Investigating Benefits and Limitations of Asymmetric Collaboration for Designing Sensory Experiences in Mixed Reality

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ABSTRACT

Immersive technologies, such as Virtual Reality (VR), support creating virtual worlds to simulate various scenarios. Tactile and visual experiences can increase the sense of immersion and make virtual objects tangible. Designing them is challenging and requires to be immersed in the virtual environment, which is tiring and limits the kind of parameters controlled. Designers must therefore often switch back-and-forth between the virtual environment and a desktop computer to fine-tune the experience. This project studies the benefits and limitations of asymmetric collaboration to design such sensory experiences, i.e., one user is immersed in the virtual environment to feel the experiences and design them in-situ while a collaborator controls its parameters in more details on a desktop computer, as opposed to a single user switching back-and-forth between the two setups. Our goal is to identify whether collaborative setups can leverage the benefits of each environment while minimizing their respective limitations.

HOSTING LABORATORY

The PhD candidate will join the LOKI research group based in the Inria centre at the University of Lille. It is part of the CRIStAL laboratory (UMR 9189) and includes professors and assistant professors of the University of Lille, as well as Inria researchers. Lille is at the northern tip of France and its metropolitan area, situated at the crossroads of northern continental Europe, is the 5th biggest in France. Loki is a dynamic and multicultural team with members coming from different countries (Germany, Canada, China, Iran, France, etc.) and communicating daily in English.

CONTEXT

Immersive technologies, such as Virtual Reality (VR), support creating virtual worlds to simulate various scenarios. Such applications range from recreational games to

simulations and training scenarios that are otherwise impractical, economically unfeasible, or too hazardous in real-world conditions. As users immerse themselves in these virtual worlds [1], they can *feel* virtual objects during manipulation through, e.g., vibrations or visual illusions that simulate physical sensations of weight and forces [2]. While these tactile and visual experiences can increase engagement, enjoyment and enable skill transfer and learning [3], designing them remains challenging as designers need to consider several factors intrinsic to the overall context, task, and experience they aim to produce.

Authoring tools exist for vibrotactile [4] and pseudo-haptic experiences, but they remain mostly based on desktop interfaces relying on WIMP metaphors that strongly limit hands-on design processes, limiting designers' expressivity and control. Their interface design makes them unusable directly in the virtual environment, forcing designers to switch back and forth between the designing interface and the testing environment. Not only can this be tiring, but it can also break the design workflow. Authoring tools can be adapted to enable in-situ design in VR [5], but remaining in the VR environment for too long is tiring and will lead to exhaustion, especially when directly manipulating virtual objects with mid-air gestures.

We will investigate whether asymmetric collaborative design [6], i.e., one user in VR and another on a desktop computer, can leverage benefits from both approaches in synchronous collaborative scenarios. By studying the design process, this work will enable novel collaboration approaches in mixed settings by addressing communication challenges, optimizing control for each designer, and synchronizing awareness of interactions.

PROJECT GOALS

This project studies the benefits and limitations of using asymmetric collaboration [6] to leverage advantages of designing sensorial experiences in VR or on desktop computers, i.e., one user is directly feeling and designing the experience in VR while another uses a desktop computer to fine-tune parameters of this experience. We will investigate the tradeoff between limitations of designing in VR (not adapted to fine-tune parameters of an experience, tiring) and limitations of designing on a desktop computer (not directly feeling the experience in the virtual environment), and will particularly focus on communication patterns between users to clearly identify benefits and limitations of this approach. Our goal is to identify whether collaborative design tasks with users assigned to different roles and manipulating different parameters of the experience lead to a more efficient workflow overall, or on the contrary would add more limitations than scenarios in which single users switch back and forth between the VR and desktop environments.

We will particularly compare collaborative scenarios in which users synchronously control the same or different parameters in different working environments, and sequential scenarios in which users perform tasks sequentially to support or even force breaks that might be necessary, especially for the person in VR, and to wait for a the collaborator to finish their task. Fundamentally, this raises questions on the benefits and limitations of sequential vs. parallel tasks in asymmetric collaboration. Another primary focus will be on communication challenges; discussing vibrotactile feedback is known to be challenging [7] and collaborative scenarios require fluid communication [8]. We will study whether collaborative design creates more challenges than it provides benefits on this aspect.

RESEARCH QUESTIONS

We propose a list possible research questions investigated in this project, that could vary based on the candidate's interests:

- What benefits and limitations asymmetrical collaboration provides when designing sensory experiences?
- Are challenges on communicating one's intention when designing sensorial experiences a strong limitation to collaborative design?
- Can we identify the tipping point when designing in VR is becoming cumbersome and desktop interactions would be beneficial, and vice-versa?
- How are collaborators sharing the workload when designing sensory experiences? Are sequential tasks more beneficial than parallel tasks overall or does it depend on the nature of the experience?
- Should controls on the experience parameters be split between collaborators or should they both be able to control any parameter at any time to maximize the design workflow efficiency?

POSITIONING IN THE PEPR PROGRAM

The primary focus of this project is to investigate the **benefits and limitations of asymmetric collaboration in mixed reality** to design sensory experiences. The results obtained should expose benefits and limitations of collaborative setups for designing such experiences over single user processes. **This falls in the scope of the PC1 CATS that investigates synchronous collaboration in AR or VR, through different devices (desktop, HMD), and arguably in different contexts as the two designers might not share the same point of view on the experiences they design.**

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