
# Optimization of CAD System for Ceramic Decoration Pattern Design Based on Virtual Reality Technology

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**Abstract**. The continuous progress of computer technology has led to the development of many excellent graphic applications both at home and abroad, which has changed the design of patterns from traditional manual design to computer design. With the intelligence of the computer, to achieve a qualitative leap in the creation of patterns. With the increasingly fierce market competition, people's living standards continue to improve, today's consumer demand for products not only stay on the function, appearance is equally important to attract consumers, the appearance of the product pattern has gradually become one of the factors for consumers to decide whether to buy. In this paper, we combine the service model theory of virtual reality (VR) technology and product customization features to develop a corresponding pattern design module for ceramic pattern design. Using object-oriented software development technology, the ceramic pattern design plug-in is developed based on the ceramic CAD platform and fractal theory. Users can easily modify fractal data in the application interface without modifying the source program code. In the creation of ceramic decoration software based on fractal theory, it is the software, algorithms, a variety of mathematical functions, simple graphic elements as the main body, designers can generate complex and varied ceramic design patterns with simple operation of the software. It facilitates the design of better patterns. The study focuses on the development and implementation technology of the VR platform-based ceramic product pattern system to ensure the versatility and flexibility of the system, and reduce unnecessary duplication of development, and reduce the cost of development, and improve the efficiency of development.

**Keywords:** Intelligent Computer; Computer Aided Design; Virtual Reality; Ceramic Decoration Pattern; CAD System
**DOI:** https://doi.org/10.14733/cadaps.2022.S5.110-120

## 1 INTRODUCTION

With the improvement of living standards and the development of modern computer technology, people no longer choose a commodity simply by its function, appearance has also become one of the factors of their choice. As the appearance language of the product, the pattern is the most direct visual perception to people through the art form. Now all walks of life are paying more and more attention to the pattern. Ceramics, a special product, has the special characteristics and irregularity, which makes the pattern design applied to ceramics more troublesome. When the pattern is applied to ceramics, it is more or less constrained by the shape of ceramics, and if it is to be applied to ceramics, then the pattern design needs to be perfectly combined with the special characteristics of ceramics, so that the pattern of ceramic products can be better designed [1]. Applying decorative patterns to ceramics reflects the perfect combination of artistry and practicality. It originates from nature and expresses a strong visual impact and artistic appeal with its unique structure and rich colors. When the pattern is expressed with the help of ceramic carrier, its design can beautify the ceramic and satisfy people's aesthetic enjoyment, while the intuitive feeling given by the pattern invariably plays the role of marking and conveying information, thus different pattern styles not only reflect the style of ceramics, but also reflect people's different characters and different local characteristics [2]. The patterns themselves also represent the culture of a nation and reflect different life sentiments and aesthetic concepts proposed by AL - Turki et al. [3].

Today's ceramic products have penetrated into many aspects of our lives, the competition of ceramic enterprises tend to design competition, pattern design in the competition will play a pivotal role. With the fierce competition of ceramic products and the internationalization of the market, ceramic pattern design has the far-reaching significance of enhancing the artistic level of products, economic value and market competitiveness of products. With the rapid development of computer technology, Raposo et al. [4] proposed that the use of computers to make and create patterns is a new way of pattern design. Pattern design and creation exist in many industries. Traditional pattern design and creation are done by hand, they design and creation include two parts: conception and expression. First, the product pattern designers according to their own professional knowledge and social experience of production materials, markets, consumers, production processes and many other factors to analyze and judge, using their own brain space imagination naturally generated by an artistic thinking image, and then use different technology and material materials, the brain out of the conception of the product image to concretely present, so that this imaginary The imaginary product image becomes a concrete and real product that can be grasped [5]. The traditional pattern design and creation method is far from meeting the domestic and foreign markets today [6]. Many traditional handicraft technology is difficult or simply can not create the shape of the pattern is slowly and easily achieved, which provides a new process to meet the product pattern design of flexible and varied, multi-species, small batch market requirements. Traditional pattern design is often formatted and stereotyped, and the design of the traditional type of pattern is single, lack of diversity proposed by Azarbal et al. [7]. Now the use of fractal theory to design patterns can well change this traditional pattern design mode, to create a pattern design method can be realized by the computer, so that the pattern design into a new era of mathematical instructions. However, fractal theory often involves advanced mathematical expertise and complicated dimensional calculations, which makes pattern designers sometimes feel intimidated [8]. In fact, if you simply master the principles of fractal pattern generation, you can easily design very beautiful fractal patterns. Therefore, the use of fractal theory to design ceramic patterns has opened up a new era of artistic graphic creation [9]. Bruzamolin et al. [10] proposed the concept of pattern design using fractal theory combines abstract and figurative thinking in an organic way, which makes the design of patterns step into a new realm.

