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Animation Model of Multi-object in Fractal Form Based on Partitioned-random Iteration Algorithm

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Abstract

Animation model of objects in fractal form has many advantages over animation model of objects in traditional form. Traditionally simple object is drawn by drawing functions and the slight different form of object should be redrawn by different function, so every manipulation effort to change or to animate the form of object should call the different function. Naturally fractal object is drawn by a single algorithm through drawing pixels at the position according the code of fractal, so to change the form of or to animate the fractal object is done simply by changing the code of fractal such as IFS code at any time interactively. IFS code is the inverse problem representation of object in fractal form. The IFS fractal objects can be reconstructed by random iteration algorithm and the multi-object of fractal can be reconstructed by partitioned-random iteration algorithm from the IFS code sets.

Keywords: Animation; drawing; fractal; IFS code; inverse problem: multi-object; partitioned-random iteration

1. Introduction

Normally an animation of an animated object is conducted easily by drawing repeatedly and slightly changeing the position or size. A geometrical simple object can be drawn by means of drawing functions, such as draw-line,

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draw-rectangle, draw-oval etc. A Problem is raised when there is the need of making an animation of a complicated object by means of drawing functions. Animation of fractal object has many advantages, first it has objects that are easy to be controlled over and it has relatively needed smaller size of animated objects in fractal form than in non-fractal form when those are stored. The second advantage of fractal model is it can be constructed easily to represent a lot of natural objects, such as trees, clouds etc., rather than non-fractal model. The other advantage of the fractal model is it can be zoomed and still has good resolution over the non-fractal model [1]. The IFS (*iterated function systems*) code sets as the inverse problem of any objects in fractal form contain the scaling, rotation and translation factors of affine transformation and represented by the coefficient-**a, b, c, d, e** and **f** [4]. The number of function in a set depends on the complexity of the fractal object. Each transformation equation pin point to the next position of point inside the object that depends on the previous one can be expressed as mathematics expression as presented in the Fig. 1 below. Those code set can be reconstructed become objects of fractal by means of random iteration algorithm and become multi-objects of fractal by means of partitioned-random iteration algorithm. So at any time the position and or the size, and also the form of IFS fractal object can be changed easily simply by drawing many pixels randomly at the position determined by IFS code over and over again. The most remarkable advantage of fractal object is the easy way of its manipulation such as evolutional changes between two slightly different IFS code sets by interpolating of its factors as a metamorphic animation and can exhibit a special effect such as rotational effect around Z- axis perpendicular to the 2D space [10]. There is other kind of rotational effect that will be described in the next section.

$$w \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix}$$

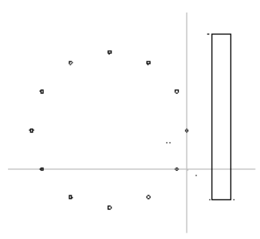
Fig. 1. Affine transformation equation

2. Fractal and IFS Code

2.1. IFS Fractal Object

The inverse problem result of an object can be represented as the set of IFS code in text format form that represents the self-iterative affine transformation functions (*self-affine*). According to collage theorem, part of object can be encoded as a single self-affine function and the collection of self-affine functions can be decode back or generated becoming an object of fractal as the composition of each part of the object iteratively by random iteration algorithm based on its probability factor of each function [2,3,5]. As an example in figure-2 (a) below, a circle-like and a rectangle of IFS fractals are displayed, and as an example of IFS code of circle-like fractal is presented in Fig. 2 (b) below and also as an example of IFS code of rectangle fractal is presented in Fig. 2 (c) below.

(a)



(b)

a	b	c	d	e	f
0,020	0,000	0,000	0,020	-0,022	0,539
0,020	0,000	0,000	0,020	1,078	-0,561
0,020	0,000	0,000	0,020	2,178	0,539
0,020	0,000	0,000	0,020	1,078	1,639
0,020	0,000	0,000	0,020	0,125	-0,011
0,020	0,000	0,000	0,020	1,628	-0,414
0,020	0,000	0,000	0,020	2,031	1,089
0,020	0,000	0,000	0,020	0,528	1,492
0,020	0,000	0,000	0,020	0,528	-0,414
0,020	0,000	0,000	0,020	2,031	-0,011
0,020	0,000	0,000	0,020	1,628	1,492
0,020	0,000	0,000	0,020	0,125	1,089

(c)

a	b	c	d	e	f
0,800	0,022	0,000	0,000	-0,116	1,903
0,000	0,000	-7,166	-0,200	-0,369	-2,705
-0,800	-0,022	0,000	0,000	-0,884	-0,439
0,000	0,000	7,166	0,200	-0,631	4,169

Fig. 2. (a) Circle-like & rectangle of fractals (b) IFS Code of circle-like (c) IFS Code of rectangle

2.2. Multi-object of Fractal

A Composition of several primitive objects can be constructed becoming a multi-object of non-primitive object in fractal form by means of partitioned-random iteration algorithm. The simple clock model of fractal as an example of multi-object in the fractal form that consist of four primitive objects (two modified rectangles and two circle-like objects) is displayed in Fig. 3 below. To compose at least two fractal objects as a new multi-object of fractal, the partitioned-random iteration algorithm as a modified version of the random iteration algorithm is needed. This modified version of algorithm is based on the use of partitioned random number generation for each object in a multi-object, so the name of algorithm is coming from. In the Fig. 4 below the decision tree form describes the mechanism of the partitioned-random iteration algorithm based on the probability values of self-affine functions of each object in the multi-object as the partitions of the whole.

