A Method for Generating Texture Images used on Landscape Simulation

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Abstract: When new buildings, roads or bridges are constructed, landscape simulation is used to investigate if the new constructed objects can match with the current scene. Landscape simulation needs a large number of modeling data, which are created with computer graphics modeling software. On the modeling, a technique called texture mapping is used to make the manmade modeling data realistic. Texture mapping is a computer graphics technique, which maps real pictures onto surfaces of buildings, roads or bridges created by modeling software. However, in order to make the manmade modeling data very realistic, many pictures are needed and that requires much work for both taking pictures and managing them. This paper describes a method for generating texture images such as surfaces of houses or roads. With this method, texture images are generated automatically using random and fractal functions. The generated images look like very natural and enable the modeling data of landscape simulation very realistic. This method uses two types of image. One is a material image and the other is a weathered one. The material image is generated by placing some fundamental patterns at random. The more patterns are used, the more varieties are generated. On the other hand, the weathered image is generated using fractal functions. Selecting the fractal seeds can make an intended image such as a texture that represents water drop track on a wall. Also, combining both material and weathered images can make more realistic images for texture mapping. With this method, we succeeded in creating realistic modeling data for landscape simulation.

Keywords: *Texture Mapping; Landscape Simulation; Image Generation; Fractal*

1. INTRODUCTION

When new bridges or buildings are constructed, landscape simulation is used to evaluate if the new objects match the current scene. Landscape simulation enables us to put some objects onto the current scene and to changes the color, size or materials of the objects very easily for evaluation. In order to perform the evaluation, it is necessary to build many objects, which are composed of the scene, as computer graphics (CG) data. Once the all data are built as CG data, it is very easy to manage the objects

However, CG object data are usually created by specifying vertices that are composed of them, and the rendering method is based on mathematical functions so that the display result looks manmade and not so realistic. Then, there are some methods to make CG image realistic and the most useful one is texture mapping. Texture mapping is a CG technique, which maps pictures taken by a camera onto CG objects such as houses, buildings, bridges and so on. Using texture mapping, CG images can be realistic; however, it requires real image per object or surface that constructs an object. This causes two problems: 1) work to take pictures and 2) management of them. Therefore, there are other approaches for creating realistic CG images. For example, mathematical algorithms could be used for generating textures on which stains are added or for weathering effects to existing textures. Honamai, Tanaka and Ohnishi (1999) suggested a method to generate textures of dirty floors caused by human feet traffic. Dorsey, Pedersen and Hanrahan (1996a) simulated water flow to make weathered images. Kato, Kaneda and Yamashita (2000) suggested a simple method to generate texture images with water flow stains. Also, Dorsey and Hanrahan (1996b) presented a weathering approach with metallic patinas. Takagi and Cai (1998) suggested a method to express cracks of Japanese teacup with 1/f fluctuation and Tokai et al (1993) presented a rendering method of citrus fruits.

However, these approaches are targeted to a specific object and do not have an effect for other objects. Therefore, this paper suggests a new method to create general texture images used on landscape simulation. The texture image is decomposed into two types: 1) material image and 2) weathered one. The material image is generated by placing fundamental patterns at random, while weathered one is generated by fractal functions with some seeds.

2. MATERIAL IMAGE

2.1. Fundamental pattern

(a) (b)

Figure 1. Pictures of a road (a) and a wall (b).

The surface of a road or a wall has unevenness (Figure 1) so that the material images of them can be generated with some fundamental patterns that have unevenness appearance. In order to search for useful patterns, some patterns, which have 2x2, 3x3 and 5x5 pixels, are experimented. Figure 2, Figure3 and Figure 4 shows all patterns of 2x2, 3x3 and 5x5 respectively. In the pictures, white and black pixels show light and dark parts of the image respectively, where all black and white patterns are rejected because they do not have unevenness.

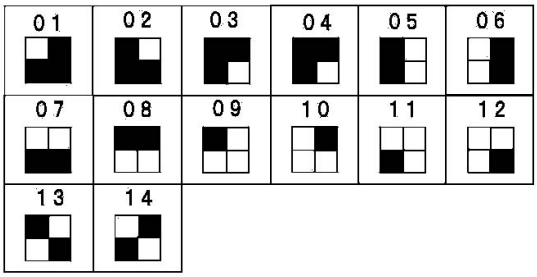

Figure 2. Fundamental patterns with 2x2 pixels.