People are often vague about the end result of a pattern design when they first start creating, so there is an urgent need for a sketch design software, through which you can create the appropriate layout based on such vague ideas, even if they are vague at the beginning. Based on such an idea and layout, the appropriate elements are selected. So, to design such a sketch design software to provide a functional plug-in for ceramic product CAD system to strengthen the design function of the system. With the continuous development of today's computer technology, the competition of enterprises will become more and more fierce, the production of products not only in function but also in appearance to meet the consumer, so the product pattern has slowly become one of the important factors for consumers to buy. As an important part of product design, a good design system can not only design more suitable for the product, but also reduce the design cycle of the enterprise, so that the product has better market competitiveness. This paper analyzes and studies the feasibility and necessity of product pattern design on the basis of ceramic CAD platform. Through the analysis of product pattern design at home and abroad, the research objectives and contents of the paper are proposed. A ceramic pattern sketch design and fractal pattern generation system is studied and developed. This provides a new pattern design idea for ceramic pattern design, while the generated fractal patterns enrich the types of ceramic graphics. Based on this, a ceramic product pattern design system based on ASP platform was studied.

## 2 VIRTUAL VISUALIZATION IN CERAMIC DECORATIVE PATTERN PROCESSES

### 2.1 NRM Information and Virtual Visualization

The definite term "immaterial" affirms the abstract information property of ICH, which is a form of information and a body of information composed in a specific form. The information of ICH is attached to the carrier and often hidden behind the carrier, which is easily ignored by people. Throughout history, NLA information is a very broad concept, which includes the craftsmanship, technology, culture, faith, and spirit behind all human activities [11]. This involves two issues: one is the dissemination of non-heritage information, i.e., how to expand the scope and effect of the dissemination of non-heritage information; the other is the understanding and acceptance of non-heritage information by the public, i.e. how to present non-heritage information in a way that can better attract the public and be easily understood and accepted by them. "Dissemination is the core of realizing the conservation value of non-heritage digital resources". In the context of today's Internet, it has become a trend to push NRM information to the public in close proximity with the help of the network platform, and the continuous progress of digital technology of NRM information has also played a role in the dissemination of NRM information. The Internet is an effective way to expand the scope of the dissemination of NRM information. On this basis, presenting NRM information on the Internet platform to attract the public to explore more information, and providing an entrance and opportunity for the public to understand NRM information, as well as conveying NRM information accurately and effectively, are the key points to be considered. Information understanding "should be seen as a continuous process from data to wisdom". As shown in Figure 1, information is data that has been filtered and processed by individuals, and it is data that can have an impact on individuals. The process of information comprehension is the process of receiving information by individuals, and it is the process of active acceptance. This process is influenced by the way and intention of the information disseminator in presenting the information, and is also related to the knowledge and social background of the information receiver. The study of information visualization is centered on these factors. Lee et al. [12] summarized nine social contextual reasons for why information visualization is used to achieve information understanding. The overall reason is the change of information environment and the change of public demand and psychology for information. Information visualization meets the modern people's needs for information, aesthetics, and experience in the process of information comprehension. The receivers in the process of information comprehension of NRM do not have relatively fixed knowledge and social backgrounds like other communication processes, but are oriented to the general public, and there are

considerable differences. Therefore, these factors should be taken into consideration at the beginning of NRM information dissemination, and the same content should not be limited to one or several ways of expression, but should be combined with the content, dissemination channels and scope, and the recipients to choose the appropriate information visualization methods. Only in this way can we achieve the ultimate purpose of NRM information dissemination.

