Multimedia-based Computer-aided Ceramic Design

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Abstract. This paper conducts an in-depth study on the design of ceramics based on the principles of multimedia computer-aided design, defines the concepts of computer-aided design and ceramic art design in the research process, and explains the connotation and requirements of information technology to promote the design ability of ceramic art professionals. Through the overview and analysis of ceramic traditional craft, the design methods and principles applicable to the digital experience of the traditional craft situation under the ceramics are found, and attempts are made to transform the advantages of digital technology into new potential energy for the protection and inheritance of traditional craft. Starting from the theory of non-heritage information and virtual visualization art performance, the information content, basic process, and development context of ceramic craft are organized, the ceramic craft content and its matching information visualization display methods are compared, and it is proposed to present and disseminate the information of kiln porcelain assembly and firing craft through the construction of a three-dimensional model of ceramic furnace and virtual visualization display. The virtual visualization art aesthetics is divided into three aspects: content aesthetics, visual aesthetics, and interactive aesthetics, and the art performance in the virtual visualization system of the kiln is studied from three aspects: art aesthetics, visual performance, and interactive display. The study utilizes modern tools such as augmented reality and virtual reality technologies for the innovative transmission, research, sharing, and dissemination of cultural heritage digital content, enabling users to interact with digital content simply and naturally.

Keywords: multimedia; computer-aided design; ceramic design.
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1 INTRODUCTION

In the information age, the application of information technology to participate in the design of art and design has developed rapidly. As a result, the way people produce, live, and think has changed dramatically. Modern art and design inherit the essence of traditional design and at the same time integrate new technical elements. It makes the designed products change people's way of life and truly serve humans. With the rapid development of science and technology, people's demand for well-designed art and design products is constantly changing, and aesthetics are also gradually improving [1]. Take ceramic crafts as an example, people's functional requirements for ceramic ware gradually rose from storage equipment to the height of spiritual and cultural products. At the same time, consumers are increasingly demanding the novelty and aesthetics of ceramics, but also hope that ceramics are not limited to use in a variety of daily family life, but also in more areas of application of ceramics. The development of digital media technology has broadened the digital expression of non-heritage [2]. In a short time, graphic materials, websites, documentaries, animations, and even interactive games on the protection and promotion of non-heritage have mushroomed. Although information visualization is a young discipline, it has been developed based on the intersection of multiple disciplinary theories, including cognitive psychology, humanistic theory, semiotics, and so on. In the digital preservation of non-heritage, it should emphasize the communication value of non-heritage itself while recording and preserving information to deepen the audience's understanding [3]. Therefore, applying the concept and technology of information visualization to the digital preservation of ICH can effectively promote this purpose. Information visualization of non-heritage is required to analyze, interpret, and process the information of non-heritage and present it to the audience in a visual way. The application of information visualization to the protection of non-heritage, can reduce the cognitive load brought about by the traditional didactic form of propaganda, stimulate the audience's interest, from the passive acceptance, know such a thing converted to active exploration, but also convenient for the audience to be able to more quickly excavate the information they need [4].

Dehurtevent et al. mainly study the basic theory, technology development, and application of digital ceramic design software, as well as some thoughts on the industrialization of digital ceramic technology [5]. Lin et al. mainly study the concept of design, various forms, design and aesthetics, art, science and technology, and a series of theoretical basic knowledge, and introduce the general principles and applicable laws of art and design in a general way [6]. Schlenz et al. give a detailed account of aesthetics, color theory, modern light and shadow theory, and the expression and application of digital aesthetics in art and design [7]. Cuiling and others made a detailed study of the origin of Chinese arts and crafts, the establishment of the concept of arts and crafts and its development history, and so on [8]. Awad et al. introduced the Song dynasty kiln structure of the Yaozhou kiln, reviewed the firing technology of the Yaozhou kiln horseshoe kiln, and in another article in the same year described the replica process of the Yaozhou kiln sauce glaze porcelain from the billet, glaze recipe and other aspects [9]. With the continuous progress of the Internet+, the amount of information that people have access to every day has multiplied, but the ability and manner in which people, as receivers of information, process and receive information do not enable them to effectively accept the surge of information. In addition to being limited by the ability of the receiver to process information, information transmission can also be achieved by improving the way the subject conveys information [10].

