Virtual Reality for Consensus Building: Case Studies

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Abstract. This demonstration presents a real-time virtual reality (VR) system that has primarily been used as a tool for simulating and negotiating transportation-related designs. Visualization creation and presentation methods are briefly described. Case studies include applications to infrastructure, traffic, and environmental planning, as well as evacuation analysis. An emphasis is placed on using VR as a tool for translating technical information to non-experts and, ideally, enabling members of the public to better participate in decision making.

Key words: VR, transportation visualization, real-time simulation

1 Introduction

The closer a model can come to appearing real, the less interpretation is necessary. Here we will explore the use of virtual reality as a common visual and experiential language for discussing and improving civil engineering design.

Virtual reality is usually described as a technology that allows users to interact with a simulated world. Leaving the hardware aside, VR can also be defined in terms of human experience, and the sense of being present in an environment [1]. Recent work in transportation visualization is evolving from a focus on how projects look towards a desire to see how they actually work [2]. Particularly when VR is utilized for conveying a sense of presence, an understanding of the nature of movement through and evacuation from public spaces can help demystify large-scale project plans. As transportation infrastructures and environments are shared resources, the goal is to create interactive VR models that are able to not only improve designs, but also lift barriers to non-expert participation in the planning process.

2 Methods

2.1 VR Space Design

The development of a 3D real-time VR software program called UC-win/Road [3] provided the engine and interface for simulation creation. As a first step in

creating a virtual environment, terrain data and road alignment design information are imported. Road cross-sectional elements are designed and applied to the road network, and intersections are automatically generated. The 3D space is enhanced by models, textures and the adjustment of visual options such as weather and sun position. Traffic agents are automatically generated on roads and human agents move through space on pre-defined routes. Models can be animated and preparing several 3D data sets allows changes to be shown sequentially.

2.2 Presentation

The VR space can be observed within the software's interface on a desktop PC. Free navigation in real-time allows users to observe the 3D environment from any location and angle. Scripts and scenarios are designed to present planning alternatives and driving situations. Video, image, and sound output are also possible. For basic simulations, vehicles act as intelligent agents and obey traffic rules. Yet when a car is controlled by an external device, the user can drive freely through a road network or scenario, and a responsive VR space enhances the user's sense of presence. Such devices include gaming pads, steering wheels and pedals, and full-size driving simulators.

3 Case Studies

3.1 Large-scale Infrastructure and Traffic Planning

A 1 x 1 mile square digital model of downtown Phoenix, USA assists urban planning research and provides a platform for interdisciplinary discussion (Figure 1). Buildings are modeled prior to construction, and scenarios can predict, for example, how traffic will build up during future events at the convention center and opera house.

The Daishi Junction project simulated a new interchange and nearby construction on the route between Tokyo and Kawasaki, Japan (Figure 1). Road alignments were input so that the plans could be analyzed for safety from a driver's perspective. Road signs were edited and tested out virtually within the interface in order to improve their placement and visibility in real life.

Fig. 1. Large-scale Infrastructure and Traffic Planning: Digital Phoenix Project by UC-win/Road III [4] *(left)*, Simulation Carried Out at the Daishi Junction and Ventilation Place [5] *(right)*.

3.2 Environmental Design

A VR model of Sakai City, Japan is being developed in order to gain consensus for an "eco-town" urban revitalization project. The visualization includes a re-allocation of road space for greener transportation methods including an LRT and bus lines, and pedestrian and bicycle paths (Figure 2). The model is edited for presentation at monthly meetings where citizens can attend and voice their opinions.

Similarly, the Ministry of Water Resources in Shanghai created visualization data to gain approval and grant money for an environmental remediation project in the Yunnan province (Figure 2). A model of the environment as it could look in its natural state helped convince authorities to invest in cleaning up polluted areas.

Fig. 2. Environmental Design: Sakai City Oshoji LRT Project VR Data [6] *(left)*, 3D Exhibition of North Grand Canal Ecological Rehabilitation [7] *(right)*.

3.3 Evacuation Analysis

Evacuation visualization was performed to assuage safety concerns prior to the construction of a 6 km long tunnel connecting Qingdao and Huangdao, China (Figure 3). Results from an evacuation analysis program, EXODUS [8], were imported into the VR platform. Evacuation routes and real-time location coordinates were then shown in 3D space to replicate accident scenarios.

Similarly, a reassessment of tunnel infrastructure in Japan has included analyzing and simulating the behavior of different age groups in crisis situations (Figure 3). With a growing elderly population, pedestrian dynamics have shifted and of particular concern is mobility in evacuation. The tunnel environment was created in VR space and safety measures, such as repainting doorways, were proposed to improve the calculated evacuation times.

4 Conclusion

Various kinds of visualization can contribute to designing safer and more sustainable spaces. VR modeling, particularly with its interactive component, can enable non-engineers to understand transportation and environmental plans in a way that might not be possible through more static visual presentation methods.

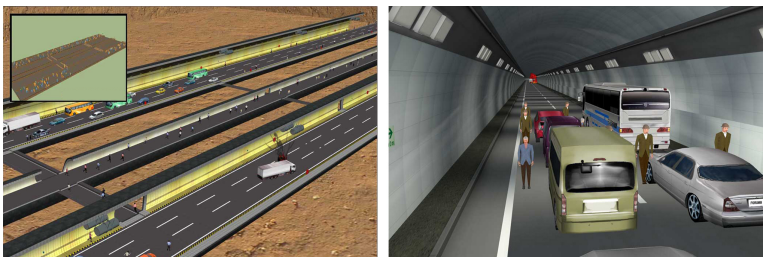

Fig. 3. Evacuation Analysis: Qingdao JiaoZhou Bay Tunnel Project [9] *(left)*, Simulation of an Evacuation in an Aging Society using 3D VR [10] *(right)*.

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