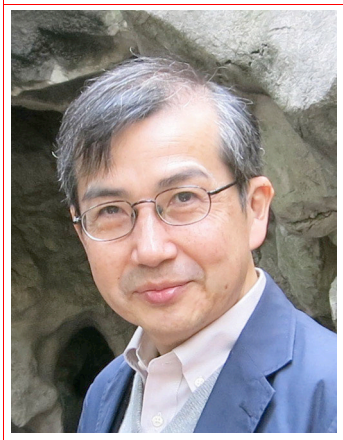
Tatsuo Unemi

Installation: **Non-stop Evolutionary Art You are Embedded in**



Topic: Interactive Installation

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Abstract:
In a similar mechanism as the huge variations of complex organisms appeared and disappeared on the earth through the evolutionary process for billions of years, it is possible to organize a process of non-stop development in the computer to produce unpredictable complex patterns, utilizing a technique of evolutionary computation. This visually interactive installation is one of the extended variations of author's previous work entitled *fully automated evolutionary art* [1]. It continuously produces abstract images and animations by a type of evolutionary computation based on a minimum gap of generational changes and combination of computational aesthetic measures as the fitness criteria. It was purely autonomous without any effect from the outside, the author extended it using Kinect® camera to embed the visitors' figure in the visual output. The information captured by the camera does not affect to the evolutionary process, but it changes the audio output because the process of sound synthesis is based on the features extracted from the visual output [2].
This is the shallowest connection between the production process and the action of visitors, but it's more enjoyable than the oneway effect where the visitors are just observing the production. And, it is the start point toward deeper interaction and mixture between the life in the machine and the life in the nature.

Example: Image visual output.

References:
[1] Tatsuo Unemi, "*A Fully Automated Evolutionary Art*", GA2012, Lucca, Italy, 2012
[2] Tatsuo Unemi, "*Synthesis of Sound Effects for Generative Animation*", GA2012, Lucca, Italy, 2012

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Non-stop Evolutionary Art You are Embedded in

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Premise

To extend an evolutionary art to be interactive with visitors, we introduced a mechanism to mix the visitor's image captured by the live camera and the image produced by the automated evolutionary process. This is the shallowest connection between the production process and the action of visitors, but it's more enjoyable than the one-way effect where the visitors are just observing the production. It is a start point toward deeper interaction and mixture between the life in the machine and the life in the nature.

1. Introduction

In a similar mechanism as the huge variations of complex organisms have appeared and disappeared on the earth through the evolutionary process for billions of years, it is possible to organize a process of non-stop development in the computer to produce unpredictable complex patterns, utilizing a technique of evolutionary computation. Evolutionary art is one of the generative approaches to produce interesting complex patterns inspired from the evolutionary process of natural organisms. The framework of Interactive Evolutionary Computing has been used by several number of artists and researchers in order to generate these kinds of patterns that fit with human's preferences, just similarly to the breeding process of ornamental plants and pet animals following a type of aesthetic criteria. This method is obviously based on a type of cooperative mechanism between man and machine, where a human is always taking a necessary role for creation.

On the other hand, owing to the recent improvement of image processing technology in both software and hardware, the automated production of similar type of patterns became possible. This visually interactive installation is one of the extended variations of author's previous work entitled fully automated evolutionary art [1]. It continuously produces abstract images and animations by a type of evolutionary computation based on a minimum gap of generational changes and combination of computational aesthetic measures as the fitness criteria. It was purely autonomous without any effect from the outside. We have received many times of comments from the visitors that it would be more interesting and playful if it could have a type of visual interaction with visitors. These comments should be agreed considering from our experience with flocking orchestra [2] and identity-SA [3] that are installations of visually interactive swarm utilizing a live camera and generating sounds. The visual feedback easily and effectively attracts the visitors of wide generations from the elementary school kids to elder persons if the response is quick enough. Even though the information captured by the camera does not affect to the evolutionary process, it is effective if it changes the result visuals. At the same time, the audio output is also affected because the process of sound synthesis is based on the features extracted from the visual output [4].

