AudioDash

Neel Chaudhari, James King, Tara Trinh, Angela Zhang

Cluster 5 - Sound for Virtual Reality: An Exploration of 3D Sound and Movement Using Mobile Devices and Wearable Sensors

California State Summer School for Mathematics and Science

Abstract

The reaction time of an average human being slows down with time. AudioDash was created to improve reaction time and to promote activity in today's youth. AudioDash plays sounds in a simulated three dimensional space around the user, using Apple's AVFoundation Framework, to which the user must react by pointing the device. AudioDash allows the user to select sounds, background noise volume, and difficulty. These sounds play at set time intervals around the user's head. Based on how precisely the player can locate the sound, AudioDash calculates an accuracy percentage which reflects the user's abilities. This plays into the competitive nature of humans, encouraging the user to practice and improve. As the users continue to utilize AudioDash in their training, their reaction time will improve along with their accuracy.

Introduction

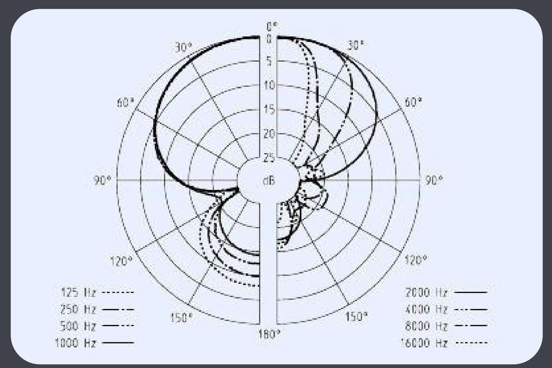
Research suggests that the fundamental concepts behind each sport rely on quick decision making, reaction time, and dedicated practice. Therefore, neglecting to focus on reaction time can have serious consequences on one's ability to perform. Without practice, reaction time slows when exercising or participating in other physical activity (Delignières 1994). Young athletes must develop a variety of physical qualities relating to reaction time, such as rhythm and reactivity to acoustic and visual signals, as well as other skills such as balance and spatial orientation (Drabik 1996).

In order to better train athletes of all skill levels and ages, individuals must practice to maintain these attributes. Due to the fact that humans react more quickly to auditory stimuli than visual stimuli, using sound provides more effective instruction, especially when testing and training reaction time (Shelton 2010). Ultimately, research has proven the necessity of improving reaction time, especially with respect to the quick pace of many athletic endeavors.

AudioDash tests reaction time in the form of a game. By compelling users to increase their high score, their competitive nature will draw them to play the game frequently (Prensky 2003). As a result, the repetitive exercises should lead to decreased reaction times, allowing for spatialized, high-intensity training that benefits not only athletes, but anyone who has to make time-sensitive decisions (Tønnessen 2013).

