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CPE 322 – Engineering Design 6
Assignment 5

Section 1

Research on this project was divided into four distinct areas: 3D audio recording, audio processing and playback, stereoscopic video recording, and stereoscopic video playback. Each member was responsible for one of these areas. Eric Chae was responsible for stereoscopic video playback. Phong Lai was responsible for 3D audio recording. Eric Pantaleon was responsible for stereoscopic video recording. Lastly, Ajay Reddy was responsible for audio processing and playback. The final report was compiled by Eric Chae.

	Eric Chae	**Phong Lai**	**Eric Pantaleon**	**Ajay Reddy**
Percentage Of Effort Towards this assignment	31%	23%	23%	23%

Section 2

In this section, implementations and practical considerations for each technical area are explored.

Audio Recording

There are a few methods in creating a binaural recording. At the most simple, having two omnidirectional microphones with preferably a flat frequency split into stereo output will create a binaural recording. This is demonstrated in Mitra's 3d Mic Pro. In the 3d Mic Pro, there is additional audio processing system which they call SHEM to create the difference between space such as the difference between front and back.[1]

When it comes to high end studio recording, Neumann has a high tier microphone and enclosure called the KU 100. The enclosure is the model of a head, where the two microphones elements are part of the ears. This model geared towards studio professional with balanced inputs, low self-noise and the need of phantom power.[2] Similar to the KU 100, 3diosound has created a product with ear cavities as microphone elements but without the use of the rest of the head. This allows a camera to be mounted in between the ears to give an immersive experience. This product is geared towards consumers with its price range one twentieth of the KU 100.[3]

Another way to record binaural audio is using your own head as the enclosure. Sound Professional has many models that uses in ear mics to capture binaural audio. Each user would record the sound space differently since now two heads are exactly alike. Factors like head size, and shape of ear lofts as well its symmetry creates a unique recording experience.[4]

Roland has created their own in ear device called the CS-10EM. These have the capability to be used as a microphone as well as earphones. This might be an issue if both functions are being

used as the same time because the microphone will pick up what the user hears and possibility create feedback.[5]

Audio Processing and Playback

One of the programs that will be of most use to use for this project as far as audio processing is concerned is Audacity. It's a free, open-source program for audio processing and there is a lot of material on implementing it for various purposes online. Better yet, the license that it operates under allows it for commercial use, so we won't have any concerns about that.

Dynamic range compression with Audacity seems to be rather straightforward, and should be doable in one step with a control panel.[6] Automating it will be a programming project, and I was not able to find any definitive how-tos on how it can be done. However, as doing dynamic range compression amounts to a few clicks and a little typing, automation should not be high on our list of things to do.

I was able to find a plugin for Audacity that seems to be able to do everything we would require to simulate sound coming from various settings.[7] The one thing it doesn't seem to be able to simulate via audio processing is surround sound, but this is not a big problem if we use binaural recording when we create the raw audio data to begin with. In that case, we will not need any special hardware to simulate surround sound, or even 3D surround sound with standard, stereo headphones.

Creating effects with Audacity are very simple and straightforward things to do. For people who want to make movies, audio processing on their end for our headset will not really change too much at all, as their usual software tools will eventually result in playable audio for our headset. I would compare the jump from standard speakers to our VR headphones to Blu-Ray vs. 3D Blu-Ray in that the latter is more immersive, but not incredibly more complicated to achieve for the creators.

What we can do is take the source code for the things that the user would have used Audacity for, and create a very simple program that will run when the user uploads recordings from the headset to his or her computer. This program will process the audio components of the recording.

Stereoscopic Video Recording

Currently there are a few companies who have manufactured and sold video recording glasses. The glasses made by ZionEyez are priced at $199 with features including 720p video quality, two to three hour battery life, Bluetooth and WIFI capability, and a USB port for charging and uploading video. The shape was convenient regular sized glasses, but the earpieces were slightly thicker to accommodate the battery, camera, Bluetooth and WIFI antennae, and the USB port.[8]

While branching upon that idea of a regular 2D video recording glasses prototype, some design tweaks can open up the world to 3D video recording. Although some design flaws that we must

accept are that the size of the glasses must be bigger/bulkier in order to accommodate two cameras and two microphones for 3D audio/video recording.

Another company named Pivothead also came out with video recording eyewear. They are shaped like really big sunglasses, but can be very stylish. The price is estimated to be $349. Some features include, four-element glass lens, 8GB storage, and 3 different video modes including 1080p. Some complaints are that they capture noisy audio during indoor recordings and the camera was unable to focus correctly at times.[9]

If we can learn from the mistakes of the other companies, we may be able to come up with a great 3D visual/audio experience at a low price, while maintaining a simple/sleek design. This will take a lot of time and research, but the results would be very rewarding for the effort put in.

