International Cartographic Association
Association Cartographique Internationale

Information Visualization during Mixed-Reality-based Navigation in Visually Complex Environments

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Keywords: information visualization, Mixed Reality (MR)-based navigation, visually complex environment

Abstract:

Navigation applications are widely used in daily life. Aside from the ubiquitous navigation services on smartphones, mixed reality technology (MR) is being introduced to navigation. MR, which is also referred to as augmented reality (AR) in some research (Halik & Medyńska-Gulij 2017), displays virtual holograms and the actual physical world simultaneously. MR reduces mental workload (McKendrick et al. 2016) during navigation as the user does not need to switch their attention between the environment and the navigation interface. It has shown great potential in navigation, especially the head-mounted devices (HMD) MR.

MR has been shown to be helpful during navigating in visually simple areas (Liu et al. 2021), such as highly identical buildings within universities and hospitals. However, its usability in visually complex environments is not clear yet. Such environments are different from the previous ones in two aspects. First, the visually complex environments are usually semantically or functionally complex as well. For example, various shops, restaurants, and supermarkets can be located in the same shopping mall. Second, temporal but important changes or events can happen, e.g., the reschedule or construction information at the train station or airport, and there is usually already much physical information related to the navigation (Figure 1). The complex and temporal information must be delivered to the users efficiently and effectively.

Figure 1. Physical navigation instructions near Stuttgart Central Train Station

With MR-based navigation, such information can be easily visualized using virtual holograms. However, there is also the risk that the added virtual holograms hinder the identification of crucial physical information. Great efforts have been made to improve view management in different areas (Bach et al. 2017, Kishishita et al. 2014). Grasset et al. (2012) proposed organizing the virtual texts during navigation. But their work focuses on labeling the constant and physical objects. The temporal or abstract information during MR-based navigation needs to be visualized properly, i.e., to be efficient but not distract users from the physical surroundings.

In this work-in-progress, we explore the possible visualizations in typical MR applications (e.g., using icons, providing interactions), integrate them into navigation interfaces, and identify an actual use case in a busy canteen. We are designing an HMD MR navigation interface and conducting user studies to collect real users' opinions about the

https://doi.org/10.5194/ica-abs-5-91-2022 |

interface design (Figure 2). We expect to find out if the designed visualizations and interactions assist users in finding the correct locations and get new inputs about the possible visualizations from the users.

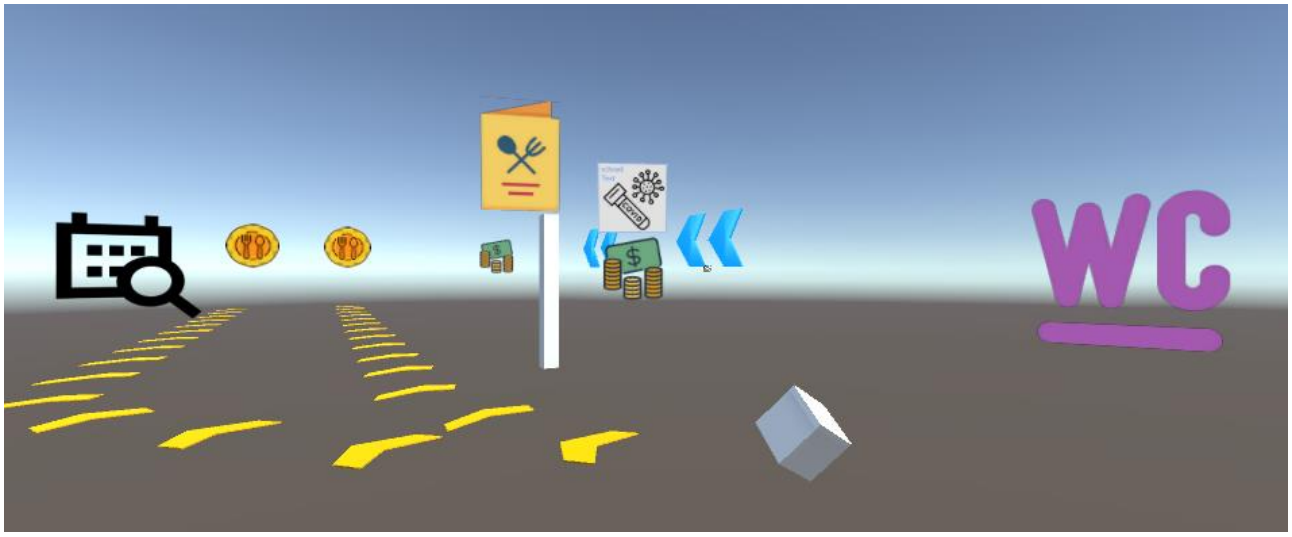

Figure 2. Designed MR navigation interface for the canteen

The display of HMD MR is influenced by the lighting condition. Therefore, the current ongoing user study focuses on indoor navigation. However, the generated results should also apply to the outdoor scenarios. This study extends the implementation and improves the usability of MR-based navigation in more cases.

Acknowledgments

This work was supported by the China Scholarship Council under Grant No. 201806040219.

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