Interim Report

Perceptual Plausibility in Augmented Auditory Feedback for Interaction with Physical Objects

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During the first year of my doctoral studies, different aspects of auditory augmentation have been explored and discussed. One result of this process are three continuously growing documents: (1) an extensive bibliography, listing all relevant literature, well-sorted by topics; (2) a glossary containing definitions for the most relevant terms and their german/english translation; (3) a description of possible experiments assessing plausiblity and usability of augmented auditory feedback. The literature review confirmed that the plausibility of sensory feedback has not been researched sufficiently, and its exploration is assumed to be highly relevant and important for Human Computer Interaction (HCI) in general and auditory augmentation [1] in particular.

In a preliminary study, the potential of augmented spatial extent of sound sources has been evaluated in a listening experiment. The results results were published as a peer-reviewed conference paper at the Conference on Digital Audio Effects (DAFx) 2016 [2].

A relevant side-project was the sonification of body-movement itself, with no physical objects involved. Its practical application on the diagnosis of clinical tremor led to two peer-reviewed conference papers [3], [4]; the first of them has been awarded as "best paper" at the Interactive Sonification Workshop (ISon) 2016 in Bielefeld. In a more artistic application, I assisted 2nd supervisor Gerhard Eckel in correpetition and live-electronics for the dance-performance "Every Move a Sound" [5].

Further research was performed on the usability of interactive systems. Most everyday objects are designed for a specific purpose and can therefore be evaluated by established standard procedures. I contributed to a new method for evaluation of interactive systems which lack a specific purpose and therefore can't be examined by already established methods. A peer-reviewed conference paper was published at the ACM SIGCHI Conference on Designing Interactive Systems (DIS) 2017 [6].

I presented my work at the doctoral forum and passed the required courses, e.g., scientific writing, Hochschuldidaktische Ausbildung, and doctoral forum. I assisted in course preparation and lecturing for musical acoustics and sonification.

A experimental platform was built for the purpose of development and evaluation of auditory augmentations. Near-flat frequency response of integrated structure-borne exciters is achieved by inverse filtering with measured impulse responses.

For July 2017, external advisor Thomas Hermann invited me to a research stay and presentation at Bielefeld University. There, we implemented a similar experimental platform for inter-institutional

collaboration and reproducibility. We further refined it based on a low-latency embedded system, and developed several new ideas on practical applications of auditory augmentation, which lay out the path for the second year. We successfully implemented a transformation of perceived material, which seemed to be plausible in informal experiments. We started the implementation of a database for hand-surface interaction sounds, in order to explore the correlation of acoustic features and material/interaction type. The focus of the dissertation has been narrowed to auditory augmentation of flat surfaces, which is seen to be sufficiently broad and provides promising applications, e.g., for touch-screen- or stylus-based systems.

[1] T. Bovermann, R. Tünnermann, and T. Hermann, *Auditory augmentation*, K. Curran, Ed., ser. Premier reference source. Information Science Reference, 2010.

[2] M. Weger, G. Marentakis, and R. Höldrich, "Auditory perception of spatial extent in the horizontal and vertical plane," in *Proc of the 19th International Conference on Digital Audio Effects (DAFx-16)*, Brno, Czech Republic, 2016.

[3] M. Weger, D. Pirrò, A. Wankhammer, *et al.*, "Discrimination of tremor diseases by interactive sonification," in *Interactive Sonification Workshop (ISon) 2016*, Bielefeld, Germany, 2016.

[4] M. Weger, D. Pirrò, and R. Höldrich, "Evaluation of an acoustic interface for tremor analysis," in *Proceedings of the 14th Sound and Music Computing Conference (SMC)*, Espoo, Finland, 2017.

[5] G. Eckel, A. Gottfarb, A. Nowak, *et al.* (Jun. 2017). Every move a sound, [Online]. Available: `https://www.kug.ac.at/index.php?id=1293&tx_ttnews[tt_news]=5548&cHash=2996ee250270d008634ff1d614f481da`.

[6] G. Marentakis, D. Pirrò, and M. Weger, "Creative evaluation," in *Proceedings of the 2017 ACM Conference on Designing Interactive Systems*, ACM, Edinburgh, UK, 2017.