AUDIO ORIENTEERING – Navigating an Invisible Terrain

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Abstract

AUDIO ORIENTEERING is a collaborative performance environment in which physical tokens are used to navigate an invisible sonic landscape. In this paper, I describe the hardware and software used to implement a prototype audio terrain with multiple interaction modes and sonic behaviors mapped onto three-dimensional space.

Keywords: wii, 3-d positioning, audio terrain, collaborative performance.

1. Introduction

This piece allows multiple users to explore an invisible landscape using orientable physical tokens. Each user will hold a device (called an "Egg") containing sensors that track position and orientation. The Egg's position is superimposed onto a pre-composed "terrain" of sound, revealing and concealing various sonic "landmarks" as users move through the space. The multiple-user model allows for many modulations with relatively few landmarks. An Egg's orientation will manipulate sonic parameters local to each waypoint, so that while actions are repeatable, they are not consistent across the space—for example, the same gesture may have different results depending on the user's position within the space.

2. Background

My practice explores the modalities and metaphors surrounding the relationship of a body-in-space to an audio source. Here, my interest lies in placing a group in a context that causes them to think carefully about their relationship in/to space, and how to modulate that relationship.

A compass is an object that transforms an invisible phenomenon into information about one's immediate physical environment. It is a point of intersection between the virtual, conceptual space of geomagnetism and the physically-perceivable world.

In this application, I have abstracted the symbolic function of a compass and inverted the physical/virtual relationship. Here, each Egg functions not only as a token whose position in the room maps isomorphically onto another, invisible space, but also as a point of inflection around which these real and imaginary spaces may pivot. Here the metaphor of an audio terrain becomes useful—whereas a song is a one-dimensional progression from beginning to end, AUDIO ORIENTEERING presents a multidimensional map of sonic elements on which its users are free to improvise and explore.

While not an instrument in and of itself, this interface is a new mode of interaction between a participant and the space's music, complicating the relationship between composition and remix: each user's trajectory through the space endlessly reconfigures a complete-but-asynchronous original composition.

3. Implementation

AUDIO ORIENTEERING uses one MacBook Pro running Processing 0135 and Ableton Live 7. This computer receives orientation data from each Egg using a mesh networking protocol. Three-dimensional position data is captured by two Wii remotes ("Wiimotes"), inexpensive Bluetooth controllers which contain IR cameras and blob detection hardware. To improve object-tracking ability on the Wiimotes, each was outfitted with a custom ring light of infrared LEDs.

3.1 Hardware

For this implementation, hardware for the Egg was mounted onto an acrylic form to facilitate debugging. The final hardware will be mounted within a handmade wooden egg-shaped ergonomic enclosure. For now, each Egg (see Figure 1) has a small sphere covered in retro-reflective tape that serves as the main tracking point for the Wiimotes as described in Section 3.4. In addition to the reflective sphere, each Egg contains an inexpensive 2-axis accelerometer and a XBee wireless board.

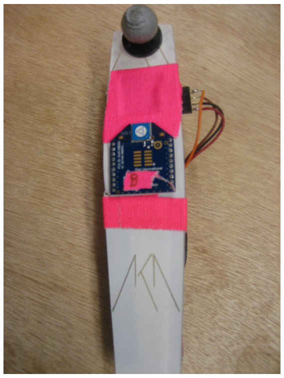

Figure 1. The "Egg" wireless device

3.2 Software

All the object tracking and MIDI mapping is done in Processing. To get information from each Wiimote, I used open-source libraries available on the Wii hacking website wiili.org [1], as well as on the Processing community forums. In particular, I used RWMidi [2]; wrjp45 [3]; and wiiremotej [4]. By integrating these libraries' functionalities, I was able quickly to experiment with arbitrary space-to-MIDI mappings in relatively few lines of code.

3.3 Optical Positioning

Rather than attempt to construct a dead-reckoning IMU system, I chose to adapt the consumer-level DIY approach first popularized by Johnny Chung Lee [5].

The Wiimotes are placed at right angles; future implementations of this work will involve more flexible trigonometric positioning using a method developed by Hay, Newman, and Harle at Cambridge [6].

3.4 Mappings

In order to present a complex and engaging experience, different position-to-control and orientation-to-control mappings were implemented simultaneously:

3.4.1 Spheres of Influence

Using simple proportional relationships familiar to everyone, single points in space can be perceived through the proportional increase or decrease of the volume of a particular sonic element. Once inside this sphere of influence, the Egg's orientation (pitch and roll) became mapped to other qualitative changes in the same sonic element—for example, once inside the sphere of influence of a vibraphone sample, the pitch of the Egg modulates the cutoff of a lowpass filter, and the roll modulates a downsampling effect.

3.4.2 Multi-user metaparameters

Other sonic parameters are linked to aggregate data gathered from all the Eggs in play. The intent in this form of mapping is to encourage users to be aware of each others' movements and positions, and to encourage group play and exploration.

4. Results

Users were able reliably to locate and return to different places within the virtual terrain. The most common errors observed were due either to occlusion of the beacon or to software errors in binding incoming accelerometer data with the correct IR beacon.

5. Limitations and Future Work

The possibility of occlusions and relatively small working area are the main areas in which this approach needs improvement. However, adding more camera devices will diminish the portability and versatility of the setup and possibly introduce ambient IR scatter problems.

6. Final Words

Using off-the-shelf consumer electronics, free or low-cost software, and the help of a dedicated online community of hardware hackers, I have demonstrated the feasibility of three-dimensional, multi-user audio terrains that can be easily transported and enjoyed with minimal setup time.

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