A Study on use of computer graphics (CG) for evaluation of urban landscape

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In this study, we draw several pictures using the method of computer graphics which have various degree of detailedness and make consciousness survey to evaluate these pictures. The purpose of this study is to search the possibility of the data simplification in computer graphics in order to enhance availability on a site of civil engineering and architectural construction.

We obtained a possibility that even a relatively simplified computer graphics pictures can be used for evaluation of a urban landscape.

Key words : Computer Graphics / Urban Landscape / Consciousness Survey

1. Introduction

Recently, a practice of evaluating the landscapes appearance for city planning is gaining popularity due to mounting interest in urban landscape. For a preliminary evaluation, the landscape simulation is necessary to obtain a view after completion of urban planning project. There are various methods for a landscape simulation, such as scaled models, photo-montages and perspective drawings, the last being most popular. The perspective is drawn using plan and elevation, and requires a great deal of time for computing coordinates and transferring them on a board.

Therefore, use of the computer graphics (hereinafter referred to as CG) has been introduced and become widespread because of the recent advancement of computer technology.

For landscape simulation, it is necessary that the obtained expressions of pictures or models simulated reproduce appearance of actual objects as closely as possible.

To obtain such a close expression by CG, an advanced equipment and a large number of trial runs are usually repeated. A large computer was used in the past, but by the recent advancement of the computer technology, the landscape simulation by CG becomes possible even with a small personal computer (hereinafter referred to as PC). Today, a lot of PCs are used to run CG on a site of civil engineering and architectural construction. The problem of the present CG method is the large quantity of data and vast time to generate them. It takes a great time and labor to obtain detailed pictures which can be used for the landscape evaluation. Therefore it is necessary to find a way to solve this problem to popularize the use of the CG method. If it is possible to evaluate a landscape with relatively simplified CG pictures, this method will be used much more common on a site of civil engineering or architectural construction.

The purpose of this study is to search the possibility of the data simplification, i.e. reduction of inputted data, in CG methods in order to popilarize availability on a site of civil engineering and architectural construction. We make CG pictures having various degree of detailedness and study how they will be evaluated.

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2. Development of CG and Recent Studies

The development of landscape simulation by CG pictures is summarized as follows.

The first expression technique of CG began with the wire-frame model which is a line drawing expression, the second one is surface model which can express the surface and the third is solid model which can express material. Moreover, metaball model and fractal model which can express curved surface and the natural objects were also invented.

In the field of civil engineering and architectural construction, following studies have been made : the operational system for the landscape evaluation[1)2)], the expression of the natural objects such as trees[3)], and animated objects [3)4)], construction of a data base system[5)] and an application for the traffic engineering,[6)7)] To our knowledge, there has been only one study on simplification of data which uses scaled model.[8)]

3. Image Generation

The method of the survey we conducted is as follows. We make pictures with various degree of detailedness and compare them through consciousness survey in order to find out the influence of the data simplification on the evaluation of CG pictures. The studied site should be well known by the examinee. Here, we make CG pictures of "Oote dori" which is the major street of Nagaoka City, Niigata Prefecture. Photo-1 shows actual scene of image point.

We use the following equipment to make CG pictures.

Personal computer : X68000 (SHARP Corp.)
CG software : DoGACGA (Presented by Project team Doga)[9)]

The degree of detailedness of CG pictures means the reproduction degree based on the real scene. To show several degrees of detailedness, we select as drawing items, color of buildings, windows, signboards, white lines of road and cars. On the basis of a combination of selecting these drawing items, we make several CG pictures with a various degree of detailedness. The picture number and items are shown in Table-1.

In the ordinary CG picture making procedure, we always draw signboards when windows are drawn. We observe this practice in this study.

Photo.-1 Actual photograph of "Oote Doori"

Table-1 Correspondence of picture number and combination of drawing items

No. of CG Picture	Drawing Item					Number of Data
	Item of Building			Item of Road		
	Color of Building	window	Sign-board	White Line	car	
0	○	○	○	○	○	36804
1	○	○	○	○		32757
2	○	○		○	○	36554
3	○		○	○	○	30439
4		○	○	○	○	36804
5	○	○		○		32507
6	○			○	○	26282
7	○			○		22235
8				○		22077
9	○	○	○		○	33688
10	○	○			○	33438
11	○	○				29391
12	○					19119
13						18961

Note : Picture 0 is referred as Full Data CG and all others as Partial Data CG in the text.

