

# Research on the Design of Paper Cutting Patterns and Digital Preservation Strategy of Non-heritage Based on Deep Learning

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**Abstract:** With the continuous development of science, combining art and science has become a new means of conservation. This paper first analyzes the application of deep learning in the field of NRM conservation, and then implements paper cutting pattern design in three aspects: generating fractal patterns, network architecture design, and perceptual loss function. Finally, this paper proposes a strategy of digital conservation of paper cutting non-heritage based on deep learning by cultivating intelligent interpreters, constructing a paper cutting database, and reconstructing a paper cutting virtual field to develop ideas for designing paper cutting patterns as well as spreading, protecting, and passing on paper cutting non-heritage.

**Keywords:** Deep Learning; Paper Cutting Pattern Design; Digital Preservation of Non-heritage

Paper cutting is a folk art with a long history and wide circulation, fully embodying the essence of China's traditional culture. Yuxian paper cutting was included in the first batch of national intangible cultural heritage lists in May 2006. It is the representative of paper cutting culture in China. With its unique style, Yuxian paper cutting has created a unique folk paper cutting new school, which enjoys a high reputation at home and abroad. Due to the special inheritance space and relatively closed cultural space of paper cutting intangible cultural heritage, its protection and inheritance are extremely urgent. With the development of science, using modern new technology to protect art and science has become a new means. It can not only change the existing form and communication mode of intangible cultural heritage, but also enable more social audiences to contact and experience paper cutting intangible cultural heritage in a new way, so as to improve the social recognition of paper cutting culture. Based on this, the research on paper cutting pattern design and digital protection strategy based on deep learning technology in this paper will help to develop paper cutting pattern design ideas and protect, spread, protect and inherit intangible cultural heritage art.

## 1. Application of in-depth learning in the field of Paper Cutting intangible cultural heritage design and protection

The paper cutting intangible cultural heritage was created and developed on the basis of agricultural civilization. Due to the special inheritance space and relatively closed cultural space of paper cutting intangible cultural heritage, its protection and inheritance are extremely urgent. Deep learning is a new research direction in the field of machine learning. Its purpose is to achieve high artificial intelligence. The application of deep learning in the field of intangible cultural heritage design and protection is the application of original AI technology. In the protection of intangible cultural heritage, with the development of science, art and science have become a means of protection by using modern new technology. With the help of new technology, the existing form and communication mode of intangible cultural heritage can be changed, such as intangible cultural heritage databases, intangible cultural heritage websites, etc. In terms of the protection of paper cutting intangible cultural heritage, the way of in-depth learning is used to enable agents and intelligent systems to reconstruct the existence form and communication mode of paper cutting intangible cultural heritage through different technical forms, enrich paper cutting communication forms, improve paper cutting communication efficiency, and thus improve the social popularity and influence of paper cutting intangible cultural heritage. In the aspect of paper cutting intangible cultural heritage design inheritance, more social audiences can contact and experience paper cutting intangible cultural heritage in a new way through in-depth learning of artificial intelligence, stimulate the public's cognitive enthusiasm for paper cutting intangible cultural

heritage, and then provide basic talents for paper cutting intangible cultural heritage inheritance [1].

## 2. Paper Cutting Pattern Design based on Deep Learning

The creative paper cutting pattern is designed by using the generation of fractal graph and deep learning network structure calculation, and the perceptual loss function is used to ensure that the details of the creative paper cutting pattern are not lost in the generation process. The science and paper cutting art are integrated to further develop the design idea of paper cutting pattern and add new elements to the paper cutting pattern design.

### 2.1 Generation of Fractal Graph

The birth of fractal graph originates from the monograph of mathematician Mandelbrot on fractal geometry. Through Tensorflow (in line with the digital system), the fractal graph is programmed and designed, and then the boring data is transformed into gorgeous graphics through program code, realizing the visualization of program code. The generation principle of fractal graph is relatively complex, which also determines that it has extremely fine structure and is not easy to copy the attribute characteristics. Fractal graphs can effectively integrate science and technology with paper cutting art. In the process of production, fractal graphs can form regular flat graphics. Various beautiful and rich graphics can achieve very creative, deep and realm design, which opens up new ideas for paper cutting, a traditional cultural pattern design. Use the fractal pattern generated by Tensorflow, and design the ideal figure or pattern through programming to provide basic materials for paper cutting pattern design[2].

### 2.2 Network Structure Composition

Through in-depth learning of the network structure, we can design very creative patterns, apply it to paper cutting pattern design, and add new elements to paper cutting pattern design. Its network structure is mainly composed of image conversion network  $f_w$  and convolution neural network model (as shown in Figure 1). In the image conversion network  $f_w$ ,  $w$  is the optimal weight of all neurons in  $f_w$ ; The convolutional neural network model is developed by oxford university, and the loss network  $\varphi$  is used to calculate the loss function. The neural network can effectively express the human visual perception of images and help paper cutting pattern design. The specific calculation process is as follows: By defining  $y = f_w(x)$ , fractal graphs  $x$  can generate creative paper cutting pattern  $y$  through the calculation of transformation network  $f_w$ . The solution process of  $f_w$  can be converted by using equation (1) to obtain the optimal solution, and  $\lambda_i$  is the weight proportion of each loss function  $l_i$ .

$$W^* = \arg \min_{x, \{y_i\}} \left[ \sum_{i=1} \lambda_i l_i(f_w(x), y_i) \right] \quad (1)$$