There are several types of possible methods to mix these two images. Our approach introduced here is relatively simple but effective enough to attract visitors.

2. Mixing Methods

SBArt is using functional expression as the genotype that maps a coordinate in the spatiotemporal space to a color value in the HSB (hue, saturation and brightness) color space. Each of the frame images of animation is rendered with *x* and *y* coordinates and the same value for the time variable *t* for each pixel. The visitor's real time image captured by the live camera is usually a distribution of color values in a two-dimensional lattice. There are several possible methods to combine the generated image and the captured image, but we need to design a method to make it easy for visitors to recognize both images in the display at same time. One of the easiest methods is to calculate the average color value between values extracted from corresponding position in the two images for each pixel, but it is uninteresting because mutual affection is too obvious. It is easy for visitors to separately recognize each of the original images as shown in Figure 1.

Another method to keep the color combination of the generated image is to shift the time value by the brightness, or another scalar measure, extracted from the captured image. Figure 2 shows a sample result image. This method provides an effective mixture of two different images in different features, the color distribution from generated image and shape from captured image. However, it doesn't seem suitable because the smooth gradation typically drawn in expression-based evolutionary art has gone from the result image due to a spatial noise in the background part of camera input.

To achieve the requirement that it should present both features of evolutionary art and recognizable visitors figure, we introduced a method to eliminate the effect of camera image from the part of background by extracting the part of visitor's body. It is not difficult by using a simple method to take a difference of pre-recorded background image and the current captured image, if the background of the installation environment is stable, that means nothing moving behind the visitors and no fluctuation happens at the lighting condition. To adapt to an unstable environment, we introduced a Kinect® camera instead of ordinary web camera to use depth, distance between a camera and an object, but not the brightness. Kinect® is a trademark owned by Microsoft Corporation®. Adjusting the threshold depth to distinguish the object and the background, it is easy to extract the visitor's figure from the captured image. Figure 3 shows a typical example of the result image processed by this method. Only the depth values shorter than the adjustable threshold value affect the mixing process with the generated image.

SBArt, itself, has two types of alternative modes to embed external images and movies, namely deformation and discoloration [5]. These methods are also available to introduce a type of interactivity by using camera image as the external one. However the disadvantage is difficulty on calculation of the fitness value for each candidate in the evolutionary process. Though the evaluation should be processed on the image mixed with the captured image, the selection must be done before displaying it to the visitor. Some minutes of delay between capture and display is unavoidable. Considering an expected staying time of visitors, the time delay should be shorter than ten seconds or so, to make them aware of the interactivity.