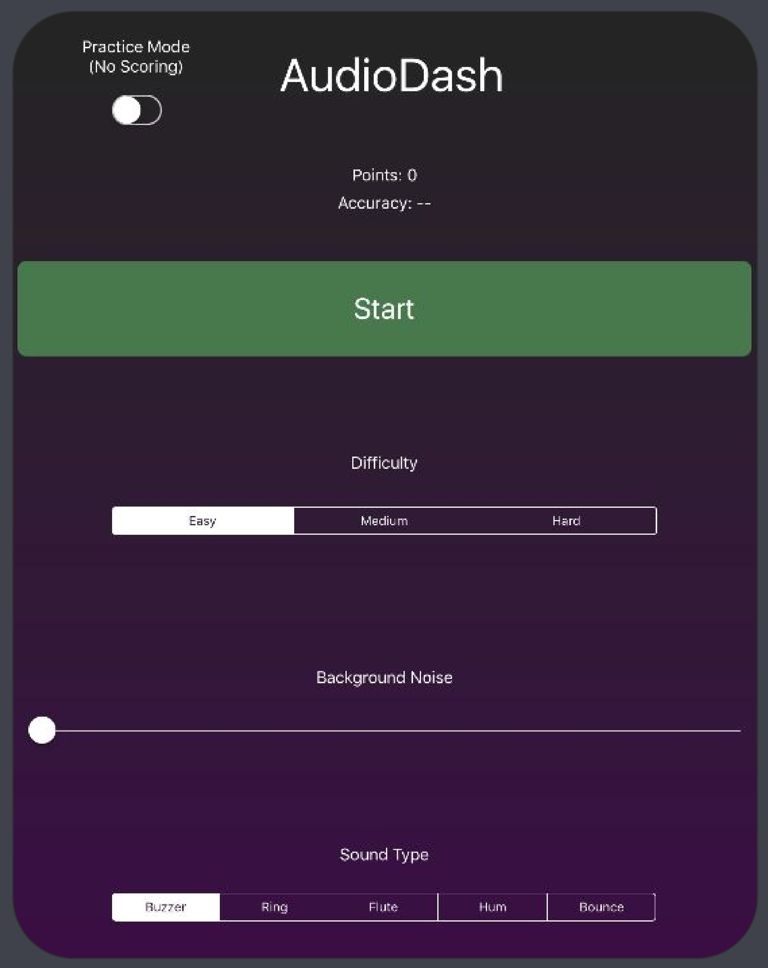
Materials

- Sennheiser ME-67
- Zoom H5 A/D Convertor
- MM-1 Preamp
- MacBook Air & Pro
- iPad Mini
- Audacity
- Xcode
- Swift
- AVFoundation
- Github



Pickup Pattern of Sennheiser ME-67

Diagram of Audio Equipment



AudioDash GUI

Methodology

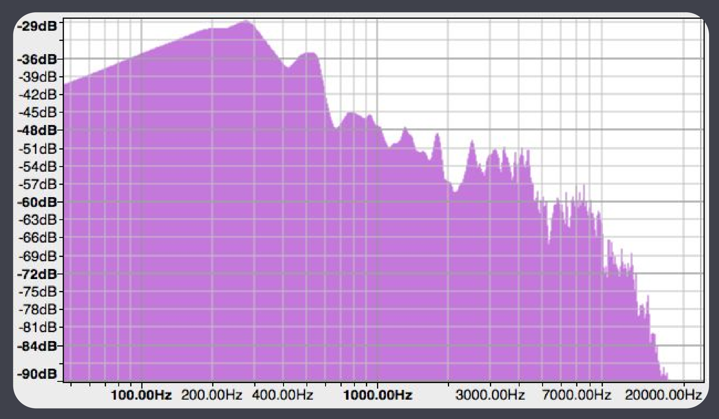
The development of AudioDash necessitated breaking down the process into several distinct steps. We first brainstormed the features of AudioDash: whether it would include an on/off switch, a background volume slider, and/or a sound selector. We created the Graphical User Interface (GUI), using Xcode, which is an Integrated Development Environment (IDE). We used AVFoundation framework, which controls the 3D sound engine, to ensure it interacted properly with the GUI.

The final version of our engine features several key characteristics. First, the sounds are generated randomly in 45 degree increments so that users can more easily locate them. Additionally, background noise was introduced to increase the difficulty of locating the beeps. Most importantly, the engine was designed to compensate for the user's movement by taking information from the device's gyroscope, allowing the tones to sound as though their position remains constant. All of these settings remain static while the sound is playing to avoid any potential errors or crashes, and can only be modified when the player is off.

