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Developing an Immersive Virtual Reality Interface for Urban Digital Twins: Integrating CAVE and HMD Systems for Enhanced Urban Analysis

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Understanding and managing the complexities of urban environments poses significant challenges due to dynamic changes in population, climate, traffic, and infrastructure. Building solutions to tackle the challenges that cities face is a complex task, as scientists and engineers need to understand the impact of their project and anticipate any weaknesses or harmful side effects. The presented research leverages advances in Digital Twin and Virtual Reality technologies to provide a powerful tool for scientists and engineers to analyze, understand, and address urban problems in a controlled virtual setup. The research focuses on creating an immersive presentation interface for a digital copy of an urban surface, pursuing two main research directions. First, scientific literature reviews and experiments were conducted to analyze methods for capturing, storing, modifying, and rendering realistic virtual cities. Second, we present details on implementing an immersive VR environment using both CAVE (Cave Automatic Virtual Environment) and HMD (Head-Mounted Display) setups to render digital twins of cities. Using these two virtual reality techniques, our research aims to create the foundation to simulate realistic scenarios inside virtual urban areas, enhancing user immersion through precise 3D replication and realistic projections. The implementation of our presented work will facilitate better decision-making in areas such as pollution management, infrastructure development, traffic control, and disaster response as the research progresses.

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