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Abstract

The purpose of this study was to examine the feasibility of introducing computer graphics (CG) at each of three levels of landscape assessment, and the issues arising from its introduction. This was based on the idea that it is important to carry out landscape assessments as an analysis of a series of three levels — the regional level, to analyze the spatial structure of the region; the district level, to analyze the elevation, and spot level, to analyze the design of the site. The results showed that application of CG was extremely effective on all three levels. At the regional level, CG was valuable as a visual analytical method to examine the visibility of various elements; at the district level,it was extremely effective as a way to identify the effect on the view of changes of perspective; at the spot level, it was possible to carry out a landscape simulation, which served as a tool for examining measures to preserve the landscape, taking into consideration the growth of trees and shrubs and properties of forests.

Study Goal

The importance of landscape assessment as a part of environmental assessment continues to grow. To forecast changes in landscape and carry out an impact evaluation from an assessment perspective, it is essential to have a visual understanding of the landscape as people will actually see it. For this reason, expectations for CG as an effective tool in landscape assessment are rising. This study started from the idea that it is important to carry out landscape assessments as an analysis of a series of three levels --- a regional level that analyzes the spatial structure of the region, a district level that analyzes the elevation of the site, and a spot level that analyzes the design. The purpose of the study was to clarify the feasibility of introducing CG at each of these levels and the issues that might arise therefrom.

Method of Investigation and Analysis

The study area designated for this research was the hilly land of the Minamikawachi region in Osaka Prefecture, a region located in urban fringe, and where development has recently become marked (see Figure 1). To resolve the question of the effectiveness of introducing CG at the regional level, CG was used to investigate the interrelationship between urban developed area and its spatial