The use of information technology in the classroom has become commonplace, and computer-aided design courses in ceramics are becoming increasingly popular, but most schools aim to use Photoshop and 3Dmax as part of their curriculum. There has not been much research on how these two courses promote students' design abilities and how they promote students' design abilities. This study attempts to supplement and correct this shortcoming in the field of ceramic art and design to make the study more theoretically relevant. Bringing convenience to the creation of ceramic art designers, it also enriches the means of creating modern ceramic art. It breaks the

limitation of traditional handmade design and makes the art design in various forms. It has the advantages of accurate and easy modification, easy communication, and high simulation. It improves the success rate of ceramic art creation, shortens the creation time, and reduces the creation cost, which makes this research more practical. Information technology makes ceramic art and design education like a tiger's wings, so that the ceramic art from content to form, has a new change, and this change will not stop, has been the fastest speed to make society changing rapidly. The students are the beneficiaries of this change, and they get the most direct improvement of their design ability in the new model of ceramic art design education.

2 MULTIMEDIA COMPUTER-AIDED CERAMIC DESIGN ANALYSIS

2.1 Multimedia Computer-Aided Design System Design

Today, augmented reality AR and virtual reality VR are covering all areas of the world like crazy. Major international companies and research institutes are investing a lot of workforce and resources in this field, fueling the growth of virtual reality and augmented reality. The spurt in the development of virtual reality technology has not only brought great impact to various industries, but also revolutionary changes to consumer cognition and business activities, which will be a visual and perceptual revolution. Text and graphics information visualization is the visual presentation of information through a combination of text, graphics, or graphics [11]. This type of information visualization can be traced back to prehistoric people's knotted stories and totemic murals. Text and graphics are the earliest and most basic forms of information visualization, as early as the oracle age, the specific boundaries between text and graphics are very vague, such as the earliest hieroglyphics, which can also be called graphics. With the differentiation of time, the boundary between text and graphics became clearer. In daily life, textual and graphic information forms are everywhere, we see and receive many textual and graphic information every day, such as newspapers, instruction manuals, posters, and so on. Converting textual information into simple, intuitive graphics, sometimes supplemented by a short text, can convey a great deal of information, as shown in Figure 1.

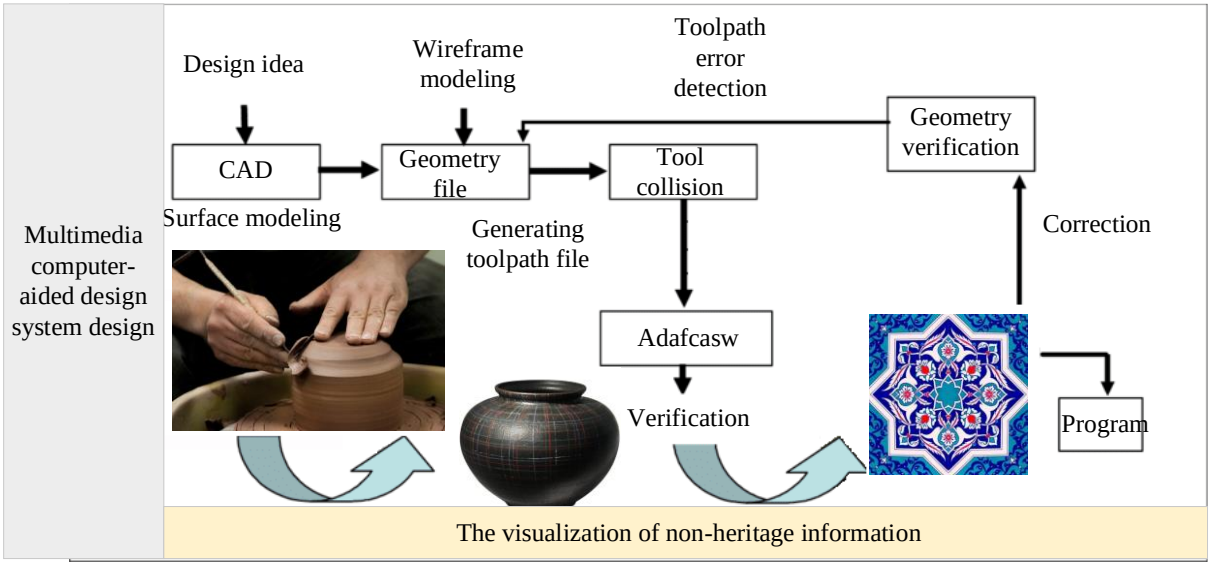

Figure 1: Multimedia computer-aided design system design.

