From Real to Virtual Rapid Architectural Prototyping

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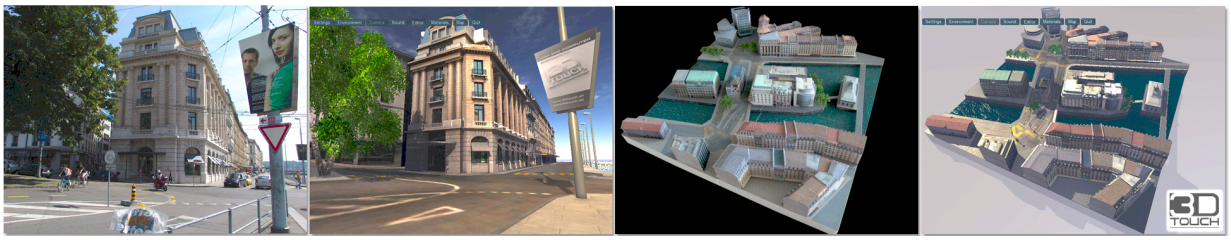

Figure 1: *real architectural scene; corresponding virtual scene; larger-area scale model; equivalent larger-area virtual model*

1 Introduction and Main Concept

Can greater visual realism of a real-time architectural virtual walkthrough achieve as high sensory impact, or qualia, as a physical 3D printed scale model of an urban landscape does? Our work aims to answer that question by allowing a real existing city landscape during a large urban planning project to be 3D modeled and subsequently be studied via a dual output: a real, physical scale model based on a latest high quality color 3D printer and a 3D virtual walkthrough of enhanced real-time visual realism based on a recent game engine. Conclusions of this experiment and user study suggest that a virtual, interactive simulation of high visual-realism based on specific latest real-time rendering algorithms can indeed convey a similar user experience and feeling of "presence" that an equivalent architectural scale model offers, regarding fast appreciation of both space and structure.

Recent studies [Egges et al. 2007; Slater et al. 2009] have shown that visual realism enhances realistic response and the feeling of "presence" while interacting with an immersive virtual environment. Recent advances in 3D printing technology [Gibson et al. 2002] have allowed for a transformation of the process on how architectural scale models are built; based on a 3D model of a CAD system, a complete, colored small-scale model can be built in an efficient and fast manner. Our work aims to extend the intrinsic properties of real scale architectural models and compare them with latest real-time game engine powered virtual walkthroughs of the equivalent architectural scene (Figure 1), for enhanced, large-scale urban planning and experimentation.

2 Novelty

Our main novelty is the research on whether rapid prototyping based on advanced, serious-game 3D rendering is more suitable than rapid prototyping via 3D printing, given the same 3D architectural models as starting point. This targets the application of future architectural urban planning and visualization, in a low-cost, efficient methodology. Our final goal is to overcome the need for scale models in the future via incorporating the unique features that they offer in a virtual, serious game environment: low cost, portability of experience, fast examination of alternative structures and finally heightened presence and user experience (UX).

3 Implementation and Vision

The same, existing real architectural scene was substantiated with rapid prototyping using CAD software and a) the ZPrinter™ 650 color 3D printer for the real scale model and b) the Unigine™ game engine and their programming environment for real-time simulation of the same scene (as depicted in the scale model). Advanced 3D printing features such as multi-part coloring were employed as well as latest 3D rendering techniques for HDR image based day-night sun-path simulation, spherical harmonics-based cube map interpolation, screen-space ambient occlusion, dual-quaternion camera path animation and cloud, particle systems for natural, event-controlled atmospheric effects.

The experiment involved 15 participants, asked to search for a specific object (a model of a car) hidden inside the real scale model and subsequently to perform the same task in the equivalent real-time virtual scene. After the completion of each task they were given a questionnaire to complete [Slater et al.2009]. The results of our experiment suggest that enhanced visual realism as provided by latest game engines can enhance realistic behavioral response, despite the different interaction metaphors and scaling. However, still for a fast appreciation of the depicted area-space, the scale model performed better according to the user study (mainly due to camera control in the virtual environment). Hence in the future we aim to continue UX tests with an AR or VR HMD with head-tracking scene simulation.

References

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