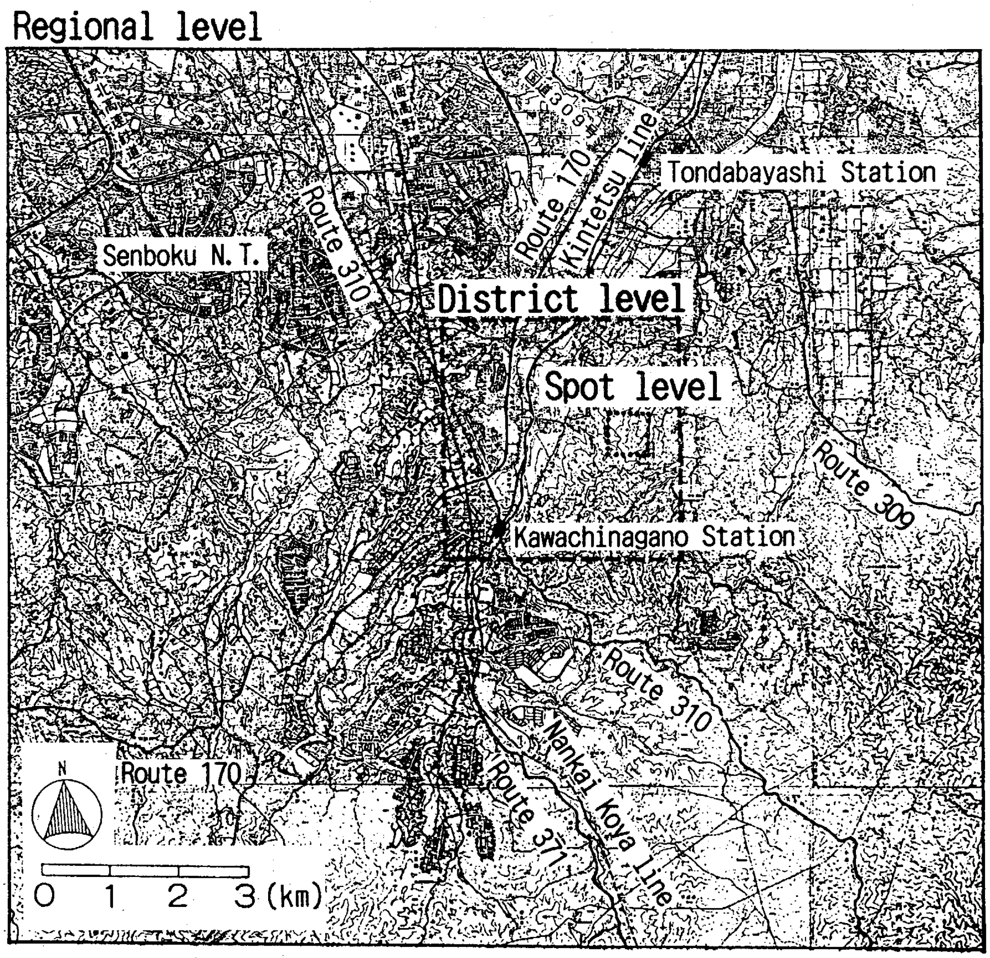

Fig. 1 Study area

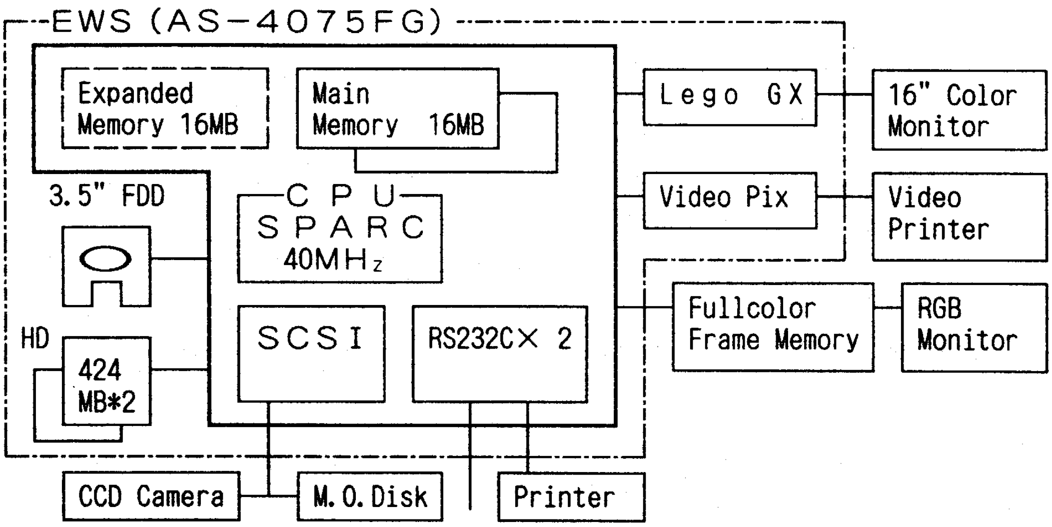

Fig. 2 CG System (hardware)

structure of topography, and to analyze the visibility of various elements. At the district level, beginning with the idea that it is important to comprehend the relationship between the overall 'view' and harmonization with the regional landscape, at first an examination was carried out to enhance the reality of the composite image, then the perspective was changed to find out how strong or weak the impact on the landscape was, to resolve the question of how effective CG introduction could be. At the spot level, an examination was first carried out to enhance the reality of the composite image, then performed design-related landscape simulations, taking two to three samples to resolve the question of how effective CG introduction could be at the spot level. The software used to create CG images was "AS/LINKS" which was composed of L/Shape, L/Manage, Neozoic Paint and L/Image. Fig.2 shows the hardware system to create CG images.

Results of Analysis and Consideration

1. *Feasibility of CG activities at the regional level*

In landscape assessment at the regional level, first, as mentioned above, it is important to grasp the interrelationship between the urban developed area and its spatial structure of topography. Furthermore, from a visual perspective, it is important to understand the visibility of various elements of the urban developed area.

Precision of analysis and production of the composite image: Based on a mesh of 250m circumference, and focusing on a spatial territory of approximately 13 km in each direction, a three-dimensional topography was created as the basic image from numerical topographical data read from a 1/25,000 topographical map. Next, to create the composite image, following each surface condition was mapped onto the basic image the topographical classification, altitude classification, and vegetation and urban developed area, which defined the spatial structure (see Figure 3).

Case study: Using the composite image described above, to understand the interrelationship between the urban developed area and the spatial structure, a 360° field of view from 19 points set at 1-km intervals along Route 310 within the region was reproduced using CG images (see Figure 4) in an attempt to investigate the visibility of various elements of the urban developed area (see Table

