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Visual knowledge guided intelligent generation of Chinese seal carving

Key words: Seal-carving; Intelligent generation; Deep learning; Parametric modeling; Computational art

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Motivation

1. Seal carving is the art of engraving Chinese characters on seals, and it has an about 3000-year history. Exploring the intelligent generation of seal-carving art could improve the efficiency and quality of seal-carving art creation and assist in reviving this ancient art form.
2. The intelligent generation of seal-carving art is complex and challenging, requiring multiple disciplines across computer science, such as data science, computer vision, computer graphics, and human-computer interaction.
3. Visual knowledge and deep learning methods show great potential in art generation.

Main idea

1. Seal-carving datasets are required to obtain the knowledge.
2. Seal characters need to be generated at first, and the visual knowledge and deep learning can be helpful.
3. The layout of seal characters should be learned from the seals.
4. To design a system for users to obtain their customized seals, we should use interactive methods.

Method

1. The knowledge base in this study is the Qiushi Seal-Carving Database, which consists of open datasets of images of seal characters and seal stamps.
2. We propose a seal character generation method based on visual knowledge, guided by the database and expertise.
3. To create the layout of the seal, we propose a deformation algorithm to adjust the seal characters and calculate layout parameters from the database and knowledge to achieve an intelligent structure.

Method (Cont'd)

Visual knowledge guided intelligent generation of seal carving

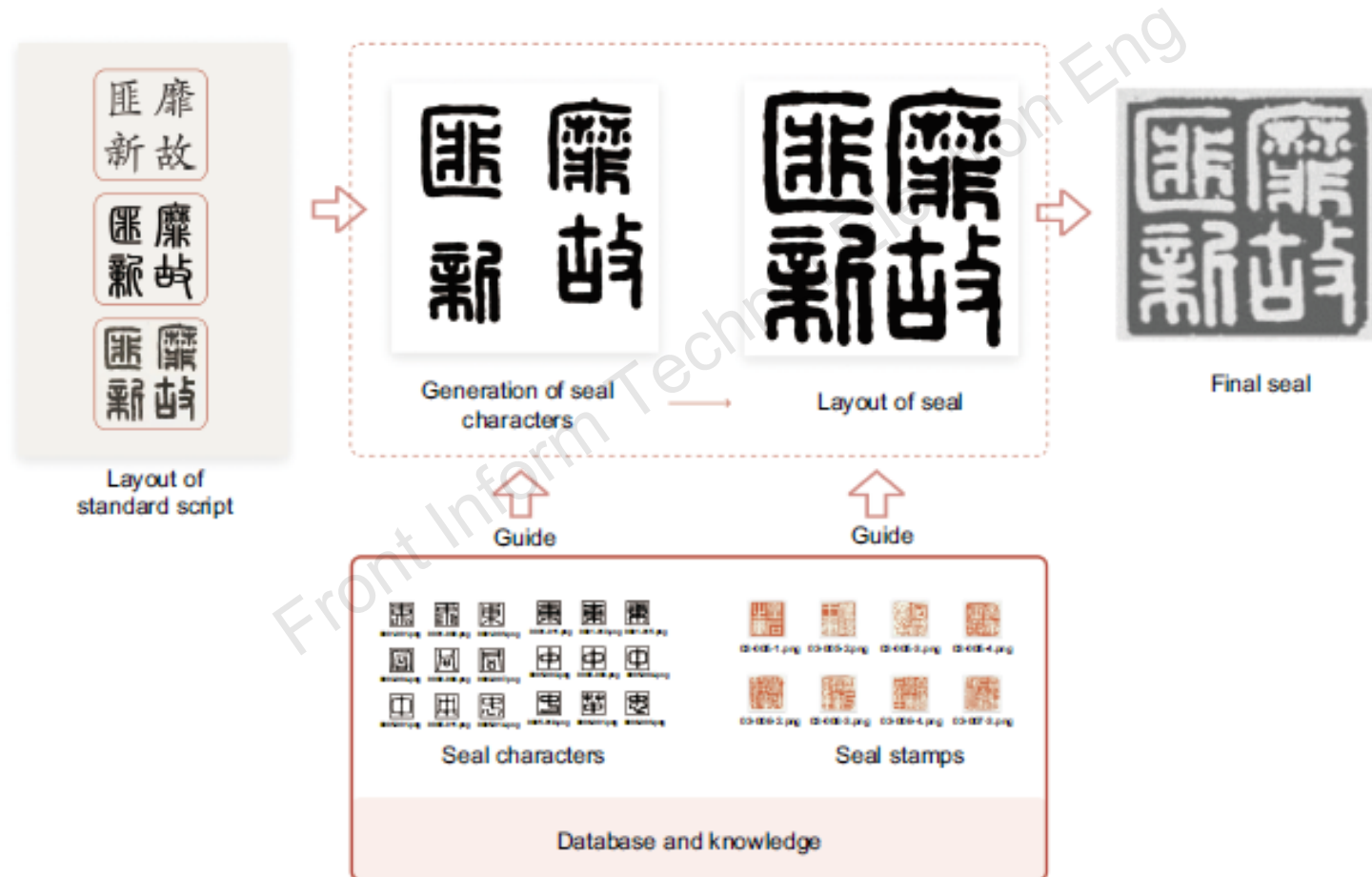


Fig. 1 Flowchart of intelligent generation of Chinese seal carving

Major results



Fig. 9 Experiment results (GAN: generative adversarial network)