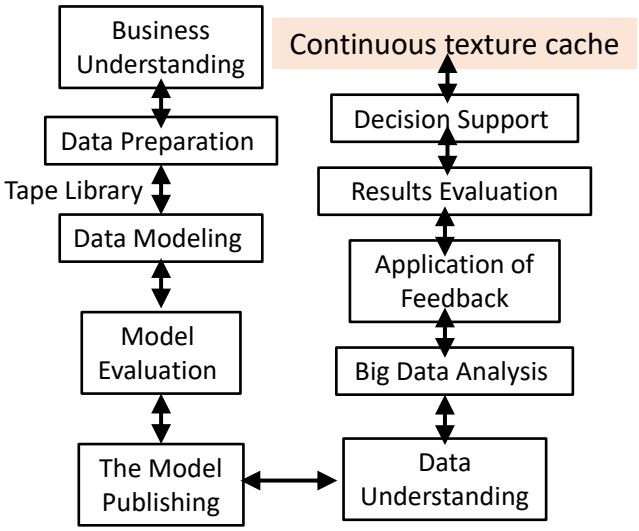


**Figure 1:** Information Understanding Schematic.

Virtual visualization is based on 3D modeling, and 3D modeling is the foundation and the key of virtual visualization. At present, the mainstream 3D modeling techniques mainly include photo modeling technology, digital geometry modeling technology, and inverse engineering technology. Photo modeling technique is to extract the 3D data information of the modeled object through a large number of physical acquisition photos. This modeling method can complete the modeling task quickly and efficiently, but the modeling fineness is not very satisfactory. The photo modeling technique is fast, easy and convenient to operate, and does not require high art skills and equipment operation level. For some objects requiring general accuracy, photo modeling is a very good choice. With the continuous improvement of photo modeling technology, it can definitely play a great role in the conservation of NRM. Digital geometric modeling technology is a modeling method that highly integrates computer technology and aesthetic art. This modeling method has high requirements on the modeler's art skills and aesthetics as well as the degree of use of 3D modeling software. The threshold of digital geometry modeling is high and the modeling speed is slow, but the accuracy of the model can be made according to the actual demand and can reach a very fine degree. The mainstream modeling software on the market are Maya and 3D Max from Adobe, Zbrush for fine sculpting, and Rhinoceros for industrial modeling. This method is suitable for some high requirements for model accuracy or objects that do not exist in reality or no longer exist for virtual recovery modeling.

The initial textual record, image record, video image and virtual reality have become important tools for the preservation of NLA information. As an emerging technology, virtual reality provides new ideas and directions for the digital preservation of NRM information. Virtual reality technology can virtually reproduce or construct a scene or object that does not exist in reality or even in reality, so that people can be immersed in the virtual scene generated by computer technology and have strong interactivity. Because of the special nature of NRM information, most of it no longer exists or

is not the original appearance in the current environment, and needs to be reproduced in scenes or objects. Virtual reality technology is able to fill this gap. The virtual reality technology mentioned here also includes Augmented Reality (AR) and Mixed Reality (MR), which are developed on top of VR technology, including the use of 3D models for virtual reproduction, etc. Both AR and MR overlay or fuse the virtual environment and the real environment, and present the fused scene through display devices. The virtual reality display can be used to display the fused scenes. Virtual reality display has unparalleled advantages in presenting non-heritage information, especially information that no longer exists and is difficult to recover. In general, virtual reality technology is still mainly used in the field of tangible heritage, and it is still in the initial development stage in the visualization of ICH information, and it has shown its important value in the transmission of ICH information such as traditional skills and performances. At present, the achievements of using virtual reality technology for NRM information protection at home and abroad mainly focus on digital restoration and scene reproduction of heritage sites. Carrozzino et al. designed a virtual interactive display platform to show the whole process of traditional Italian bronze casting techniques. The user can not only clearly witness the process of bronze casting, but also see the process of bronze casting. Users can not only clearly witness the whole process of bronze casting, but also pause at will during the viewing process to carefully analyze each casting detail.