Stereoscopic Video Playback

Similarly to the above methods for 3D video recording, there are many head-mounted displays that can support 3D, typically by having one display for each eye. These glasses are usually marketed for virtual reality purposes where the 3D effect is computer generated. However, there is no reason they could not be used for playing back live action 3D content.

One example is the Oculus Rift. These are virtual reality goggles currently in development and aimed at the gaming market. They support a resolution of 1280 by 800, have DVI/HDMI inputs, and an inertial sensor. Additionally, there is an SDK in development in order to be able to add 3D support to games and other applications. Since we will be dealing primarily with live-action recordings, this is of little use to us. At $300 for the developer kit, these goggles are a bit too expensive, especially considering that the included code base and inertial sensor are unnecessary and just add cost to the project.[10] We only need the physical display.

The core of the Oculus Rift itself is basically just two displays mounted over each eye. This can be emulated and built with readily available parts. All that is needed is one big LCD or two small LCDs and two lenses to focus each eye on the correct area. A controller board is also needed to connect the LCDs (usually via LVDS) to DVI/HDMI ports. Some ingenuity will be needed to mount the displays on the wearer. For rapid prototype production, foam and duct-tape can be easily purposed for the head mount. Once this is done, it is just a matter of feeding in a DVI/HDMI video signal to the display.[11]

Section 3

Constraints

3D is still a relatively new consumer technology. While it has been around forever, it is only just entering the marketplace. Virtual reality has always been possible, but it has also always been prohibitively expensive. Since this project uses live-action recordings, there is very little to do in terms of complex processing. Most of the effort is going into designing the physical peripherals

for recording and playing back immersive videos. These peripherals can be designed entirely from very readily available and common electronic parts so the final cost should be fairly reasonable (~$200 for each peripheral). A modern smartphone has the same capabilities, just in a different form factor. Similarly, these peripherals should be as easy to manufacture as any other consumer electronic device.

Unfortunately, electronic devices are sometimes difficult to make environmentally friendly and sustainable. They usually contain some amount of toxins and hazardous chemicals. This can be mitigated by making sure the build quality is high enough so that it lasts a long time (at least five years) before being discarded. It should also be easy to repair and upgrade in order to prolong product life even more. Most modern electronics are made with the opposite philosophy. For example, smart phones are usually replaced every two years and are usually difficult to repair. The consequence is that there are many old cellphones being thrown away.

A higher build quality will also be more practical for documentary and journalism uses of this system. These peripherals must be rugged enough to withstand recording in hostile environments, whether artificial or natural.

Safety concerns should also be taken into account. As both the recording and playback peripherals are head-mounted, they can potentially block the user's eyesight and decrease his situational awareness. There is also very little history of immersive devices in the marketplace so there is a slight risk of detrimental health effects such as nausea or seizures.

Professional and Ethical Responsibilities

There are a few ethical and professional concerns for a project such as this. The biggest one is making sure that users are completely aware that the playback peripheral deprives the user of his normal seeing and hearing sensory perception. While it is obvious that one should not operate heavy machinery or drive while watching a video, someone will do it if not given a warning.

The additional level of immersion of this system will also likely be used heavily for grass-roots journalism. A hand's free, first person recording can be very powerful for portraying a story. In the interests of freedom of expression, we must ensure that everyone has fair access to this technology.

