Takao Kobayashi

Paper: **Contents creation system using pattern recognition technology**

Abstract:

We propose a contents creation scheme as algorithmic art and pattern recognition collaboration.

Generally, in the creation process of algorithmic art, computer programs, which are created by an artist, generate artworks randomly and automatically. Then, the artist judges whether each of them is truly an “artwork” or not. The judgment is considered to be a part of the artist's creation process, where he has to examine all of the artworks generated by the programs.

On the other hand, pattern recognition technology has been studied past several decades by numerous researchers of computer science, and today its achievements are applied in various fields such as face detection, object and scene recognition, ITS systems using camera, etc. Pattern recognition methods classify input images into suitable categories using their shapes, colors and even high level features. To realize a complete automatic art-creation system, we utilize the pattern recognition methods.

In this paper, a semi-automatic font creation system is shown, which is an experimental complete automatic art-creation system utilizing the pattern recognition methods. In fig.1, the module-1 creates images by some mathematical algorithms. It continues to output random images automatically. And the module-2 decides whether each of them is a readable font or not. This module-2 was generated by learning of a handwritten character recognition method. The experimental result shows that our system produce unexpected various shapes of fonts with a very little human operation. This idea will provide new creation scheme of contents and artworks.

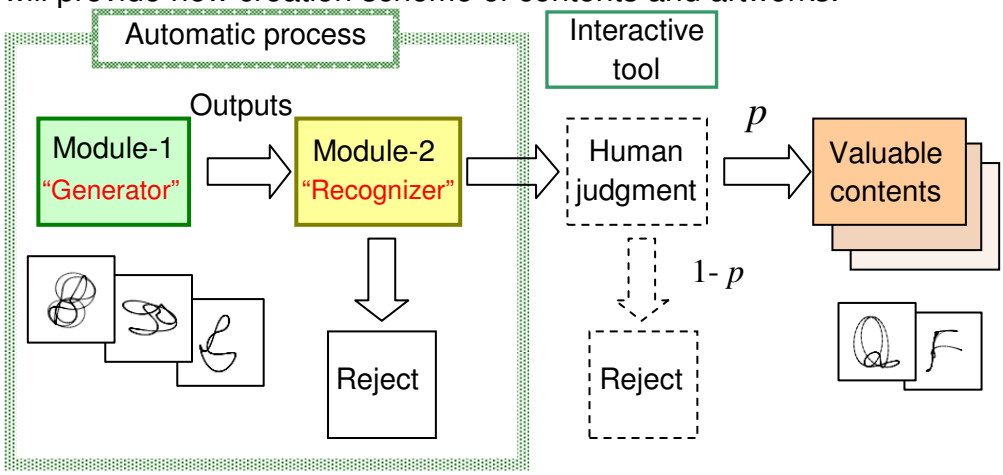

Fig. 1 Outline of semi-automatic contents creation system

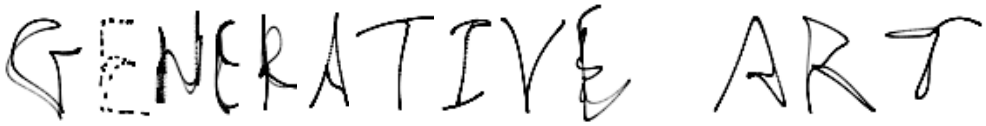

Fig. 2 Examples of fonts created by the system

Topic: Art

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Contents creation system using pattern recognition technology

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Abstract

Can the computer create artworks by itself? In this paper, we consider this question from the engineering standpoint. Through the consideration we propose a new methodology of creation of contents and artworks using pattern recognition technology.

1. Introduction

For the past several years, computer graphics technology has been significantly contributed to creation of visual arts. Particularly, the field of algorithmic art stands on its unique position in the art history because its creation process and texture of arts are far from those of the traditional paintings.

Generally, many people are apt to believe that algorithmic artists write computer codes only and if once these are written these codes automatically produce artworks. However, in fact artists always participate in a large part of their creation process very actively. In particular, the artist always judges whether each of the computer-generated images is truly an “artwork” or not using his/her own aesthetic sense.

