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Style Consistent Calligraphy Tablet Design

Abstract. *A style-consistent calligraphy tablet designing approach is proposed in this paper. The layout of the tablet is calculated firstly. The calligraphy characters are retrieved from the ones written by the specific calligrapher, while the style-consistency calligraphy character synthesis approach is applied to synthesize the non-existent ones. Finally, these characters are adjusted so that their styles are unified to be put on the calligraphy tablet according to the layout. The experiments show that the proposed approach can produce aesthetic calligraphy tablet.*

Streszczenie. *W artykule zaproponowano metodę projektowania tabliczek z kaligrafią, mający na celu ułatwienie i ujednolicenie produkcji. Zastosowany algorytm działania oparty został na bazie odniesienia znaków, przez co tworzone napisy mają jednorodny styl, co przekłada się na ich estetykę. (**Projektowanie tabliczek z kaligrafią o jednorodnym stylu**).*

Keywords: Style-Consistency, Calligraphy Tablet Design, Style Evaluation Model (SEM)
Słowa kluczowe: jednorodność stylu, projektowanie tabliczek z kaligrafią, model określania stylu.

Introduction

Chinese calligraphy is among the finest and most important of all Chinese art forms and an inseparable part of Chinese history. Its delicate aesthetic effects are generally considered to be unique among all calligraphy arts. Numerous collections of historical Chinese calligraphy works are valuable parts of Chinese cultural heritage. In the China-America Digital Academic Library (CADAL)[1], lots of famous ancient calligraphy works are digitized. Tens of thousands of calligraphy characters written by ancient famous calligraphists are segmented and annotated. Strassmann presented a 2-D virtual brush model [2]. Some years later, a 3-D virtual brush model was proposed [3]. It described a suite of models which can generate a calligraphic character when all the parameters in the model were assigned. A series of ellipses were used to simulate the calligraphic characters and an ink depositing model was also proposed. Wong [4-6] proposed some approaches to extract the parameters of virtual brush model from a calligraphic character and they also gave some examples of reproducing the calligraphic characters with the virtual brush model using the parameters extracted. There are only a few image based methods to synthesize calligraphy characters. A system to synthesize Chinese calligraphy in the style Cao was proposed in 2005 [7]. It can reproduce typical stroke forms in style of font Cao. A style-consistency calligraphy character synthesis system is presented in 2009 [8], which can produce new calligraphy characters in a specific style. A novel approach will be proposed to generate a calligraphy tablet in a specific style. The layout of the tablet is calculated firstly according to the size of the tablet and the number of characters. Then the calligraphy characters are retrieved from the database which contains all calligraphy character written by the specific calligrapher. A style-consistency calligraphy character synthesis approach is used to synthesize the missing characters. After that, the styles of all calligraphy characters both retrieved from the database and synthesized are unified, and they are put together to form the calligraphy tablet. A calligraphy tablet design system is implemented using the presented approach. The experiments show that the system is very effective. The architecture of the system proposed in this paper is shown in Fig. 1.

Style-Consistency Calligraphy Character Synthesis

A former version of style-consistency calligraphy character synthesis approach is proposed in 2009 **[8]**. Some improvements are presented in this paper.

The whole process of style-consistency calligraphy character synthesis is shown in Fig. 2.

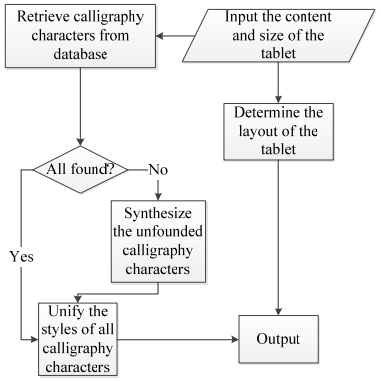

Fig. 1. The architecture of style-consistency calligraphy tablet generation system

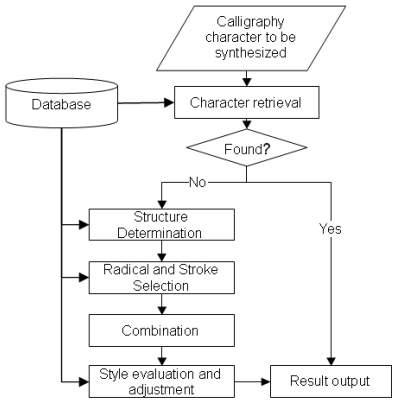

Fig. 1. Process of style-consistency calligraphy character synthesis

The calligraphy characters written by some certain calligraphers are segmented from the digitized calligraphy works in CADAL. These calligraphy characters are annotated and their fonts are all tagged.

