Enhancing immersion in multisensory VR environments through e-textile haptics, sound and visuals

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Researching haptics and tactile feedbacks in a multisensory VR experience combines different fields within the HCI community. We propose, that crucial for the successful design of haptics in multisensory virtual environments, it is the choice of methods and reflection on existing systems to update the interdisciplinary team in the beginning of a process, to identify the potential areas of research and to strengthen the design vision. The interdisciplinary research project "Klima-ACT" is an example, where a haptics-featured playful VR-environment allows to experience climate-change in a game context to reflect one's own behavior in the real world. A state of the design process of the haptic applications will be presented, and the methodological planning of first-, second- and third person methods. We resume with preliminary conclusions of identified challenges and close with an outline for the next steps in our process.

CCS CONCEPTS • Insert your first CCS term here • Insert your second CCS term here • Insert your third CCS term here

Additional Keywords and Phrases: Multisensory VR Experience, Tactile Feedback, Interactive Textiles, Haptics in VR

ACM Reference Format:

1 INTRODUCTION

In the research project "Klima-ACT!" we investigate the potential of immersive and multi-user-capable technologies to motivate users to change their daily behavior towards more climate-friendly actions. In a playful VR environment, together with a haptic device, climate-change becomes experienceable through a multisensory system, a combination of sound and visuals conveyed through a VR-Set and haptics embedded in an e-textile wearable.

At the state of our research, we work on a framework where we on one hand, test and analyze haptic devices such as gaming wearables, on the other hand use first person methods to define criteria for rich immersive VR experiences, that can catch nuances of weather expression.

Thus, we address our work to the proposed sections of “Controllers and Devices” and “Accessibility and communication of haptic experiences”.

2 BACKGROUND

In HCI, the understanding of interfaces and controls has evolved massively throughout the years: today, the design of responsive spaces and interactive experiences is in the focus [12]. Options for material choices have become wider, and the disciplines meeting in HCI research of tangibles, haptics and tactiles more divers [2]. The research for new ways and material-led interactions for example with the use of e-textiles has become a bigger field, the research about experiences with (interactive) materials has gained more attention [4,5,8].

Tactile feedback has been applied in wearables for functional applications for example posture correcting yoga pants [14] and artistic projects that can change people’s own body perception, like the “Magic Lining” by Kuusk and Tajadura-Jimenez, that allows wearers to feel like clouds, a tree or another material.

Alternative controllers of textile materials, resulting in controller-wearables and soft game-controllers has been developed by Kobakant and Kate Hartman et al [6,11:107], researchers like Jung et al investigate concepts for alternative gaming wearables to enrich VR gaming experiences [7]. In their ideation workshops, the participants created concepts, where actions from the real world, like protecting yourself within a cape is directly translated in the game through tracking of a real cape-wearable.

In their research, Vidal, Ley-Flores at al apply movement sonification and its manipulation to change individual body perception and by that enhancing people’s motivation to become more active [10]. Research like that shows how the brain can be tricked with sound combined with daily actions [9]. Ahn et al showed in their study, how a learning effect can be enhanced with the help of an “interactive and perceptually rich experiences [in VR], compared against traditional text and video messages”[1].

Studio MannD [15] created a multisensory VR installation to make people experience the terrible conditions in fast fashion production. The experience consisted of a VR-environment showing videos and pictures from sweat shops or fabric dying in rivers, corresponding with a physical installation parkour, in which participants were supposed to walk through to feel dry air, dusty grounds or wet feet according to the visuals in VR.

Methodology in HCI is an emerging field, due to its interdisciplinarity, the field has not only applied but also researched methods and processes in the design of interactive devices. We will mention a few references that we have involved actively in our research project so far.

Desjardins et al report tendencies in HCI research that apply more first person methods approaches to be able to involve personal experience into the design process, that are not filtered or biased by communication [3]. Another suggestion to solve the problems with verbal feedback are the “Soma-bits” by the Soma Design Research Group, which to help researchers and study participants to communicate nonverbally about their bodily experience [13].