By the way, when we think of relation between the computer and the art, a great question is raised:

Question A: Can the computer program create artworks by itself?

This question is extending in art, philosophy, and computer science and in spite of a lot of discussions for many years it is still unsolved. In this paper we shall consider this question from the engineering standpoint. Through this study we also propose a new methodology of creation of contents and artworks.

Discussions about creativities of algorithmic arts are seen in literature. We present two representative opinions from different standpoints. Nake claims that artists are creators of works only, whereas society may turn a work into a work of art [1]. On the other hand, Richie claims that the creativity of an individual is manifest in the artifacts they produce. He also states that he shall adopt the (possibly over-simplified)

assumption that the internal workings of a program are not part of the relevant data. [2][3]. In this study we adopt the latter.

2. Modeling of creation process in the algorithmic arts

To investigate what the computer program which creates artworks is, we firstly construct a model of the artists' creating process of the algorithmic arts.

Generally the creating process of the algorithmic arts consists of following components (see figure 1):

(1) Making ideas and translating them into programs.
(2) Selecting parameters of the program. Executing, controlling and halting the program.
(3) Evaluation of generated images.
(4) Feedback into the program and the parameters from the results of the evaluation.

Hence algorithmic artists are required of abilities of creating programs and aesthetic sense to judge the artistry of generated images[4]. Probably, the most important factor in creating artworks is the ability of creating the ideas of algorithms that will create marvelous artworks.

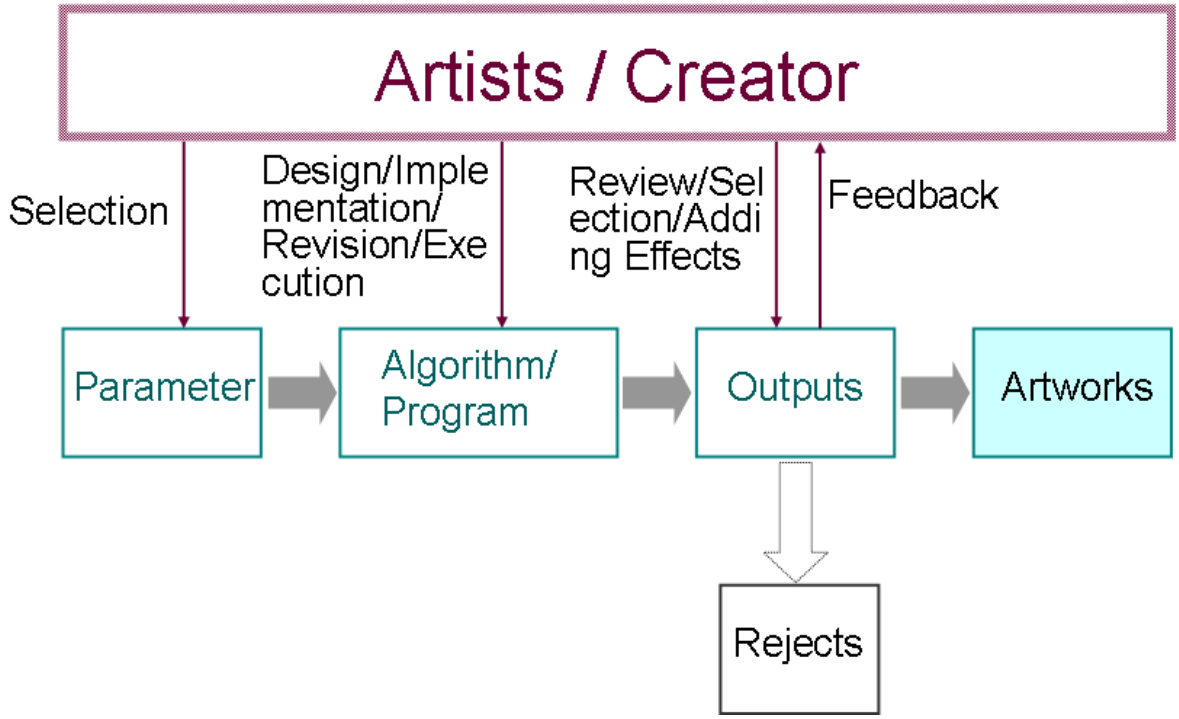

Fig.1. A Creation Model of Algorithmic arts

We here present a formulation for creating images of the algorithmic art.

