atmoSphere: Designing Cross-Modal Music Experiences Using Spatial Audio with Haptic Feedback

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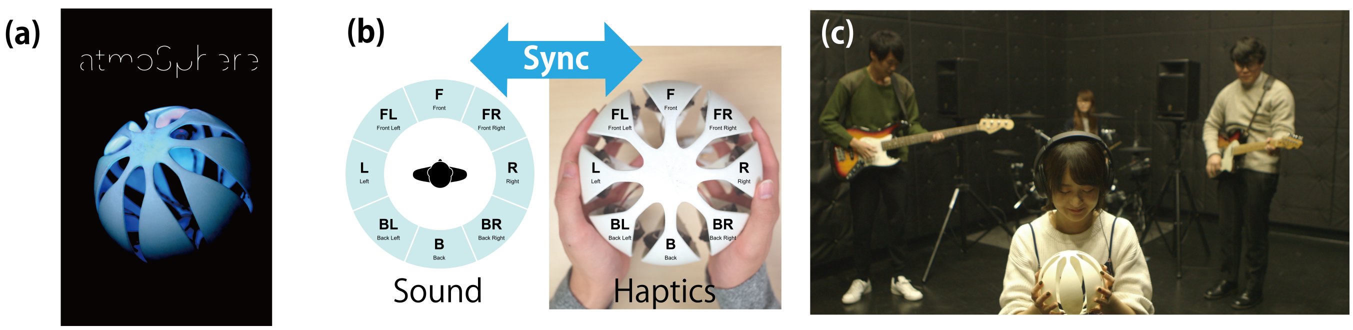

Figure 1: (a) atmoSphere / (b) Motion Synchronization / (c) User Experience

ABSTRACT

We use cross-Modal correspondence -the interaction between two or more sensory modalities- to create an engaging user experience. We present atmoSphere, a system that provides users immersive music experiences using spatial audio and haptic feedback. We focused on cross-modality of auditory and haptic sensations to augment the sound environment. The atmoSphere consists of a spatialized music and a sphere shaped device which provides haptic feedback. It provides users imagination of large sound environment although they feel haptic sensation in their hands. First user feedback is very encouraging. According to participants, atmoSphere creates an engaging experience.

CCS CONCEPTS

•Human-centered computing →Haptic devices; •Hardware →Haptic devices;

KEYWORDS

Haptics, Spatial Sound, Cross-Modality, atmoSphere

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1 INTRODUCTION

Cross-modal effects in human perception are defined as interactions between two or more different human senses. Effects concerning audio and vision are very well understood and often used in Human Computer Interaction as well as other disciplines. As haptic feedback technologies are more broadly available, we also see more and more works that tackle cross-modal effects with touch and vision as well as audio [Fujisaki et al. 2015]. Still only very few researchers use these principles for interaction or user experience designs [Gu et al. 2015; Israr et al. 2012; Makino et al. 2016].

In our research we explore how to use cross-modal effects and correspondences to accelerate learning, increase immersion, and relaxation. This paper focuses on the later two: immerssion and relaxation.

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The contributions are as follows: (1) we present atmoSphere a haptic device mapping directional audio to corresponding haptic sensations on a round, hand-held device, (2) we show two usage scenarios for atmoSphere, one to augment the spatial perception of a music perfromance and one to augment the relaxation during mindfulness training.

2 SYSTEM COMPONENTS

The atmoSphere (Figure 1(a)) provides immersive music experience using cross-modal effects. Surround haptics[Israr et al. 2012] proposed that a grid of vibrating actuators can generate moving tactile strokes on the skin. Po2[Israr et al. 2015] suggested illusion of tactile sensation by providing vibrations on the hand. Reality Jockey[Fan et al. 2013] proposed that spatial motion of sound with haptic feedback gave users the illusion that the vibration source was also moving. It proposed combination of haptic and auditory sensation augments your spatial perception.

2.1 Sphere Device

The atmoSphere device consists of a USB audio interface(Roland UA-1010), a Preamplifier and a power amplifier, 8 tactile sound transducers (Acouve Laboratory Vp2), a USB-audio transducer (PLANEX PL-US35AP), a noise-cancelling headphone (Boss QuietComfort 35), a 3D printed sphere made of white ABS resin. AtmoSphere consists of 10 seperate parts (with spacing in between). Each of the 8 side parts has a tactile sound transducer (Figure 1(b)). There is a cushioning material between a transducer and an ABS resin part to reduce the noise of the transducer vibrations.

A sphere shaped device is linked the image of sound environment. It is divided into 8 parts and each of them has a tactile sound transducer. Users can touch 2 or 3 parts with one hand so that they can feel movement of vibration. It provides users spatial motion of tactile feeling corresponding to spatial audio (Figure 1(b)).

2.2 Spatial Sound Music

The music for atmoSphere was composed with binaural recorded audio. We conducted binaural recording of various kinds of sounds like hand claps, whisper voice, and water sound. These sounds were recorded from 8 directions. The localization of these sounds are correspond to haptic feedback so that users can feel movement of sound.

3 USER EXPERIENCES

We implement two user demonstrations, augmenting a music experience and a mindfulness meditation. Both are designed to give the user a relaxing feeling.

3.1 Augmented Music

Users wear headphones and hold a sphere so that they hear and feel sound. For example, they can feel someone walking around (Figure 1(c)). The sphere provides vibrations in conjunction with such stereoscopic localization of sound. It enables users to imagine large sound environment although they feel vibration in their hands.

3.2 Augmented Mindfulness

We use J!NS MEME, smart glasses that measure relative eye and head movements, to infer the relaxation state of the user[Ishimaru et al. 2015]. We provide synchronized haptic and audio feedback with the relaxation state. The user hears the sound of a circulating brush stroke (as in calligraphy) moving around him with circular haptic feedback in a rhythmic pattern (stimulating him to breath accordingly). The more relaxed the user gets the lower the sound and the haptic feedback.

4 USER FEEDBACK

We showcased atmoSphere in several public events from our graduate school (forums and open labs). Participants' reactions and comments indicate that atmoSphere can provided entertaining experiences. However, cross-modal correspondence seems to depend highly on the type of sound and haptic feedback. Participants report that footsteps and rain drops seem to work very well, for example a user commented: " It really seems that someone is walking around me."

5 CONCLUSION AND FUTURE WORK

Combining haptic feedback and spatial audio, we created an engaging user experience considering user comments. We will evaluate immersion and engagement quantitatively in user studies.

In a next step we will test further spatial audio and haptic feedback design to explore other cross-modal correspondences. Also we will look more into application areas related to immersion, learning, localization and relaxation.

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