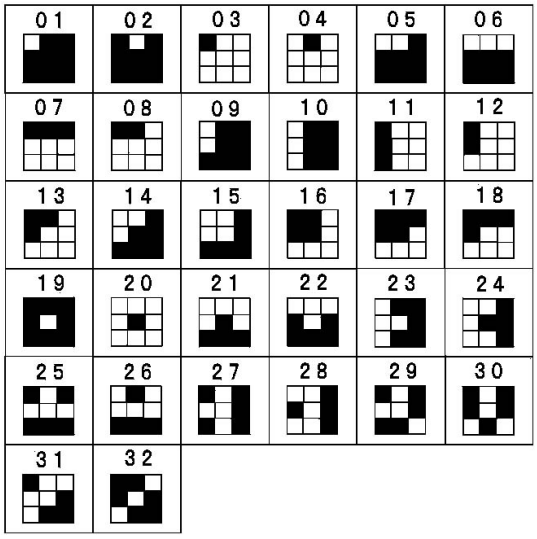

Figure 3. Fumdamental patterns with 3x3 pixels.

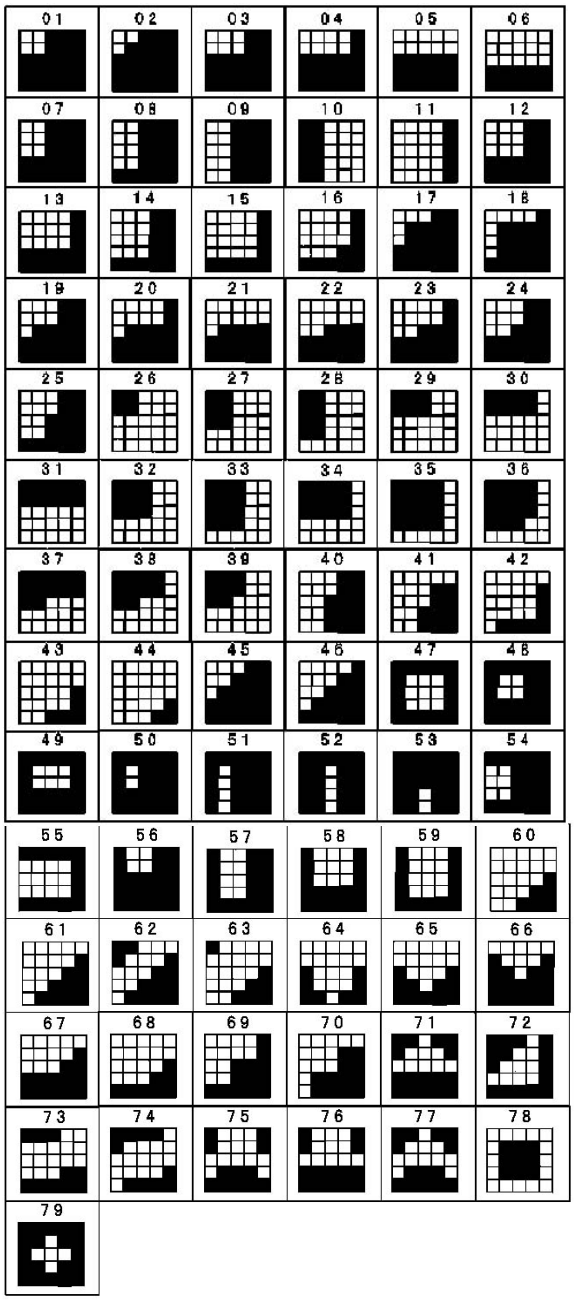

Figure 4. Fundamental patterns with 5x5 pixels.

2.2. Material Image Generation

With fundamental patterns shown in Figure 2, Figure 3 and Figure 4, material images can be generated. In the experiment, 10,000 patterns are located at random on 400x400 pixels size image and the normalized color coordinate system, where R, G and B is treated between 0.0 and 1.0, is used. The background color is initialized as (R,G,B)=(0.5, 0.5,0.5), and the white and black pixel has 0.75 and 0.25 value for RGB respectively, where white and black pixel are defined as the upper and lower quarter value respectively. Among all generated images, some are useful as the material image of a road or a wall. Two examples are shown in Figure 5 and Figure 6, where the only upper-left quarter images are shown for enlargement.