Let $(u, v)=F(x)$ be a function and $\{x_n\}$ be a sequence. Then a two dimensional point set can be created.

$(u_n, v_n) = F(x_n), \quad n=1, 2, \ldots$

By drawing these dots on the image canvas, an image is generated. In case of the algorithmic arts, the function F is often very simple. For example, we use a simple quadratic function, which is called as logistic function:

$f(x) = 3.8x(1-x)+\varepsilon$, (ε : noise)

then

$x_n+1 = f(x_n)$

makes a sequence. Therefore d dimensional vectors are created as

$v_n = (x_n, x_n+1, \ldots, x_n+d-1)^t$, for $n=1,2, \ldots$.

and we use an arbitrary 3-by-d matrix A, then $\{v_n\}$ are projected onto 3 dimensional space.

$(u_n, v_n, w_n) = A(v_n - \mathrm{E}[v_n])$

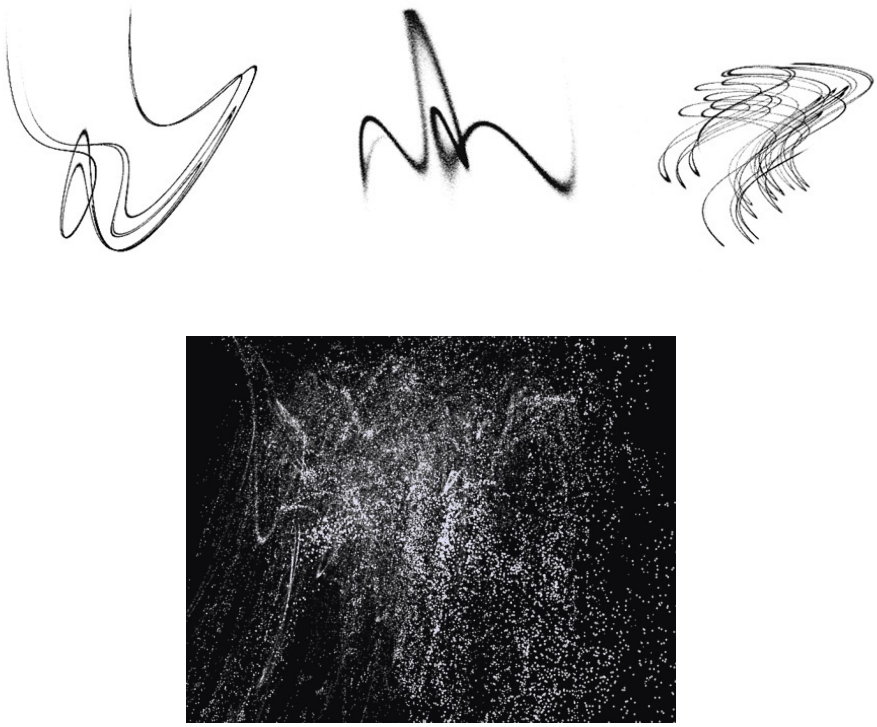

Fig. 2. Examples of generated images using the logistic function. (Below is a captured image from a movie we created)

Finally an image is generated by drawing projection of them on an image canvas. Figure 2 shows some examples of generated images. As shown here, even very simple mathematical algorithms can create quite interesting images (I have no idea if they can be artworks…)

3. Setting the challenge

We clarify the necessary conditions of the computer programs that satisfy the question A.

Lemma: if there exists the computer program that satisfies question A, the program does the unpredictable behavior and generates only artworks infinitely.

Proof: If the program outputs finite number of images only, its behavior is "deterministic." Namely, man can make the identical images by doing the same calculation as the program does. (In this case, he may use any drawing software or utility programs as a tool.) In other words, such a program simply simulates man's action and hence man can create these images without the program.

Next, if the program's behavior is predictable, even though the program generates infinite number of artworks, then man can create the same sequence of images by himself. Hence this case is not acceptable because the program which is created to do so by human is just simply simulates man's action.

