MEMORANDUM

To: Dr. Winfree

From: Team Virtual 3D Audio - Stuart Jackson, Hangdi Hu, Anjun Zhang, Maximillian Jones

Subject: Design Review 3 Documentation

Date: March 9, 2019

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1 Document Introduction

Greetings!

This document serves to explain our current state of affairs with the design of our project, as well as show a breakdown of each individual subsystem and the person who is working on it. These Work Breakdown Structures should make it clear how the work is being separated, and viewed by the members of our team.
As team virtual 3D Audio, our primary goal is to create, as the name suggests, a virtual 3D audio system using stereo headsets, combined with a GUI. This is being done with the intention to use the device in helicopters to hear the position of not only the people in your cabin, but possibly other helicopters as well. With this overall goal in mind, we have created the following outline for our goals and deliverables.

2 Project Scope

2.1 General Objectives

1. Create a program that allows for the emulation of 3D audio using stereo headphones

2. This program should allow us to choose a location, and play a sound that comes from that point relative to the listener

3. If the other objectives are completed, implement a multi-user option

4. If time allows, implement this design on standalone hardware

3 Subsystem Breakdown

3.1 HRTF Improvements

Figure 1 describes the first subsystem which must be completed - the head related transfer functions. We are specifically focusing on improving the design that we used during our prototype presentations last semester, as our previous design worked well in the azimuth plane, but not well in the elevation plane. Work on this subsystem is being headed by Stuart Jackson, but requires assistance from all members of the team. The primary goal of this subsystem is to make improvements on the accuracy of the elevation plane when emulating 3D audio. After speaking to our client, this will be done by finding Head Related Impulse Response (HRIR) data that most accurately matches each user, and then using measurements and HRTF's found in a database from UC Davis. This will allow each user to select which HRIR set sounds best to them, and then the audio will be convolved with the HRTF's from that set. This should allow for much more accurate sounds in the elevation plane. Unfortunately, this implementation will be less easy to use than a generalized HRTF set, but our client has chosen this direction.
Additionally, this code must have the ability to be easily integrated with the GUI which will be designed around it. This will require work between Stuart, Anjun, and Hangdi to ensure that the two subsystems synergize properly.
Lastly, the code must be portable. As we look into different ways of implementing this on hardware, we must keep in mind that there is a possibility that we will have to use an environment other than MATLAB. This means we should avoid any MATLAB-specific toolboxes or workshops.

3.2 GUI

The GUI will be developed in sync with the HRTF software. The GUI should allow for selection in a 3d system, which will then be sent to the HRTF software in order to emulate 3d audio. (Figure 2)

3.3 Subsystem Integration

Anjun is in charge of ensuring the projects integrate properly (Figure 3). He will coordinate the three designs, GUI, HRTF, and hardware, to ensure that they can be properly synchronized. This will require support from every other member of the team, which will be coordinated by Anjun.

3.4 Hardware Implementation

A hardware implementation (Figure 4) will require us to possibly modify the code for a new environment. This is a primary thing that must be considered when deciding on the hardware that we will use. Additionally, it will ideally integrate all the previous subsystems. This will require Max, the subsystem head, to work hand in hand with the rest of the group, especially Stuart and Anjun. We are still considering whether a GUI will be viable on a hardware implementation of

Person Primarily Responsible: Stuart Jackson				
ID	**ACTIVITY/TASK**	**DESCRIPTION**	**DELIVERABLE(S)**	**OTHER PEOPLE**
1	**HRTF IMPROVEMENTS**			
1.1	Improve 3d emulation in elevation plane	Improve accuracy in elevation plane of HRTF implementation	Working method to accurately simulate audio in the elevation plane	Research help – all
1.2	Add new HRTF methods to current design	Synthesize MATLAB code based on improvements discovered in 1.1	Working MATLAB code that can generate accurate sounds in both azimuth and elevation planes	Ensure ability to integrate with GUI – Anjun and Hangdi
2	**Portability**			
2.1	Ensure code can be easily ported to other environments	The code may have to be remade in a new environment / language, ensure it does not rely heavily on MATLAB specific plugins	Code that can be easily transferred between environments, ideally using as few MATLAB toolboxes as possible	Requires knowledge of what hardware will be used - Max

Figure 1: Head Related Transfer Functions Work Breakdown Structure

our system.
This system will require careful planning, as if we choose the wrong hardware, we may waste money, and be unable to complete this portion of the project.

