Landscape Simulation in Outdoor Settings using Stereoscopic Augmented Reality

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Abstract

This paper reports on an augmented reality (AR) system that handles virtual realizations of buildings and civil engineering structures at real scale in outdoor settings. This system consists of a real-time kinematic (RTK) GPS and a 3DOF inertial measurement unit (Sensor). With additional software, these devices improve the precision in computing camera position and orientation. Moreover, the system uses a 3D head-mounted display (HMD) rendering shadowing of all virtual buildings to achieve a real-world look. The system enables practical AR landscape simulations for architectural design to be made.

Keywords: Augmented Reality, Outdoor Setting, Real Scale, 3DOF inertial measurement unit, Real Time Kinematic - GPS, 3D Head Mounted Display.

1 Introduction

Although advanced information technologies have been introduced in architectural design and building construction, more effective simulation methods are currently required. Conventional methods, such as photo montage and virtual reality, are inadequate in giving realistic simulations in exterior settings. With AR technology, we can freely move camera position to borrow real-scene backdrops that can be added to a simulation.

Similar systems from previous research focused primarily on portability [1][2]. In contrast, we emphasis performance over portability aiming for a stereoscopic AR that can handle large and complicated 3D shapes.

2 System Architecture

2.1 Hardware

We use a RTK-GPS and a 3DOF inertial measurement unit to obtain camera position and orientation. In addition, we employ a 3D-HMD and two cameras to develop stereoscopic views for more realistic simulation. We have packed these devices into a compact portable unit suitable for outdoor use.

2.2 Software

First, we developed a VRML parser to ease loading of 3D models into the system. Second, because the devices generate small errors that betray a real-world appearance, we implemented five functions with the following descriptions:

Figure 1. The virtual bridge experiment (Right is the virtual bridge)

1) ignores Sensor outputs if angular velocities fall below a threshold value;
2) ignores GPS outputs if accelerations fall below a threshold;
3) corrects Sensor outputs accelerations due to gravity;
4) corrects Sensor outputs by using a series of locations previously acquired from GPS data; and
5) corrects Sensor outputs through template matching from previously-captured landscape images.

Functions 1) and 2) resolve the slight shaking in the rendering of virtual buildings even if a camera is at rest, whereas functions 3), 4), and 5) improve the precision in computing camera orientation.

Ultimately, high quality rendering is required in architectural design simulations. We achieve a realistic rendering by shadowing the virtual buildings. Furthermore, to preserve real-time performance, our program was developed with multi-threading to ensure the functions run concurrently and smoothly.

3 Conclusion

In this research, we developed an AR system that handles complicated virtual buildings on a real scale with outdoor backdrops. Implementing corrective functions improved computations of camera position and orientation and casting of shadows enriched landscape simulations of large virtual buildings. Field settings such as the one illustrated in fig. 1 are possible.

References

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