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INTELLIGENT ELEMENT LAYOUT ALGORITHM OF CERAMIC DESIGN DRAWING BASED ON GENETIC ALGORITHM

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Abstract. Conventional intelligent layout algorithm of ceramic design drawing elements mainly uses density distribution method to obtain ceramic design drawing element units, which is vulnerable to the influence of pattern density, resulting in a low distribution balance of design drawing elements. Therefore, a new intelligent layout algorithm for ceramic design drawing elements needs to be designed based on a genetic algorithm. That is, combining the characteristics of ceramic design drawing elements, the intelligent parting structure of ceramic design drawing elements is constructed, and then the brilliant layout model of ceramic design drawing elements is designed using genetic algorithm. The experimental results show that the developed intelligent layout algorithm of ceramic design elements has a high distribution balance, which proves that the designed intelligent layout algorithm of ceramic design elements has good performance, reliability, and certain application value, and has made specific contributions to improving the aesthetic quality of ceramic design drawings.

Key words: Genetic algorithm; Ceramics; Design chart; Element; Intelligence; Layout diagram

1. Introduction. Ceramics is a typical handicraft mainly composed of pottery and porcelain. Ceramic has a long history in China and is also one of the essential representatives of Chinese art [7]. As early as the Neolithic Age, China began to study the style of ceramic display and try to combine the pattern elements contained in it. By the Ming and Qing Dynasties [12], China's ceramic production technology was perfect and various patterns were lifelike. In recent years, the living standard of our country has gradually improved, and the selection of ceramics is not only focused on its use [9], but also the graphic element composition (aesthetic visual characteristics) of its appearance has become the main consideration for people to select ceramics.

The research shows that ceramics show strong irregularity [26] due to its special structure, so when designing patterns, they pay special attention to the intelligent layout and balance elements of graphic elements. To improve the layout balance of graphic elements, intelligent design [18] must be carried out in combination with the original structural characteristics of ceramics, to combine the practicality and appearance of ceramics organically. The early layout method of graphic elements originated from natural factors. People often carry out artistic visual design [10] on ceramics according to the unique perception of nature to improve the comprehensive aesthetic sense of ceramic patterns. In addition, some ceramics pay attention to the combination of information display and transmission in the process of graphic element design to further display the aesthetic characteristics of ceramics.

Ceramics have essential application value in China [16], and are also used in exhibitions, daily use, and many other aspects. In recent years, the competition in the ceramic market has gradually intensified. Suppose you want to improve your comprehensive strength. In that case, you must ensure the balance of ceramic patterns, make them meet people's aesthetic needs, and ensure that ceramic patterns have effective aesthetic significance. In the computer age, ceramic graphic element design technology is undergoing a significant transformation, gradually changing from early manual design to intelligent design using computers [1]. Although intelligent design can improve the efficiency of pattern design and reduce the design cycle, it often fails to consider the actual needs of ceramic graphic element design, resulting in a single design pattern and rigid layout structure. Relevant researchers have designed several conventional ceramic visual element intelligent layout algorithms [15] according to the smart layout characteristics of graphic elements, but the balance of these algorithms is

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relatively poor. In order to solve the above problems and improve the aesthetic balance of ceramic design drawing elements, this paper designs a new intelligent layout algorithm of drawing elements based on a genetic algorithm.

The conventional intelligent layout algorithms for ceramic design drawing elements primarily rely on density distribution methods to obtain ceramic design element units. However, these methods are susceptible to the influence of pattern density, resulting in a low distribution balance of design drawing elements. Therefore, there is a need to develop a new intelligent layout algorithm that addresses these limitations and improves the overall distribution balance of ceramic design drawing elements. Genetic algorithms offer a promising approach to optimize the arrangement of these elements, considering their specific characteristics and achieving better aesthetic quality in ceramic design drawings.

Research Question are as follows:

1. How can the distribution balance of ceramic design drawing elements be improved by designing an intelligent layout algorithm based on a genetic algorithm?
2. How can the intelligent parting structure of ceramic design drawing elements be constructed by incorporating their specific characteristics?
3. How does the proposed algorithm contribute to improving the aesthetic quality of ceramic design drawings?
4. What are the potential applications and practical value of the designed intelligent layout algorithm in the field of ceramic design.