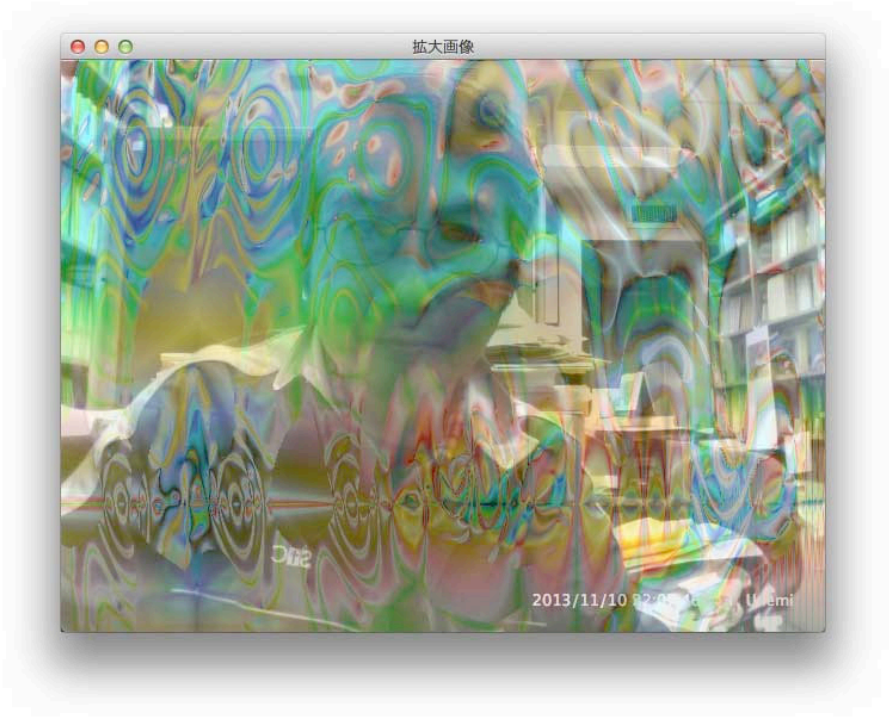

Figure 1. A simple mixture of generated image and captured image by taking the average color values for each pixel.

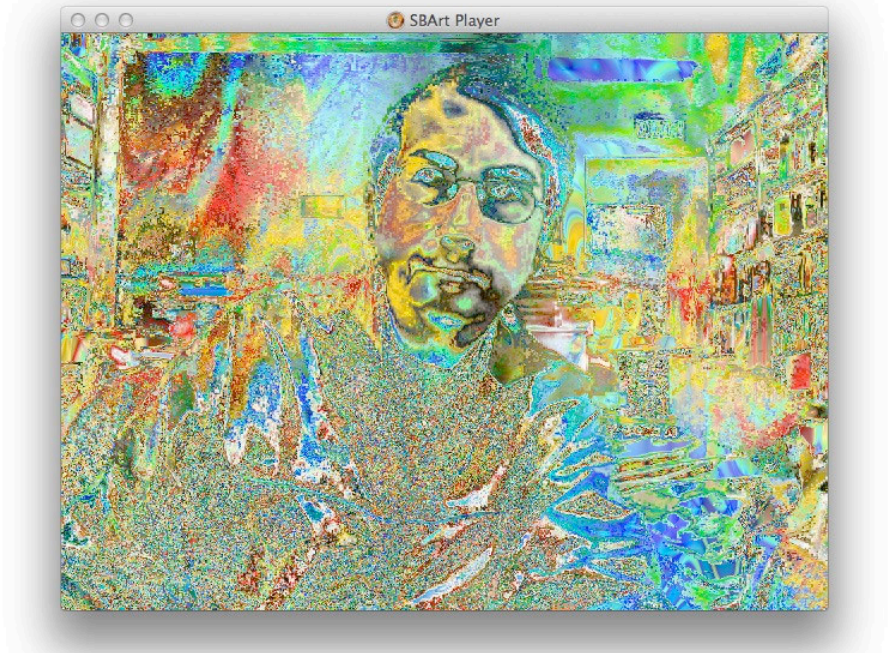

Figure 2. Shifting the value of time variable t by the brightness of captured image for each pixel.

Figure 3. Mixing visitor's figure with generated image using Kinect® camera.

3. Implementation

The latest version of SBArt is using compiled code of each genotype to render the image that enable to utilize hi-speed parallel processing by graphics processing unit. Owing to this extension, it achieved the real time rendering of smooth animation faster than 24 frames per second [6]. To continue to take this advantage, we designed a modification process of shader code in order to embed a captured image. A new argument was added to the main function of fragment shader to which the image sampler for the depth values is assigned, and a new code was inserted to modify the time value *t*. Figure 4 is an example of modification of shader code, where the extended parts are indicated in bold face with underlines. The depth values greater than the threshold value are replaced with zeros before it forms a sampler object from camera input.

Because this extension doesn't affect the evolutionary process but only in the rendering process for display, we implemented this functionality in the player module but not in the evolving side. Figure 5 illustrates the system configuration of computers, devices and software modules. The player module receives a source fragment of shader code from the evolution module, and then modifies it to be applicable to the mixing process described above. This module was extended to capture the distribution of depth values by Kinect® camera and feed the data in a form of sampler object to the compiled code.