It has been discussed before that in the multimedia form of virtual reality, changes in aesthetic form, process, and context lead to changes in the audience's aesthetic psychology. People are no longer satisfied with the functionality of the interactive system and are beginning to have new demands on its aesthetics. Based on being able to achieve goals and achieve them quickly, they also require being able to have a comfortable and pleasant experience during use. From the point of view of aesthetic experience, the interactivity of virtual reality technology can increase the user's sense of participation, together with visual feelings directly to the audience, smooth interaction and the visual changes brought about by interactivity can make the audience have a pleasant aesthetic feeling. In today's pan-aesthetic environment, people's needs for aesthetics are as common as their emotional needs.

Therefore, the focus on interactivity is also a focus on the audience's aesthetic needs. Therefore, it is necessary to study the interactive display of virtual scenes from the viewpoint of the audience's aesthetic needs. The natural interaction pursued by interactive display focuses on the mutual coordination and comfort and pleasure of the senses of the audience in the process of experience and brings the audience a pleasant aesthetic feeling. Good interaction can make people unconsciously complete the interaction with the system, the whole process is smooth and comfortable, and will not give up to achieve the goal because of poor aesthetic feelings. Focusing on the audience's aesthetic feelings can make the audience choose and accept information independently in a pleasant mood, enhance the subjective initiative to accept information, let the audience accept more information unconsciously, and achieve the purpose of information dissemination. The natural interaction that interaction design focuses on is the key to bringing aesthetic feelings to the audience.

2.2 Ceramic Design Analysis

A comprehensive analysis of the process characteristics and perceptual cognition of the colorful porcelain process under ceramics, the creation of the experience scenario will be developed from the static element extraction and 3D scene creation, static elements using Adobe Illustrator vector drawing software and 3D max modeling software for the visual design of the process scenario. Element extraction starts with the selection of characters and scene elements in the Fengshui scene, the elements in the scene are divided into critical and non-critical elements [12]. The critical elements are defined as those elements that are closely related to the craft techniques, such as the steps of the craft technicians, while the non-critical elements are defined as those elements in the scene that are not compatible with the techniques and the context. The static image elements are imported into Adobe Illustrator to extract the external outline of the key elements in the situation, and the spatial structure and depth in the flat extracted content need to be processed appropriately. According to the extraction method of the Fengshui technique, another important process link in the ceramic lower iridescent porcelain process, the glaze application process, was digitally extracted. The glazing process is divided into two parts, the glazing before painting and the spraying after firing, which is the key step to create the special effect of the decorative pattern in the porcelain technique, as shown in Figure 2.

Roughing and repairing is a fundamental part of all ceramic processes, but it is also the first process that an expert craftsman or beginner needs to understand, so the extraction of this process also needs to be reflected in the process. The pulling and reworking of the blank focus on the craftsman's control of hand strength and posture and the extraction of static visual elements mainly extract elements of the process context.

The first step is the extraction of elements of the traditional technique, which is condensed into the most common and familiar eight stages: kneading, drawing, repairing, glazing, firing, marking, Fengshui, and high-temperature firing. AR augmented reality is most directly presented by 3D models, which are available in a wide range of types, including characters, animations, and other objects. The scenes contain visual elements such as the aesthetics of the scene, color schemes, particle effects created by virtual engines, and so on. These scenes are often a refinement and

design of real scenes and are based on virtual elements of real scenes. Based on the above analysis of the requirements and principles of augmented reality AR scenes, the first step is to organize the relationship of spatial attributes in the ceramic under the colorful porcelain craft scene from the collected and organized data. The process is a step-by-step relationship, and the next process step can only be carried out after the previous process is completed. The working state and production skills of the craftsmen in each process need to be represented through model animation, the use of tools and modeling, and these spatial attribute relationships together constitute the virtual space prototype.

