Hearing loss Detection through Audiogram in Mobile Devices

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Abstract - Hearing loss detection through audiogram in mobile devices (HearAssist) is a mobile software project which is an attempt on creating an android application to demonstrate Android smartphone as an educational tool for hearing impairment. Hearing correction in Mobile devices is a software system which aims to help people with mild to moderate hearing loss, by first creating a medically accurate audiogram report of the audibility of the user and then using the audiogram graph to also generate a textual report for the convenience of the user. Apart from this, all the reports generated across any and all devices are stored online on a database for generating and visualizing trends of hearing capabilities of users across various age groups.

Key Words: **Audiogram, Audiometry, Android, Hearing Aid, trends.**

1. INTRODUCTION

According to WHO (World Health Organization) over 466 million people in the world have some sort of hearing loss and it is estimated to go to around 900 million or One in Ten people by 2050. Hearing loss is not just limited to old people in today's world as technology has moved so forward and auditory systems have become better than before, most of us tend to use earphones, speakers or any related audio devices beyond the safe limit without thinking of the repercussions. This has resulted in a growing trend in some sort of hearing loss in young people ranging from 18 to as old as 25 years of age.

The audiogram report is the most efficient and easily accessible generated method to detect any sort of hearing loss a person may or may not have. Since the standard hearing capacity for humans is from 20Hz to 20KHz the audiogram generating devices are designed in a particular way to play frequencies ranging from 250, 500, 1000, 2000, 4000 and 8000 Hz at decibels ranging from 0 to 100 db.

Existing traditional audiogram generating devices are huge and bulky which require a specific setting and a pre-registered appointment which is more time consuming to receive the full report. Our proposed software aims to eliminate the whole process by helping the user to take up the test and generate the audiogram results in both, graphical and textual format. The reports of the conducted tests are displayed on-time on the Android powered mobile device in the comfort of the users' home with nothing more than just a good quality of earphones to use for.

2. EXISTING SYSTEM

2.1 Traditional Audiogram and Hearing Aid Device

An audiometry test can be performed at Audiology department of a hospital. A GP audiologist presence is required at the time of test conduction. These human efforts can be reduced, since no inspection is required while conducting the test on the smartphone device. The devices at the laboratory are expensive and also require high maintenance, also the environment of the room needs to be adjusted. Overall process is tiresome of both the parties involved which involves man power and money, which we aim to eliminate. [1] [2]

2.2 Existing Software Audiogram System

The existing software available in the market can be used to customize the physical hearing aid device to modify the levels of volume/volume level. Also provides the flexibility to adapt according to the changing environments around the user. The feature this software lacks is Audiogram generation. On top of that the values are manually inserted to the software to generate result. Audiograms generated are only in the form of graphs which may not be totally understandable to the user. [3] [4]

3. PROPOSED SYSTEM

The proposed system tends to eliminate or overcome the previous shortcomings. Here we aim to create a medically accurate audiogram for which the user has to give inputs for the frequencies he will hear through the application. We achieve this by using the same frequencies which are used when someone takes an audiogram test at a lab, but instead on a mobile device which is more than capable to output these frequencies after the which the user is asked to give an input whether he can listen to the frequencies in the particular intensities or not. Once all the frequencies are played and the user gives all the inputs, the application then creates an audiogram based on these results along with the textual report for the user to view. [8]

Every test taken on the application is automatically stored on the cloud through google sheets API which can be used to check out trends for different age groups for the hearing loss classification.

4. SYSTEM ANALYSIS

4.1 Data analysis and trends

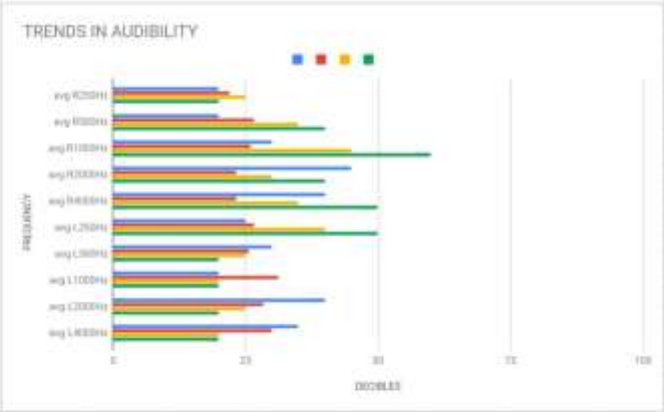

Chart-1: Google sheets data visualization
Front-end layout for the user-based application

