**Project AirDrums**

**Project Idea and Motivation**

Learning to play the drums can be very difficult for some people. They are expensive, with the cost for a complete drum kit ranging from $300-$1000, depending on quality, brand, usage and number of parts. They also require a large space for storage. And last of all, they are loud. Playing the drums can often bother neighbors, or even the residents that live in the same house. As an alternative, there are electronic drums that can solve the noise problem, but, although smaller than the standard drums, they’re hard to carry around.

By building a prototype for a virtual, mobile drum kit, this project aims at enabling its users to carry their “drums” around, wherever they go, requiring only a head-mounted display, some fiducial marker(s) and haptic drum sticks. The use of such a system will not only help aspiring drummers around the world to play and enjoy the music that they love, but also allow individuals to learn and practice, without the complications of purchasing and storing a physical drum kit.

**Group Members & Roles**

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| --- | --- |
| **Names** | **Roles** |
| Anthony Jimenez | Software Programming (good at C#, Python and Java). |
| Dhananjai Hariharan | Research, System Design, Software Programming (Java, C++, C#. Experience in Android App Development). |
| Shitao Guo | Software Programming (good at Java, Processing and a little bit C), and soldering if needed. |
| Tiago Justino | Software Programming (experience with embedded systems and Android. Experience with C, C++, Java, Ruby, Shell) |
| Ziyan Huang | Software Programming (Java, matlab) |

**Literature Review**

Academic literature demonstrating prior research towards similar goals can be found. Bott et al. [1] proposed a prototype video game for musical expression that used novel 3D spatial interaction techniques using accelerometer based motion controllers, such as the Nintendo Wii Remotes and Nunchuks. The video game provided interfaces for 6 different instruments, each of which used significantly different gestures for playing tunes. Holland et al. [2] introduced the haptic drum kit, which used four computer-controlled vibrotactile devices (controlled by an arduino), attached to the wrists and drums. While that paper introduced the use of haptics towards playing the drums, it still involved a physical drum set while in use.

Other similar research for a more portable and mobile drum set demonstrated a prototype for a portable multi-pitch e-drum with large-area ring shaped pressure sensors. Such a project, while being a work-in-progress, was bendable and robust, as well as succeeded in providing real time sound responses. Smus and Gross [4] presented the ‘Ubiquitous Drums’, a prototype for a wearable drum kit using force sensitive resistors to detect taps and their pressure. It involved placing these sensors on the knees, shoe soles and upper abdominal areas of the user. While it was a work-in-progress demonstration, the downsides of this prototype was that it needed to be connected to a computer using wired connections, since wireless connections resulted in a latency of the sounds being played. Ren et.al [5] developed an interactive virtual percussion instrument system, allowing a group of users to collaboratively emulate music in real time. However, the interactions were limited to a stationary tabletop platform, which also required a large space.

There have also been some attempts at building a virtual reality environment for playing the drums [6]. This implementation uses devices such as the Oculus Rift Head-Mounted display and the Razer Hydra gaming controller. Some shortcomings of such a system were that the user firstly needed to orient himself into the virtual world, then use his real hands control the virtue hands. The whole interaction process made it "hard to play with no resistance", for a lot of users. By enabling users to control they hands directly and visually connect to the world, the level of interaction might give the user more real and natural experience. Combining features from past research, and by using more contemporary devices, it would be possible to develop the proposed mobile haptic drum kit.

**Planned Contributions**

By developing such a novel method of interaction with virtual instruments in

I meant - this section will say ‘Our project will help improve x y z aspects of HCI in music creation and learning.. I hope you get it. If not, do not worry, I will help you edit it tomorrow morning.

1. provide more ways(interface) to interact with computational music.
2. explore the new dimension of interaction. (not VR, not invisible)
3. test the feasibility and practice of AR interaction for specific purpose ( drum playing ).
4. identify potential issues which might remain in this kind of interaction.

