Augmented Reality for Situated Outdoor Visualization
Master 2 Internship

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Internship period: starting in March/April 2025, 5 or 6 months duration.
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Context

Augmented Reality (AR) superimposes information in the user's field of view and is particularly relevant to outdoor contexts of use, where users can access digital data and seamlessly relate those data to their physical surroundings. This can be useful for leisure activities (outdoor games, tourism), but in a variety of work contexts as well such as urban planning, construction work, and a variety of scientific activities. To take one particular example, geologists often need to access data about the location they are currently visiting: terrain models, soil sample data analyses, documents about the area, including maps.

Figure 1: Artist's rendering of a geologist working in the field and interacting with data in AR.

To further illustrate this scientific case, let's consider Tephrochronology, a discipline of Earth Sciences that analyzes samples of volcanic eruptions in order to reconstruct the volcanic history of a place. When going to the field, Tephrochronologists extract soil samples in places close to certain volcanoes. They later analyze these samples to extract information such as their geo-chemical composition and age with specialized machines. To associate the sample to a volcanic eruption, they correlate the extracted information of a new sample with previously analyzed samples. An important problem in this process is that information is disconnected between steps, making the overall process difficult to manage for the scientists. On the one hand, geologists in the field usually do not have access to the analyses they conducted before going to the field (planning phase). And even if they have tablets to access the data, it is hard to make interactive queries adapted to new hypotheses formulated in situ, in the field at the location itself, and to visualize and relate those data to what they see around them.

Augmented Reality can provide effective support to such users, by enabling them to display data in their field of view and interact with them using freehand gestures. However, designing visualization techniques for such outdoor contexts is challenging. One of these challenges is that many visualizations will be most effective when seen from a bird's eye view of the scientist's current location rather than from his first-person (necessarily limited) perspective on the ground.

Thanks to Mixed Reality (MR) technologies, it is possible for users to seamlessly switch – wearing the same headset – between an AR and a fully-immersive VR-based display that can theoretically enable them to observe their surroundings from a variety of perspectives, without actually moving physically. But designing smooth transitions between first-person AR and third-person VR perspectives raises multiple challenges and research questions.

Internship Goal

The goal of this internship is to explore ways to transition between an augmented reality view with, for example, a situated visualization [1, 2] about the field in front of the user, and a virtual reality view with information on the whole area of study that can guide them where to go next.

Work Plan

Activities to be performed by the internship student include:

1. Review relevant literature in Augmented and Virtual Reality, focused on locomotion methods and transitions between viewpoints (e.g., [3, 4]).
2. Design AR/VR viewpoint transition techniques and assess their relevance.
3. Implement a subset of those techniques.
4. Evaluate them in a controlled user study.

Requirements for Applicants: Training in Data Visualization and Human-Computer Interaction. Design and software development skills, in addition to user evaluation and prototyping methods. Knowledge of Unity or WebXR is a big plus.

References

[1] Bressa, N., Korsgaard, H., Tabard, A., Houben, S., and Vermeulen, J. What's the situation with situated visualization? a survey and perspectives on situatedness. *IEEE Transactions on Visualization and Computer Graphics 28*, 1 (2022), 107–117.

[2] Lee, B., Sedlmair, M., and Schmalstieg, D. Design patterns for situated visualization in augmented reality. *IEEE Transactions on Visualization and Computer Graphics* (2023), 1–12.

[3] Lee, J.-I., Asente, P., and Stuerzlinger, W. Designing viewpoint transition techniques in multiscale virtual environments. In *2023 IEEE Conference Virtual Reality and 3D User Interfaces (VR)* (2023), pp. 680–690.

[4] Lobo, M. J. L., Brédif, M., and Christophe, S. Interactive transitions between 2d and immersive 3d map views. In *Journée Visu, 2024* (2024).