A WEATHERED IMAGE GENERATION METHOD FOR LANDSCAPE SIMULATION

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ABSTRACT

In landscape simulatin, it is necessary to express very realistic image generated by computer graphics. One solution is to use texture mapping; however, it needs a lot of work and time to obtain images for texture mapping since there are huge variety of images for buildings, roads, stations and so on, and the landscape image is diverse due to the weather and time. Especially, weathered images such as stain on walls, crack on roads and so forth, are needed to make the landscape image very realistic. These weathered images do not have to be strict so that it saves a lot of work and time for obtaining the images for texture mapping if we can generate a variety of weathered images automatically. Therefore, this paper describes how to generate a variety of weathered images automatically by changing the weathered shape of the original image.

Keywords: image processing, computer graphics, landscape simulation, fractal

1. INTRODUCTION

Computer graphics (CG) and virtual reality (VR) technologies are now used in a variety of fields such as industrial design, architecture, movie, entertainment and so on. Landscape simultion is one of the applications for assessment of new buildings, bridges, shopping malls, and so forth. In these cases, computer generated images should be realistic so that the assessment can be correctly performed. One method of making CG images realistic is to use texture mapping, which maps real pictures onto to the surfaces generated by CG. Real pictures have some stains on walls or cracks on roads. Then, there are some researches for making weathered images by CG.

Weathered images caused by water flow were made by Dorsey, where water drop model made by particle was proposed [1]. Dorsey also proposed a generation method of metallic patinas [2], while Kato et al. proposed water droplet model to represent water flow stains [3]. With these proposed methods, a variety of stains caused by water flow could be generated. On the other hand, there are some other works that can generate other kinds of weathered image. Takagi and Cai proposed a method that could generate cracks on traditional Japanese tea cups by using 1/f functions [4]. Tokai et al. suggested another kind of method that could render citrus fruits [5]. In addition to those methods, fractal function is often used to express various kinds of weathered shapes. Honami et al. generated dirty floor images made after people walking [6].

The targets of these researches are explicit and the weathered images are generated by simulations with some physical models. On the other hand, there are many kinds of weathered images in landscape simulation such as stains on walls, cracks on roads and so on. Therefore, we have been researching a method that can generate a variety of weathered images by using fractal function [7-10]. The target of these papers is to generate artificial weathered images for texture mapping in landscape simulation. In these papers, weathered image is constructed with two types of image: material and weathered shape. Material image represents the feature of the material, on which weathered image is generated, such as cement of walls, asphalt of roads and so forth. On the other hand, weathered shape image represents the shape of stains on walls or cracks on roads. Material image is made of the combination of black and white pixel, while the weathered shape one is made with fractal function. The method can generate a variety of weathered image by changing material and weathered shape images. The generated image is used for texture mapping in landscape simulation and it makes the simulation image very realistic.

However, the selection of the two images, material and weathered shape, is manual. That is, it is necessary for human to select the images by comparing a real picture, which has weathered shape, with the registered image on an image data base. Therefore, we are researching for a method that can generate another weathered image automatically from a real weathered one, which is on a real picture [11]. This paper describes how to generate another type of weathered image from a real one, especially for how to change the weathered shape by using image processing techniques.

2. GENERATION PROCESS

Fig. 1 shows the generation process of the proposed method. First of all, a real picuture that has weathered shape is input into the system. In this paper, only gray scale image is treated so that the picuture is binarized after gray scale conversion. The binary image has a lot of noises so that noise reduction is performed since these noises are not so important to generate weathered image automatically. However, the resultant shape after the noise reduction is important because it represents the principal shape of the weathered image. Then, the boundary of the weathered shape is traced in order to detect what kind of weathered shape composes the boundary. After the weathered patterns are obtained by the boundary trance, these patterns are compared with the images on the database, which are pre-generated with fractal function. Some similar weathered patterns are retrieved from the detabese. By mapping these fractal images onto the boundary of the target image, weathered image is generated. The resultant image has only one bit plane so that the image should be expanded into 8 bit planes to generate gray scale image. With these processes, we can generate another type of weathered image from a real picture.