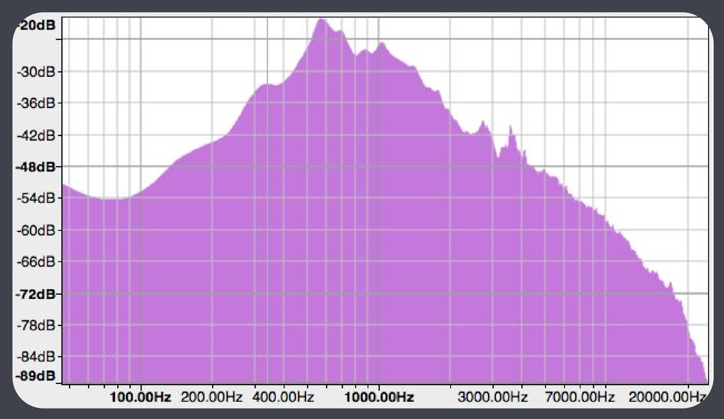
After we completed the engine, the placeholder sounds were replaced by sounds recorded at the music department at UCI. All of the sounds were then edited in Audacity, digital audio editing software, to improve sound quality, amplitude, and clarity. The sounds were then integrated into AudioDash.

Additional features were added to improve the quality of AudioDash, including a practice mode, gyroscope support, and a scoring system. Finally, we edited the aesthetic features of AudioDash, including the icon and color scheme.

Data



Spectrum Analysis of Cheering Audio File



Spectrum Analysis of Countdown Audio File

Results

AudioDash tests a user's ability to pinpoint sounds during a preset interval by applying sound spatialization, also known as 3D sound. AudioDash tests not just reaction time, but also how accurately the user locates the sound by using the device's gyroscope. AudioDash aims to speed up the reaction time of users through repetition and audio stimulation.

```swift
motionManager = CMMotionManager()
motionManager.deviceMotionUpdateInterval = 0.1
motionManager.gyroUpdateInterval = 0.1
motionManager.startDeviceMotionUpdates(using: CMAttitudeReferenceFrame.
    xTrueNorthZVertical, to: OperationQueue.main) {
    (motion: CMDeviceMotion?, _) in
    if let attitude: CMAttitude = motion?.attitude {
        self.yaw = Float(attitude.yaw)
        if(self.isOn){
            var currUserDeg1 = (self.yaw*180.0)/self.PI; // conversion to degrees
            if( currUserDeg1 < 0 ){
                currUserDeg1 += 360.0
            }
            let angleDiff = (((currUserDeg1 - Float(self.lastUserYaw)) + 180.0 +
                360.0).truncatingRemainder(dividingBy: 360.0)) - 180.0
            self.mixer3d.listenerAngularOrientation.yaw = self.mixer3d.
                listenerAngularOrientation.yaw - (angleDiff)
            self.lastUserYaw = Double(currUserDeg1)
        }else{
            self.lastUserYaw = 0
        }
    }
}
```

Swift code to adjust 3D sound based on data from gyroscope sensor

Acknowledgements

Professors: Mr. Jim Simmons, MFA (UCI)
Dr. Martin Jaroszewicz (UCR)
Graduate TAs: Mr. Walker Davis, MA (Stanford)
Mr. Josh Simmons (PhD Student UCI)
Teacher Fellow: Ms. Doloumar R. Bergen, MA (CSUSB)

We would like to thank our professors, graduate teaching assistants, and teacher fellow for all of their assistance and guidance throughout the development of our app.

Bibliography

Delignières, Didier, Jeanick Brisswalter, and Patrick Legros. "Influence of physical exercise on choice reaction time in sports experts: the mediating role of resource allocation." *Journal of Human Movement Studies* 27.4 (1994): 173-188.

Drabik, Józef. "Children and sports training." Island Point, VT: Stadion Publishing Company (1996).

Shelton, Jose, and Gideon Praveen Kumar. "Comparison between Auditory and Visual Simple Reaction Times." Neuroscience & Medicine 01.01 (2010): 30-32. Print.

Tønnessen, Espen, Thomas Haugen, and Shaher AI Shalfawi. "Reaction time aspects of elite sprinters in athletic world championships." The Journal of Strength & Conditioning Research 27.4 (2013): 885-892.