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From Real to Virtual Rapid Architectural Prototyping

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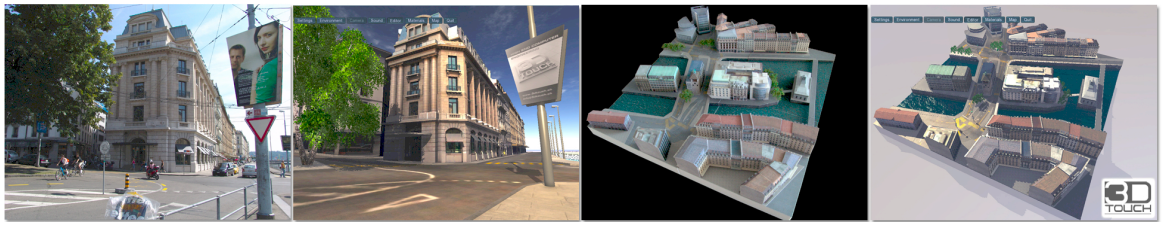

Figure 1: *real architectural scene; corresponding virtual scene; larger-area scale model; equivalent larger-area virtual model*

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 3D model on 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, that a rigid scale model cannot offer.

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, for future architectural 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 a 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 car object 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 and UX as in real scale models, despite the different interaction metaphors and scaling. Thus we can expect that such type of virtual walkthroughs based on game engines and serious game scenarios will be utilized more in the near future, rather than traditional scale models or offline architectural animated movies.

References

GIBSON, I, KVAN, T, MING, LW. 2002. Rapid prototyping for architectural models. In Rapid Prototyping Journal, vol. 8 (2), 91-95.

EGGES, A, PAPAGIANNAKIS, G, MAGNENAT-THALMANN, N. 2007. Presence and Interaction in Mixed Reality Environments. In The Visual Computer, Springer-Verlag, vol. 23 (5), 317-333.

SLATER, M, KHANNA, P, MORTENSEN, J, YU, I. 2009.Visual realism enhances realistic response in an immersive virtual environment. IEEE Computer Graphics and Applications, vol. 29 (3), 76-84.

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Questionnaire Presence Questions		1	7
1. Please rate your sense of being in the virtual Bel-Air, on the following scale from 1 to 7, where 7 represents your normal experience of being in the real place. *I had a sense of being there in the virtual Bel-Air… :*		at no time	almost all the time
2. To what extent were there times during the experience when the virtual Bel-Air was the reality for you? *There were times during the experience when virtual Bel-Air was the reality for me… :*		at no time	almost all the time
3. When you think back about your experience, do you think of the virtual Bel-Air more as images that you saw, or more as somewhere that you visited? *The virtual Bel-Air seemed to be more like... :*		images that I saw	somewhere I visited
4. During the time of the experience, which was strongest on the whole, your sense of being in the virtual Bel-Air, or of being in the real world of the laboratory? *I had a stronger sense of… :*		being in the virtual Bel-Air	being in the lab
5. During the time of the experience, did you often think to yourself that you were just in a laboratory or did the virtual Bel-Air overwhelm you? *During the experience I was thinking that I was really in the VR laboratory... :*		most of the time	rarely
6. How much did you behave within the virtual Bel-Air as if the situation were real? *I responded as if the situation were real… :*		not at all	very much
7. How often did you find yourself automatically behaving within the virtual Bel-Air as if it were the real place? *I responded as if it were a real place… :*		never	almost all the time
8. How much did you deliberately behave within the virtual Bel-Air as if it were the real place? *I deliberately responded as if it were a real place… :*		never	almost all the time
9. How much was your emotional response in the virtual Bel-Air the same as if it had been the real? *My thoughts with in the virtual Bel-Air were the same as if it had been real … :*		never	almost all the time
10. How much were the thoughts you had within the virtual Bel-Air the same as if it had been a real situation? *In spite of my knowledge that the situation wasn't real I found myself behaving as if it were real… :*		never	almost all the time
11. To what extent were your physical responses within the virtual Bel-Air (e.g., heart rate, blushing, sweating, etc.) the same as if it had been a real situation in the real place? (In this case if in such a real situation you would have had no or few such physical responses and also within the virtual Bel-Air you had no or few physical responses, then your answer should be closer to 7 than to 1). *My physical responses within the virtual Bel-Air were the same as if it had been the real … :*		never	almost all the time