2. Design of intelligent layout algorithm of ceramic design drawing elements based on genetic algorithm.

2.1. Build intelligent parting structure of ceramic design drawing elements. To solve the problem that the element distribution balance of the ceramic design drawing is reduced due to the influence of the pattern density when the density distribution method is used to obtain the element units of the ceramic design drawing, this paper constructs the intelligent parting structure of the ceramic design drawing elements based on the characteristics of the ceramic design drawing elements. In the conventional layout of graphic elements, several elements [6] are constantly added to form a variety of layout styles, or the same elements can be arranged in equal proportion to create a regular layout. On this basis, to effectively build the intelligent parting structure of ceramic design drawing elements, it is necessary to design the corresponding intelligent layout plug-in [7], adjust the brilliant layout rule library, save it in the template, and intelligently generate drawing elements. In the above process, you can save the sketch simulation using the same collection class to obtain intelligent parting parameters. Based on the above steps, you need to load the initial diagram elements first, and the loading process is shown in Figure 2.1.

It can be seen from Figure 2.1 that an intelligent typing record will be generated when loading the initial diagram elements. At this time, it can be recorded in the rule base, to record the initial position [8, 24] displayed by the diagram elements for a balanced layout of the diagram elements.

After the initial element is loaded, it is necessary to determine the basic loading information of the element, further obtain the element address, and ensure that the element has not been removed, and there is relevant graphic data [22] in the graphic element library. The corresponding management rules [4] are followed during the basic information processing of diagram elements, so a basic sketch template can be generated to realize an intelligent display of parameters. At this time, the schematic diagram of diagram element information saving rules is shown in Figure 2.2.

It can be seen from Figure 2.2 that the intelligent layout threshold can be set in combination with the above graph element information saving rules, but if you want to improve the intelligent layout effect, you need to save the graph element intelligent generation parameter [23] to obtain the original layout template. The intelligent parting structure of ceramic design drawing elements has several basic characteristics. First, it has self-similarity, that is, there is a similarity relationship between the design part and the design subject. Second, it is self-affine, that is, it carries out similarity expansion [5]. Finally, it needs to determine the parting dimension to generate an effective intelligent parting structure. At this time, the generated parting structure is shown in Figure 2.3.

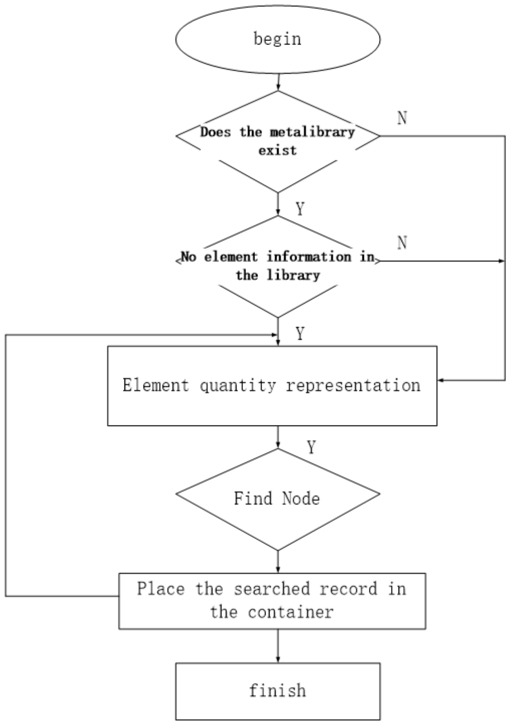

Fig. 2.1: Initial diagram element loading process

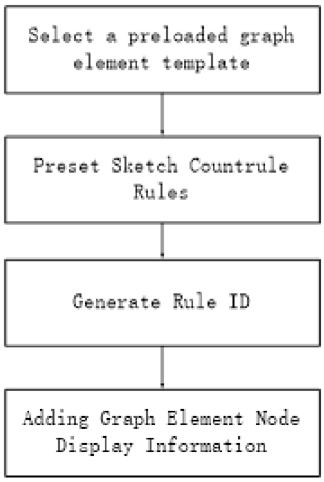

Fig. 2.2: Rules for saving diagram element information

It can be seen from Figure 2.3 that using the above intelligent layout and typing structure of ceramic design drawing elements can determine the basic design characteristics of the drawing elements, and carry out the metrological design into processing [19], so as to generate a new subject fractal diagram element design graph, and ensure the balance of intelligent layout to the greatest extent.