In case the program generates both of artworks and non-artworks infinitely, man need to judge whether each of them is artwork or not. Hence it is not acceptable because man participate in creative process of artworks.

Consequently the program which generates artworks automatically must behave unpredictably and must also generate infinite number of artworks only. Q.E.D.

From this result we set up a new challenge as follows:

Challenge B: Construct a program which generates images infinitely in which artworks are included at the probability *p*.

Where *p* is expected close to 1.0 as well as we can. If *p* can reach 1.0, the question A will be solved in the affirmative. Further, we introduce the assumption that artworks belong to valuable contents for human. Consequently we set up a revised challenge as follows:

Challenge B': Construct a program which generates images infinitely in which valuable contents are included at the probability *p*.

Through tackling these challenges, the roadmap of creation of artworks by the computers will be revealed.

4. Semi-auto contents creation system

Based on the results of the previous chapter, we propose a semi-auto contents generation system as follows.

The system consists of the module-1 and 2 (see figure 3). The module-1 continues to generate images randomly using the methodology of the algorithmic art. The module-2 receives generated images from the module-1 and makes judgments on each of them, and then outputs ones which are judged to be "valuable", otherwise rejects. On the final stage man judges the output images of the system and rejects inappropriate ones. Thus we can accumulate valuable contents by using this system.

Note that the images automatically output by the system include proper contents at the probability *p*. Where *p* is depend on the ability of the module-2.

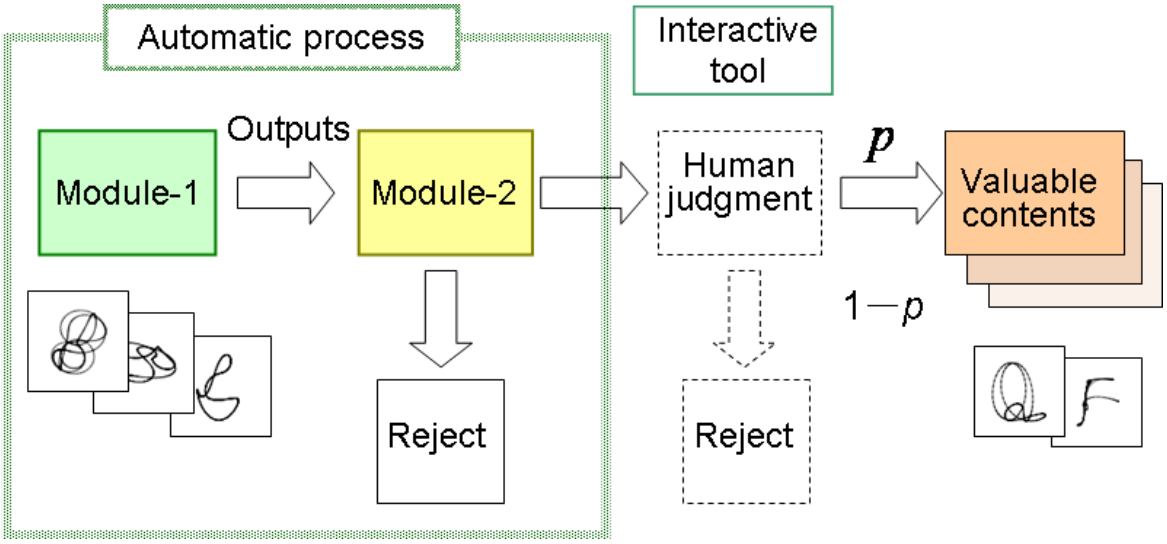

Fig. 3. Illustration of the semi-auto contents creation system

Because the module-2 guesses whether an image is appropriate or not using some criteria, furthermore, because it processes a large amount of images automatically, we emphasize that pattern recognition technology can be applicable to it.

The aim of pattern recognition is to simulate man's cognition which thinks that an object belongs to a suitable category. A classifier for recognizing patterns is created from a set of samples labeled with ground-truths on the basis of statistical learning theory. Leaning samples are collected from actual data and are tied to true categories by man's manual operations. Namely, the set of learning samples includes results of man's cognition and knowledge. Thus classifiers also have the human's knowledge about which category each pattern belongs to. Therefore the module-2 plays the same role of the artists in the point of finding out artworks or valuable contents in the computer-generated images.