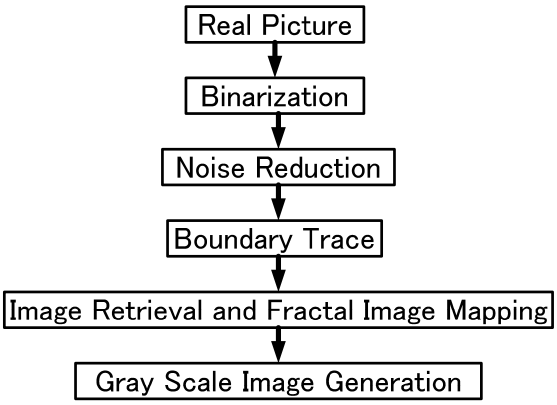

Fig. 1 Generation process

3. WEATHERED SHAPE GENERATION

In this chapter, we describe how to generate several kinds of weathered shape automatically from a real picture by changing the weathered shape according to the generation process shown in Fig. 1.

3.1 Binarization

The current target of this paper is gray scale image so that a real picuture is gray scaled with Eq. (1) if it has color.

$$Y=0.299R+0.587G+0.114B \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, R, G and B represents Red, Green and Blue components of the original picture respectively, and Y represents Lightness of the gray scaled image. The gray scale image is binarized by setting threshold, which can be easily defined from the histgram of the image. Fig. 2 shows the original, gray scale and binary images, respectively.

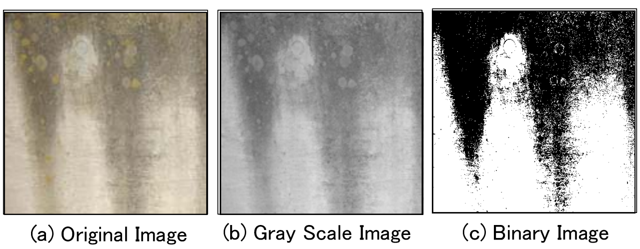

Fig. 2 Original, gray scale and binary images of the target

3.2 Boundary tracing

Fig. 1 (c) shows the binary image of the target, however, there are some noises in the image, which is not so important to generate the weathered shape. Therefore, noise reduction is performed. Weathered patterns appear along the boudary of the weathered image so that weathered patterns can be obtained by tracing the boundary. Fig. 3 (a) and (b) shows the image after noise reduction and the boundary of the weathered image, respectively.

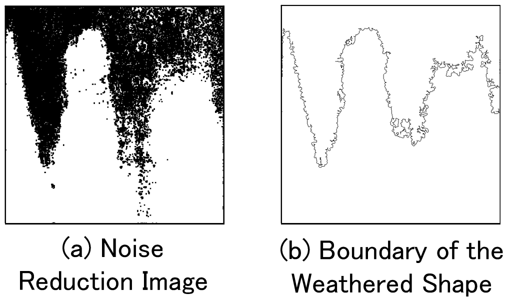

Fig. 3 Noise reduction image and the boundary

3.3 Image retrieval

Fig. 4 shows weathered patterns that are placed near the boundary of the weathered shape shown in Fig. 3 (b). In this paper, we try to replace these weathered patterns with artificial patterns made with fractal function. By replaceing these weathered patterns with others, a variety of weathered patterns can be generated automatically. These weathered patterns are outside of the boundary, however, mapping artificial fractal images inside of the boundary makes different type of weathered pattern.

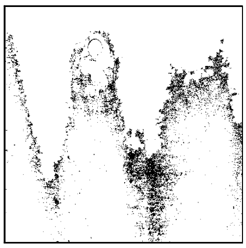

Fig. 4 Weathered patterns

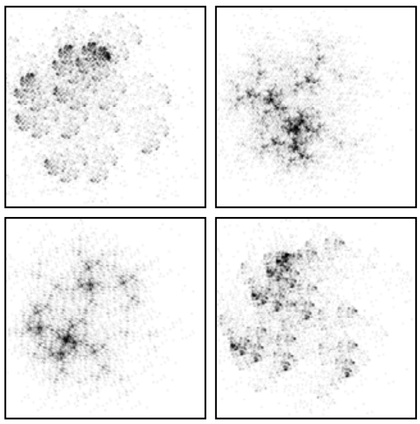

Fig. 5 Fractal images

Fig. 5 shows some images generated with fractal function. In our method, only dots of a fractal generator are drawn to generate a fractal image and the fractal generator roates when it is drawn. This generation process and the generated images are shown in Fig. 6. In addtion to that, a variety of fractal images are generated by combining some fractal generators. The fractal generators and the generated images are shown in Fig. 7.

