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An Interactive Action of Automatic Artwork by Using An Evolutional Model

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Abstract

This paper describes the process and creation of interactive computer formative system based on an evolutional model with genetic algorithms. The evolutional model has a sound environment, which has prototypes of creatures inside. Initially, the prototypes move randomly using pre-programmed "energy" within them. When the mouse is moved, these prototypes gravitate towards the cursor, which is a metaphor for the sun, the creator of life. Just as real life forms move towards the sun, so the prototypes grow and move together towards the cursor. We call these shapes "creatures." When these creatures join together, they cross over and sometimes mutate, based on the evolutional model they are following. These "creature formative system" can automatically replicate them.

Key words: Sound Space, Gravitation Movement, Evolutionary model, Genetic Algorithms and Interactive Action

1. Introduction

This paper focuses on the creation of artwork, which is created using an evolutional model. The evolutional model combines the concepts of artificial life, i.e., life that is generated using genetic algorithms [0] [1]. Emphasis in this paper is being placed on creating artwork, which is automatically generated by using the interactive action of a mouse to control the operation of the genetic algorithms of an evolutional model.

At the beginning of the simulation, we set up an environment, which has a sound space set in a three-dimensional colored cube. Next, we set up the program to generate the creatures. Then the interactive action of the mouse is programmed. The mouse controls the direction of movement in an evolutional environment. Finally, the artwork can automatically generate creatures by themselves.

2. The environment of sound and color

At the beginning of the simulation, we set up an environment (Fig. 1) with a sound space, which matches the three-dimensional color cube. The three-dimensional space is constructed using axles x, y and z. The center of the environment is set at the value of (0.0, 0.0, and 0.0). The prototypes of the creatures move dynamically with each color and different sounds inside in real time.

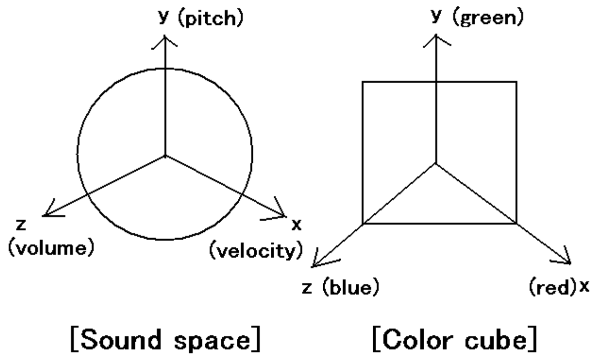

Fig.1, The environment of sound and color

2.1 Sound space

According to the elements of the sounds, we set up each the velocity on the axle of x, the pitch on the axle of y and the volume on the axle of z. The value was set between (0.0, 0.0, 0.0) and (255.0, 255.0, 255.0) for the pitch, velouity, and volume of the sound space.

2.2 Color cube

According to the elements of the colors red, green and blue, the values were set between (0.0, 0.0, 0.0) and (255.0, 255.0, 255.0) for the color cube. The value of red was set on the axle of x, the value of green was set on the axle of Y, and the value of Blue was set on the axle of z.

3. Creature generation in the evolutional model

According to the evolutional model flow chart [2][3][4][5], (Fig. 2), the creatures generate automatically. The evolutional model, based on the genetic algorithms, can be seen below.

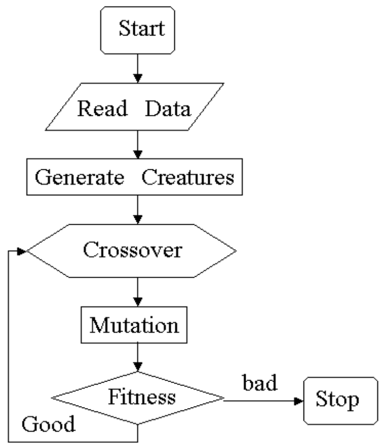

Fig.2, Flow chart of the evolutional model

3.1 Phenotype and Genotype definition

(a) Phenotype definition

The phenotypes of the creatures are defined by the shape, color and sound information of their respective geometric shapes. The shapes, (Fig. 3), of a sphere, cone, cylinder, frustum, as well as the color information and the pitch, velocity and volume become the original prototypes.