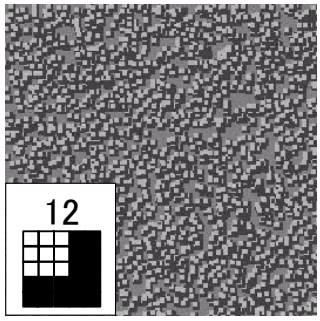

Figure 5. Material image generated with the pattern #12 of 5x5.

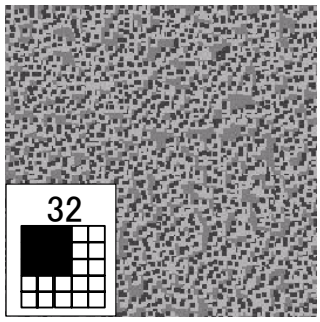

Figure 6. Material image generated with the pattern #32 of 5x5.

The pattern #32 of 5x5 is generated from the pattern #12 of 5x5 by reversing every pixel; however, the result images have different appearance from each other and it is very interesting. The generated image with the pattern #12 of 5x5 looks like a road made of asphalt, which has many projected balls. On the other hand, the image of #32 looks like a pumice stone, which has many holes.

We have evaluated the generated images by asking people which patterns can be used for a road, a wall or a brick. As a result, almost all (12 out of 14) are useful for 2x2 patterns; however two thirds (20 out of 32) are useful for 3x3 patterns and one thirds (23 out of 79) are useful for 5x5 patterns. This means that only some (about 20) fundamental patterns are useful although the more pixels can generate the more patterns.

2.3. Combination of multi patterns

In the above experiment, only one pattern is used to generate one material image; however, the combination of multi patterns generates more appropriate images because it produces more irregular patterns. Figure 7 and Figure 8 shows the material image generated with only one pattern #31 of 3x3 and #22 of 5x5, and Figure 9 shows the result image generated with the combination of these.

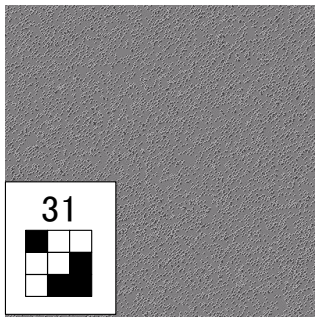

Figure 7. Material image generated with the pattern #31 of 3x3.

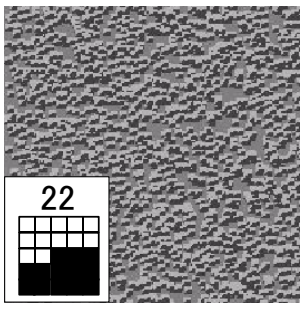

Figure 8. Material image generated with the pattern #22 of 5x5.

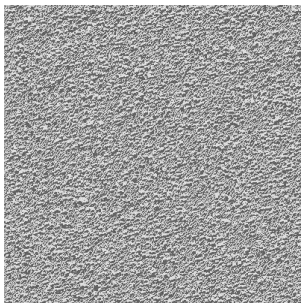

Figure 9. Material image generated with the combination of #31 of 3x3 and #22 of 5x5.

3. WEATHERED IMAGE

3.1. Fractal function

Figure 10. Pictures of bricks (a) and a wall (b) weathered by wind, rain, smog and etc**.**

Bricks or walls are getting weathered gradually day by day (Figure 10). In order to create very realistic CG images, the result images should be intentionally weathered. On the other hand, fractal functions are very useful and used to create natural objects such as mountains, seashores, trees and so forth (Kai, 2003). Therefore, a trial to generate weathered images with fractal functions was performed. Seed patterns are needed to generate images with fractal functions. In this trial, some patterns, which are composed of 3, 4, 5 and 6 points, are used (Figure 11, 12, 13 and 14).

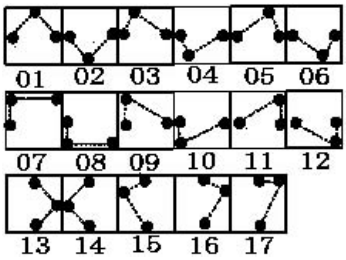

Figure 11. Fractal seeds composed of 3 points.

