DSound

iOS-based Sound Processing

Authors: Emma Beebe, Wynn Pho, Shane Mitchell
Advisors: Dr. Liran Ma

reSEaRCh
Science and Engineering Research Center

TCU College of Science & Engineering

SciCom Let's Talk Science

Problem - Hearing Aids

Cost
- 1 hearing aid can cost anywhere between $1,500 - $4,000.
- 13% of people 12 years and older have hearing loss in both ears increasing the cost up to $3,000 - $8,000.

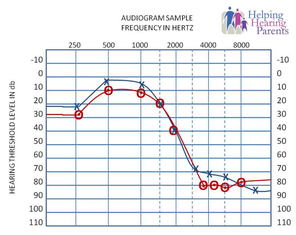
Durability
- The average hearing aid lasts up to 5 years which means spending up to $8,000 again for another set.

Availability
- Audiologists are not as accessible in developing countries making it difficult for people to get hearing aids.
- 80% of people with hearing loss live in low and middle income countries.

Solution - DSound

Process
- Doctors will prescribe an audiogram similar to the one on the right.
- From this graph, DSound can estimate the amount of amplification a patient needs at any frequency replacing the need for a hearing aid.

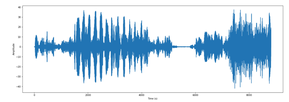
Advantages
- Affordable for the average user.
- The only hardware needed is a phone and earbuds making it accessible to more people.
- The app gives the user more control



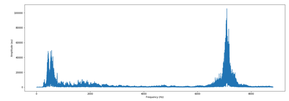
Audiogram Example

DSound's Internal Structure

Sound Processing
- Sound is air vibrating, and we hear sound at different frequencies.
- The iPhone perceives sound as air pressure measurements. The iPhone 7 can measure 48,000 samples per second.
- Fast Fourier Transform (FFT) converts the measurements from time domain to frequency domain.



TIME DOMAIN



FREQUENCY DOMAIN

The Applications Architecture
- The user inputs their prescription into the application.
- After initializing listening button the phone starts receiving audio through an internal or external microphone
- The sampled information will go through the SoundEngine which will filter/amplify the sound.
- Once finished the altered sound will be played back to the internal or external speaker.

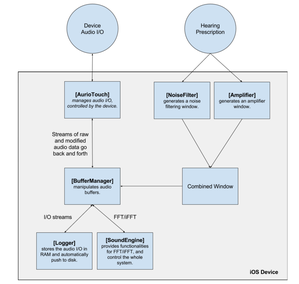
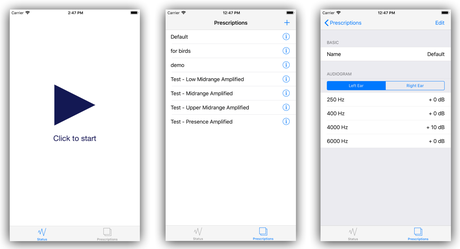
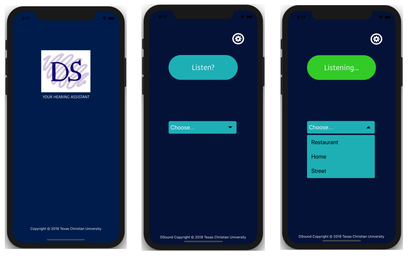


DIAGRAM OF THE SYSTEM ARCHITECTURE

Simplified User Interface



PREVIOUS DISTINCT SOUND USER INTERFACE



NEW DSOUND USER INTERFACE

Apple's App Store Publishing Requirements

Publishing Process
- To publish an app one has to become a member of Apple's Developer Program and pay a yearly subscription of $99.
- Before starting the submitting process the following information has to be synthesized:

AN ICON

A SCREENSHOT/APP PREVIEW

APP METADATA SPECIFICATIONS 5.10.1

- Once the information is collected Betas can be built and sent to specific testers to help debug before the initial release using Apple's TestFlight.
- The app will then be submitted to Apple's testing team and reviewing process can take from 1-3 days.
- If the app is approved it can be published to Apple's App Store, otherwise a detailed report can be found in the Resolution Center and the debugging starts over again.

System Requirements
- Work on the newest software - iOS12.2
- Compile on the latest Xcode software - Xcode10.2
- Compatible to the newest hardware - iPhone XR
- Use the newest Swift Language Version - Swift5.0
- Have an updated `metadata.xml` file that describes the delivered content using the structure documented in this specification
- Follows all of Apple's Human Interface Guidelines
- Utilizes the Model-View-Controller design strategy

Technologies Used

Swift is the native language for iOS development.

Jupiter Notebook is our testing and visualizing environment.

Python is the native language of Jupiter Notebooks.

XCode is the IDE developed by Apple for Swift.

Conclusions and Future Work

- DSound will continue to be transferred over to the newest iOS 12.2 software and any future software updates
- The code is in the process of migrating from Swift 2 to Swift 5
- Once testing is done a Beta will be created and sent to testers
- Next years goal is to have DSound on Apple's App Store

References

- **Audiogram Information**: http://helpinghearingparents.com/communication-information/audiograms-an-explanation-on-interpretation/
- **Hearing Loss Data**: https://www.sound-seekers.org.uk/hearing-loss/
- Hearing Loss Statistics: https://www.nidcd.nih.gov/health/statistics/quick-statistics-hearing
- Human Interface Guidelines: https://developer.apple.com/design/human-interface-guidelines/ios/overview/themes/
- **Jupyter Notebook**: https://jupyter-notebook.readthedocs.io/en/stable/
- **Swift Information**: https://developer.apple.com/swift/

Acknowledgements

The DSound team would like to thank the following professor:

Dr. Liran Ma for providing guidance and the resources necessary to advance development and create an innovative application. The whole team appreciates the enthusiasm and passion he brings to this project.