4 Closing

Our current point in the design process has us showing a lot of potential, as we have not hit any major roadblocks as of yet. With our most recent developments in improving our Head Related Transfer Functions, we have gotten past what we assume to be our most difficult bridge to cross. Should we face any issues going forward, we have plans in place to deal with them, such as viewing currently existing GUI's for a similar data set, or asking advice from professors who have knowledge better than ours regarding possible hardware that we could use to implement our designs. As of now, we are on track to complete our capstone by the delivery date.

WBS of Hangdi Hu				
	Task	Description	Deliverables	Other People
1	Build a PC based GUI			
1.1	Build a standalone GUI	Build a GUI in MATLAB that has no connection of program	• Fundamental buttons on the interface: coordinates, volume, run function • Can let users input three dimensional coordinates (x,y,z)	
1.2	Improve the GUI	Improve and test		
1.2.1	Connect with code or program	When Stuart finishes his HTRF, I will edit code to let GUI connect with program	• This part can't delivery individually and needs to test in 1.2.3 to see whether it works well	Need code to be completed by Stuart Jackson
1.2.2	Interactive	Make program run the users' input data	• When inputting coordinates, these data can be seen from the variables window in MATLAB • The data equals to input coordinates	Help from Anjun Zhang
1.2.3	Test	Test the GUI, at the same time test the HTRF	• Can hear the positional sound • Change the location, can feel that the direction of sound changes • The volume of sound can be changed	Testing help from Stuart Jackson, Anjun Zhang, and Max Jones

Figure 2: Gantt Chart

Person Primarily Responsible: Anjun Zhang				
ID	**Activity / Task**	**Description**	**Deliverable(s)**	**Other People**
1	**Integration** (step 1)			
1.1	Integration of GUI and HRTF database	After we have a nice-looking GUI and a functional HRTF database, we need integrate those together in to a user friendly and functional MATLAB based application.		
1.1.1	Integration	Actual work to integrate GUI and HRTF database.	1.GUI 2.HRTF database 3.MATLAB application	
1.1.2	Simulation and Test	Build up the application and run test.	1.Test data; 2.Simulation result 3.Application	All team members would take part in the testing.
1.2	**Integration** (step 2)	Stretch goal. We need put our app into a standalone device.		
1.2.1	Translate	Translate MATLAB language into hardware language	1.MATLAB application 2.Translated hardware language 3.Hardware standby.	Lots of work to do, could use some help from team.
1.2.2	Integration	Integrate translated language into hardware like VHDL (haven't deiced yet)	1.Hardware working with positional sound. 2.Working with different type of headset 3.Working with different sound source.	

Figure 3: Integration Work Breakdown Structure

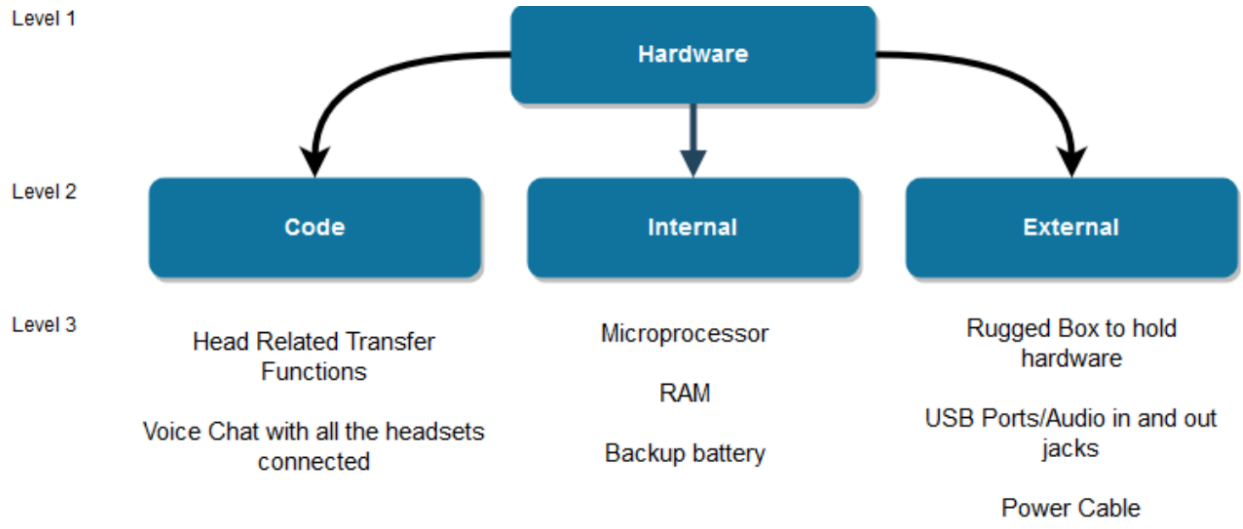

Figure 4: Hardware Implementation Work Breakdown Structure