Major results (Cont'd)

Table 2 Descriptive statistics

Experiment	Seals	Aesthetic harmony	Visual balance	Texture roughness	Stroke spacing	Stroke uniformity	Variation of strokes	Space distribution	Overall aesthetics
I	GAN	2.574	2.746	2.850	2.358	2.366			2.459
	Ours	5.520	5.448	5.057	5.480	5.326			5.548
	True seals	4.986	5.086	4.642	4.957	4.953			5.022
II	GAN	4.150	3.978	4.383	4.006	3.983	4.011	3.922	4.000
	Ours	5.106	5.161	4.933	5.372	5.417	5.072	5.067	5.461
	True seals	5.117	5.250	4.983	5.267	5.267	5.044	5.028	5.267

Table 3 ANOVA analysis results

Experiment	Aesthetic harmony	Visual balance	Texture roughness	Stroke spacing	Stroke uniformity	Variation of strokes	Space distribution	Overall aesthetics
I	687.464*	600.434*	214.835*	686.366*	533.84*			749.338*
II	31.533*	90.802*	9.336*	75.105*	71.685*	77.405*	38.356*	43.332*

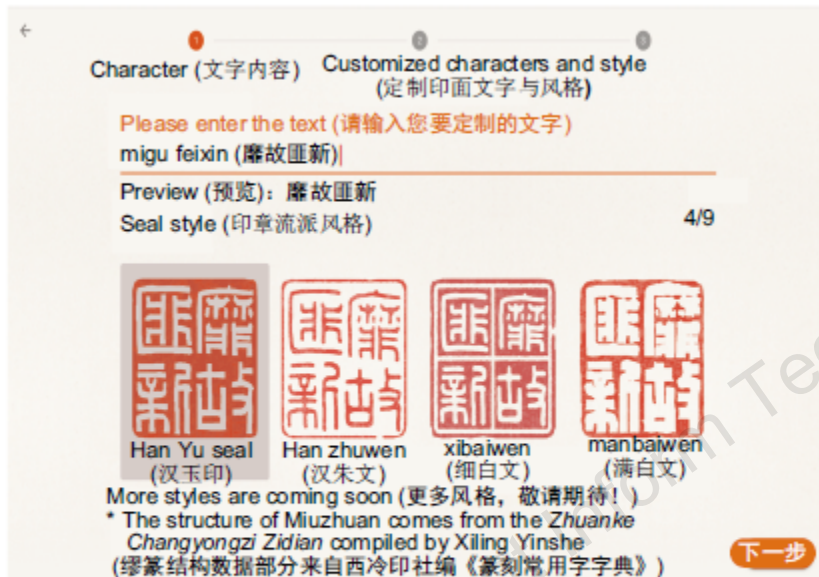
* $p < 0.001$

Table 4 Multiple comparisons

Experiment	Seals	Aesthetic harmony	Visual balance	Texture roughness	Stroke spacing	Stroke uniformity	Variation of strokes	Space distribution	Overall aesthetics
I	Ours-GAN	2.946**	2.706**	2.208**	3.122**	2.961**			3.090**
	Ours-true seals	0.534**	0.362*	0.416*	0.523**	0.372*			0.527**
II	Ours-GAN	0.956**	1.183**	0.550**	1.367**	1.433**	1.061**	1.144**	1.461**
	Ours-true seals	-0.011	-0.089	-0.050	0.106	0.150	0.028	0.039	0.194

* $p < 0.01$; ** $p < 0.001$

Major results (Cont'd)



(a)



(b)

Fig. 10 Integrated intelligent system for seal-carving art generation: (a) the first step, customizing the seal characters and style; (b) the second step, adjusting the seal interactively

Conclusions

In this paper we proposed a pipeline for the intelligent generation of Chinese seal carving guided by visual knowledge. First, we constructed the Qiushi Seal-Carving Database, including the seal character dataset and seal stamp dataset. Then we proposed a generation method for seal characters. With the help of the layout knowledge and deformation algorithm, we achieved an intelligent layout. Finally, a layout of a standard seal script can become a usable seal after the generation of seal characters and layout.