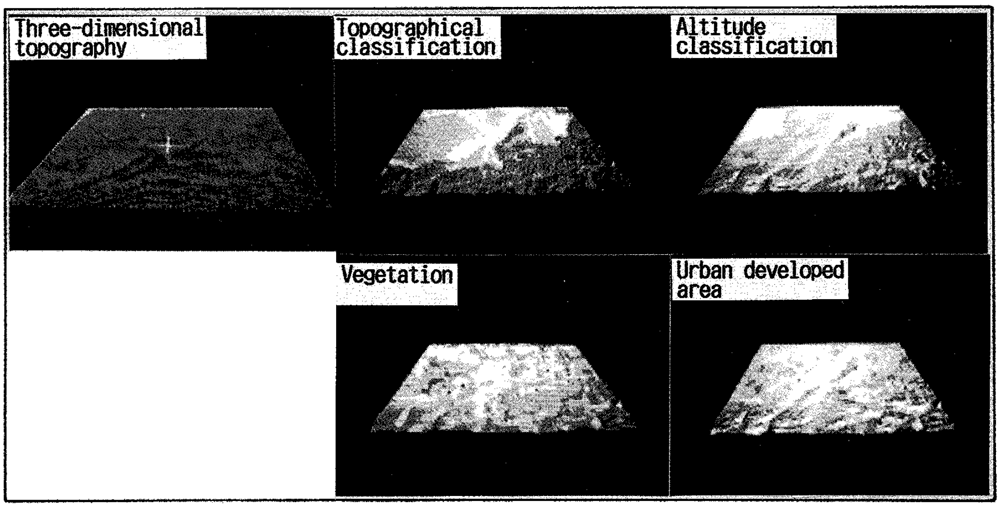

Fig. 3 Basic composite image and overlaid composite images (regional level)

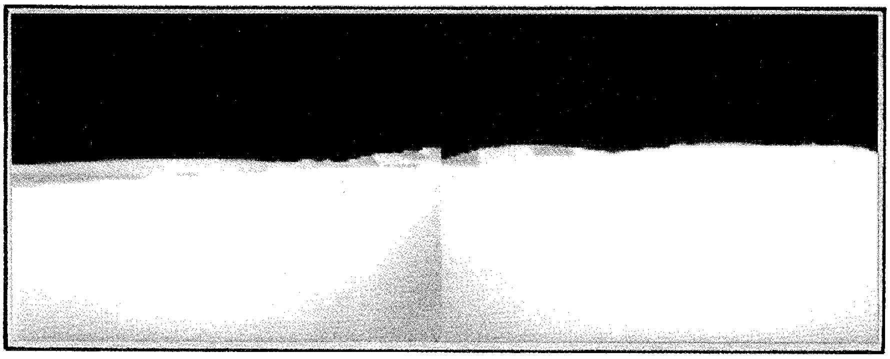

Fig. 4 Visibility of urban developed area (regional level)

Table 1 Visible urban developed area at the each view point

View point No.	Visible urban developed area No.
1	4 9 23 44 46 57 61
2	4 14 31 34 37 46 57 61
3	9 46
4	14 46 61
5	9 14 18 46
6	9 14 18 41 46 57 61
7	18 31 41 44 46 57 61
8	18 23 30 31 46 50 53 61
9	18 23 31 41 46 50 61
10	23 31
11	27 49 58 59 61
12	46 61
13	24 26 27 30 40 50 53 55 61
14	53 61
15	24 25 30 61
16	25
17	25 61
18	――――
19	――――

1).

Value of application of CG and related issues: Based on the three-dimensional topographical map created using CG, by overlaying the various factors that define the spatial structure of the urban developed area, the interrelationship between them was able to be visually analyze and the value of CG was able to be recognized. It also became clear, however, that there were limitations to the analytical data and the related quantitative analysis. At the same time, in an analysis of the visibility of various elements, the viewing position and target (urban developed area) could be set at any spot desired, confirming the value of CG in allowing a judgement to be made instantly using the composite image.

2. *Feasibility of CG activities at the district level*

In carrying out landscape assessment at the district level, using information on the elevation analyzed from eye-level, it was important to clear the interrelationship between harmonization with the regional landscape and the view, upon using the CG image, and made the assumption that reproducibility of the actual landscape could be ensured.

Precision of analysis and production of the composite image: Using a mesh of 50m circumference as a standard, a spatial territory of approximately 3.5 km in each direction was focused on. It included the urban developed area and which, according to the regional-level analysis, had the widest field of view. We created a three-dimensional topography of this territory as the basic image from numerical topographical data read from a 1/10,000 topographical map.