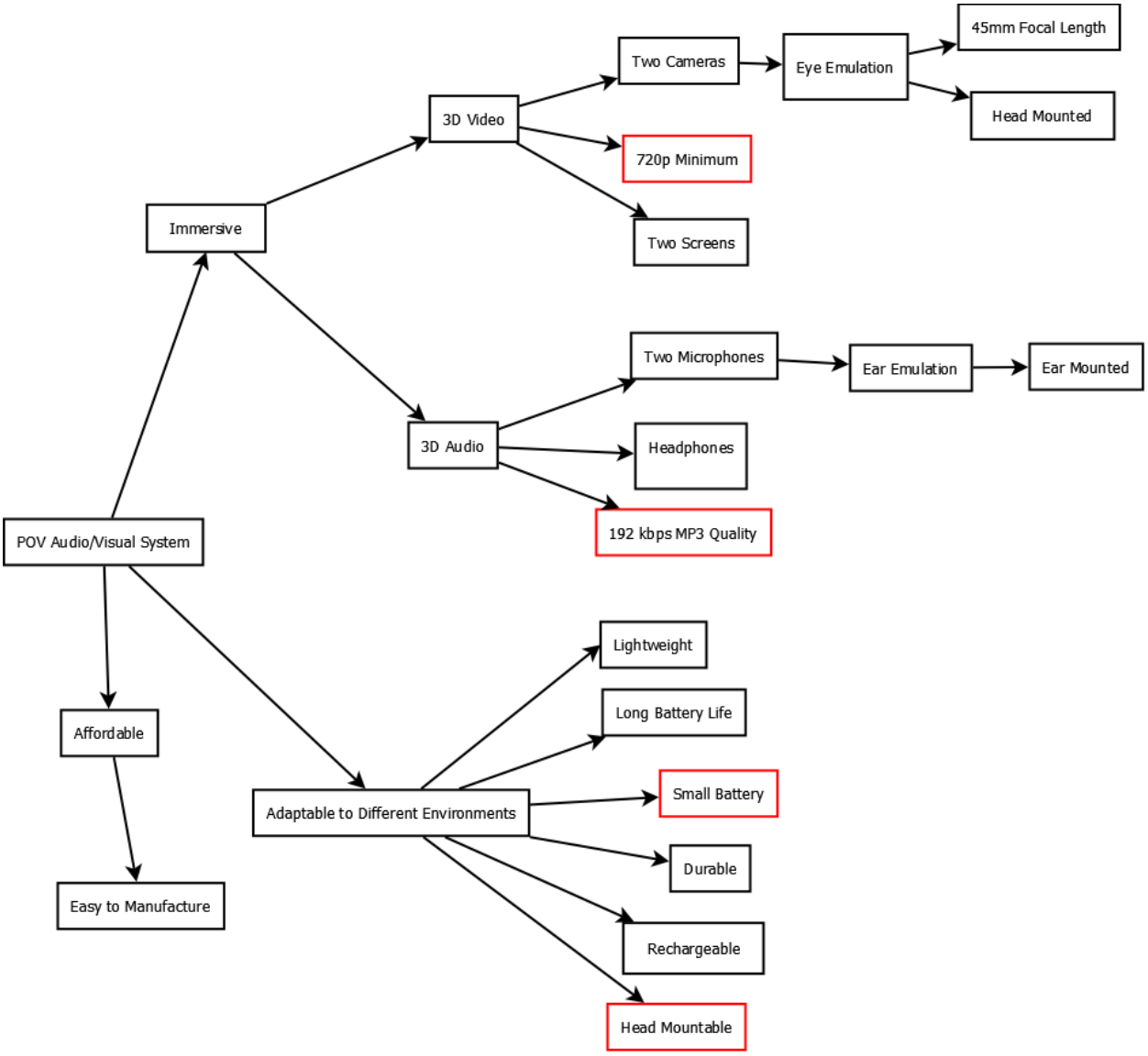
Additionally, as the web shifts to more content consumption and even more content creation, it is important to address the intellectual property concerns that are now so prevalent. If a content producer were to decide to release content for this device, we must decide whether to implement digital rights management and copy protection. Both choices have consequences and can alienate our users if we are not careful.

Section 4

Attributes List

Immersive audio/visual experience – The system must be able to record and play back the user's experience as realistically as possible.
3D Video – Video must be recorded in 3D to provide depth perception and immersion.
Long Battery Life – Devices must be able to record for several hours and playback at least one movie-length video.
Rechargeable Battery – Battery must be chargeable so the system is reusable.
HD Video – Minimum 720p.
Two Cameras – Two cameras will provide depth perception.
45mm Focal Length – The human eye has a focal length of around 45mm.
Small Cameras – Cameras must be small and head-mountable. This will ensure that footage can be taken anywhere.
3D Audio – Audio must also be recorded with 3D characteristics intact to provide total immersion.
Quality Audio – Must be at least 192 kbps MP3 or other format equivalent.
Two Microphones – Two microphones will provide surround sound.
Small microphones – Microphones must be small and head-mountable or ear-mountable.
Ear Emulation – Needed to match the human ear in recording.
Ear Mounted Microphones – Method of ear emulation.
Easy to manufacture – Parts must be easy to source.
Usable in many environments – Must be able to take footage anywhere.
Durable – Must be able to survive anywhere.
Lightweight – Must be easy to wear and portable.
Small Battery – Battery must be small.
Affordable – Must be affordable for the average person.
Two Screens – Provides 3D video effect.
Head Mountable – Everything must be head mountable.
Headphones – Provides 3D audio.

Objective Tree



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