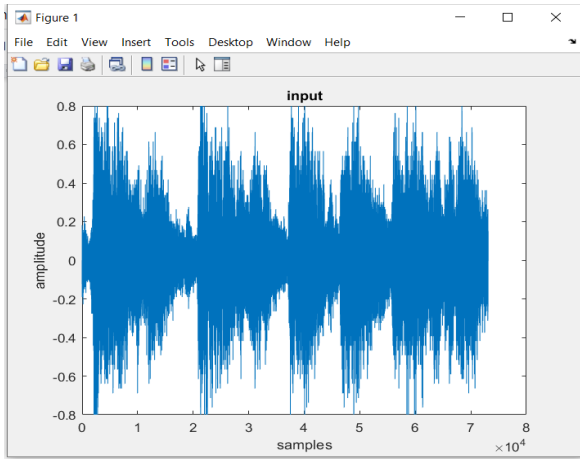
By using this procedure Frequency Shaping transfer function Magnitude vs Time Graph and Spectrogram is plotted. The same procedure can be used for different levels of hearing losses.

Simulation and Results

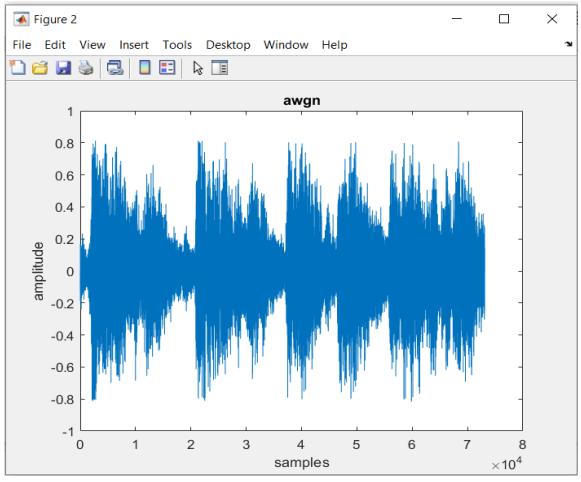
The code is written in MATLAB, first the input signal is loaded and then Adaptive white gaussian noise and random noise is added before the signal is processed through different functions to get an output audible to hearing impaired person.

The patient suffers moderate hearing loss with threshold of hearing 40db, threshold of pain 90db and have difficulties to hear high frequencies.

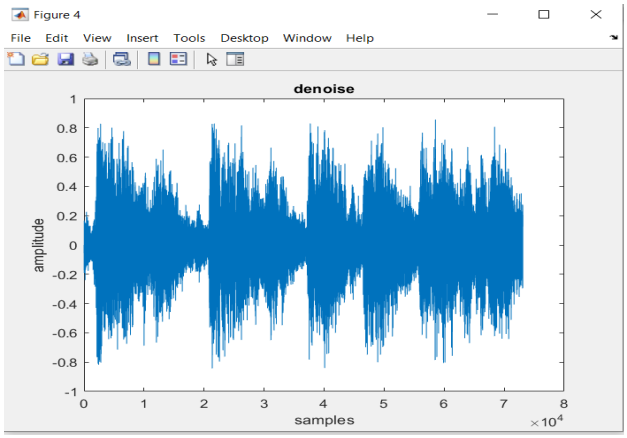
Here the input signal is plotted with amplitude plotted against samples.



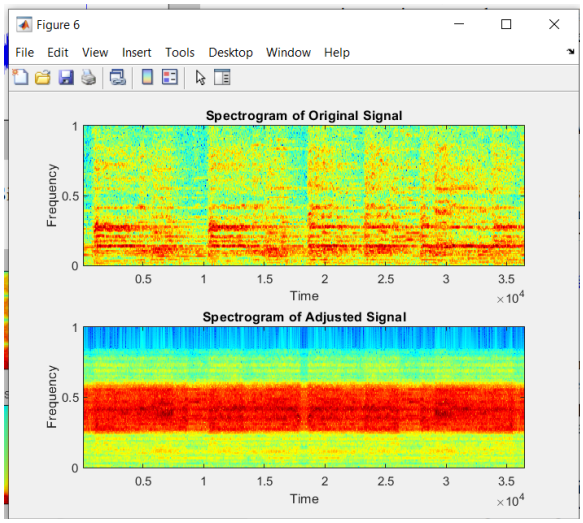
Next AWGN and random noises are added to the input signal to simulate real life situation. The signal after noise addition is shown:



After this denoising of the signal is done. The signal is shown below:



The spectrogram of input signal and adjusted signal is shown below:



Spectrogram is plot of short time fourier transform of signal or to plot the different frequencies on time axis. The brighter color indicates more energy.

Conclusion

Thus the digital hearing aids are more flexible as the signal can be improved and be made suitable for the listener. Digital Hearing Aids allow noise reduction, frequency shaping and amplitude enhancement. The signal is amplified depending on user requirements which

eliminates the issues with traditional hearing of amplifying sound along with noise. Due to digitalization of signals in digital hearing aids the signals can be analyzed and filtered according to needs of user.

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