The controller module for Kinect® is written in C language utilizing an open source software library named *freenect* by OpenKinect project [7].

Original code:

```
kernel vec4 individual01(float T, float width, float height){
  float t=T*-2.018997+0.769912;
```

```
  vec2 p=(destCoord()/vec2(height,height)*2.-vec2(width/height,1.))*...;
  vec3 v=((power(abs((-(vec3(t,p.x,p.y)))-(cnst(t,vec3(-0.375667,...
  ...
  return vec4(v,1.);
)
```

Modified code:

```
kernel vec4 individual01(float T, float width, float height, sampler cmr){
  vec4 C=sample(cmr,destCoord());
  float t=(T+(C.x+C.y+C.z)/3.-.5)*-2.018997+0.769912;
  vec2 p=(destCoord()/vec2(height,height)*2.-vec2(width/height,1.))*...;
  vec3 v=((power(abs((-(vec3(t,p.x,p.y)))-(cnst(t,vec3(-0.375667,...
  ...
  return vec4(v,1.);
)
```

Figure 4. An example of shader code modification.

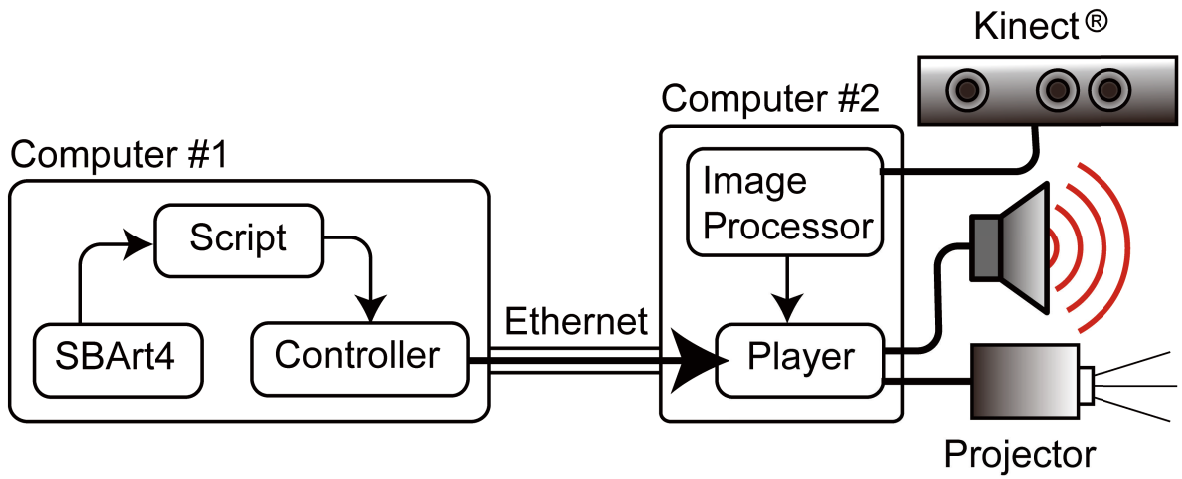

Figure 5. Configuration of computers, audio visual devices and software modules.

4. Concluding Remarks

We implemented a new functionality for visual interaction between a generative image and a captured image in the display module of *fully automated evolutionary art*. This is the shallowest connection between the production process and the action of visitors, but it's more enjoyable than the one-way effect where the visitors are just observing the production. There are a number of the other places into which we can introduce some type of interaction, such as selection of the set of functions for genotype, parameters in the evolutionary process, projection methods for final visuals, and so on. We hope the installation design described here will be one of the start points toward deeper interaction and mixture between the life in the machine and the life in the nature.

References

[1] Tatsuo Unemi, “SBArt4 for an Automatic Evolutionary Art,” Proceedings of the IEEE World Congress on Computational Intelligence (WCCI 2012 - IEEE CEC 2012), pp. 2014-2021, June 10-15, Brisbane, QLD, Australia, 2012.

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