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RESEARCH ARTICLE

Improvement of registration accuracy of a handheld augmented reality system for urban landscape simulation

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Landscape simulation;
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Abstract
The need for visual landscape assessment in large-scale projects for the evaluation of the effects of a particular project on the surrounding landscape has grown in recent years. Augmented reality (AR) has been considered for use as a landscape simulation system in which a landscape assessment object created by 3D models is included in the present surroundings. With the use of this system, the time and the cost needed to perform a 3DCG modeling of present surroundings, which is a major issue in virtual reality, are drastically reduced. This research presents the development of a 3D map-oriented handheld AR system that achieves geometric consistency using a 3D map to obtain position data instead of GPS, which has low position information accuracy, particularly in urban areas. The new system also features a gyroscope sensor to obtain posture data and a video camera to capture live video of the present surroundings. All these components are mounted in a smartphone and can be used for urban landscape assessment. Registration accuracy is evaluated to simulate an urban landscape from a short- to a long-range scale. The latter involves a distance of approximately 2000 m. The developed AR system enables users to simulate a landscape from multiple and long-distance viewpoints simultaneously and to walk around the viewpoint fields using only a smartphone. This result is the tolerance level of landscape assessment. In conclusion, the proposed method is evaluated as feasible and effective.

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1. Introduction

Increasing environmental awareness requires the development of methods that assist in the assessment and

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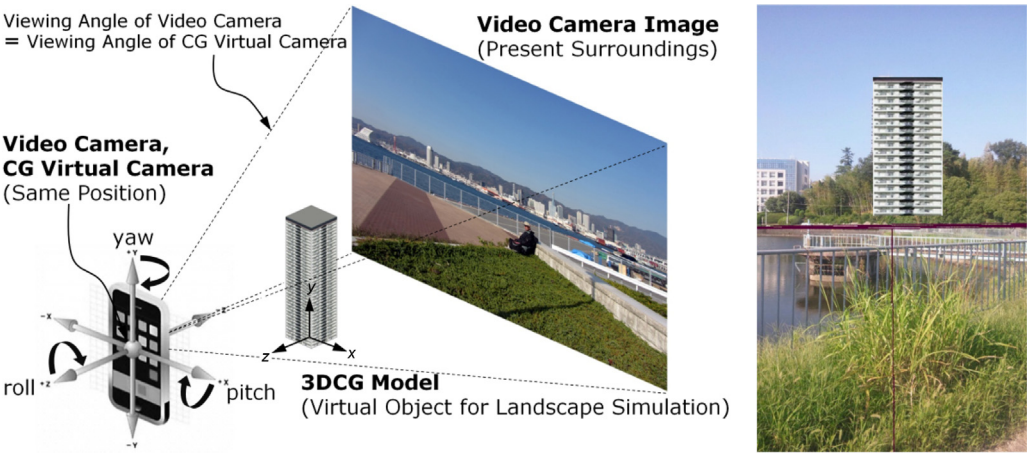

Figure 1 Conceptual diagram of handheld AR (left) and AR screenshot (right).

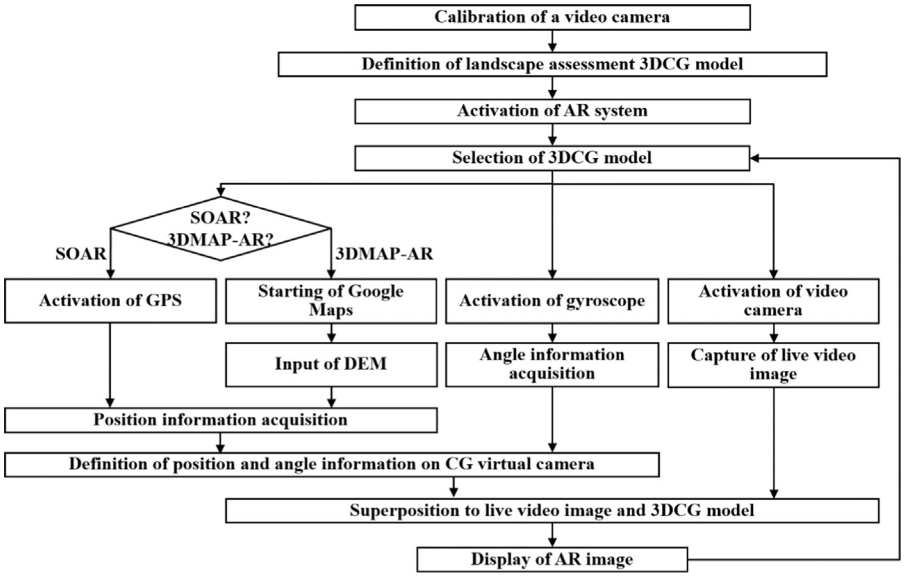

Figure 2 3DMAP-AR and SOAR system flow.

evaluation of environmental change, including visual impacts on the landscape (Lange, 1994). Preserving good visual landscape is important in enhancing our quality of life. The need for visual landscape assessment in large-scale projects for the evaluation of the effects of a particular project on the surrounding landscape has grown in recent years. Landscape assessment is the process in which a project executor evaluates and modifies his project plan based on some of the opinions of policymakers, experts, neighborhood residents, and so on. These stakeholders help create a good landscape through their involvement in each project phase, including the planning, design, construction, and maintenance phases. A landscape comprises a number of elements, such as artificial objects and natural objects. Hence, imagining concretely a 3D object that has yet to exist is difficult for stakeholders, such as project executors, academic experts, and residents. Sheppard (1989) defined visual simulation as images of a proposed project shown in perspective view in the context of the actual site. Based on this definition, a landscape simulation method using visualization systems, such as computer graphics (CG) and virtual

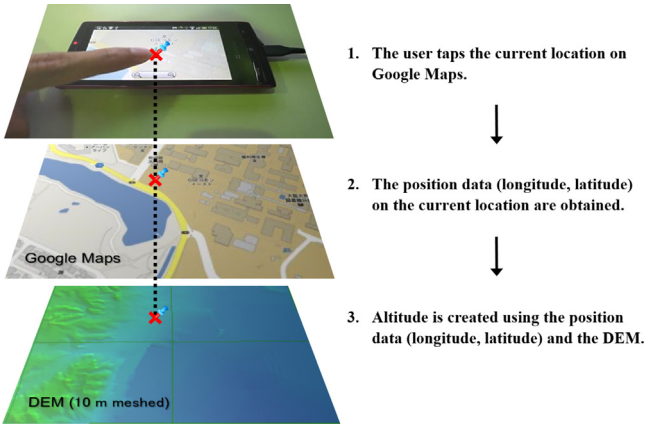

Figure 3 Obtaining of position data using 3DMAP-AR.

reality (VR), has been developed and applied (Lee et al., 2001; Ishii et al., 2002). Lange (1994) highlighted the importance and advantage of dynamic simulations, in which