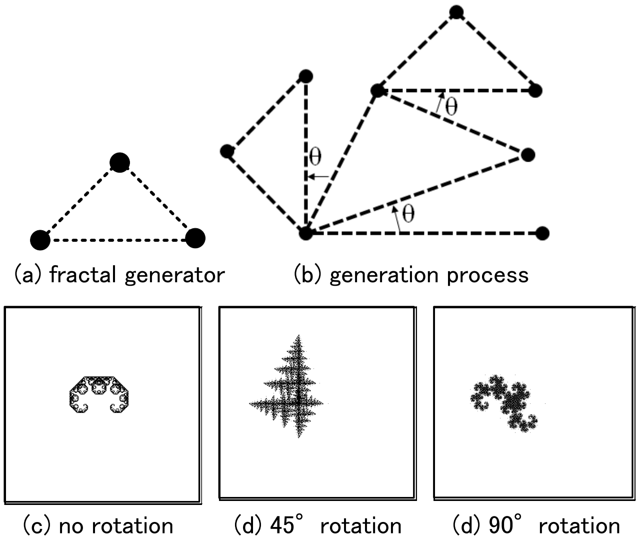

Fig. 6 fractal image generation with rotation

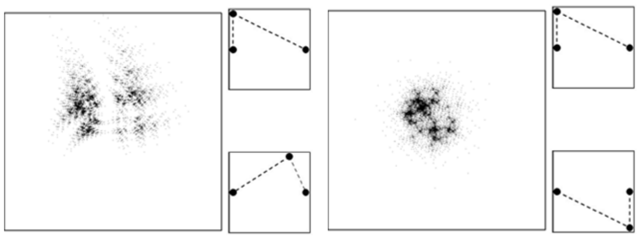

Fig. 7 fractal images by combining two generators

A variety of fractal images are generated with the above method and the generated images are registered on an image database. After picking up some weathered patterns along the boundary, these patterns are compared with the fractal images registered on the database. Some similar fractal images are retrieved and mapped inside of the boundary. The resultant image is shown in Fig. 8.

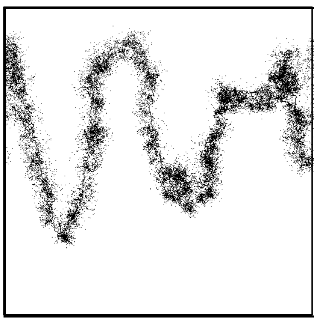

Fig. 8 Boundary after fractal image mapping

3.4 Gray scale image

Fig. 9 shows the bit planes of the gray sclaed original image. Fig. 9 says that the upper 3 bit planes (8,7,6 bit planes) have a clear weathered shape, while the lower 5 bit planes (5,4,3,2,1 bit planes) do not have a clear shape. Therefore, we have to generate the upper 3 bit planes from the resultant image shown in Fig. 8, which corresponds to the 8 bit plane shown in Fig. 9. Fig. 8 can be similar image to Fig. 9 (a) by filling inside of the boundary and mapping some weathered patterns.