Test of reality: The reality of the composite image according to two criteria was tested: a sense of height scale indicating vertical distance in relation to horizontal distance and a sense of texture indicating forested land. Using CG, the magnification of the y-axis of the basic image was set at 1.0 ×, 1.5×, 1.75× and 2.0×. At each of these settings, a composite image from points 1.0 km to 3.0 km apart and tested the reality of the height scale sense with a photograph of the actual landscape view. The results showed that when the height scale was set to 1.75× on the side scale, a decision of sense of scale was achieved even at great distances (see Figure 5). Turning to the sense of texture, at this landscape level the individual trees on the surface of the forested land was wanted to convey the sense of texture. Using CG, a landscape photograph of forested land was read into the basic image from a charge-coupled device (CCD) camera and mapping was performed changing the resolution from high to low. A composite image was then output from distances of 1.0 to 3.0 km and the reality of the texture sense was tested with the photograph of the actual landscape. The result was that, when the mapping elements were set to medium resolution, a decision of sense of texture was achieved even at great distances (see Figure 6).

Case study: Using a composite image with enhanced reality, in a single case of landscape assessment, the viewpoint was selected according to both the horizontal distance and the height from the urban developed area, to determine how strong the impact on the landscape of the urban developed area would be. The result showed that at this landscape level there is very little change in impact according to height. However, it is possible to identify change in impact according to horizontal distance: the effect on the landscape of the impact on the surrounding area is highly important,and in particular the effect of land use adds a large visual effect.

Value of application of CG and related issues: By manipulating the sense of scale and texture using CG, it is possible to enhance the reproduction of the real landscape to a certain degree.

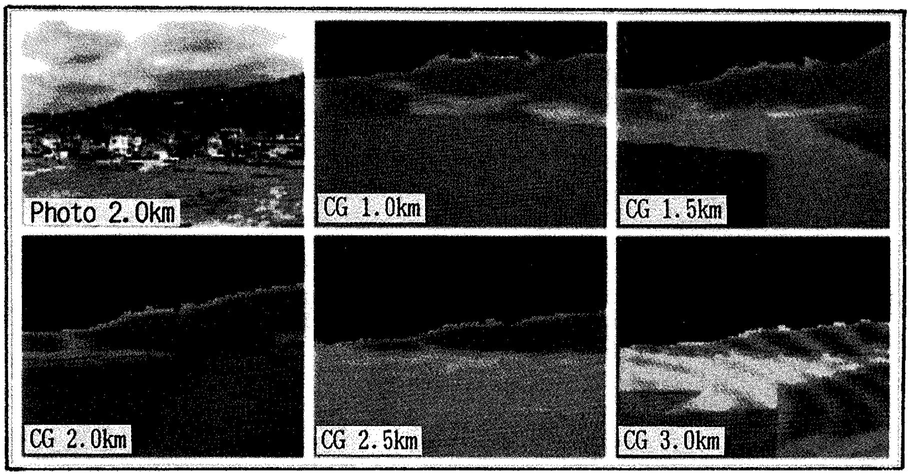

Fig. 5 Comparison existing landscape with composite images (sense of height scale)

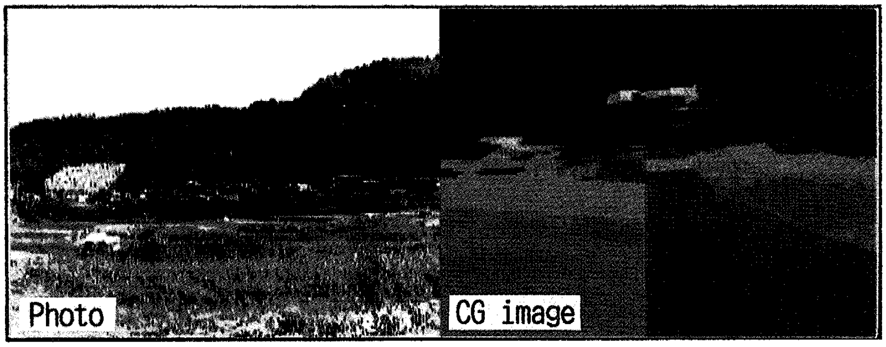

Fig. 6 Comparison existing landscape with composite image (sense of texture)

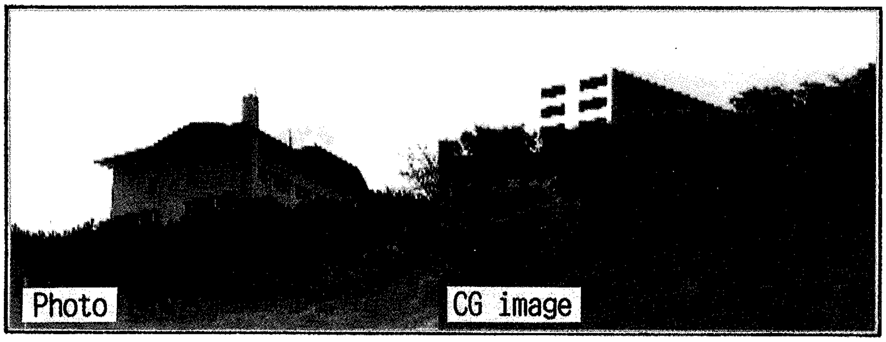

Fig. 7 Comparison existing landscape with composite image (sense of forest landscape)

