

Title: *Keeping together during transitions between places when collaborating in social VR*

Host institution: Nantes University, LS2N, équipe PACCE

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Context: Social VR and Metaverse solutions are rapidly advancing, enabling users with Head-Mounted Displays (HMDs) and controllers to embody avatars and interact with each other to participate in immersive experiences in dedicated places (Harrison and Dourish 1996), for work (e.g., meet, brainstorm) or leisure (e.g., games, virtual tourism). As virtual environments grow larger, encompassing digital twins of cities and open worlds, collaborators not only need to navigate between them but also move from place to place within the same environment (e.g., from room to room in the same building). This thesis focuses on transitions between places within social VR environments and their impact collaboration.

Maintaining a sense of social presence and collaborative task awareness during transitions is crucial for sustained collaboration (i.e., the sense of other participants' presence and social connection) (Oh et al., 2018, Kyriltsias et al. 2022). However, ensuring seamless transitions between places poses significant challenges due to the difficulty of moving with a group, and as a group, in social VR. For instance, deciding to move together, setting up on the destination, initiating the movement itself can be much more tricky in VR than in reality. Also, when navigating the same space at various speeds or directions using steering (e.g. with a joystick), walking (e.g. by moving the arms), or teleporting by pointing at a nearby destination (Al Zayer et al. 2020), it is difficult to keep perceiving the presence of the others as avatars or the sense of a common movement. When teleporting by selecting a place in a list, difficulties may arise because of the loss of context (quitting a common place, arriving to a new place to invest), temporal offset (due to individual teleportation or loading times), spatial offset (changes in the relative positions, or arriving all at the same coordinates).

Scientific and technical objectives: Our main scientific questions are: What are the main characteristics of group transitions in the Metaverse? (contexts of occurrences, technical, cognitive and group determinants, associated lived experiences, etc.) What are the issues associated with them? Can we design principles or tools to mitigate the main issues? Our technical questions are related to the possibility to design tools and methods both to study such transitions in the lab and in the wild, and to implement our proposed solutions for helping a collaborating group stay together while changing places in social VR.

Approach. Our approach is related to carrying 5 mains tasks: 1/ *interdisciplinary bibliography* on related topics (mainly VR and CSCW) 2/ *ethnography*, so as explore the current practices of moving from place to place within current social VR platforms (e.g. Engage VR, VR Chat, Horizon Worlds, etc.); 3/ *experimentation*: so as to assess the main determining features; 4/ *system design*: design tools and/or interaction means to improve those experiences and mitigate the main issues; 5/ *evaluation*: in appropriate context. At first, we will have a broad view, and consider all the available modes of transitions, in their relations to communication means (e.g. voice, audio, messages, etc.), for different sizes of groups (e.g. 2, 3, small groups, large groups). Various contexts will be considered, be it *leisure* (e.g. going from one gaming place to another with friends, walking in a parc with family or friends), *work* (e.g. from one focus to another in a digital twin visit), or *teaching / therapy* (e.g. maintaining coherence of class between activities, going from one therapeutic activity to another with the practitioner). Depending on our first results, we will focus on the most important and promising use cases. A good use case could be that of scientific conferences organized in social VR where participants form multiple types of groups and carry multiple activities across multiple spaces (presentation rooms, social venues, etc.).

Challenges. 1/ Use concepts from both CSCW (e.g. awareness, coordination) and VR (e.g. avatar embodiment, 3D embodied perception of others and the world) to accurately consider social presence before, during, and after transitions. 2/ Focus on well defined and important questions despite the lack of studies on the topic, by conducting ethnographic work so on existing social VR systems. 3/ Design means for implicit and emergent rather than explicit ways of deciding and carrying out transitions as a group, leveraging visual and auditory perception to foster group awareness. 4/ Design experimental means to study how people keep together as a group during transitions, by giving adequate tasks (e.g. conversing), and collect behavioral and experiential data, and qualitative and quantitative measurements.

Originality and importance. The focus on transitions in collaborative VR is original, because it is very less studied than collaboration itself. It is important and timely because social VR for collaboration is rising, and will take on more and more importance in the next few years, needing adequate co-navigation and co-teleportation means to be designed and validated.

Positioning. With regards to the PEPR thematics, our focus on meaningful transitions between collaboration places so that collaboration is maintained corresponds to PC 1 / thematic priority 4. With regards to the state of the art, we can consider a few directions. **Transitions in general.** Grasset et al. (2011) argued that maintaining a seamless spatial and visual representation during transition is an *important and open question*. **Co-Navigating in a world.** Weisker et al. (2021) proposed a model for group navigation based on vehicle metaphor, and various navigation means giving the responsibility of navigation to one user, possibly completed by a second (Weisker et al. 2020, Weisker & Froehlich, 2021). Chheang et al (2022) proposed that one user controls group teleportation from a 3D world in miniature map. We are interested in techniques where *group navigation rather emerges and stabilizes from individual behaviors and awareness of the others* rather than relies on explicit interactions and decisions between participants. **Co-teleportation between worlds.** There are some works on the experience of transitions between worlds (Men et al., 2017) and how to smooth them, for example portals to see the arrival world (Freitag et al. 2014). To our knowledge, there are *no studies on the effects on groups*, despite real systems exist, that allow e.g. one to control group teleportation, or users to follow themselves in portals. **Embodiment and social presence during transitions.** Avatars are important in the metaverse as one's body is one's spatial reference and essential to social presence: "people can see me and I can see them". Both avatar's appearance (Casaneuva, 2001) and animation (realistic gaze, accurate arm movements) have an effect on social experience during cooperative tasks. However, how they affect social presence during co-navigation or co-teleportation remains unexplored. There are a few results we could use for co-navigation: locomotion methods have little influence on avatar perception (Dewez et al. 2020), and avatar positions can be tweaked to smooth the perception of the movement for others (Freiwald et al. 2022).

Project organization. Year 1: bibliography / state of the art; study of existing applications, ethnography of collaboration in social VR, publication. Experimental design to study the effect of various parameters on group transitions (e.g. teleportation durations, locomotion mode, other avatars movement rendering, etc.), development or adaptation of an existing environment, experimentation. Year 2: Data analysis and publication. Design of tools / interaction that favor group continuity, development, experimental design of their evaluation. Year 3: experimentation, data analysis, publication. Thesis report.

Partnership: the candidate should have a degree in computer science, with a major in HCI/VR. He/she will work in the PACCE team of LS2N UMR 6004 CNRS. **Yannick Prié** will be the director, he is a full Prof. in Computer science at Polytech Nantes, who has long been involved in interdisciplinary work on (social) VR projects. **Rebecca Fribourg** is an associate Prof. at Centrale Nantes, with expertise on perception in VR and AR, in particular on avatar embodiment and social VR. **Jean-Philippe Rivière** is an assistant Prof. at Nantes University in HCI, with expertise in CSCW, embodiment, and the study of lived experience. They are currently working (with Pr Jean-Marie Normand) on a related project which aims to design techniques to allow two people experience "walking together" as avatars in social VR, which can be thought of as an instance of co-navigation in the same environment.

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