4. Consciousness Survey

1) Displaying methods

Using the CG pictures, we survey the consciousness of the picture evaluation. We use color slides of the CG pictures which are photographed from the monitor display of PC for the picture evaluation. We show two CG pictures at a time with two slide projectors and two projection screens.

At first, we did comparison study between the picture of the actual scene and the CG picture with all drawing items included (hereinafter, referred to as "full data CG"), (Method-1).

Then, we made a comparison study between full data CG and a CG picture which includes a part of the drawing items (hereinafter, referred to as "partial data CG"), (Method-2).

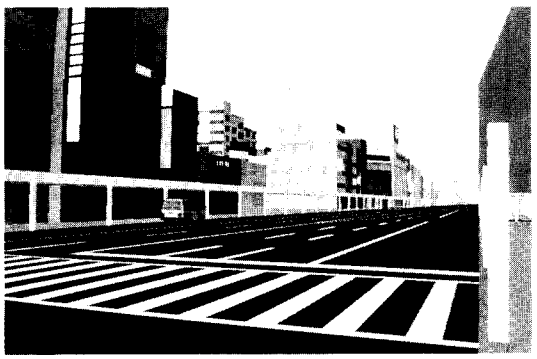

Photo.-2 Slide No.0 (full data CG)

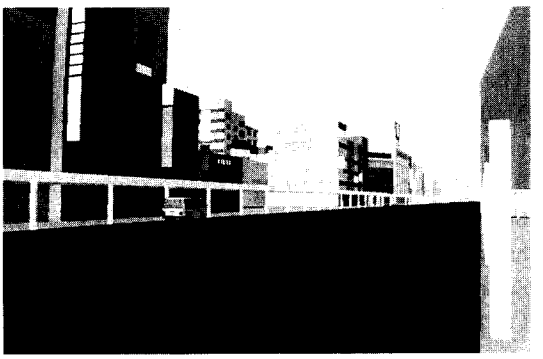

Photo.-5 Slide No.9 (Without white lines)

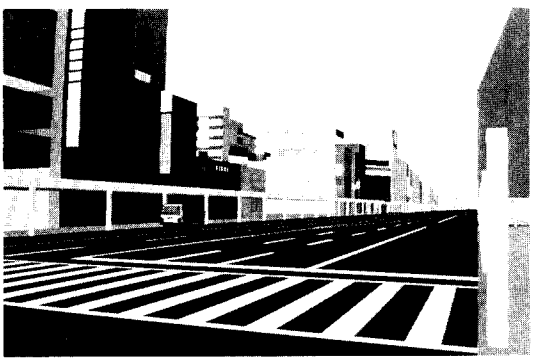

Photo.-3 Slide No.3 (Without windows)

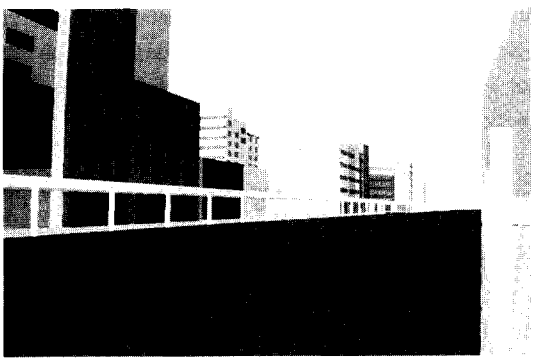

Photo.-6 Slide No.11 (Without signboards, white lines & car)

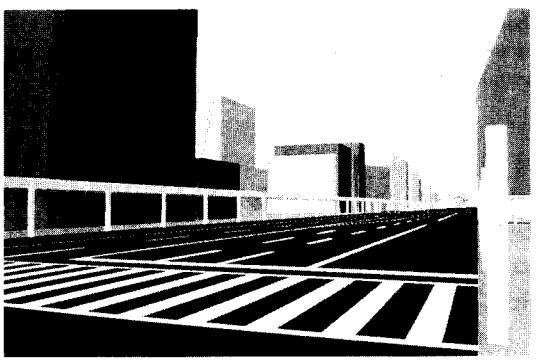

Photo.-4 Slide No.7 (Without windows, signboards & car)