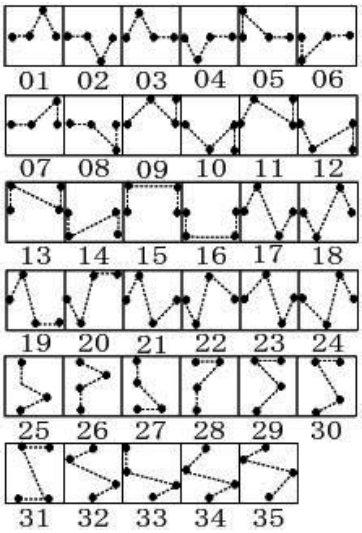

Figure 12. Fractal seeds composed of 4 points.

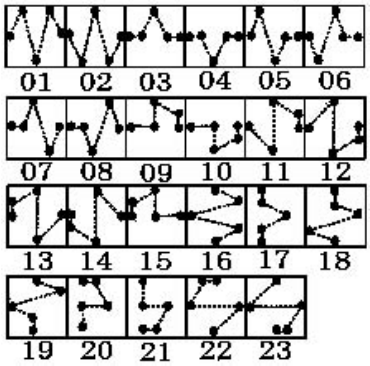

Figure 13. Fractal seeds composed of 5 points.

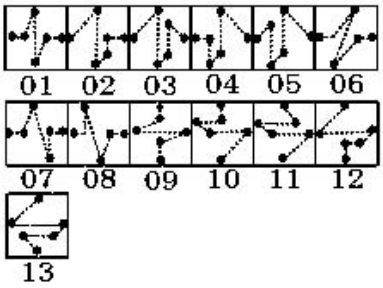

Figure 14. Fractal seeds composed of 6 points.

3.2. Weathered image generation

With fractal seeds in Figure 11, 12, 13 and 14, weathered images can be generated. In the experiment, the image size is 1,000x1,000 pixels and the iteration number is 9. Figure 15, 16, 17 and 18 show some examples of the results. Figure 15 and 16 can be used as textures weathered by dust, while Figure 17 and 18 can be used as textures weathered by water drop.

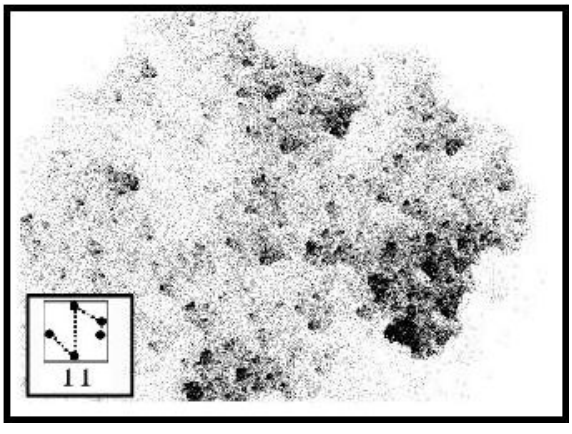

Figure 15. Weathered image generated by #11 of 5-point seeds.

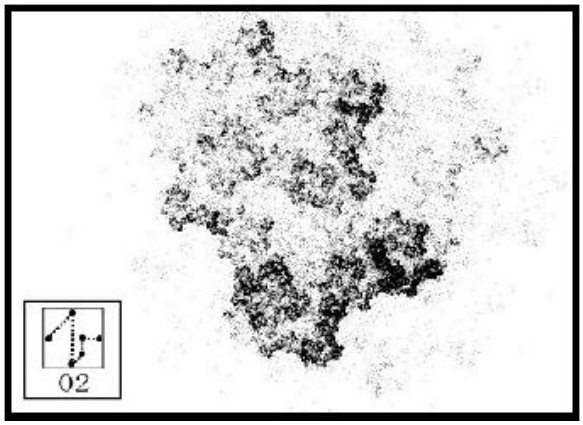

Figure 16. Weathered image generated by #02 of 6-point seeds.

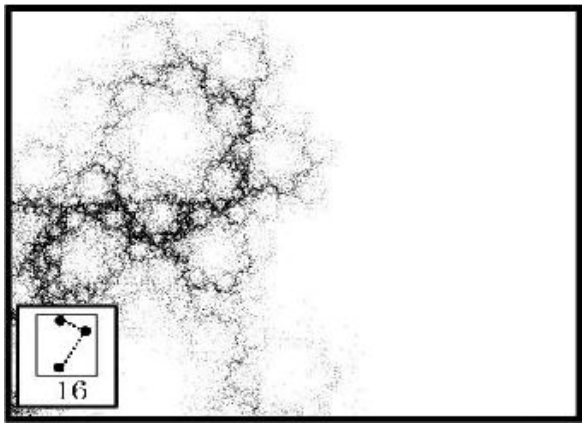

Figure 17. Weathered image generated by #16 of 3-point seeds.