### 2.2 Ceramic Pattern Information Visualization

The text-graphic visualization method is better to make people understand at a glance, so that they can quickly browse the information and selectively watch some content. According to the characteristics of this form of presentation, the information on the porcelain making process of Yaozhou kiln can be divided into temporal information, explanatory information and display information. Temporal information refers to the information that has a temporal relationship with each other. For example, the process of making porcelain, picking clay first and then panning, practicing clay first and then pulling billet, has a fixed time sequence. Such information can be presented in the form of comic strips or step-by-step illustrations. The audience can quickly understand the sequential relationship between the steps, and also carefully analyze a particular step in the process. Explanatory information refers to some additional information that needs to be introduced in detail. For example, the introduction of production tools, some production details of close-up introduction, etc., can be described in detail by means of graphics with text. Display information is the kind of information that is simply for the convenience of the viewer, to keep and record, this kind of information is mostly in the form of text supplemented by images to display. It is mostly found in books, websites, etc. This type of information can be used to record almost everything about the porcelain making process of Yaozhou kilns, but it is relatively small in scope and requires a certain level of knowledge, interest and purpose.

For the information content characteristics of the porcelain making process of Yaozhou kiln, moving images can faithfully record the whole process of the porcelain making process. Moving images are divided into video images, game images and interactive images. Video is the most common method, and it is also a relatively mature technology with wide dissemination channels. Video images are mainly used to introduce, record and preserve some information. This method can be used to record the process of porcelain craftsmen in the production of porcelain, with part of the audio commentary or subtitles. It can also be used to show specific production details. Or it can be used as a simple introduction for children in the form of animation. The 3D virtual scene of Song Yaozhou kiln is designed to restore the whole process of firing porcelain in the Song Dynasty, including loading, firing and opening the kiln, and to introduce and simulate the internal and external structure of the kiln as well as the firing process, so that the audience can understand the firing techniques of Song Yaozhou kiln as if they were actually witnessing it. Therefore, the 3D virtual scene is mainly divided into the following four parts for display.

YAOZHOU Kiln Display. The first is the display of YAOZHOU kiln information, as shown in Figure 2. By modeling the three-dimensional virtual restoration of the Song Dynasty Yaozhou kiln, the

whole picture of the fifth kiln of the Song Dynasty is virtually displayed. It enables the audience to fully understand the architectural structure of the Song Dynasty Yaozhou kiln, the information of each part of the kiln and its role in the firing process, as well as the wisdom created by the ancient people. This part of the exhibition is based on the virtual display of the fifth kiln model of Song Dynasty Yaozhou kiln, and the information of the interaction points triggered by the audience is displayed in the form of superimposed layers, i.e. several interaction points that need to be introduced in detail are set, such as furnace grates and ventilation channels, and when the audience triggers the interaction point, the detailed information of this interaction point will be presented on the upper layer of the model. Reproduction of kiln loading scene. The first step in the firing technique is to load the kiln. This section mainly shows part of the kiln loading tools and their use, part of the display of porcelain stacked on top of each other and the area with a higher success rate when loading the kiln highlighted on the kiln bed, i.e., the area where the porcelain should be placed centrally. The kiln firing process is shown. The kiln firing process is crucial in the porcelain making process. However, based only on the experience and skills of the kiln workers, the firing process is not particularly fixed and strict norms, which are difficult to translate into quantitative information. This section of the exhibition focuses on the introduction and virtual display of the firing atmosphere, the observed use of firelight, and a diagram of the temperature transfer in the kiln. Through these demonstrations, the audience can have a general understanding of how the kiln temperature changes during the firing process and how to observe and adjust the temperature in a timely manner. Opening the kiln to check the billet process. The opening of the kiln is the final step in the firing of porcelain. There is a process of waiting for the kiln to cool. This part of the display is relatively simple, mainly the display of some porcelain and a brief introduction of firing temperature, color, etc.