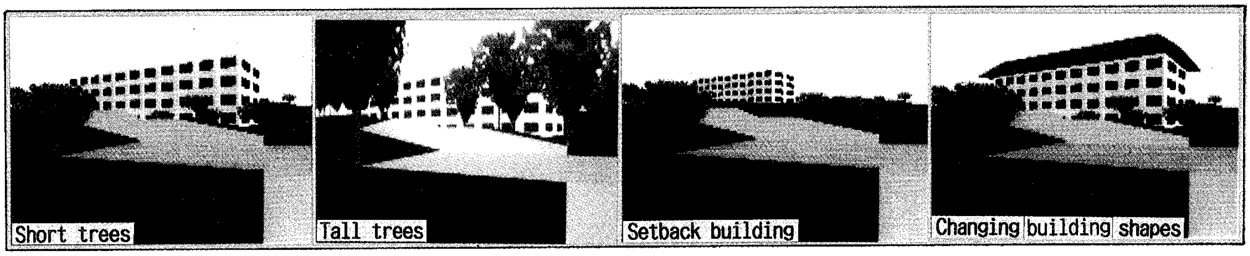

Fig. 8　Landscape simulation models (spot level)

However, it is clear that mapping with two-dimensional elements has limitations in the expression of the diversity of the forest land. Moreover, the value of CG application was recognized in making it easy to understand the relation to the view, that the impact on the landscape was affected by the surrounding spatial structure.

3. *Feasibility of CG activities at the spot level*

Looking at landscape assessment at the spot level, landscape centered on individual facilities and buildings was concentrated on. It was therefore important to grasp aspects of their design such as shapes, colors, materials, etc. This made securing the reproducibility of the real landscape when using the CG image even more important than at the district level.

Accuracy of analysis and creation of the basic image: Using a mesh with a 10m circumference as a standard, the building site of the urban developed area and the spatial territory of a 0.5 km perimeter in all directions was focused on. The basic image was produced by creating a three-dimensional topography from numerical topographical data read from a 1/2,500 topographical map, and creating simplified buildings.

Test of reality: It seemed that reality of the composite image at this landscape level required that it convey a sense of the texture of the individual leaves of the trees and shrubs. Therefore, the reality of the individual trees was tested as well as of the forest landscape as a whole. For individual trees, by mapping a photograph taken on two crossed transparencies of the trees by the CCD camera, it was shown that it was possible to produce a reasonably good reproduction of trees of various heights. Next, a composite image was produced of the forms of tall and short trees using the trees mentioned above and introduced onto the basic image. This was then compared with the actual landscape to test the reproducibility of the forest landscape. The result was that, by selecting the shapes of the short trees and by raising the density, it was possible to make a reasonably faithful reproduction of the forest landscape (see Figure 7).

Case study: Using the composite image with enhanced fidelity, as two or three examples of landscape assessment, a landscape simulation was carried out in which it was hypothesized that the short trees would grow into tall trees, and another in which the positions and shapes of buildings was changed (see Figure 8).

Value of application of CG and related issues: By using CG to create a forest and manipulating its density, it was possible to enhance the reproducibility of the real landscape, but the study demonstrated that there was a limit to its ability to reproduce the diversity of natural elements. Furthermore, as a result of performing two to three landscape simulations, the value of CG application was recognized in forecasting the change in impact on the landscape of hypothetical forest growth, and as a visual method of expression of plans for reforestation or building extension.

Conclusion

The value of CG at the regional level was clarified, as a visual analytical method to examine the visibility of various elements. As an issue for the future, there will be an urgent need to secure analytical data gained from CG application and a related series of quantitative analytical methods. At the district level, CG application was extremely effective as a way to understand the effect on the view of changes of viewpoint. CG application demonstrated its effectiveness at the spot level as well, as it was possible to carry out a landscape simulation which served as a tool for examining measures to preserve the landscape, taking into consideration the growth of trees and shrubs and the properties of forests. Nonetheless, to reproduce the diversity of the natural world at the spot level in the same way as on the district level, there is still considerable room for further study, which will be a major issue in the future.

Acknowledgments

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