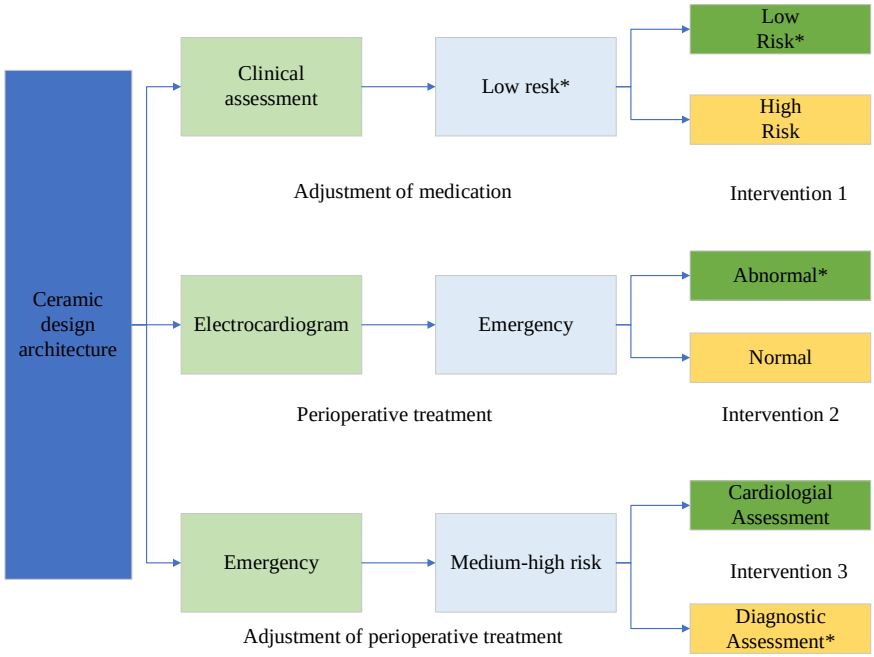

Figure 2: Ceramic design architecture.

The final proposal will be based on the shape and decoration of the four vessels. Based on these four types, the final proposal will be to design two types of ornaments in the shape of a bottle and a decorative ornament in the shape of a plate, starting from the shape of the vessel and the method of decoration. The presentation of the design is done through software and hand-drawing of the models and drawings.

The extraction of the process link is mainly in the form of graphic illustration, and the color selection of the illustration opens the overall effect of the picture with a stronger contrast, which on the one hand highlights the extracted elements, and on the other hand, helps to generate the augmented reality effect later. The digital experience of traditional craft on mobile is no longer a strange experience for users. One direction that distinguishes the traditional craft digital experience from the non-heritage experience products in the market is the craft itself. The difference between the underglaze porcelain technique and other ceramic techniques lies in the process of making underglaze porcelain, with the hooking Fengshui process and two firings being the main components of this digital experience.

3 ANALYSIS OF RESULTS

3.1 System Performance Analysis

Traditional craft culture is a specific region of a specific group of people, after years of development and inheritance to form a kind of regional culture with obvious regional, historical and social, to explore the value of a specific regional culture, it is necessary to start from the local knowledge of the region. The local knowledge has its unique cultural ecology and cultural system in each era, and this cultural ecology and cultural system are also constantly innovating and integrating. The innovation and inheritance of culture should be carried through objects, and the connotation and meaning of culture should be extracted before realizing the transformation of objects, through symbolic transformation and then design transformation. The extraction of cultural elements of traditional crafts is after shaping a specific spatial scene, the user can feel the information and emotions in the scene, it is this contextual atmosphere to stimulate the user's cognition and convey a deeper meaning. In the derived contextual experience, it is important to maintain the authenticity of traditional craft culture and the integration of traditional craft with new elements and features, as well as the sublimation of connotation, as shown in Figure 3.

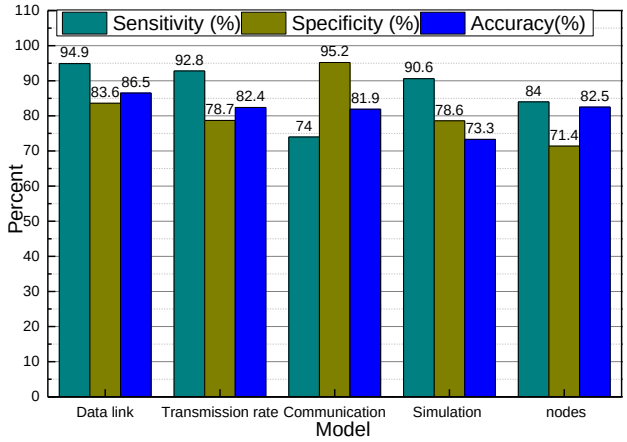

Figure 3: Scene parameter settings.

