Optimal Design: Bekesy Test for Mobile

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1.1 Introduction

We are designing a mobile phone application that will accurately model professional Bekesy audiometry, for Dr. Douglas Oliver. The Apps that are currently available on the various online stores bear little resemblance to the accuracy of a professional audiogram. Thus far, there is no mobile phone application that has the ability to reliably identify hearing loss in a subject. This is due to a lack in normalized threshold over which to accurately measure a subject’s hearing. Essentially there is no App that reproduces Pure Tone Audiometry (PTA), which is used to identify degree, type and configuration of a hearing loss.

At the most basic level an audiogram is a screening test like that which is used in schools. A series of tones at fixed volumes are presented to the listener who then indicates which he or she can detect. PTA is a subjective and behavioral measurement of hearing threshold, because it relies on patient initiation of a response to acoustic stimuli. PTA is designed for clinical use on adults and children old enough to understand and execute the test procedure. Like the majority of clinical tests, calibration of the test environment, the equipment and the stimuli to ISO standards is pivotal, as PTA measures thresholds of hearing only (in contrast with other methods which delineate sound localization).

The design that will be detailed further in the proceeding sections was chosen because it most closely reflects the Bekesy test and will likely generate more accurate results. This design is also easy to learn and use, which will result in reduced operator error and increased accuracy/reliability.

1.2 Subunits

This will be a software application, designed for mobile devices, that performs an accurate and efficient test of auditory stimulus response. The results will be comparable to a clinical audiogram, designed to determine the threshold of hearing at each frequency being tested. The user will begin by identifying the type of headphone he/she is using, choosing from a list of headphone varieties and possibly models i.e. over-ear, ear-buds.

The fundamental concept behind the Bekesy audiometer is that the patient records his or her own threshold automatically on an audiogram black. When the audiometer is turned on, a pure tone at a midrange frequency will come through the earphone. The subject will control the intensity of the stimulus by pressing a button while listening to a pulsing (0.5s) pure tone whose
frequency slowly moves through the entire audible range. This is what is called an “interrupted”
tone. The intensity diminishes as long as the button is depressed. When the intensity is too low
for the subject to hear the tone, the button will be released and the intensity will start to increase.
When the subject again hears the tone, the button will be pressed again, producing a zigzag trace.
The test will involve diagnostics on each ear, after which the tracings of both the left and the
right ear will be compared. The test will be usable to differentiate between cochlear and neural
hearing losses.

The frequencies will be scaled and calibrated contingent upon the type of headphone
selected in the starting menu. The user will then be able to determine whether or not he/she is
suffering from hearing impairment based on their test results

Because of the importance of having the calibration of the headphone and output jack be
constant across all users of the app, the mobile platform chosen for the development of the app is
Android Platform, using the wildly popular Google Nexus 7 Tablet. Due to the widespread use
of Apple ear buds, the app will be calibrated according to the ear buds and Nexus 7 combination.
Such uniformity is not so apparent in Android phones, due to the variety of manufacturers (and
likewise headphones and/or output gains).

Hardware: Android Phone/Tablet

User interface: Touch Screen

Hardware interface: Google Nexus 7 Tablet, apple earbuds

headphone dB output values
Békésy Test

Press the Red Button until the tone disappears...

UI Layout

Békésy Test

Release the Red Button until you hear the tone again...
The UI layout for design 1 would have a start button and a toggle button for user-attenuation of the tone. There will not be a lot of client facing information to make it straightforward and easy to use. This design will also feature a running display of frequencies being played: 250 kHz, 1000 kHz, 4000 kHz and 8000 kHz etc. The app will compile user data and create a graph of each ear at the end over a normal hearing threshold. We will use the AudioManager component of the Google API to generate audio, openGL to generate 2D graphics, and Google Maps Geolocation API to locate nearby audiologists.

2 Realistic Constraints

Some limitations of the app depend on the operation of the app. The app will work optimally in a quiet environment, using a pair of Apple ear bud headphones.

Environmental: The code used will be recyclable and environmentally friendly. Uses products that are already available.

Sustainability: Highly sustainable, as the app can be updated, and will be designed for a lasting professional platform and comparatively future-proof.

Manufacturability: Easily reproducible (download distribution) and free hosting.

Social/Ethical: Make certain that the design created is our own, and that we are not reproducing someone’s idea.

Safety/ Health: Volume will be attenuated appropriately to avoid any chance of hearing damage.

Life-Long Learning: Will become proficient in android development, will gain experience in the software development cycle, and will allow me to improve my Java development abilities.