Sonic Interaction in Virtual Environments

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ABSTRACT

This paper summarizes the main research topics addressed at the 2nd workshop on Sonic Interaction in Virtual Environments (SIVE) that took place in Arles, France in March 2015. The workshop is part of the annual IEEE Virtual Reality Conference.

Keywords: Sonic interaction design, virtual reality, multimodal interaction, tangible interfaces, 3D sound.

Index Terms: H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

1 INTRODUCTION

The second edition of the Workshop on Sonic Interaction in Virtual Environments (SIVE'15) took place on March 24 2015, in conjunction with the IEEE Virtual Reality Conference. The point of departure of the workshop was *Sonic Interaction Design,* which is defined as the study and exploitation of sound as one of the principal channels conveying information, meaning, and aesthetic/emotional qualities in interactive contexts [1], [2]. This field lies at the intersection of interaction design and sound and music computing [3].

In the virtual reality community, the focus on research in topics related to auditory feedback has been rather limited when compared, for example, to the focus placed on visual feedback or even on haptic feedback. However, in communities such as the film community or the product sound design community it is well known that sound is a powerful way to communicate meaning and emotion to a scene or a product.

The main goal of the SIVE series of workshops is to increase among the virtual reality community the awareness of the importance of sonic elements when designing virtual environments. We also discussed how research in other related fields such as film sound theory, product sound design, sound and music computing, game sound design and computer music can inform designers of virtual reality environments. Moreover, the workshops featured state of the art research on the field of sound for virtual environments.

The submissions received in the second edition provide a broad coverage of the SIVE topics, namely sound synthesis, modeling, design and rendering for virtual environments, sound spatialization, headphones and speakers reproduction, binaural sound and head-related transfer functions, gestural control of sound in virtual reality, multisensory (audio-visual, audio-haptics) interactions, personalization and customization of virtual auditory displays, navigation and way-finding through sonification, and evaluation of user experience and sound quality.

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The workshop has proven that there is a vibrant community of researchers interested in embedding sounds in interactive multimodal applications. Yet, more research is still needed in order to achieve a better understanding of the detailed role of sound.

2 WORKSHOP PAPERS

The submissions are presented under the following groups below.

2.1 Sound Spatialization

The immersion of each listener in acoustic spaces allows infinite nuances in sonic interaction. Accordingly, technologies for spatial sound rendering should be able to render highly realistic environments and virtual scenes with high degree of freedom for interaction designers and composers.

Binaural reproduction through headphones is one of the most promising spatial audio technologies for mobile applications and interactive scenarios, once combined with emerging low-cost head-mounted displays. In binaural synthesis, listener anthropometry has a crucial role especially for elevation perception of sound sources. The paper by Geronazzo *et al*. reports a performance analysis of vertical localization in virtual auditory displays via auditory models, with particular attention to personalized *head-related transfer function* (HRTF) rendering. The proposed framework and perceptual metrics are flexible tools for systematic evaluation of different parameterizations of HRTF models.

Loudspeaker reproduction is essential in composing and producing electroacoustic in a concert hall. The intentions of the composer create abstract and artistic scenes, which are strongly interconnected with sound spatialization technologies. A composer's perspective is given by Timmermans. In his paper, the multi-speaker set up is seen as a complex instrument on which a composition could be performed, manipulating every single compositional object with its own character and its own acoustic properties including spatial positions, trajectories and acoustic space.

2.2 Sound, Music, and Motion

Music was an important theme in the SIVE workshop. Mandarici and coworkers presented a framework for motion based music applications. An example of an application is the Harmonic Walk, a method to teach harmony to students using enactive learning.

Hamilton presented his approaches in creating procedural audio for computer games, and how he used data from game mechanics to sonify games. His competencies as a composer allow him to approach sound design for games from a musical perspective.

Sikström presented his research on estimating the weight of an avatar by using sound. Results show that sound is an important parameter that can affect listener's perception of the weight of a virtual reality character.

2.3 Gamification and learning

Sonic interaction design can be applied to learning environments and gamification contexts in order to improve a specific performance. Pfaff and Lervik, for instance, explore the possibility of creating a collaborative music-making process in a virtual space through a virtual 3D environment combined with game mechanics. In this specific context they have also proposed a test showing that collaborative music making in a virtual space might not only lead to a new way to create, but also to perceive music, especially in combination with game mechanics.

The creative approach to an artistic expression such as musical composition can be applied also to drawing-learning environments. Yamamoto proposes a new drawing learning support system based on presenting the ideal stroke motion of the learners (past brilliant learner-self) as teacher's motion. Audio and visual feedback is used to provide information to the users in order to draw ideal strokes again.

Finally, the desire to create a safe and inexpensive alternative to real-world skill training has led Allain *et al*. to the development of a 3D exploration game for blind children in order to assist orientation & mobility learning activities. In this application scenario, spatial sound (HRTFs with head-tracking) is used within an audio-game. This leads to an immersive and engaging experience in virtual learning environments. This confirms, among other, the important role of sonic interaction in space (see also Sec. 1.1).

2.4 Interactive Sonification

Papachristodoulou, Betella, Manzolli and Verschure presented a case study from the BrainX3 project, which takes advantage of high end immersive facilities present in Barcelona, where motion capture, immersive visualization and monitoring of physiological data are combined. The project showed an interesting sonification of complex data sets using these facilities.

Summers, Lympouridis and Erkut argue for a need to refocus on the experiential, embodied, contextual, playful and holistic properties of sonic interactions. They provide guidelines to sonic interaction designers, in order to implement this refocus. Boyer and colleagues present several sound installations where sound and touch complement and augment each other. Experiments on audio-tactile virtual surfaces are presented, which are inspired by the research in sensory substitution and haptic perception.

Baldan and his colleagues present a synthetic, physically-based model for combustion engine sounds. The model relies on the simplified description of the four-stroke engine mechanics, runs on Max/MSP and is available for download at https://github.com/SkAT-VG/SDT

3 Conclusion

The 2nd edition of the SIVE workshop presented several interesting research and applications directions, ranging from the fields of tangible interfaces to larger virtual reality installations.

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