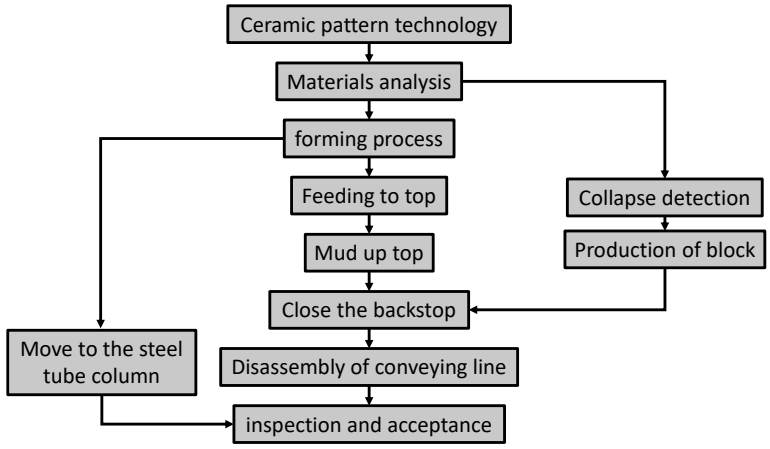


**Figure 2:** Presentation of furnace information.

Virtual reality information visualization is probably the latest but most popular presentation method, which combines technology, art and interactivity. Virtual reality information visualization uses the most cutting-edge communication media technology to shift the way of information presentation to virtual, and expand the dimension of information presentation, enrich the form and content of information display, and maximize the utility of information presentation and dissemination. The main features of virtual reality information visualization are reflected in the following aspects: virtualization, interactivity and immersion. Virtualization refers to the digital virtual display technology can realize the virtual display of physical objects, but also reproduce some physical objects do not exist or difficult to achieve the content. There are numerous examples of virtual reality technology used in cultural heritage conservation. Many cultural relics are difficult to restore because of inconvenient handling, inconvenient close display, and dilapidation, etc. The use of virtual

technology to display them gives the audience a chance to see them up close, and some can even be simulated by touch. Interactivity is to establish an effective way to communicate with each other in dialogue between information visualization and the audience. The core point of virtual visualization design is how to let the audience talk to the information more naturally and directly. The message can only be made more compelling if the viewer is present and involved. Immersion is the illusion of reality that the viewer has in the current virtual environment. Immersion is created by using multi-sensory mobilization, story environment plot setting and interactive interaction to give the audience an immersive experience. Virtual visualization of the porcelain-making process of Yaozhou kiln, such as the holographic projection stage in the Yaozhou Kiln Museum, showcases the most representative vessel of Yaozhou kiln, the inverted flow pot, and virtually demonstrates the working principle of the inverted flow pot through dynamic displays. Because of the importance of virtual visualization in the conservation of NRM and its inherent characteristics of information visualization, this paper focuses on virtual visualization as the main focus of analysis. Based on the characteristics of virtual visualization, the Song Dynasty Yaozhou kiln can be used as the object of virtual display, and a reasonable plot design can be made to show the firing stage of the porcelain making process of Yaozhou kiln.

## 3 OPTIMIZATION OF VR-BASED CAD SYSTEM FOR PATTERN DESIGN

### 3.1 Sketch Module Design

The process of creating traditional patterns is mainly based on the idea and establishing the corresponding layout. According to the idea and layout, the appropriate elements are selected. Finally, the art pattern is generated intelligently. Sketch plug-in can easily simulate the creation process of traditional patterns. In the paper, the corresponding solutions are given for the key technologies of sketch plug-in such as the management of element library, the management of rule library, and the intelligent generation of patterns. With the gradual development of science and technology and economy, people's living standards are gradually improving and their pursuit of art is getting stronger and stronger, which makes people put forward high requirements for the design of works, which can be applied and practiced on the one hand, and require works to have high ornamental effects on the other. In order to solve such technical problems, a lot of excellent pattern design software has been developed, which makes the design of patterns from the traditional manual design to computer design. The advantage of this is to improve the efficiency and reduce the difficulty of creation at the same time. The use of computers in pattern design has led to a leap forward in the creation of patterns, which can accomplish tasks that are traditionally impossible. Compared with other powerful pattern design software, the sketch design plug-in is more targeted, this plug-in can be better combined with industrial production, taking the essence of tradition, with the help of computer intelligence, to achieve a qualitative leap in the creation of patterns. Can create the traditional process is difficult to achieve, the style of different patterns. It makes the creation process of art patterns really efficient and fast. He combines the magic of creativity, rich imagination, and a complete library of materials. He uses the computer to simulate such a process from pre-conception to sketch design to drawing, based on the traditional pattern creation process in real industrial production.

