The Artwork Generating System of Escher-Like Positive and Negative Pattern Evolution

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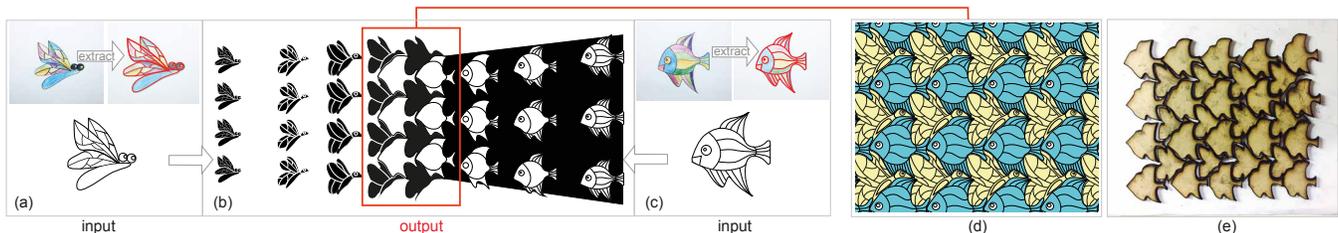Zhejiang University
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Figure 1: (a) and (c) The extraction of original patterns contour lines. (b) The generation of an "artwork" with positive and negative evolution. (d) and (e) Application of patterns' seamless connection.

ABSTRACT

Inspired by the composition characteristics of Escher's images, we noticed that regular mosaic patterns can be interconverted from background to foreground smoothly by gradually changing borders of mosaic shapes in a non-linear way. Based on this, we developed an interactive system to assist children in creating artworks of pattern evolution.

In this paper, taking the child's graffiti patterns as a source of inspiration, our system employed interactive GA (IGAs) to achieve the transformation and evolution of patterns as well as the positive and negative conjunction among any two or more patterns.Our developed system aims to not only help children complete the art creations for the transformation and conjunction of innovative positive and negative forms among patterns, but also inspire the development of their brain which is the original purpose of building the system.

CCS CONCEPTS

• **Computing methodologies** → **Graphics processors**; • **Human-centered computing** → *User interface programming*; • **Software and its engineering** → Software design techniques;

KEYWORDS

Escher, interactive system, children, artwork

1 INTRODUCTION

Escher,a print artist from Holland, was specialized in artistic creation through scientific analysis method who created a new visual language form. The ingenious combinations are presented that patterns change with "evolution-conjunction-segmentation" transformation style in his works. One or several types of shapes or tiles are collected in a tiling of the plane which is covered without any gaps and overlaps.

Inspired by the composition characteristics of Escher's images, we noticed that regular mosaic patterns can be interconverted from background to foreground smoothly by gradually changing borders of mosaic shapes in a non-linear way. Based on this, we developed an interactive system to assist children in creating artworks of pattern evolution (**Figure 1 (a),(b)and(c)**). A plenty of studies and computations have been made on the optimization of segmenting Escher's images. Hiroshi Koizumi proposes a new and efficient method for "Escherization", that is, for generating a tile which is close to a given shape and whose copies cover the plane without gaps or overlaps except at their boundaries [Koizumi and Sugihara 2011]. Satoshi has developed a system that can create figure shapes for Escher-like tiling patterns by Interactive Genetic Algorithms in cooperation with users [Ono et al. 2014]. However, the existing research for Escher patterns is limited to a single fixed form of deformation tiles.

In this paper, taking the child's graffiti patterns as a source of inspiration, our system employed interactive GA (IGAs) to achieve the transformation and evolution of patterns as well as the positive and negative conjunction among any two or more patterns.

2 SYSTEM SETUP

The contribution of our system lies in starting from the perspective of design thinking and utilizing digital computing technology. First, the image recognition technology is used to extract the line elements of the child's work after importing any two patterns into the system. Then our system will conduct to the process of "evolution-conjunction-segmentation" according to the extracted contour lines and corresponding computer algorithms. This step will automatically generate an "artwork"with positive and negative evolution which is similar to Escher's works. In addition, the user could also automatically adjust the series of evolution according to their own needs, including the color, quantity, density, size and other parameters of the patterns to construct the evolutionary positive and negative patterns with aesthetic value. The user interface as shown in **Figure 2**.

Our developed system aims to not only help children complete the art creations for the transformation and conjunction of innovative positive and negative forms among patterns, but also inspire the development of their brain which is the original purpose of building the system. In the meanwhile, the system can infinitely extend and fully pave any plane without gap or overlap through extracting the completely fit parts of two patterns, which could save a mass of materials and attract children's attention. The system is also significant for producing and manufacturing jigsaw puzzles (**Figure 1 (d) and (e)**).
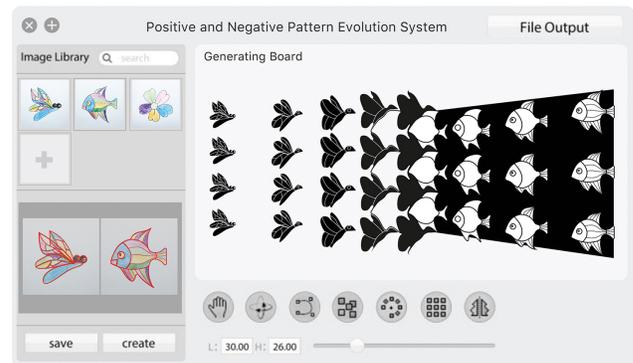
Figure 2: The user interface

3 FUTURE WORKS

In the next stage, we will continue to extend pattern principles to improve the identification accuracy and increase the quantity of patterns which are transformable mutually. We hope that our system could provide more opportunities for producing a large batch of molds to bring users more enjoyments in the future.

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