In order to develop the system, we employ character recognition which is one of the most mature fields in pattern recognition.

Although many studies about the automatic font creation system have been proposed (for example [8]), our study completely differs in methodology. The past automatic font creation systems are realized that prototype fonts are prepared in advance and deformed by the deforming rules that are designed by human. However, to doing so is no better than adding some effects to paintings or arranging music into different styles. Does creativity exist there? Probably such systems will not create new kind of contents far from the prototypes.

On the other hand we try to utilize the abundant power of creativity of the algorithmic art for our methodology. Although the algorithmic arts generally make use of very simple mathematical algorithms, their ability of creating arts is more powerful than

man produces artworks directly. By introducing the idea of the algorithmic arts into our system, the system will be able to produce any images in the vast shape space which is free from the limit of man's imagination. In addition, by employing pattern recognition technology, worthless images will be rejected automatically, and only images which impress us will be output.

5. Implementation and Experiments of the system

In this study, we conduct character recognition of handwritten numerals and upper-case alphabets. We make use of the public character pattern database [5] for creating classifiers with applying the learning method we have developed [7].

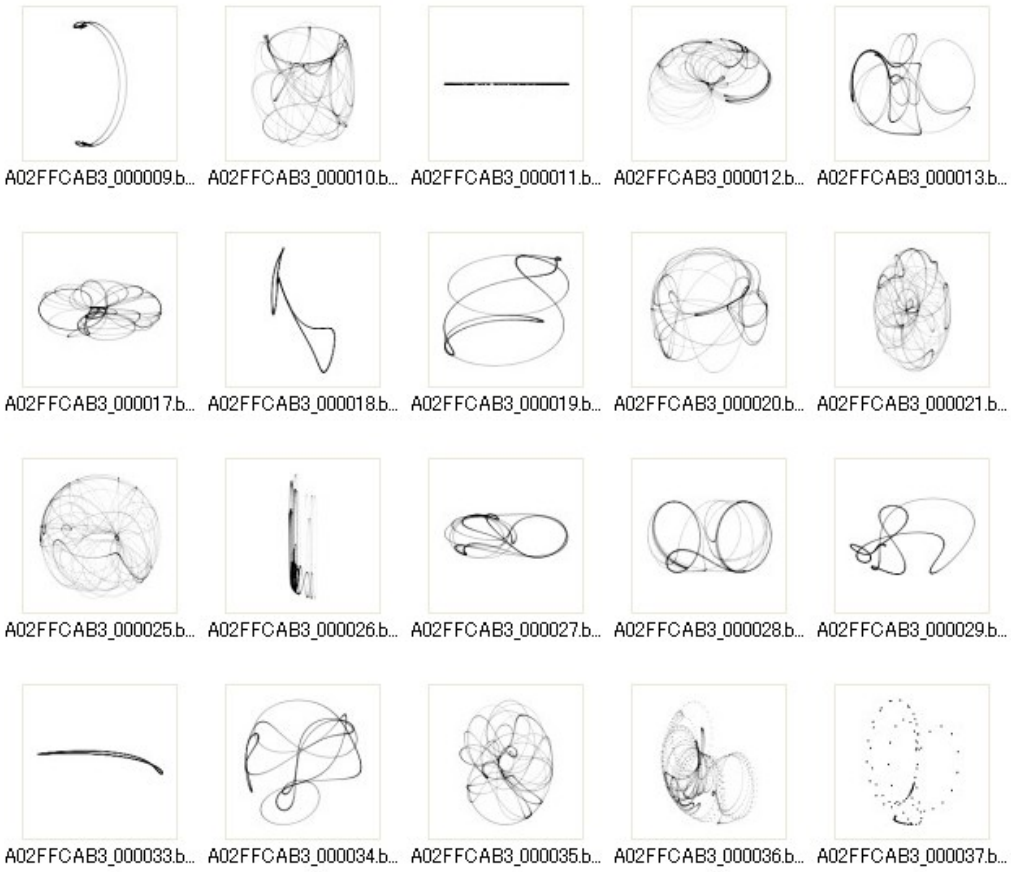

Fig. 4. Images generated by the algorithm we adopted in the system. Almost all of them are unaccountable and meaningless shapes.

