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Visualization of landscape by VRML system

Tsuyoshi Honjo*, En-Mi Lim

Graduate School of Science and Technology, Chiba University, 1-33 Yayoi-cho, Inage-ku, Chiba 263, Japan

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Abstract

Virtual reality modeling language (VRML) is a high performance language for three-dimensional (3-D) visualization on the World Wide Web (WWW). Three-dimensional information can be easily transferred through the Internet by this technology. In this study, we made a landscape visualization system that enables virtual experience in a planned landscape by using VRML and the applicability of the system to the landscape design was shown. To perform real-time rendering of landscape, a tree was expressed by using two textured planes instead of thousands of polygons. Trees were placed automatically on a textured terrain based on the plant database by the system developed in this study. With the system, we made models of real gardens based on measured data and walk-through simulations in the gardens were tested. The system showed good performance and it also indicated the potential of VRML systems. The information on the virtual landscape can be placed on WWW. This method can be utilized both for the design of and for the public discussion on landscape planning.

Keywords: Computer graphics; Landscape design; Visualization; Virtual reality; VRML

1. Introduction

In landscape planning, simulation of the landscape is a powerful tool for public understanding and for selection of alternative planning scenarios. In the simulation, reality of the simulated image is very important and recent progress of computer graphics enables very precise simulation of the landscape.

In the computer graphics of landscape simulation, quality of plants plays an important role. Many researchers have studied realistic plant modeling (Honda, 1971; Aono and Kunii, 1984; Bloomenthal, 1985; Oppenheimer, 1986; Prusinkiewicz et al., 1988; De Reffye et al., 1988; Greene, 1989; Viennot et al., 1989). By using techniques of plant modeling, very realistic images have been made for landscape planning and estimation (Honjo et al., 1992; Saito et al., 1993, Morimoto, 1993; Honjo and Takeuchi, 1995). In these cases of landscape simulation, still images were mainly utilized because the numbers of polygons that comprise simulated scenery are very large. Walk-through animation or real-time rendering of the landscape were difficult. Animations were made as sequences of the still images, by changing the eye points and viewed points.

In this study, we made a system by using virtual reality modeling language (VRML) and the applicability of the system for landscape visualization was evaluated. The VRML system enables real-time virtual experience of walk-through simulation in a planned landscape. VRML is also a high performance language for three-dimensional (3-D) visualization on the World Wide Web (WWW) and 3-D information

* Corresponding author. Present address: Faculty of Horticulture, Chiba University, 648 Matsudo, Matsudo-shi, Chiba-ken 271-8510, Japan. Tel.: +81-47-308-8896; fax: +81-47-308-8896.
E-mail address: honjo@midori.h.chiba-u.ac.jp (T. Honjo).

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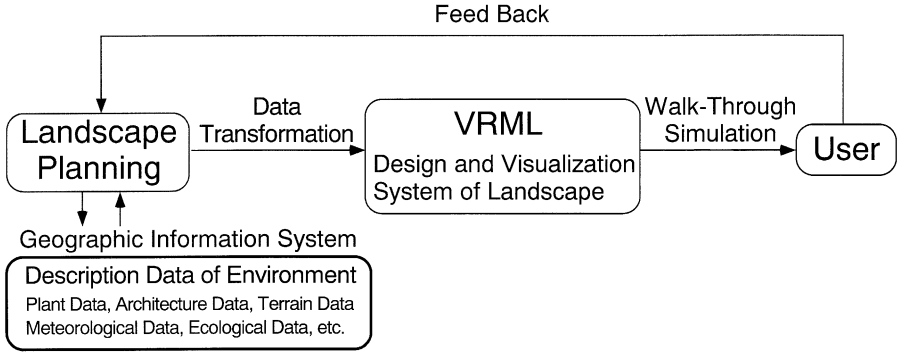

Fig. 1. Process of landscape planning using visualization by VRML.

can be easily transferred through the Internet (Honjo and Takeuchi, 1997; Honjo and Takeuchi, 1998).

Application of virtual reality to landscape planning will make possible the precise recognition of the plan but needs real-time rendering of the landscape according to the moving viewpoint. Formerly, to realize the real-time rendering, virtual reality systems consisted of input and output devices and a high-performance computer was necessary. On the other hand, to make virtual reality environment on the Internet with VRML, it is possible to make the environment on a personal computer economically.

In landscape planning, the feed back process from user to planner shown in Fig. 1 is important. The VRML system is suitable for this feed back process because walk-through simulation on the Internet contributes in the user's understanding of the planning (Honjo et al., 1999; Lim et al., 2000).

2. Methods

2.1. VRML systems

VRML is a programming language and library for 3-D computer graphics and has many functions. The first version was made in 1994 as VRML 1.0 and the second version, VRML 2.0, which has more dynamic functions, was made in 1996. In this study, VRML 2.0 was used to make the system.

To make the rendering very fast, VRML supports only simple rendering techniques such as shading, setting objects, projection, and texture mapping but does not support complicated rendering such as ray tracing. Programming by VRML is easier than that by a graphic library like OpenGL.

The user who downloads the program from a server can use a program made by VRML. A 3-D image made by VRML is rendered on the local computer of the user. To use the VRML, a browser that supports VRML is necessary. In this study, Cosmo Player (Silicon Graphics Inc.) was used as VRML browser with Internet Explorer (Microsoft).

For VRML programming, the VRML browser and an Internet browser are necessary. Programming and landscape planning is possible on a stand-alone computer. Cosmo Player and other VRML browsers can be used as freeware and the developing environment can be built very economically.

2.2. VRML and visualization of landscape

Basic functions for the visualization of landscape are the modeling and setting of terrain, plants, and architecture. The procedures of the visualization are shown in Fig. 2.

To validate the landscape planning, many perspective images should be made and discussed. By using the VRML system, once the program of the landscape is made, changing the viewpoint is easy and walk-through simulation is possible.

Some CAD software has a function that transfers CAD data to VRML format. However, the software does not have the function which is necessary for the landscape simulation. For example, making a VRML file from collected research data on trees by changing the expression according to the growth of the trees. In this study, we developed a system that was optimized