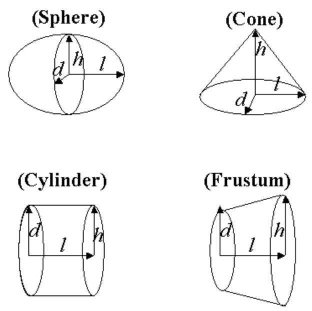

Fig.3, Shapes of prototypes

(b) Genotype definition

The genotypes evolve from the information of the phenotypes, and contain the distance of radius, height, and length of the shapes plus the values of red, green, blue of the colors and the pitch, velocity and volume, (Fig. 4). In order to generate various shapes, the genotype of shape is organized by the parameters *d, h*, and *l*, where *d,* and *h*, is the distance and height of the radius and *l* is the length of shapes.

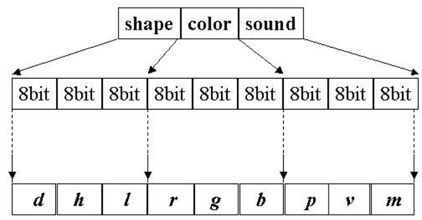

Fig.4, Parameters of the genotypes

3.2 The prototypes generation

Based on the genotype data, various shapes and colors, each with different sounds, are generated. The prototypes of the creatures are generated by random programs, and include various values, such as the radius, height, length, colors of red, green, blue, as well as pitch, velocity, and volume.

3.3 New generation of creatures from crossover and mutation

The next generations of creatures reproduce as a result of crossover and mutation. The shapes, colors and sounds of each creature are different from one another. Crossover operations have many patterns. However, in this case, we are using a uniform crossover (Fig. 5) to build new genotypes for the next generation.

The operation of the uniform crossover uses mask data to match the new genotypes. We prepared the mask data randomly. If the bit of the mask is 1, the data from the A prototype is copied to the next generation. If the bit of the mask is 0, we copied the data from the B prototype.

The mutation rate is used to change the data of the next generation of prototypes. In mutation, we convert bits of data of the genotypes from 0 to 1, or from 1 to 0. The mutation rate should not be too large, because if a large rate is used, the next generation will lose some of its special features. In this case, the rate of mutation we used was less then 0.5%, which brings about many changes to the following generations.

By repeating the operation of the crossover and mutation, we continue to create more and more novel shapes, as well as various colors and different sounds in each succeeding generation.

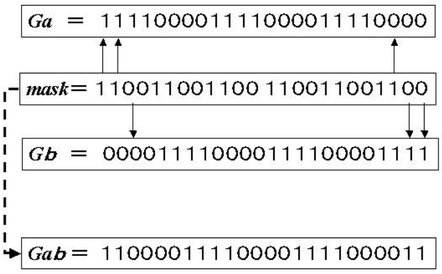

Fig.5, Uniform crossover

3.4 Fitness for movement based on gravitation

In this paper, we determined the parameters of gravitation as F and the fixed number as k, the volume of the creatures as mv and the weight of the creatures as mw and the distance between creatures each other at d. The formula for the determination of fitness of movement between the creatures is seen below.

$$\vec{F} = k\frac{mv \times mw}{d^2}$$

At the same way, the creatures gravitate toward the light in an artificial environment and design the position of light as the mouse. We set the parameters for the position of the mouse as Xc, Yc, Zc, the parameters of gravitation toward the mouse as $\vec{F}_0$ and movement within the parameter at T and maximum values of force at Fc .The formula for the determination of gravitation between the creatures and mouse is below.

$$\vec{F}_0(x,y,z) = \begin{pmatrix} F_c \sin\left(\frac{2\pi(x - X_c)}{T}\right) \\ F_c \sin\left(\frac{2\pi(y - Y_c)}{T}\right) \\ F_c \sin\left(\frac{2\pi(z - Z_c)}{T}\right) \end{pmatrix}$$

According to the movement of gravitation, the Fig.6shows the fitness of each generation as below.

