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An invisible height evaluation system for building height regulation to preserve good landscapes using augmented reality

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ABSTRACT

Preserving good landscapes such as historical buildings, temples, shrines, churches, bridges, and natural sceneries is important. Recently, destruction of good landscapes from multiple viewpoints due to construction of high rise buildings has been reported. To regulate structures such as high rise buildings and high voltage transmission towers, the government or public agencies have established or are going to constitute height regulations for building and structures surrounding the location of interest. In order to check whether some portions of high structures are visible or not behind the locations of interest from multiple viewpoints, it is necessary to make a 3D model representing geography, existing structures and natural objects using 3D CAD or Virtual Reality (VR) software. However, it usually takes much time and cost to make such a 3D model. Thus, in this research, we propose a new method using Augmented Reality (AR). In this method, a number of 3D virtual rectangular objects with a scale are located on the grid of 3D geographical model. And then, the CG models are displayed in an overlapping manner with the actual landscape from multiple viewpoints using the AR technology. The user measures the maximum invisible height for each rectangular object at a grid point. Using the measured data, the government or public agencies can establish appropriate height regulation for all surrounding areas of the locations of interest. To verify the proposed method, we developed a system deploying ARToolKit and applied it to the Convention Center of Osaka University, deemed as a scenic building. We checked the performance of the system and evaluated the error of the obtained data. In conclusion, the proposed method was evaluated feasible and effective.

1. Introduction

Preserving good landscapes such as historical buildings and structures is important. Recently, many good landscapes from multiple viewpoints have been destroyed by constructing high rise buildings on the background area of the aesthetically pleasing structure. A sample is a landscape of a mixture of a historical church or temple with a modern glassy tall office building behind. To prevent such landscape destruction, regulation of height of buildings and other structures must be enforced not only in the vicinity but also in considerably wide background area of the structure of interest. In order to properly set the height regulation, it is necessary to compute the maximum height that does not disturb the landscape from the viewpoints for all the locations in the landscape preservation area. Such maximum height is called invisible depth or invisible height [1] and can be measured by drawing a vertical cross section as shown in Fig. 1. However, it takes long time and much effort to measure invisible height for all the locations because of the following reasons.

- For each viewpoint, a large number of vertical cross sections must be drawn, and for each vertical cross section, invisible height must be measured at many points.
- Since there are a number of viewpoints for the structure of interest, the above mentioned work must be done iteratively.
- Furthermore, there may be other aesthetically pleasing structures nearby so that the above mentioned work must be done for all such structures and minimum invisible height must be selected for each location.
- The height of the structure of interest is usually not uniform.
- The background terrain is usually not flat but uneven.
- As buildings and structures which already exist can make new hypothetical structure invisible, existing structures have to be drawn in the vertical cross section.

Although making a physical model of the area including the terrain and buildings may be a solution, it would cost too much. Making a numerical 3D urban model including the terrain and buildings to use

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