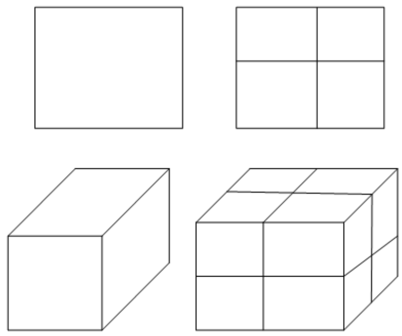

Fig. 2.3: Intelligent layout and parting structure of ceramic design elements

2.2. Design of intelligent layout model of ceramic design drawing elements based on genetic algorithm. Genetic algorithms can combine biological evolution law to conduct random searches and comprehensively search for the specified graph elements, thus improving the effectiveness of the intelligent layout of graph elements. First, ceramic design diagram elements can be used as the genetic basis to generate the initial genetic mechanism and build an effective iterative process [25]. In this process, there are fitness differences for different populations, and the heredity at this time is random. The initial population generated at this time $p(0)$ as shown in 2.1.

$$p(0) = \left\{x_1^0, x_2^0, ..., x_N^0\right\} \tag{2.1}$$

In formula 2.1, $x_1^0, x_2^0, ..., x_N^0$ represent the initial population individuals respectively, and the keyword vector at this time is shown in 2.2.

$$c = \langle c_1, c_2, ..., c_n \rangle \tag{2.2}$$

In formula 2.2, $c_1, c_2, ..., c_n$ represents an internal keyword [17]. Different intelligent layout weights have floating point differences, and the main data structures of genetic algorithms are also different. Therefore, it is necessary to construct a descending vector according to the average weight of keywords, and perform genetic operations on the initial population, that is, select the primitive individuals [11] that need to be copied, and ensure that they can enter the next generation of genetics based on fitness, so as to carry out effective design [21, 14]. Genetic approximation at this time $m(H, t+1)$ as shown in 2.3.

$$m(H, t+1) = \frac{f(H)}{f}\left[1 - \frac{P \cdot \delta(H)}{L-1}\right] OH \tag{2.3}$$

In formula 2.3, $f(H)$ represents the genetic selection operator definition moment [13], f represents low order genetic parameters, P represents the genetic index, $\delta(H)$ represents the variation selection value, L represents near genetic weight, OH represents the layout equalization parameter [3], and the binary coding accuracy at this time ξ as shown in 2.4.

$$\xi = \frac{U - U_A}{L-1} \tag{2.4}$$

In formula 2.4, U represents the coding constant [2], U_A representing the individual code length, the above intelligent layout based on genetic algorithm can be used to build an effective intelligent layout model of ceramic design drawing elements Q , as shown in 2.5.

$$Q = \frac{1}{m} sim(w, d) \tag{2.5}$$

In formula 2.5, m represents the number of individuals arranged, $sim(w,d)$ graph element keyword vector [20], using the above ceramic design graph element intelligent layout model can effectively carry out comprehensive optimization to ensure the reliability of graph element layout.

3. Experiment. In order to verify the comprehensive performance of the designed intelligent layout algorithm of ceramic design drawing elements based on genetic algorithm, this paper built an experimental platform and compared it with the conventional intelligent layout algorithm of ceramic design drawing elements. The experiments are as follows.

3.1. Preparation. In combination with the demand for the intelligent layout of ceramic design elements, this paper selects P2P as the experimental platform for the intelligent layout of ceramic design elements. This platform mainly uses IM for collaborative development, which can generate basic ceramic printing patterns, ceramic moire patterns, and ceramic basic deformation patterns. In order to improve the effectiveness of the experiment, the platform uses a Web server as the experimental client. In addition, the experimental platform can display design resources in real-time and realize the sharing of basic primitive resources.

In this research, the paper selects a P2P (Peer-to-Peer) experimental platform for the intelligent layout of ceramic design elements. The choice of the P2P platform is motivated by the need for collaborative development and efficient generation of various ceramic patterns and deformations. The platform utilizes instant messaging (IM) for collaborative development, enabling the generation of basic ceramic printing patterns, ceramic moire patterns, and ceramic basic deformation patterns.