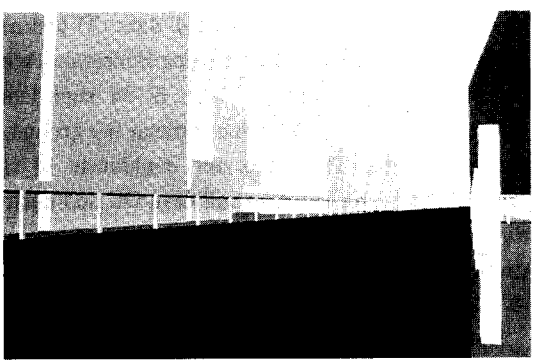

Photo.-7 Slide No.13 (Minimum data CG)

Photo-2 shows the "full data CG" picture and Photo-3 to Photo-7 show some of "partial data CG" pictures.

2) Examinees

The attributes of the examinees are as follows. Students of Nagaoka University of Technology, 19 (male) Students of Nagaoka College of Technology, 46 (male) Officers of Nagaoka City Office, 13 (male 10, female 3)

(persons in charge of urban landscape policy)

3) Survey Method

Figure-1 and 2 show examples of the survey form. The forms of Figure-1 and Figure-2 are used for Method-1 and Method-2 respectively. The degree of expression is identified and filled by an examinee in 5 steps each for strong and weak expressions. The degree of expression 0.0 means that an examinee has an equal impression from both pictures when he or she compares actual scene picture and full data CG picture.

In Figure-2, the number on the left column shows the number of partial data CG pictures. There are 5 steps each for better(+) and poorer(−) bad impressive evaluation. The evaluation value 0.0 means that an examinee has an equal impression with both pictures.

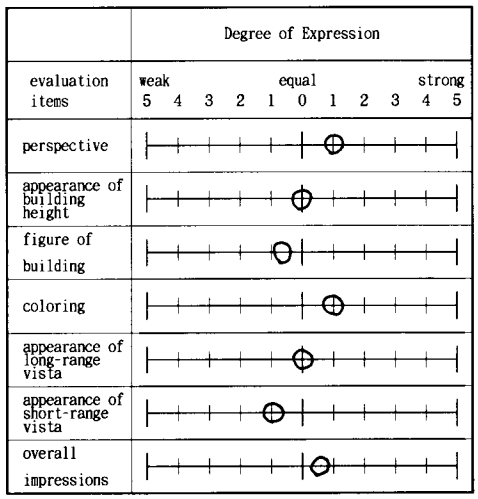

Figure-1 Survey form and the example of answers (Method-1 : For comparison between actual scene picture and full data CG picture)

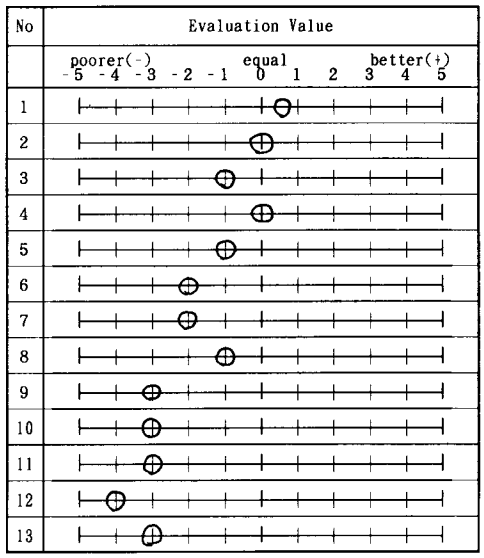

Figure-2 Survey form and the example of answers (Method-2 : For comparison between full data CG picture and partial data CG pictures)

5. Result of Survey

1) Method-1

From comparison result of actual scene picture and full data CG, we evaluate how similar full data CG can be felt to the actual scene picture. The average of evaluation value of "overall impressions" is about 0.4, so that our full data CG pictures are evaluated to give almost same impression with an actual scene picture. There is no significant difference in evaluation values among the groups of the examinees. Therefore, for evaluation of the comparison result between full data CG and partial data CG, we treated the data of three examinee groups as one set of datas.

2) Method-2

Relation between "Number of data" and "Evaluation measure" is shown in Figure-3. "Number of data" means the number of necessary coordinate data to draw each CG picture. "Evaluation measures" means the average of the evaluation values given by each examinee.

The number at the data position on the graph shows a number of CG pictures used.