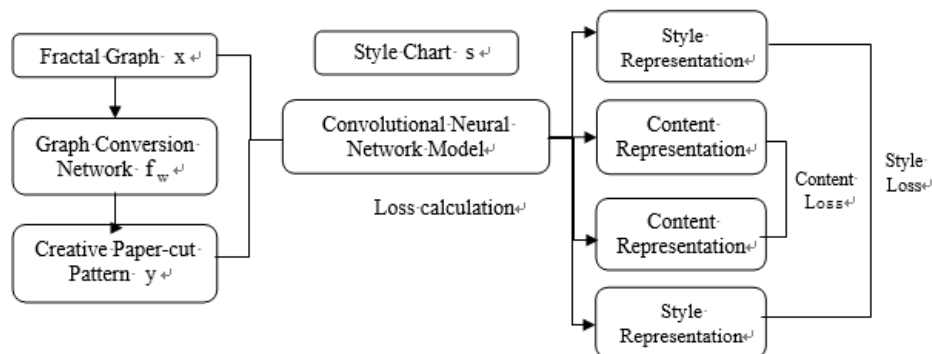


Figure 1: Deep Learning Network Structure

### 2.3 Perceptual Loss Function

Fractal patterns are usually presented in solid colors and cannot be stylized directly. Because this will cause the edges and boundaries of the fractal pattern to become blurred and uneven. Therefore, in order to ensure that the paper cutting pattern design effect is more prominent, the perception loss function is used to ensure that the fractal image keeps its own details during the generation process [3]. Firstly, the semantic segmentation of fractal graph is carried out to ensure the content processing in the optimization process; secondly, a local affine transformation is established between the fractal pattern and the final paper cutting pattern. Through this series of operations, the goal of ensuring pattern details is achieved, and finally the paper cutting pattern design based on depth learning is completed (as shown in Figure 2).



Figure 2: Creative paper cutting pattern design based on deep learning

## 3. Digital Protection Strategy of Intangible Cultural Heritage of Paper Cutting based on Deep Learning

The use of deep learning technology can further play the role of agents or intelligent systems in the protection of paper cutting intangible cultural heritage. Artificial intelligence has powerful memory and storage advantages. It can not only build paper cutting intangible cultural heritage databases based on big data and the Internet. It can also rely on relevant technologies to achieve human-computer interaction, train intelligent interpreters, rebuild intangible cultural heritage virtual scenes and other functions, and effectively promote the protection of paper cutting intangible cultural heritage.

### 3.1 Build a Paper Cutting Database through in-depth Learning to Protect Paper Cutting Art

Through in-depth learning, AI has strong memory and storage advantages. It digitally converts and stores paper cutting art, and combines big data, the Internet and other related technologies to build a paper cutting intangible heritage database. Through digital information acquisition and processing by artificial intelligence, effectively collect paper cutting related information and data; For example, the information of paper cutting art form (basic elements of paper cutting, paper cutting symbols, paper cutting patterns, etc.), operation process, classic works, inheritors of current paper cutting representatives, etc. are sorted, converted and stored digitally through artificial intelligence, and transformed into different storage forms and formats such as text, images, sounds, videos, etc., to further protect paper cutting intangible cultural heritage art. At the same time, the paper cutting database built through in-depth learning can also be viewed by people through computers and networks at any time, so that people can clearly and comprehensively feel the charm of paper cutting art [4].

### 3.2 Cultivate Intelligent Interpreters and Spread Paper Cutting Culture through in-depth Learning

From the perspective of the public, the masses do not have much understanding and contact with paper cutting, an intangible cultural heritage. Through in-depth learning, we can train intelligent interpreters of paper cutting intangible cultural heritage and further spread paper cutting culture. The intelligent chat machine has the ability to understand the natural language through in-depth learning, and the use of big data and other related technologies can enable the intelligent chat machine to provide the required paper cutting intangible heritage materials or information for different groups. At the same time, the AI machine using deep learning can also provide personalized learning experience for the demander. When the demander needs to know information or materials, let the AI machine answer relevant knowledge according to its own understanding, and further enhance the spread of paper cutting intangible cultural heritage. In addition, through in-depth learning, we can also train intelligent interpreters of paper cutting intangible cultural heritage, let intelligent machines play the role of inheritors of paper cutting intangible cultural heritage, and help protect and inherit paper cutting intangible cultural heritage [5].

### 3.3 Reconstruction of Paper Cutting Virtual Field through in-depth Learning and Inheritance of Paper Cutting Technology

Under the environment of traditional transmission and inheritance, paper cutting, an intangible cultural heritage, is mainly passed on through a special inheritance space and a relatively closed cultural space. Nowadays, with the rapid development of computer technology and the birth of artificial intelligence technology, it has changed the single mode of publicity, communication and inheritance of paper cutting traditional media, effectively broken the media restrictions between the subject of communication and the object of acceptance, and promoted the two-way communication between paper cutting intangible cultural heritage and modern people. Rebuild the paper cutting virtual field through in-depth learning technology, so that more people can experience the paper cutting production process through the paper cutting virtual field. It can not only let more people understand the history, moral, techniques and other knowledge of paper cutting more intuitively and vividly, but also further explore outstanding paper cutting talents and guide paper cutting enthusiasts to scientifically and effectively understand and master paper cutting related knowledge.

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