The utilization of IM in the experimental platform allows for real-time collaboration and sharing of design resources among multiple users. This feature enhances the effectiveness of the experiment by enabling efficient communication and coordination among designers and researchers involved in the ceramic design process. By utilizing a P2P framework, the platform enables decentralized and distributed sharing of design resources, which facilitates seamless collaboration and reduces the potential bottlenecks associated with traditional client-server architectures.

To enhance the experimental process, a web server is employed as the experimental client within the P2P platform. This choice allows for a user-friendly interface and facilitates the real-time display of design resources. The web-based client provides a convenient and accessible environment for designers to interact with the intelligent layout algorithm and explore the generated ceramic design elements. It allows users to visualize the design resources and make adjustments or modifications as needed.

Moreover, the experimental platform supports real-time sharing of basic primitive resources. This feature enables designers to access and utilize a diverse range of foundational ceramic design elements, such as basic printing patterns or deformations, provided by the platform. By incorporating shared resources, designers can leverage existing designs as building blocks to create novel and unique ceramic design compositions. The collaborative aspect of the platform allows designers to contribute their own resources, fostering a collaborative and creative design environment.

The selection of the P2P experimental platform, utilizing IM for collaboration, a web server as the experimental client, and real-time sharing of design resources, addresses the requirements for an efficient and collaborative environment in the intelligent layout of ceramic design elements. These features enhance the experimental process, facilitate effective communication and resource sharing, and contribute to the overall advancement of ceramic design practices.The selected experimental platform architecture is shown in Figure 3.1.

It can be seen from Figure 3.1 that the above experimental platform meets the requirements of intelligent layout experiment of graph elements. In order to improve the extraction efficiency of experimental data, this paper selects ASP as the experimental support, which can effectively manage the experimental cases and ensure the accuracy of the experimental structure. In addition, the above experimental platform has added a safety management part, which can be used for experimental authentication. Before the experiment, it is necessary to preset the layout area. This paper selects CAD software to draw the basic practical diagram elements, some of which are shown in Figure 3.2.

It can be seen from Figure 3.2 that the above graphic elements output by CAD has certain regularity. You can select the corresponding experimental menu through the main interface to process the parting matrix and edit the details to the specified format. Currently, the parameters of each basic graphic element are shown in Table 3.1.

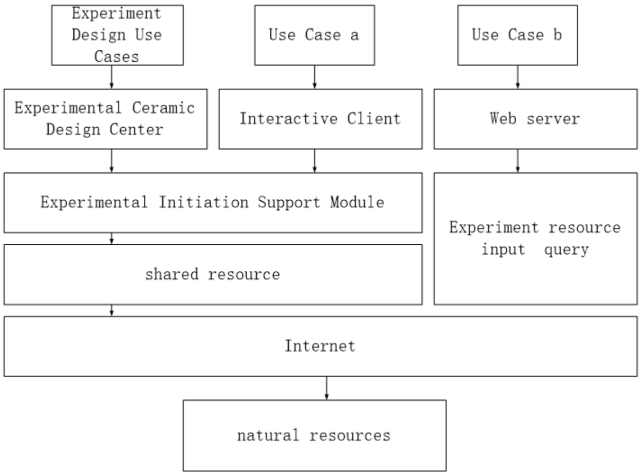

Fig. 3.1: Experimental platform architecture

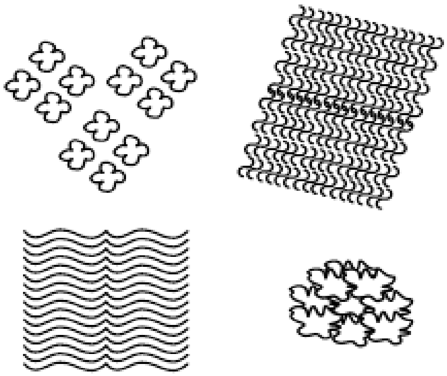

Fig. 3.2: Basic diagram elements

Table 3.1: Basic drawing element parameters

Figure Element Type	Resolution (PPI)	Image combination data amount (bit)	Basic composition parameters
Figure Element Group Type	72	3654412	1.8445
Graph element separation	72	4586635	1.9845
Figure Element Contact	72	4186632	1.2265
Figure Element Overlay	90	6254641	1.7471
Figure Element Overlay	90	6888122	1.4554
Graph element combination	90	6235141	1.9963
Figure Element Clipping	72	4584112	1.8874
Diagram Element Overlay	72	3565458	1.2252
Coincidence of graph elements	90	6845412	1.8543
Figure Element Rotation	90	6564824	1.6352
Figure element translation	90	6888452	1.8896