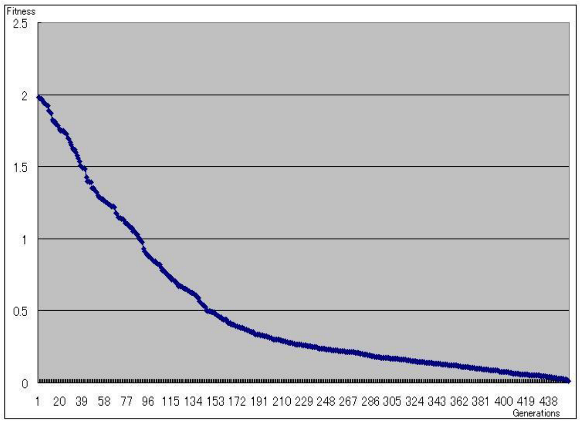

Fig.6, Fitness of each generation

4. Program the interactive action

In the Fig.7, we programmed the “Red ball” as the mouse control the creatures’ movement. When the mouse is moved, the creatures gravitate towards the direction of the cursor. User can be move the mouse to any where and the creatures also gravitate towards the “Red ball” real time. At the same time, we also can hear the various sounds from each creature.

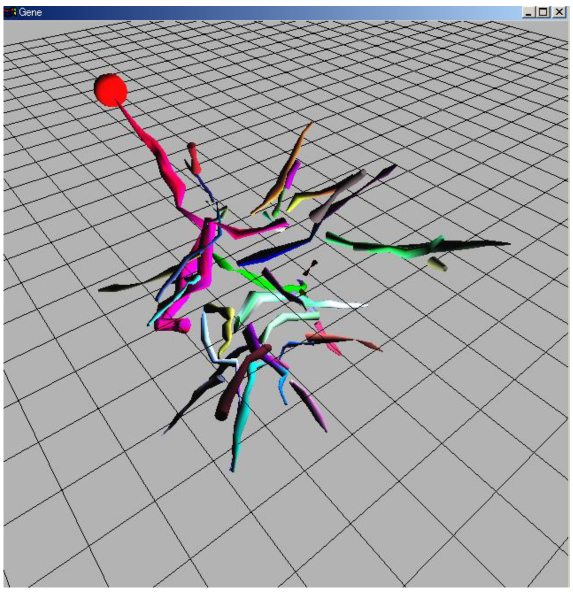

Fig.7, Creatures gravitate towards the mouse

5. Automatically generated Artwork

Various creatures generated each different shapes, colors and sounds of artworks when we giving the action of mouse, the creatures’ gravitations toward the mouse and re-generated by them. Many colors of creatures were generated when they meet each other and re-generated by crossover and mutation. As the same of each different velocity and the different volume of sounds were bee hearings on each different pitch real time. The creatures like as musician self-generated each different melody.

Anyway, this artwork running real time and the results of each shape using the smooth rendering can be seen in Figs. 8, and 9, below. The Fig.8 shows 50 prototypes' creatures generated the result of an interactive artwork. The Fig.9 shows another different result from each 100 prototypes' creatures gravitate toward different direction.

6 Conclusion and future works

In summary, a method for the creation of interactive computer artwork based on an evolutional model has been proposed. We employed genetic algorithms of the evolutionary model to automatically generate creatures, using the interactive action of the mouse. Through the presentation of this work, one can see that this method can be applied to the evolution of various shapes and colors and to each different sound. In the near future, we plan to include various harmonics, in accordance with music theory.

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Fig.8, 50 prototypes generated the result

Fig.9, 100 prototypes generated the result