The image generation algorithm we adopt in this study is formed by linear combination of trigonometric functions. We obtained this algorithm that has good properties after repeated try and error. Figure 4 shows examples of the randomly generated images by our generative algorithm.

We can specify following parameters of the system:

(1) An arbitrary string for the seed of random numbers.

(2) The number of images to generate in the module-1.
(3) Character codes of images to be output (alphabets, numerals, all, or specified character codes).
(4) Rejection level of the classifier.

In addition to generated images the system outputs generative functions and these parameters for each image. And they are saved to files of specified name.

We also developed a browsing and editing system in order to make judgment on output images by human at the final stage. Figure 5 shows its screen shots.

We conducted experimental operations of the system. Obtained insights are described below.

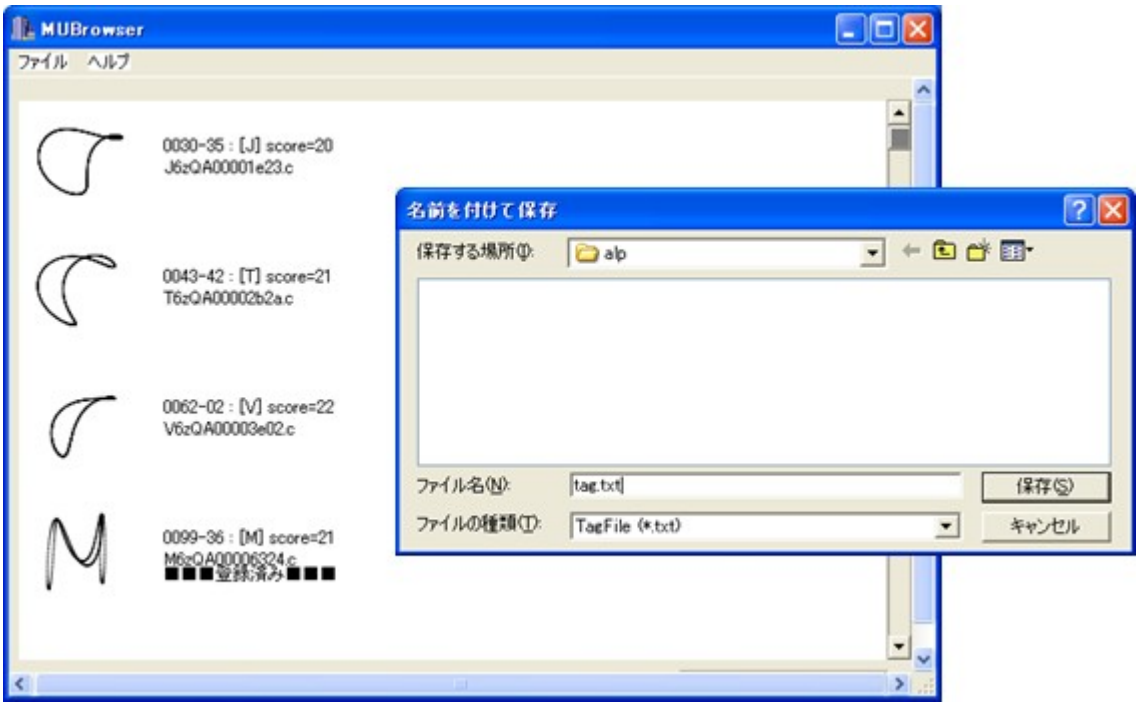

Fig. 5. The browsing and editing tool. Generated images, character codes and scores are displayed on it.