Table 3.2: Percentage of Element Thickness Pattern in Ceramic Design Drawing

Thickness	Thickness equalization coefficient	Figure Element Distribution Percentage (%)	Component ratio (%)	Composition mode Composition mode
0.2E-03	0.125	58.51	45.69	Figure Element Shape and Shape Combination
0.06E-03	0.833	41.36	44.32	There is no contact between shapes and there is a certain distance between them
0.06E-02	0.758	10.25	85.51	The edges between the shapes are exactly tangent to each other
0.03E-03	0.521	11.42	15.58	The relationship between shapes is overlapping
0.2E-02	0.466	5.62	85.33	The overlapping of transparency between shapes
0.6E-03	0.585	3.35	19.54	Shape combines with shape to form a new shape
0.06E-03	0.647	1.40	23.55	The areas covered by shapes and shapes are cut off
0.2E-03	0.869	2.98	36.95	Overlap each other
0.13E-03	0.853	3.85	29.54	Mutual coincidence
0.5E-03	0.652	14.98	22.71	Composite rotation
4E-02	0.754	15.22	20.56	Composite rotation
0.06E-03	0.658	24.96	36.85	Multiple combinations

It can be seen from Table 3.1 that the above graph elements can be uniformly designed with the specified mathematical description curve to obtain the basic experimental pixels and adjust the intelligent layout definition of graph elements. There are certain differences in the comprehensive processing of different graph elements. Bitmap elements need to be smoothed during processing, sketch elements need to use arrows for intuitive conversion, and rotating graph elements need to use Get Pixel to determine the color of graph elements before and after rotation, plan the central coordinates, and obtain the resolution of unit graph elements. For a given bitmap element, XML needs to be used to effectively describe the graph element type during the scaling operation, generate the number of basic graph element objects, and obtain the corresponding relationship between the experimental graph elements. After the basic drawing elements are processed, this paper selects the distribution balance index of design drawing elements r as an experimental index, the calculation formula is as follows 3.1.

$$r = \frac{F}{D} \tag{3.1}$$

In formula 3.1, F represent the distribution position of design drawing elements, D represents the preset distribution position of drawing elements. The higher the distribution balance of design drawing elements, the better the intelligent layout effect of drawing elements. On the contrary, the lower the distribution balance of design drawing elements, the poorer the intelligent layout effect of design drawing elements. The basic attributes of the diagram elements are different, but they are all determined by the Element tag, and do not include child nodes and corresponding attributes. Therefore, during the operation of the diagram elements, it is necessary to carry out standardized deletion according to the actual situation of Doc, determine the location of the Microsoft XML Parser experimental document, and effectively encapsulate the experiment, so as to create a basic document object and reasonably add the design root node.

Ceramic pattern design has an important relationship with the actual structure of ceramics. Therefore, the uniformity coefficient can be preset according to the thickness of different ceramic structures to determine the distribution percentage of diagram elements, as shown in Table 3.2.

It can be seen from Table 3.2 that the experimental gradient layer can be effectively planned by combining the thickness pattern percentage of the ceramic design elements in Table 3.2, so as to preset the initial distri-