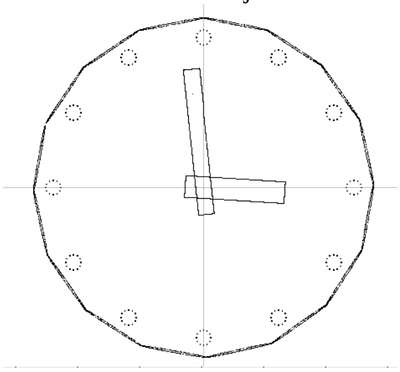


Fig. 3. Multi-object of clock in fractal form

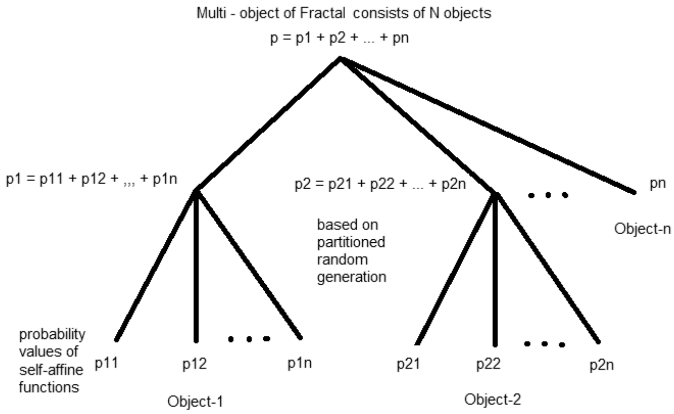


Fig. 4. Decision tree form of partitioned-random iteration algorithm

3. Related Works

Through the work on fractal-based algorithm for metamorphic animation that is studied by Chen et.al. [6], the size of objects can be measured, for which the traditional way based on Euclidean geometry is failed. An image morphing based on pixel transformation approach that is proposed by Rahman et.al. [7] depict the transformation of pixels with their neighborhoods; this method is organized with the replacement of the pixel values of a source image and convolving the neighbor with the help of a mask that is fast and efficient for image morphing. In their paper, Zhuang et.al [8] study a morphing IFS fractal by calculating local attractor's coarse convex-hull and selecting rotation matching between IFS's. The morphing procedure of two IFS's fractal attractors is done by interpolating the parameters of the iterated function. Normally morphing animation is dealing with two different objects as the start and target objects, but if the morphing animation is dealing with more than two different objects, a new approach is needed such as the method which is based on a family of multi-transitional IFS code approach [9].

4. Animation Model

The animation model of multi-object in fractal form can describe the method of animation used in this paper as illustrated in the Fig. 5 below. The explanation of the model will be presented right in the next section.

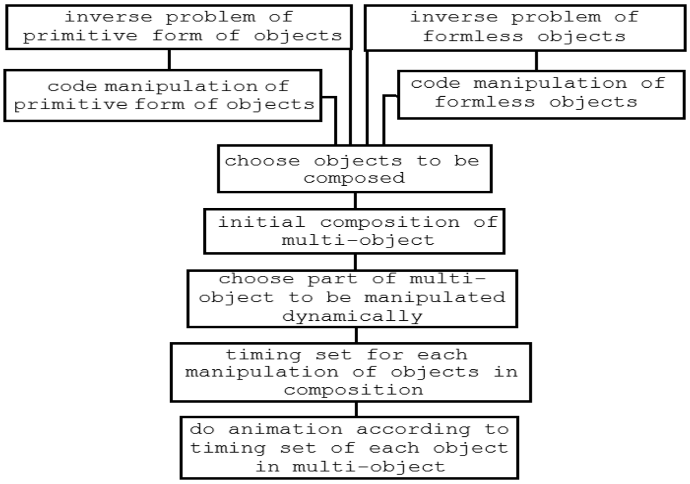


Fig. 5. Animation model of multi-object in fractal

5. Animation

From the animation model above, there are two major classes of objects; those are the simple geometrical or primitive objects represented as fractal objects and formless or fractal objects generated by inverse problem process. Both classes and the combination of those can be composed becoming a new multi-object of fractal. Each object as part of the multi-object can have the different manipulation process. In this paper, there are two kinds of animation are presented, those are the metamorphic animation of the two fractal objects which are almost identical that has a potential attractive effect to be considered and the multi-object animation that consists of two dynamical objects animated with the same but slightly different kinds of manipulation processes and two static objects without any manipulation processes.