4.2 Front-end layout for the user-based application

Fig -1: Mobile based application for the user

4.3 System overview block diagram

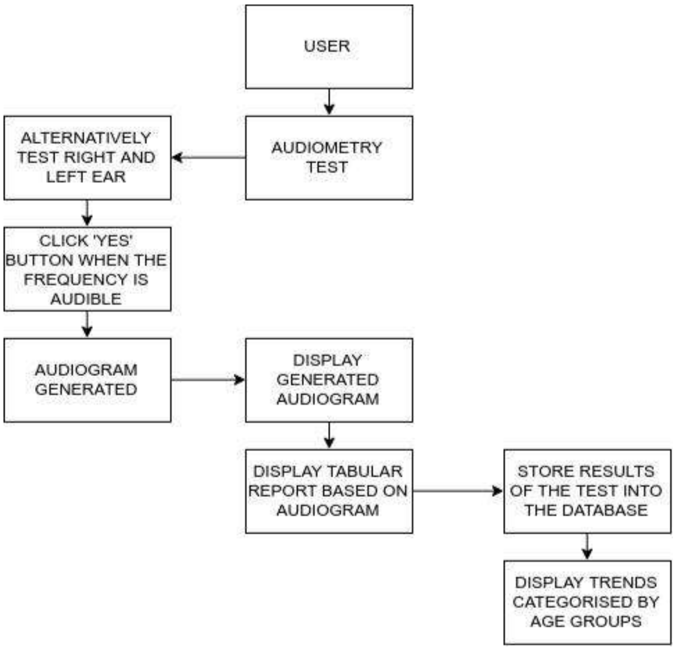

Fig -2: Functional block diagram of proposed system

4.4 Proposed system algorithm

1. Click 'Perform Test' to start the Audiometry test.

2. Left ear testing starts:

   a) Frequencies (250Hz, 500Hz, 1000Hz, 2000Hz and 4000Hz) will be played one after the other at various intensities (in dB) to generate an Audiogram. [7]

   b) The user has to respond with 'Yes' or 'No' according to audibility he/she can hear it or not. [7]

3. The same process will be repeated for the right ear. An audiogram will be generated using these inputs and will be displayed to the users.

4. A tabular representation is shown of the audiogram as a textual report.

5. The data collected from the user is send to google sheets along with the age category.

6. The data collected on google sheet is used to display a graph to show trends in hearing capabilities as per age groups.

5. IMPLEMENTATION OF SYSTEM

5.1 Frequency Generation

Required frequency is being generated using basic Digital Signal Processing methodologies. By defining duration as 5 seconds and sampling rate as 44100 Hz, we calculate number of samples and we provide required frequency which we want to generate. The frequencies range from 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz. The selected frequency is outputted at an intensity of 40dB via earphones. The intensity is incremented by 10 if the user's response is no and decremented by 10 if the response is yes. The input values are collected in the threshold array. We create an array of samples using sampling rate and frequency of the tone, which we then convert into 16-bit PCM sound array. Now we create an object of AudioTrack class to which we pass sample rate, number of samples along with streamType, channelConfig, audioFormat and mode. This object is then written in generatedSound which is then played using play method. [10]

5.2 Audiogram Generation

GraphView library is imported to implement real time graph. The input values to the graph are decided as per the user's feedback. Each minimum value of frequency at the particular decibel is noted in the frequency test activity taken before the graph activity. After all the tests are conducted all the values for both the left and right ear is stored in a final array which is passed to the graphview for plotting. StaticLabelFormatter is used set labels of the X-axis and Y-axis. LineGraphSeries class is used to plot a line graph. Customized X mark has been using canvas.drawline method. [9]

5.3 Data Trends

Here we google the google sheets API to create a Json link which is embedded in the android code of the application, every time the user saves a report the array value of all the frequencies is automatically sent to the google sheet where a new entry is created for each report. The api then automatically updates the data trends based on the data added to show relevant data visualization to analysis.

6. ADVANTAGES

1. Can be accessed anytime: The application once installed can be then used as and when required. It can be used anytime and anywhere.
2. Reduction in cost factor: This replaces the massive system to conduct audiometry test. Thus, the cost factor is reduced effectively.
3. Less time consumption: Test conduction takes no more than 15 minutes. Thus, the time required for taking test is reduced significantly.
4. Sharing test results: The test results can be shared with the doctors or concerned people by the user. Thus, making it convenient for the user to share the current results by saving his/her time of taking the audiometry tests again.

7. LIMITATIONS

Only air conduction test is performed, as it requires delivery of pure tone sounds through headphones or earbuds. Bone-conduction testing is not performed as it requires a bone oscillator, a small square box on the end of a metal headband.

8. APPLICATION AND ANALYSIS

This particular system is designed to provide hearing aid assistance on mobile devices for people with frequency deficiency. The aim of this software system is to be reliable, efficient, economical and easy to use so that more people can readily use it. Digitizing this mechanism to provide a better and handsfree hearing aid system is the main goal of this proposed system. It will be easily accessible to all as it will be in the form of a mobile application. [8]

Possible analytics with the system:

1. Left/right ear audibility range in Db at various frequencies.
2. Data points to be plotted for audiogram generation.
3. Audiogram graph showcasing the left and right ear frequency intensities.
4. Frequencies to be amplified for efficient hearing.
5. List of previously conducted tests

9. FUTURE SCOPE

1. Based on the results from the audiometry test we can implement Hearing Aid like boosting capabilities in the smartphone. This will allow the users to have comfortable hearing while listening to music or calls and even while watching videos

2. Currently the audiometry test can only detect Sensorineural hearing loss, although in future, methods can be implemented to also detect Conductive hearing loss.

3. Fine calibration of the output for various set of mobiles and earphones may also be possible, if the data regarding the output capacity of variety of smartphones and earphones is available.

10. CONCLUSION

As mobile technologies are at the brim of innovation, more and more people reach out to their mobile devices as their primary source of digital interaction. Hearing deficiency being one of the major problems the world is facing, we are compelled to take important steps towards it. Hence, this particular application not only helps the user to give a preliminary audiogram to get an initial idea of any hearing deficiency he or she might have, this mobile application also helps in providing general awareness regarding the same to more and more people who come across this software. Storing and analyzing data provided by the users also helps us maintain a ballpark of the reports to as to better understand the demography of people and the severity of hearing deficiency all in one place.

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