A database is built to store the calligraphy characters written by the specific calligrapher and the ones synthesized before. Firstly, the input character is retrieved from this database. If it exists, it will be returned as the candidate one. Otherwise, the structure of the nonexistent character will be determined, and the virtual radicals and strokes are calculated. Compared with actual radicals and strokes, the virtual radicals and virtual strokes only contain the radical or stroke type, the relative sizes and relative positions, but do not contain the actual shapes. The candidate radicals and strokes are then retrieved from the

database. The most proper one for each radical or stroke is selected, and they are put together according to the sizes and positions of the virtual radicals and virtual strokes. Finally, a style evaluation model (SEM) is used to verify and adjust the calligraphy character synthesized. There are three levels in our hierarchical representation of Chinese characters, which are characters, radicals and strokes from top to bottom. Most of the radicals and strokes are common components in different calligraphy characters. These radicals and strokes are extracted and stored. They will be used as the components of the new calligraphy character. The positions and sizes of all radicals and strokes decide the structure of the character. Therefore, the virtual radicals and virtual strokes are used to represent the structure. The radicals and strokes, which are the components of the calligraphy character to be synthesized, are retrieved from the database. The most proper ones, whose relative positions and relative sizes in the original calligraphy characters are the most similar to the virtual radicals and virtual strokes, are selected. The selected radicals and strokes are simply put together at the positions and sizes defined in the corresponding virtual radicals and virtual strokes. However, the thicknesses of the radicals and strokes chosen from different calligraphy characters may be very different due to the various thicknesses of the strokes and radicals in different calligraphic characters. When thinning the stroke, two times erosion operations and one time dilation operation are used in a round to avoid deformations of the stroke. Conversely, when thickening the stroke, two times dilation operations and one time erosion operation are used. The style evaluation model (SEM) is a collection of the calligraphy character style features. An SEM is built for each calligrapher to improve the quality of the synthesized calligraphy characters. It contains the average height-width proportion of the calligraphy characters, the average stroke width, as well as the general position and size of each radical or stroke. When the calligraphy character is generated, whether these features are about the same to the SEM will be checked. If there's slice difference, the generated calligraphy character will be adjusted to fit the SEM. If the generated calligraphy character failed to pass the verification, which is very different from the features in the SEM, the radicals and strokes needed to be selected again.

Style-Consistency Calligraphy Tablet Design

When designing a calligraphy tablet, the layout, which is the positions and sizes of each calligraphy character, is very important because it will seriously influence the delicate aesthetic effects. More than 100 famous calligraphy works are studied, and their layouts are analysed. According to the statistical result, an average layout is calculated, including the proportion between the area of calligraphy characters and white space on the work, the relative size of calligraphy characters, etc. The average layout is used as the layout of the calligraphy tablet designed. At the same time, the background of calligraphy tablet is considered, too. In calligraphy tablets, the background can be light colour or dark colour. Thus, the colour of calligraphy characters will be dark or light respectively. In our system, the background colour is white or black and, and the character colour is black or white respectively. With the layout and the calligraphy characters contained in the tablet, we can just put these characters on the suitable positions to form the tablet. However, the calligraphy characters from different works and the ones synthesized may be very different in size. When they are scaled to the size decided by the layout, the stroke widths are varied, too. Thus, the stroke widths need to be unified again with mathematic morphology.

Conclusion

This paper proposes an approach to automatically design style consistent calligraphy tablet with computer system. The layout of the tablet is designed firstly. The calligraphy characters in the tablet are retrieved from the database. The nonexistent ones are synthesized with the style-consistency calligraphy character synthesis method. The sizes and positions are adjusted for all calligraphy characters. Finally, the result tablet is output. The experiments show that the proposed approach can design aesthetic calligraphy tablet in the specific style.

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