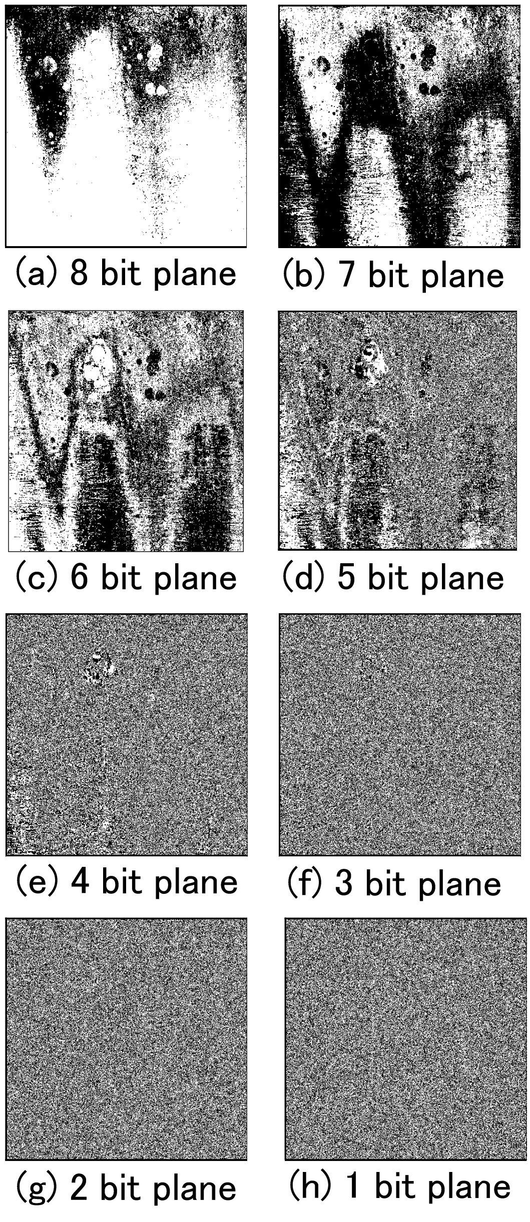

Fig. 9 Bit planes of the gray scaled original image

Bit plane generation algorithm is as follows and the resultant images of the process are shown in Fig. 10.

<Bit Plane Generation Algorithm>

1) Fill inside of the boundary with fractal images, and map some weathered patterns inside of the image in order to add some noise and randomness to it. This image corresponds to the 8 bit plane. (See Fig. 10 (a))
2) Expand Fig. 10 (a) 30 times. (See Fig. 10 (b))
3) Generate the 7 bit plane by subtracting Fig. 10 (a) from Fig. 10 (b). (See Fig.10 (c))
4) Expand Fig. 10 (a) 5 times. (See Fig. 10 (d))
5) Generate a bit plane by subtracting Fig.10 (a) from Fig. 10 (d). (See Fig.10 (e))
6) Reverse Fig. 10 (b) (See Fig.10 (f))
7) Generate the 6 bit plane by adding Fig. 10 (f) to Fig.10 (e). (See Fig. 10 (g))

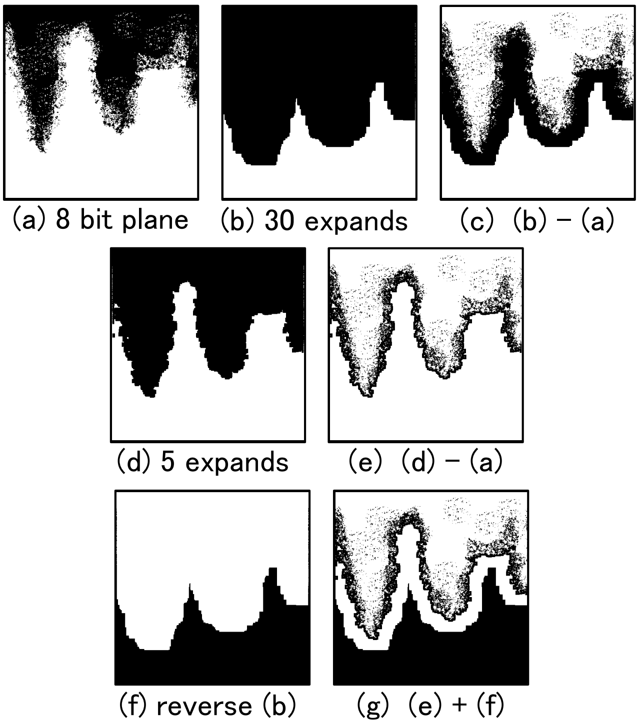

Fig. 10 Bit plane generation process

3.5 Combining with material image

In the previous section, we have generated the upper 3 bit planes, which have a clear weathered shape. However, the lower 5 bit plnaes do not have the characteristic of the weathered shape. Instead of that, the lower 5 bit planes have the characteristic of the material such as rough, sandy, smooth and so on. Then, by combining the lower 5 bit planes of a material image with the upper 3 bit planes generated with the proposed method, we can generate a variety of weathered images.

4. GENERATED IMAGES

Fig. 11-15 show some examples. In each figure, (a) is the original image that does not have weathered shape, while (b) is the image that is added by the weathered image generated with the proposed method.