If we want to realize the system, then we must first realize the design of the following three core functions: First, the management of the library of elements, mainly used to save the sketch design element material, only with this material to make the sketch design become meaningful. Second is the management of rules, only if the rules library is designed, you can save the series of rules into the sketch template, and next time you can directly call the sketch template to generate the designed pattern intelligently. Also cannot save the sketch template, directly intelligent generation of patterns. Third, the intelligent generation of patterns, this is mainly to save the information of the sketch template with a collection class, and finally the computer calls the parameters provided by the collection class to generate patterns intelligently, as shown in Figure 3.

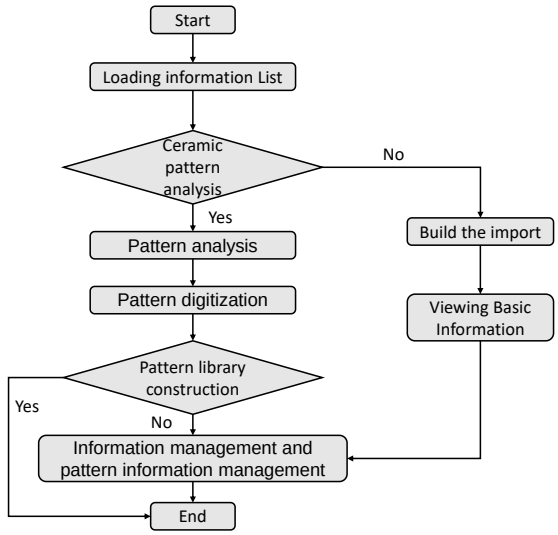


**Figure 3:** Flow chart of element loading.

### 3.2 Graphic Design Response Speed Optimization

Apart from the zooming process that inevitably filters the contextual information out of the viewport, zooming also has almost no effect on the content of the information itself, as shown in Figure 4. In the interaction process, we generally determine the viewpoint by panning, and then achieve a smooth transition in detail display by zooming. Morphing is also an interactive way to achieve detail display, but unlike panning and zooming, morphing preserves the contextual information and achieves focus by enlarging the scale of a detail. Let's say in virtual reality, zooming in on a detail is achieved by interacting with the interaction point. Isolating a part of the current viewport for the display of a detail part should also belong to the deformation interaction. There is also a total picture + detail interaction. A good example of this is the PPT production interface, which displays the details of the current page in the right-hand main screen and the thumbnails of each page vertically in the left-hand column. This allows users to view details and stay focused on contextual information at all times at their own speed and judgment, and attention can be easily switched between the two views. Highly visible thumbnails indicate where the user is currently located. This approach is also often used in virtual presentations.

User interaction interface also has time attributes. In virtual visualization, the time attribute of user interaction is easily overlooked, either because it is often presented in the form of animated videos or in steps during the virtual visualization process, or because people interact one by one according to the inherent perception of the order or placement of the interaction points. However, even if information with a timeline can be represented by dynamic video, there is a limit to the amount of time it can be displayed. This is the temporal limitation of the user interface. The main reason for the time limitation is the limited patience of the audience, especially in virtual visualization, which often requires external devices such as VR virtual reality display headsets. The heaviness of the equipment will make the audience gradually lose the initial freshness and patience in the process of experience. Therefore, when presenting temporal information, time limitations should be taken into account, as shown in Figure 5. As far as possible, the information should be presented and displayed completely within the effective time period.

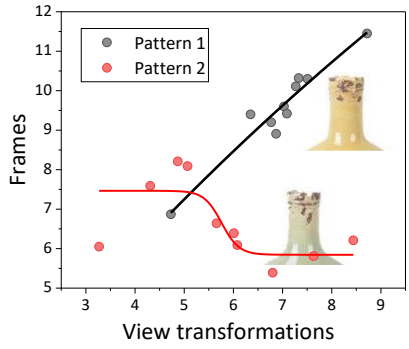


**Figure 4:** Interactive execution of view transformations.

This requires that the presentation of temporal information cannot be as step-by-step as other visualization methods. In virtual reality scenes, a more effective solution to the problem of time limitation is to display temporal information in a hierarchical manner according to chronological order or steps, avoiding too long animations or even animation transitions, so that the audience can quickly jump to the desired information page. When layering the temporal information, it should be noted that the layering of temporal information should be based on the overall classification of temporal information. And in the hierarchical display, there should be a location prompt that can indicate the overall time or step of the audience to ensure that the audience will not be lost and confused in the process of independent selection and time information jumping. Reasonable classification and layering of temporal information is an effective way to solve the problem of time limitation