**Implementation - Hardware and Software components**

**Hardware Components:**

Google Cardboard kit - x1

Raspberry Pi - x3

IR Camera module - x1

Accelerometer - x2

Vibration motor - x2

USB data cable - x1

**Software Components:**

Google Cardboard SDK

Android Studio + Android SDK

Unity 3D Game Engine

Raspberry Pi

Operation description:

The depth camera, along with a Raspberry Pi will be attached to the Google Cardboard kit. The camera will be connected to the Pi, which will then perform all the image processing tasks (recognizing gestures/drum hits). The smartphone in the Cardboard will also be connected to the Raspberry Pi, and the Pi will indicate the smartphone what sound to play once the Pi has identified a successful drum hit. These devices working together will emulate AR HMDs like Meta 1 (<https://www.spaceglasses.com/>).

The haptic drumsticks will act independently by using an accelerometer and a vibration motor (each). Whenever the accelerometer in a stick detects a force that is strong enough, the vibration motors will be triggered, these vibrations will be stronger the as the force detected by the accelerometer increases.

**Project Plan (Milestones)**

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| --- | --- | --- |
| **Date** | **Milestone Description** | **Team Members** |
| **Week 5 (Tue - Feb 24th)** | 1. Study google cardboard sdk 2. Study unity sdk | 1. member 1, member 2 2. member 3, member 4 |
| **Week 6 (Tue - Mar 3rd)** | 1. Run VR hello world on cardboard 2. Run Camera App on cardboard |  |
| **Week 7 (Tue - Mar 10th)** | 1. Implement fiducial mark detection 2. Design / Draw virtual drumset |  |
| **Week 8 (Tue - Mar 17th)** | 1. Configure Pi 2. Connect Kinect to Pi |  |
| **Week 9 (Tue - Mar 24th)** | 1. Run Kinect Hello World 2. Implement gesture recognition with kinect |  |
| **Week 10 (Tue - Mar 31st)** | 1. Track drumstick movement |  |
| **Week 11 (Tue - Apr 7th)** | 1. Design and implement phone - pi synchronization protocol |  |
| **Week 12 (Tue - Apr 14th)** | 1. Detect collision: drumstick vs drums/cymbals (produce audio feedback) |  |
| **Week 13 (Tue - Apr 21st)** | 1. Design and drumstick (vibration motor + accelerometer) |  |
| **Week 14 (Tue - Apr 28th)** | 1. Debug and Evaluation |  |
| **Week 15 (Tue - May 5th)** | 1. Paper writing; 2. Video recording |  |
| **Week 16 (Tue - May 12th)** | Final Delivery | - |

**Project Goal**

**References**

[1] Jared N. Bott, James G. Crowley, Joseph J. LaViola Jr. “Exploring 3D Gestural Interfaces for Music Creation in Video Games”. *FDG ‘09 Proceedings of the 4th International Conference on Foundations of Digital Games.* DOI: <http://dx.doi.org.ezproxy.rit.edu/10.1145/1536513.1536527>

[2] Simon Holland, Anders J. Bouwer, Mathew Dalgleish, Topi M. Hurtig. “Feeling the Beat Where it Counts: Fostering Multi-Limb Rhythm Skills with the Haptic Drum Kit”. *TEI ‘10 Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*. DOI: <http://dx.doi.org/10.1145/1709886.1709892>

[3] Chun-Ming Lo, Tsung-Ching Huang, Cheng-Yi Chiang, Johnson Hou, Kwang-Ting Cheng. “A portable Multi-pitch e-drum based on printed flexible pressure sensors”. *DATE '10 Proceedings of the Conference on Design, Automation and Test in Europe.*

[4] Boris Smus, Mark D. Gross. “Ubiquitous Drums: a Tangible, Wearable Musical Interface”. *CHI EA 2010*. DOI: <http://dx.doi.org/10.1145/1753846.1754094>

[5] Zhimin Ren, Ravish Mehra, Jason Coposky, Ming C. Lin. “Tabletop Ensemble: touch enabled virtual percussion instruments”. *I3D ‘12 Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games.* DOI: <http://dx.doi.org/10.1145/2159616.2159618>

[6] Drums with Oculus Rift and Razer Hydra (Video): <http://vimeo.com/66023452>