Demande d'accompagnement de thèse – PEPR eNSEMBLE – Giuseppina Diatmiko

PhD Title: Immersive collaboration across time through virtual surrogates in Mixed Reality

Domain and scientific context:

Digital technology is advancing to support collaborative work between people who are separated in space and time [1, 2]. Prior work in Mixed Reality (MR) collaborative systems investigated live immersive collaboration between remote located people to share a virtual copy of a physical task environment [3, 10]. However, how to enable asynchronous collaboration between people in an immersive environment has been scarcely investigated [6]. The PhD work will concentrate on such asynchronous collaboration involving multiple users interacting at different times. This project is at the crossroads of Human-Computer Interaction, Mixed Reality and Computer-Supported Cooperative Work.

Targeted scientific objectives:

Current trends in asynchronous collaboration mostly evolve around the idea of sharing pre-captured activities asynchronously [5, 7, 8, 9], which has a limitation of not allowing active interaction between people. Asynchronous collaboration must go beyond the simple scribing of information for review at a later time, as pointed out by [6]. When collaborators' embodied asynchronous representations are pre-captured with the virtual content, it can lead to awkward situations where people may think that their collaborators are ignoring them or even running into them, as observed by [4]. Recent advances in generative AI using Large Language Models (LLM) demonstrates natural and live interaction with a virtual agent through text-based online chatting became feasible. This project proposes to investigate how LLM based virtual agents can be utilized to capture knowledge and priorities of a participant in MR based immersive collaboration, creating a virtual surrogate which can interact with remote collaborators on behalf of a person who is not available at particular time.

Considered methods, targeted results and impacts:

The PhD project will investigate how to capture a person's knowledge and priorities through LLM, how to apply the captured LLM to control a virtual character in MR environment as a virtual surrogate, and evaluate how such virtual surrogates can be effective in MR based immersive collaborative environments to facilitate active interaction between participants even when collaborating asynchronously. The PhD candidate will first conduct observational studies to identify shortcomings in current asynchronous collaboration, create a MR system integrating virtual surrogates, and evaluate the benefits of this system through user studies. Targeted application scenarios include collaborative design in the field of architecture and industry, involving remote team members located in countries with large time differences. While the PhD work could significantly enhance the collaborative process in these scenarios, the expected benefits of the project can be extended to a broader range of collaborative contexts and application domains.

Environment of the PhD:

The PhD is funded by a co-fund project between the European Union, IMT Atlantique and University of South Australia (UniSA). The PhD candidate will be co-supervised by Dr. Cedric Fleury, an Associate Professor at IMT Atlantique, and Dr. Gun A. Lee, a Senior Lecturer at UniSA. The PhD candidate will be located in Brest during his/her stay at IMT Atlantique (24 months) and in Adelaide during his/her stay at UniSA (12 months). The location of the two partners in distant countries will be an excellent opportunity to set up and test an asynchronous collaboration system due to the time difference.

References:

[1] Fages, A., Fleury, C. & Tsandilas, T. (2022). Understanding Multi-View Collaboration between Augmented Reality and Remote Desktop Users, Proceedings of the ACM on Human-Computer Interaction, Volume 6, Issue CSCW2.

[2] Avellino, I., Fleury, C., Mackay, W. & Beaudouin-Lafon, M (2017). CamRay: Camera Arrays Support Remote Collaboration on Wall-Sized Displays, in Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI).

[3] Bai, H., Sasikumar, P., Yang, J. and Billinghurst, M. (2020). A User Study on Mixed Reality Remote Collaboration with Eye Gaze and Hand Gesture Sharing. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20).

[4] Chow, K., Coyiuto, C., Nguyen, C., & Yoon, D. (2019). Challenges and design considerations for multimodal asynchronous collaboration in VR. *Proceedings of the ACM on Human-Computer Interaction*, *3*(CSCW), 1-24.

[5] Fender, A. R., & Holz, C. (2022, April). Causality-preserving asynchronous reality. In *Proc. of the CHI Conf. on Human Factors in Computing Syst.* (pp. 1-15).

[6] Irlitti, A., Smith, R. T., Von Itzstein, S., Billinghurst, M., & Thomas, B. H. (2016, September). Challenges for asynchronous collaboration in augmented reality. In *2016 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct)* (pp. 31-35). IEEE.

[7] Irlitti, A., Von Itzstein, S., Alem, L., & Thomas, B. (2013, October). Tangible interaction techniques to support asynchronous collaboration. In *2013 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)* (pp. 1-6). IEEE.

[8] Lee, G. A., Ahn, S., Hoff, W., & Billinghurst, M. (2020, November). Enhancing first-person view task instruction videos with augmented reality cues. In *2020 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)* (pp. 498-508). IEEE.

[9] Marques, B., Silva, S., Rocha, A., Dias, P., & Santos, B. S. (2021, March). Remote asynchronous collaboration in maintenance scenarios using augmented reality and annotations. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (pp. 567-568). IEEE.

[10] Teo, T., Hayati, A. F., Lee, G. A., Billinghurst, M. & Adcock, M.. (2019). A Technique for Mixed Reality Remote Collaboration using 360 Panoramas in 3D Reconstructed Scenes. In Proceedings of the ACM Symposium on Virtual Reality Software and Technology (VRST '19).