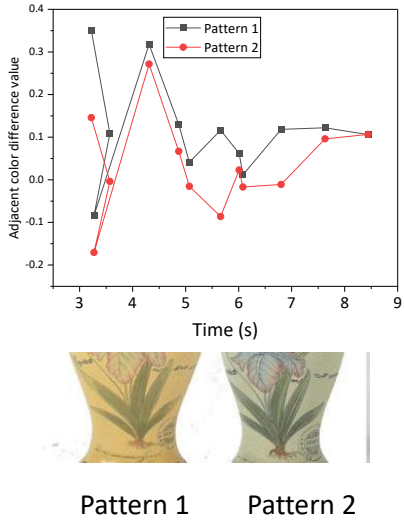


**Figure 5:** Display of valid information per unit of time.

For the virtual visualization of the porcelain making process of Yaozhou kiln, the completion of the virtual scene display is not the completion of the visualization, it is only the starting point, and the human-computer interaction is the key point to promote the dissemination of information about the porcelain making process of Yaozhou kiln. This paper focuses on the interactive beauty of the virtual

visualization of the Song Yaozhou kiln, which is a new concept in the art discussion compared to the visual beauty. The necessity of studying the interactive beauty of the virtual visualization of the Song Yaozhou kiln is mainly reflected in three aspects: first, from the viewer's emotional needs, reflecting the importance of interaction as a human-computer communication method; second, from the perspective of aesthetic needs, emphasizing the requirements of aesthetic transformation for interactive art under virtual visualization; and finally, from the perspective of artistic expression, considering that the presentation of information in a clear and organized manner is also a requirement for artistic expression. The method and process of composing patterns from selected elements according to specified rules is called intelligent generation of patterns. If the computer is to be able to generate patterns intelligently, a series of parameters must be saved so that the computer can generate patterns intelligently according to these parameters. The following CGraph saves only one rule information, and then adds this rule information, which is an instance of the CGraph class, to the collection m_ptr Array, which can save many instances of the CGraph class, so that m_ptr Array constitutes a sketch template. By calling this sketch template, the computer generates patterns intelligently. The system can design a rule class to store a series of rule information, and then store this series of rule information in the collection, a collection is equivalent to a sketch template, the system reads the parameters provided by the collection, and intelligently generates the sketch pattern corresponding to the sketch template. As shown in Figure 6.

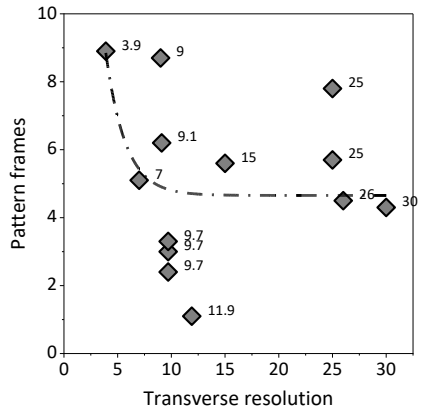


**Figure 6:** Pattern sample parameters summary.

## 4 CONCLUSION

In the human-centered design concept of modern product design, product pattern design has played an increasingly important role. The limitations of traditional product pattern design can no longer continue to meet the needs of consumers, and for the specific style preferred by consumers, designers can only do it based on experience, intuition and out of production. How to provide scientific, objective and effective design methods and procedures for product pattern design, and how to provide an effective product pattern application system to assist designers in design, is an urgent problem for product pattern design. In this paper, through the application of VR platform trends at home and abroad, the situation of enterprise information development, the application of VR platform model in ceramics is feasible and effective. Using object-oriented software development technology, based on the ceramic CAD platform and fractal theory to develop ceramic pattern design plug-ins. Users can easily modify fractal data in the application interface without modifying the source program code. In the creation of ceramic decoration software based on fractal theory, it is the software, algorithms, a variety of mathematical functions, and simple graphic elements as the main body, designers can generate complex and varied ceramic design patterns with simple operation of the software. It facilitates the design of better patterns. The study focuses on the

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