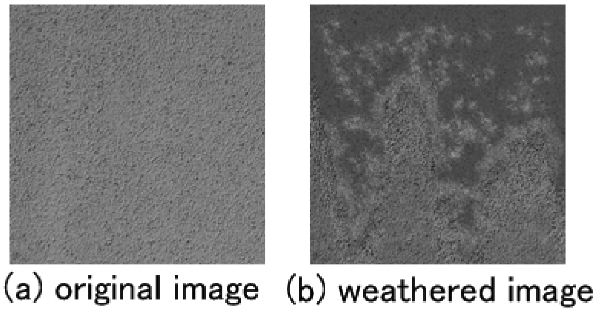

Fig. 11 Generated image (Example 1)

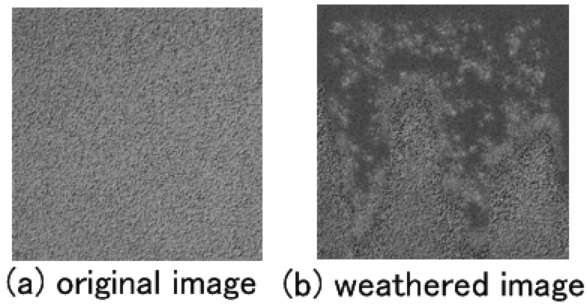

Fig. 12 Generated image (Example 2)

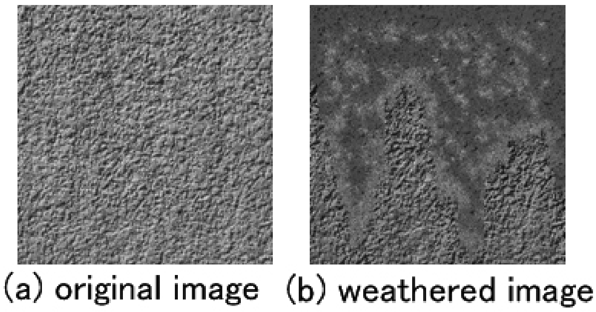

Fig. 13 Generated image (Example 3)

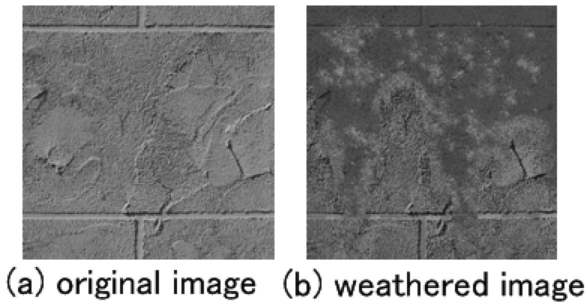

Fig. 14 Generated image (Example 4)

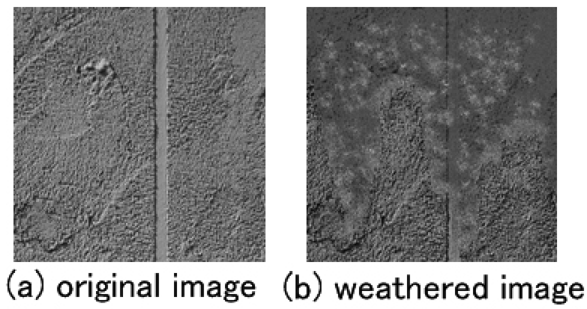

Fig. 15 Generated image (Example 5)

5. CONCLUSION

We have proposed a generation method of weathered images for landscape simulation. An original image, which has a weathered pattern, is input and the boundary is traced after binarization. Along the boundary, the weathered pattern is searched and compared with the fractal images, which are pre-registered on an image database. By mapping fractal images on the doundary and filling the inseide of the boundary, the 8 bit plane image is generated automatically. Based on the 8 bit plane, the upper 3 bit plaes are generated. By combining the lower 5 bit planes, which is taken from anther non-weathered image, with the generated the upper 5 bit planes, a new weathered image can be generated. In this paper, only one type of weathered patterns is shown, however, a variety of weathered image can be generated by changing the boundary shape, fractal images retrieved from an image database, times of expand process and so on. In the future, we plan to expand our method to colorization.

6. REFERENCES

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