Table.1. Statistical data

Target character code	(A) The number of generated images	(B) The number of images accepted by the classifier	(C) The number of images accepted by human operator	Acceptance rate (C/B)	Time consumed by the system
A-Z	20,000	286	58	20.28%	42m
X	8,900,000	26	2	7.69%	213h50m
R	9,000,000	107	7	6.54%	216h16m
B	3,000,000	32	6	18.75%	71h56m

The system has not accomplished yet the ability of the complete automatic creation of valuable contents. Output images include such bad ones that human will not recognize them to be characters at all. We perceived the fact that even for character recognition, which is the most mature technology in pattern recognition fields, the “problem of complete rejection” is not solved sufficiently [6].

Table 1 shows examples of statistical data from the operation results. The results vary according to specified character codes and the rejection level of the classifier. The acceptance rates seem not so high. However, human operations are significantly reduced because only a small number out of a huge amount of images generated by the module-1 are needed to be checked. Therefore we emphasize that pattern recognition technology can aid the creation of valuable contents.

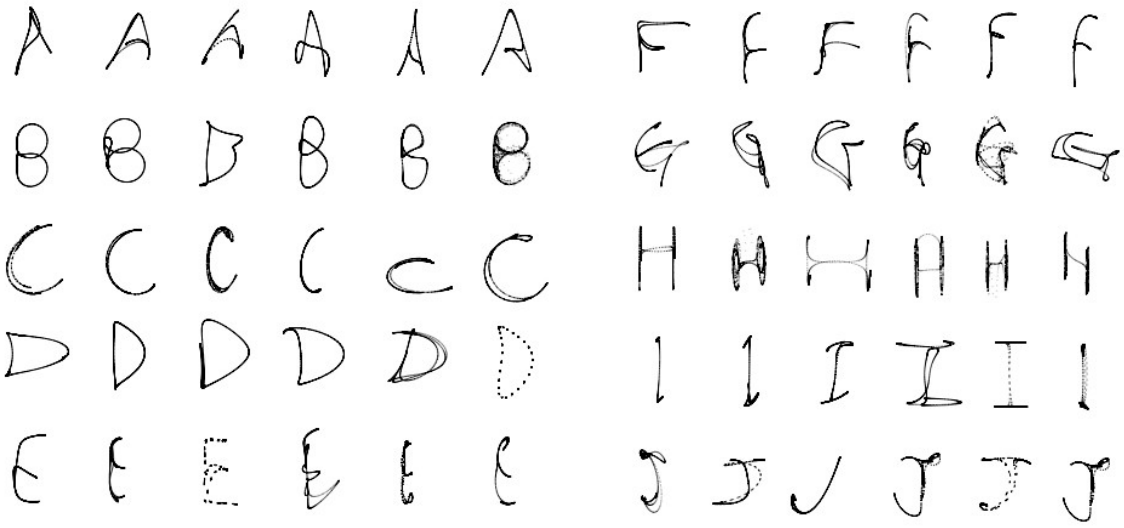

Fig. 6. Examples of fonts obtained by the system.

Figure 6 shows examples of fonts gained through the operations. There can be seen a great variety of character shapes, which are also very interesting. Needless to say, human can draw various shapes of fonts. To draw them, however, man need to imagine all of them previously, while our system generates various shapes of fonts automatically without human efforts. Thus we emphasize that in this study we have embodied a new scheme of contents generation method.

Figure 7 shows an example of drawing application of the contents. Each font data obtained by our system, which includes any shapes we once archived, can describe in about 70 bytes or less including the attributes of position, scale, rotation and color. Therefore the shown image can be described in about 1,300 bytes. While in case of TrueType fonts, in general, each character has a descriptor of more than 1,000 bytes excluding attributes of position, etc.

Fig. 7. An example of drawing application using the obtained fonts.

6. Conclusion

We proposed a new methodology of creation of contents through the consideration of the problem, “can the computer create artworks by itself?”

Also we developed a semi-automatic font generative system, conducted experimental operations, and evaluated the results.

The evolution of pattern recognition in recent years is so remarkable, that in the future our proposed methodology will produce many kinds of contents with very little human operations. Even if such technology will be realized, complete automatic creation of artworks still will not be realized easily.

However, it is important that researchers will clarify what computer can do or not and also materialize the possibilities of computer. In this study we obtained several new insights. It will contribute to computer science and art.

Acknowledgments

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