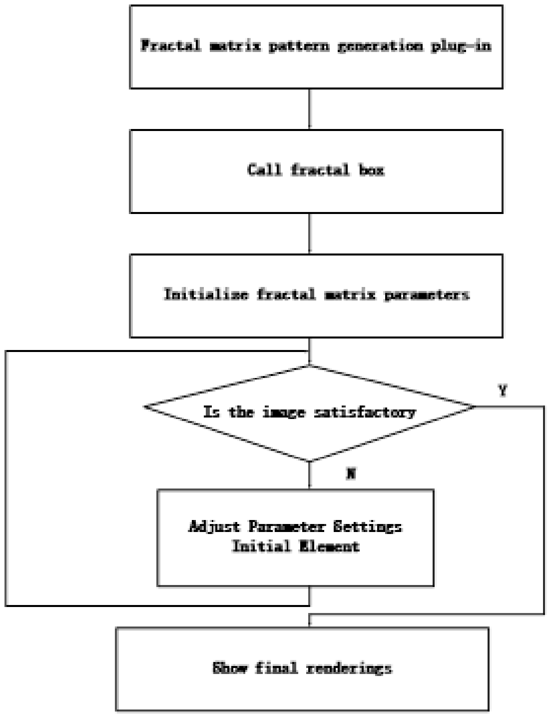

Fig. 3.3: Intelligent layout and typing process

bution position of the diagram elements. After setting the balance coefficient of the intelligent layout of the above diagram elements, this experiment is based on Web2.0 and uses VC++60 as the development language to develop the Microsoft Windows 2003 standard experimental operating environment. At this time, it needs to ensure that the server is Microsoft Sql server2000 and the browser needs to select Microsoft IE 5.0. At this time, you can set the intelligent layout classification process, as shown in Figure 3.3.

It can be seen from Figure 3.3 that combining the above generated intelligent layout and typing process can effectively process the elements of the experimental diagram and carry out subsequent intelligent layout experiments.

3.2. Experimental results and discussion. Combined with the above experimental preparations, the intelligent layout experiment of ceramic design diagram elements can be carried out, that is, the intelligent layout algorithm of ceramic design diagram elements based on genetic algorithm and the conventional intelligent layout algorithm of diagram elements designed in this paper can be used to arrange in the built experimental platform, and formula 3.1 can be used to calculate the distribution equilibrium index of diagram elements obtained by the two methods under different thickness structures. The experimental results are shown in Table 3.3.

It can be seen from Table 3.3 that the intelligent layout algorithm of ceramic design drawing elements designed in this paper based on genetic algorithm has a high index of element distribution balance under different thickness structures, while the traditional intelligent layout algorithm of ceramic design drawing elements has a relatively low index of element distribution balance under different thickness structures. It proves that the intelligent layout algorithm of ceramic design drawing elements based on genetic algorithm designed in this paper has good performance, reliability and certain application value.

4. Conclusion. Porcelain has a history of mailing in China. It is a common handicraft. In recent years, with the improvement of people's aesthetic appreciation, the choice of ceramics is no longer limited to comprehensive use, but more attention is paid to its surface pattern design. Affected by the diversity of ceramic shapes, the composition thickness of each part needs to be considered in the design process of graphic elements,

Table 3.3: Experimental Results

Thickness	The graph element distribution equilibrium index of the intelligent layout method for ceramic design drawings based on genetic algorithms designed in this paper	Distribution Equilibrium Index of Elements in Conventional Intelligent Layout Methods for Ceramic Design Drawings
0.2E-03	0.9611	0.4513
0.06E-03	0.9412	0.5362
0.06E-02	0.9398	0.4844
0.03E-03	0.9445	0.5512
0.2E-02	0.9512	0.4541
0.6E-03	0.9453	0.4696
0.06E-03	0.9365	0.5314
0.2E-03	0.9858	0.4845
0.13E-03	0.9144	0.4285
0.5E-03	0.9474	0.4365
4E-02	0.9545	0.5741
0.06E-03	0.9562	0.4896

so its design is difficult and needs to rely on intelligent layout algorithms for layout. Conventional graph element layout algorithm has poor layout effect, which does not meet the current ceramic design requirements. Therefore, this paper designs a new intelligent layout algorithm for graph elements in ceramic design based on genetic algorithm. The experiment results show that the designed intelligent layout algorithm of ceramic design drawing elements based on genetic algorithm has good balance index, good layout performance, reliability, and certain application value, and has made certain contributions to improving the aesthetic quality of ceramic design drawing elements. The research's focus on a specific P2P experimental platform may limit the generalizability of the findings. Different platforms or environments may have distinct characteristics and requirements, and the effectiveness of the intelligent layout algorithm and collaborative features may vary across platforms.

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