3 FIRST, SECOND AND THIRD PERSON METHODS IN THE PROCESS

In the project plan, we involve first, second and third person methods throughout the iterations. To declare the scope of our development and in the exploratory phase of our project, we involved mostly first-person methods like diary techniques or embodied and soma design methods.

In the further development, we plan to make studies with participants and users in a dialogue, using participatory approaches to serve the target group. We will use that to gain insides on how different users perceive the VR-experience, and also conduct comparative studies to see how participants react to different interaction concepts and sensory experiences.

As a final step, third person studies will be conducted to reflect on the full multisensory experience in the context of the Klima-ACT-hub environment. Learnings from those studies will lead to further and more detailed development of the multisensory environment, also of the aesthetical design of the involved e-textile materials.

4 ACTUAL STUDIES OF HAPTICS DEVELOPMENT

The interdisciplinary team consists of game designers with backgrounds in software and media arts, and an e-textiles material designer. Our aim is to develop a multisensory environment, where both wearables (garments with embedded technology) and interactive materials will be applied to enhance the VR-experience. A goal is to involve participants empathically, to make them reflect on their own climate-friendly acting. Thus, the haptics must simulate the weather, but also trigger emotional levels of comfort and discomfort. One challenge for this environment is, that our target group is divers. This means that we must design the VR-experience very accessible with simple interactions that are controllable.

In our ideation and development sessions, we did tests and analysis of existing systems within the team. We tested existing haptic suits developed for VR-gaming, together with games where weather simulation is a significant feature, as well as in own virtual mock-ups with embedded rain functions and virtual roofs to test how it feels to step in and out of the rain.

Our foci were 1) the combination of the sensory experience, the visuals, sounds and haptics from the suit and 2) the evaluation of the actual haptic feedback in existing suits.

Virtual worlds and weather experiences were reflected in the team: every team member participated in the chosen experience to report how it feels, how realistic, how comfortable, what distracted the immersion. Especially in the example of rain, the direction and body region where the rain hit, as it was not responsively falling from above. We experienced light settings in the visuals as a crucial component in the weather simulation. Another insight was, that the sounds must change with the weather as footsteps sound different on dry and wet grounds.

To observe the bodily involvement and the haptic experience itself, we experimented with the modules of the suit, placing them on different parts of the body than addressed in the suit: hand insides, top of the shoulders, top of the head etc. and gained richer feedbacks.

5 LEARNINGS, CHALLENGES AND NEXT STEPS

Using existing systems to identify problems and potentials for optimization and innovation was very useful in the process. We were able to directly share the settings and examples to reflect together. Another important aspect is the saving of resources, both time and workload.

A challenge is that borrowed or rented haptic devices can not be modified. From that stage where we see potential to optimize devices, we must buy our own device to modify it or build modules from scratch. Luckily, development kits are sometimes available and can be sourced.

Similarly, when researching and testing mechanics in commercially accessible games we can use readily available modification tools built into mentioned games (e.g., via the Steam Workshop) to integrate haptic devices that were not meant to be part of the playing experience. Not all games offer such modification tools. In these cases, we can use workarounds like sound-analysis to capture certain in-game audio to trigger haptic feedback actuators. Draw backs are, that we have less control over haptic feedback actuators compared to implemented triggers on a code-based level. Finally, to take fully advantage of the possibilities of perceptually rich virtual environments, we need to build our own specific game world: for full control when combining haptic feedback wearables with visual and auditive feedback all set in a specified storyline.

In all previous steps, we faced boundaries with existing systems, when our requirements became more specific. However, these steps were extremely useful when designing our own e-textiles devices, virtual environments, and sound settings. Luckily, we think more developers open parts of their work allowing to build on, as we are used from developers' platforms like Arduino or Adafruit in boards, components and codes.

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