5.1. Metamorphic Animation of Fractal Objects

An attractive changes in the sequence of images as the results of animation can be generated by metamorphic animation and this kind of animation can produce a special effect. In this paper will be discussed and presented the rotational effect of 2D fern IFS fractal around Y-axis as a result of metamorphic animation between the two of 2D fern IFS fractals which are almost the same, except the coefficient-**b** and **c** in both of those IFS code sets have the different sign as described in Fig. 6 below. The first fern IFS code as the source (type-1) is the original version and the second fern IFS code as the target (type-2) is the duplication or the flip over Y-axis version of the first one.

Fern IFS Code Type-1						
a	b	c	d	e	f	p
0.74	-.09	0.09	0.74	0.00	0.20	0.75
0.23	-.11	0.11	0.23	0.00	0.10	0.12
-.23	0.11	0.11	0.23	0.00	0.15	0.12
0.01	0.00	0.00	0.30	0.00	0.00	0.01

Fern IFS Code Type-2 (flip-Y)						
a	b	c	d	e	f	p
0.74	0.09	-.09	0.74	0.00	0.20	0.75
0.23	0.11	-.11	0.23	0.00	0.10	0.12
-.23	-.11	-.11	0.23	0.00	0.15	0.12
0.01	0.00	0.00	0.30	0.00	0.00	0.01

Fig. 6. IFS code sets of two fractal ferns

5.2. Multi-object Metamorphic Animation

The composition of several primitive objects in fractal form such as rectangle and circle-like fractals can be reconstructed to be new images such as a clock that has two narrowed rectangles with the different length rotated around the Z-axis perpendicular to the 2D space clock wisely and a collection of twelve points in circle-like formation as a boundary around. The rotational speed between the two rectangles are differ by factor 60 to simulate one rotation as a minute has 60 seconds.

6. Simulation

6.1. Simulation of Single object Metamorphic Animation

The first simulation example of metamorphic animation which is involving a single object of fractal as described in the previous section is simulated, the transitional images as the results of metamorphic animation between the two kinds of fern fractals that exhibits rotational effect around Y-axis is illustrated in Fig. 7 below.

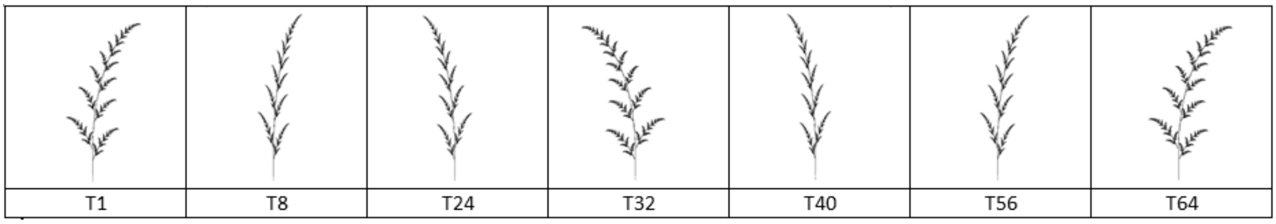


Fig. 7. Transitional images of metamorphic animation of fern fractals exhibiting rotational effect around Y-axis

6.2. Simulation of Multi-object Metamorphic Animation

The second simulation example of metamorphic animation which is involving the multi-object of fractal as a new single object as described in the previous section is simulated, the images sequence as the result of the animation of clock in fractal form is presented in Fig. 8 below

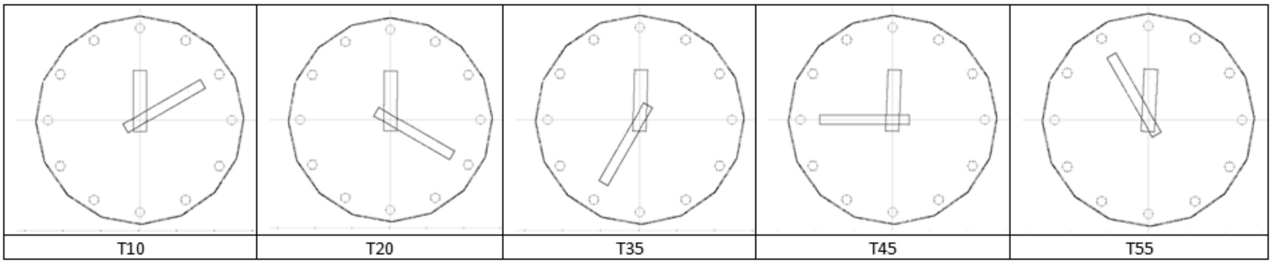


Fig. 8. Images sequence of fractal clock animation

7. Conclusion

In this paper at least two things can be concluded. First, the multi-object of fractal as a new single object of fractal can be constructed and animated that consists of several objects of primitive fractal. Each primitive object of fractal as part of a new multi-object of fractal can have the different kind of animation, but as a whole represents an integrated animation of multi-object of fractal. The second, a special effect as a result of metamorphic animation potentially can be combined to make the animation of the more complicated multi-object fractal.

8. Future Work

For the related future work of this study, the research can be extended to study the more complicated multi-object of fractal that consists of the simple geometric objects in fractal form and any fractal objects itself.

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