UNDERGROUND VISUALIZATION: VIRTUAL REALITY, EX SITU AND IN SITU AUGMENTED REALITY

Alexandre Devaux, Mathieu Brédif, Charlotte Hoarau, Sidonie Christophe*

Univ. Paris-Est, LASTIG GEOVIS, IGN, ENSG, F-94160 Saint-Mande, France
firstname.lastname@ign.fr

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ABSTRACT:

In this work-in-progress and demo paper, we present an ongoing experiment of underground visualization, in the context of urban 3D geovisualization, for operational purposes in urban planning. After a preliminary project of sewers network digitization (Nguyen et al., 2018), the 3D model of sewers has been made available for web visualization and interaction. In this paper, we show that it is possible to address various use contexts, when adding the ability to visualize and interact with the sewer 3D model in virtual reality (VR) and in ex situ / in situ augmented reality (AR). These experiments will be further experimented to validate our hypotheses to favor collaboration, immersion for simulation and training, and more secured urban development.

Augmented Reality (AR) has been identified as a relevant medium for 3D urban geovisualization, potentially improving the user experience while offering urban data immersion and interaction (Döllner et al., 2006, Drettakis et al., 2007, Hugues et al., 2011, Normand et al., 2012). In particular, AR has been extensively used indoor to visualize 3D models, such as building models (Devaux et al., 2018), potentially enabling participation between practitioners.

In this work-in-progress paper, we present an ongoing experiment of *underground visualization*, investigating virtual and augmented reality using a pre-existing digitized network of sewers (Nguyen et al., 2018).

A 3D model of sewers should be easy to visualize and manipulate for final users: 3D geovisualization is clearly relevant to fit these needs, but the capacity of a 3D geovisualization system to handle various possible use contexts is less addressed by now. According to the use contexts, the users may have preferences or needs to handle a more or less realistic model. Moreover, they may need to visualize the 3D model *ex situ* (e.g. at the office for mission preparation) or *in situ* (during the mission on the ground).

The main issue here is to be able to improve the user experience, according to the use context: we aim et designing a flexible system that could manage the possible transitions between visual devices, 3D models varying in levels of detail, in order to fit the users' needs.

*Corresponding author

1. EXPERIMENTATIONS

Based on the open-source 3D geovisualization web framework iTowns offering 3D visualization and precise interactive measurements (Nguyen et al., 2015, Devaux and Brédif, 2016, iTowns Development Team, 2018), we propose methods to co-visualize 3D city models and 3D underground models, with various visualization and interaction modalities.

Virtual Reality (VR). On a desktop PC or Virtual Reality (VR) device, the sewer model could be visualized in 3D with texture (Fig. 1-a) or with wireframe rendering superimposed on street-view imagery and building models (Fig. 1-b).



Figure 1. Ex situ Virtual Reality (VR) using a WebGL application: a) 3D view of the textured sewer model with interactive measurements. b) 3D view from the street level of the textured 3D city model and the wireframe sewer model.

Augmented Reality (AR). In AR with a HoloLens, we offer ex situ visualizations at reduced scale (Fig. 2-a) or at real scale (Fig. 2-b), as well as in situ visualizations at real scale (Fig. 2-c-d). In this last in situ experiment, the users can then walk and "see through" the ground: it may be especially useful and intuitive for sanitation workers in order to prepare an intervention or for practitioners requiring to dig the sidewalks.

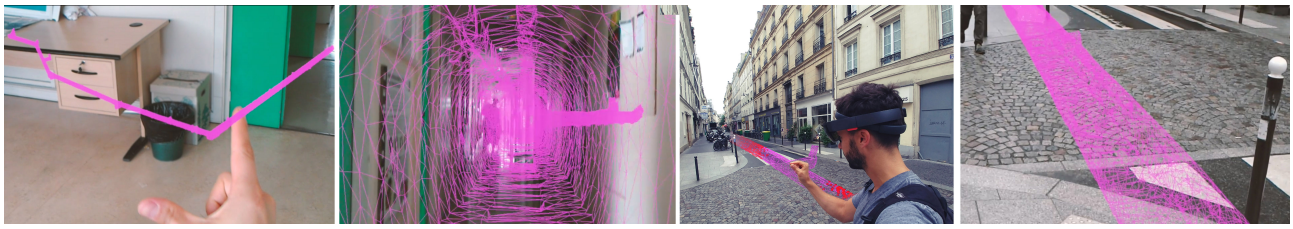


Figure 2. Augmented Reality (AR) of the wireframe model (HoloLens): a) reduced scale ex situ, b) real scale ex situ, c-d) real scale in situ.

The technical contribution of this 3D geovisualization web application is to take advantage from a shared implementation, allowing to switch seamlessly from one device to another. A demo of the capacities of the tool will be presented during the workshop/theme session on Virtual & Augmented Reality: Technology, Design & Human Factors, organized by ISPRS Working Group IV/9.

2. PERSPECTIVES

From a geographic information sciences perspective, the geovisualization of complex urban spaces and phenomena is essential to favor visuospatial thinking and to support the understanding and the decision-making for operational purposes. Scientific and technical challenges, as well as further experiments regarding in situ augmented and mixed reality are addressed in (Devaux et al., 2018).

Those preliminary experiments should now be evaluated regarding their capacity to fit the user needs, their potential to increase interaction modalities and to reduce the cognitive effort to understand the user environment.

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