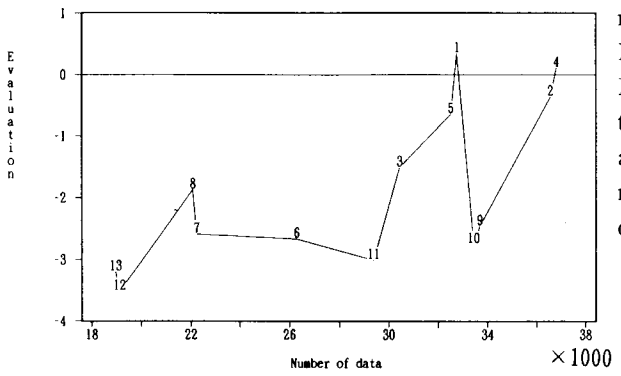

Figure-3 Relation between evaluation measures & number of data (With car item)

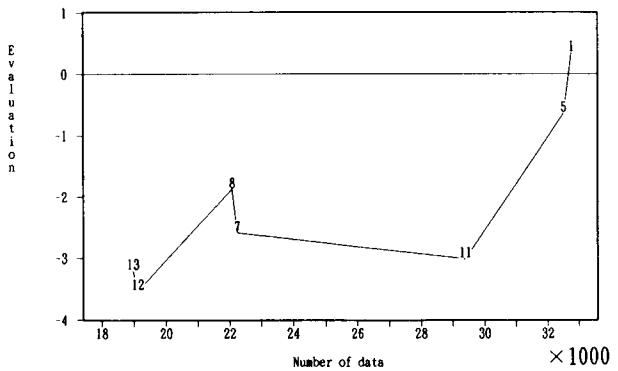

Figure-4 Relation between evaluation measures & number of data (Without car item)

We can find the following result from Figure-3.

There are CG pictures with low evaluation measures even if they include large number of data. All of these pictures have common characteristic of containing a car item.

Exclusion of all pictures which contains a car item gives Figure-4. Both No.7 and No.8 have a road white line item whereas only No.7 contains color item with a slightly reduced evaluation measure. The evaluation measures of No.7 and No.11 are almost equal in spite of large difference in the number of data. The correspondence table, Table 1, shows that No.7 contains color of the building and the road white line and that No.11 contains color of building and windows. Looking at the number of data, the difference between No.12 and No.7 is equivalent to number of the coordinate data for the road white line. The difference between No.12 and No.11 is equivalent to number of data of windows. Number of data for the latter is about 4 times as that for the former. Therefore, it is observed that addition of road white line raises the evaluation measure more effectively than the addition of windows does.

6. Discussion

The analysis of the evaluation survey shows that our CG pictures are practical and, moreover, it is found that the window and the road white line have an equal effect of raising evaluation measures with the latter more efficiently than the former.

The conventional CG methods esteemed an expression in details of buildings rather than the details of roads. However, since expressing the road white line requires smaller labor for data preparation and can raise evaluation measures more effectively than expressing the details of the building, the road white line can be evaluated as an effective drawing item.

We cannot find a significant effect on evaluation measure with the color of building and the car. The reason that the CG pictures which contain a car item do not result in definite effect on evaluation measures might be that the displayed car is only one.

The CG pictures without color of buildings get higher evaluation measures than those with it. We think the reason for this is that a black-and-white color building gave a better impression than colored. However, since the number of studied cases is small that we cannot conclude whether inclusion of the color data is necessary or not.

7. Conclusions

Comparing actual scene picture and full data CG, our full data CG pictures are evaluated to give almost the same impression with an actual scene pictures. Comparing partial data CG and full data CG, relatively simplified CG pictures are evaluated to give the almost same impression with the full

data CG picture. Especially, it is observed that addition of road white lines raises the evaluation measures more effectively than the addition of windows. It is found that a road white line is a useful item for the CG drawing.

We obtained a possibility that relatively simplified CG pictures can be used for evaluation of the urban landscape. With this simplification, it is thought that the utilization on a site of civil engineering and architectural construction can be expanded further.

If we include drawing items such as poles and wires for utilities, traffic signs, roadside trees and human beings, we can make more detailed impression. However, considering the labor of data input, it is necessary to examine how they affect the degree of expression in the CG pictures, and then this calls for a future study.

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9) "Project team Doga" is a name of a group of the students who are researching CG animation. They are distributing the software for CG animation which they developed. We acquired the software, and made our CG pictures.