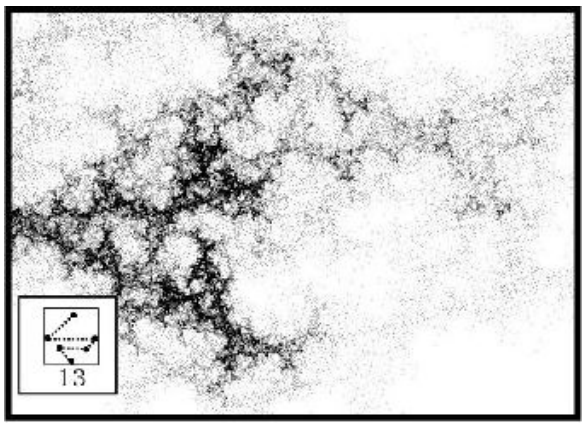

Figure 18. Weathered image generated by #13 of 6-point seeds.

3.3. Combination of multi images

In the above experiment, only one seed is used to generate one weathered image; however, as in 2.3., the combination of multi images generated by some fractal seeds would produce more appropriate weathered images. Figure 19 shows the combination result with Figure 15, 16, 17 and 18, where a material image, which is generated with the combination of #01 and #06 of 2x2, is used as the background.

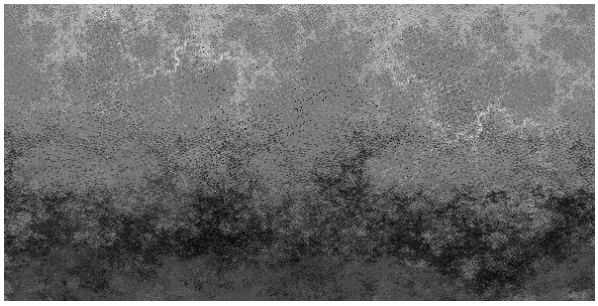

Figure 19. Weathered image generated with the combination of four different fractal seeds.

4. TEXTURE IMAGE FOR LANDSCAPE SIMULATION

With these methods described above, texture images for landscape simulation can be generated. By combining the material images of Figure 9 and the weathered image of Figure 18, Figure 20 is obtained.

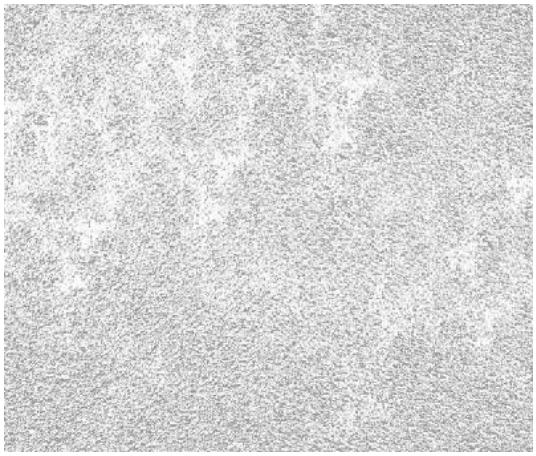

Figure 20. Texture image generated with the combination of material and weathered images.

Figure 21 shows the CG image by texture mapping with Figure 19 and 20 as the lower and the upper part image of a wall respectively.

Figure 21. CG image by texture mapping with this method.

On the other hand, Figure 22 shows the real picture of the scene. By comparison of the both images, it can be understood that this method is very useful.

Figure 22. Real picture taken by a camera.

5. CONCLUSIONS

In order to generate texture images used on landscape simulation, two types of image are generated: 1) material image and 2) weathered one. The material image is generated by placing fundamental patterns at random. Some patterns make the images look like roads that have many projected balls, and others make them look like pumice stones that have many holes. On the other hand, the weathered images are generated by fractal functions. Some seeds generate the images weathered by dusts and others generate the images weathered by water drops. Also, the combination of multi images is very useful, and combining material images and weathered ones generates a texture image weathered by water drops. By mapping the combination images onto CG objects created by modeling software, we could succeed in establishing very realistic scenes in 3D virtual space. In this stage, we have to generate the texture images before rendering; however, it will be possible to generate the images and render the whole graphics models in real time in the near future when we consider the computer power trend in these days

6. ACKNOWLEDGEMENTS

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