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Compass Bar: A Visualization Technique for Out-of-View-Objects in Head-Mounted Displays

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Abstract : In this work, we propose a custom visualization technique for Out-Of-View-Objects in Virtual and Augmented Reality applications using Head Mounted Displays. In the last two decades, Augmented Reality (AR) and Virtual Reality (VR) technologies experienced a remarkable growth of applications for navigation, interaction, and collaboration in different types of environments, real or virtual. Both environments can be potentially very complex, as they can include many virtual objects located in different places. Given the natural limitation of the human Field of View (about 210° horizontal and 150° vertical), humans cannot perceive objects outside this angular range. Moreover, despite recent technological advances in AR e VR Head-Mounted Displays (HMDs), these devices still suffer from a limited Field of View, especially regarding Optical See-Through displays, thus greatly amplifying the challenge of visualizing out-of-view objects. This problem is not negligible when the user needs to be aware of the number and the position of the out-of-view objects in the environment. For instance, during a maintenance operation on a construction site where virtual objects serve to improve the dangers' awareness. Providing such information can enhance the comprehension of the scene, enable fast navigation and focused search, and improve users' safety. In our research, we investigated how to represent out-of-view-objects in HMD User Interfaces (UI). Inspired by commercial video games such as Call of Duty Modern Warfare, we designed a customized Compass. By exploiting the Unity 3D graphics engine, we implemented our custom solution that can be used both in AR and VR environments. The Compass Bar consists of a graduated bar (in degrees) at the top center of the UI. The values of the bar range from -180 (far left) to +180 (far right), the zero is placed in front of the user. Two vertical lines on the bar show the amplitude of the user's field of view. Every virtual object within the scene is represented onto the compass bar as a specific color-coded proxy icon (a circular ring with a colored dot at its center). To provide the user with information about the distance, we implemented a specific algorithm that increases the size of the inner dot as the user approaches the virtual object (i.e., when the user reaches the object, the dot fills the ring). This visualization technique for out-of-view objects has some advantages. It allows users to be quickly aware of the number and the position of the virtual objects in the environment. For instance, if the compass bar displays the proxy icon at about +90, users will immediately know that the virtual object is to their right and so on. Furthermore, by having qualitative information about the distance, users can optimize their speed, thus gaining effectiveness in their work. Given the small size and position of the Compass Bar, our solution also helps lessening the occlusion problem thus increasing user acceptance and engagement. As soon as the lockdown measures will allow, we will carry out user-tests comparing this solution with other state-of-the-art existing ones such as 3D Radar, SidebARs and EyeSee360.

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