As shown in Figure 3, in the modeling process of the Song Yinzhou kiln, the technical beauty is mainly reflected in the optimization of the model, trying to remove the triangular and multilateral surfaces, to ensure the even distribution of wiring and to ensure the quality of post-rendering with the lowest number of surfaces, while accelerating the rendering speed to ensure a smooth experience of the scene. The artistic beauty of this model is mainly reflected in the artistic reconstruction based on the true reproduction of the Yinzhou kiln model, using the symmetry and balance principle of artistic beauty to carry out reasonable modeling. Its artistic beauty is also reflected in the artistic performance of the mapping materials. Material is through the adjustment of the three-dimensional model of the surface of the simulation of light transmission, reflectivity, and other data so that the three-dimensional model looks closer to the real texture. The texture is mapped out on the surface of the 3D model of the object's texture, color, etc. The 3D model has a high mode and low mode, the main difference is their fine degree, the most direct judgment is the number of surfaces, the more detail, the more surfaces of the model. Often, too much detail in the model will result in an excessive number of face counts, which is extremely challenging for the computer. To meet the system rendering speed and quality, reduce the number of faces, build a

low model, and then through normal mapping, texture mapping, and other ways to enrich the model details to achieve the visual reality, but also greatly simplify the modeling process. For example, in the modeling process of the Song Yaozhou furnace, the unevenness of the bricks is not to do with the model, but by the texture to achieve. The model reflects a smooth surface, as can be seen in the wiring diagram above. The textures and textures of the bricks and rammed earth are achieved by the mapping.

First, the simulation results of the network bandwidth usage are shown in Figure 4, where the experiments count the total number of information packets sent by the network nodes. It can be seen that the default flooding algorithm consumes the largest amount of network bandwidth for all node number conditions, the LFBL algorithm (shortest path routing algorithm) is the smallest, and the SPPB algorithm proposed in this paper is only slightly higher than the LFBL algorithm, which is still in the acceptable range. All three algorithms are positively correlated with the number of nodes. The curves corresponding to the default flooding algorithm have a larger growth rate, while those corresponding to the SPPB and LFBL algorithms have a relatively lower growth rate. The reason is that the default flood routing algorithm propagates packets of interest by broadcasting packets of interest and packets of data, whereas the SPPB and LFBL algorithms can suppress the broadcast of packets of interest and packets of data. The network bandwidth usage of the SPPB strategy is slightly higher than that of the LFBL algorithm.

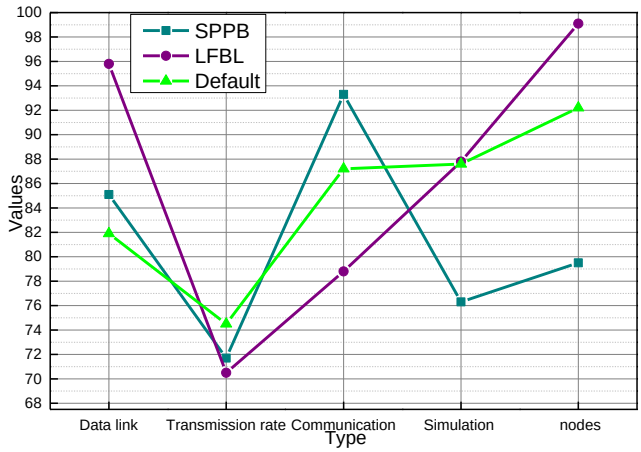

Figure 4: Network Bandwidth Usage.

The most common light effect in virtual scenes is the simulation of natural light. Natural light is the light that we see in nature daily, such as sunlight. The simulation of sunlight is most common in scenes, especially in the representation of large outdoor scenes. Typically, the simplest simulation of sunlight is to set up a parallel virtual light in the scene. Parallel light assumes that the light sources are far enough away that the distribution of light entering the scene is uniform, and the angle of incidence is infinitely close to parallel so that these sources can be simulated as parallel light. The parallel light setup is very simple, does not need to determine the exact location of the light source, only needs to be placed into the scene, set the direction of light propagation, incidence angle, etc., parallel light will illuminate the entire scene and no attenuation of light. However, in the real environment, the light is attenuated, and due to various reflections on the surface of the object creates a complex environment of intersecting light. In the virtual world, this can be simulated by setting the light source at the right location to simulate the reflected light, or by using a renderer to achieve this effect. The most widely used of these is global lighting, as shown in Figure 5.

The experimental results of the request success rate are represented in Figure 5, and the overall trend shows a positive correlation with the number of nodes. As the communication range of network nodes is fixed, in the case of fewer nodes and lower density, the number of relay nodes is small, and thus the success rate of the data request is low. As the node density increases, the number of nodes with data relay capability increases, and the success rate of the request increases. The default flooding algorithm leads to the highest request success rate because it uses a broadcast method to send packets, at the cost of maximum network bandwidth usage. The reason for the higher request success rate of the SPPB algorithm proposed in this paper relative to the LFBL algorithm is that the SPPB strategy builds the shortest path of backups in the network, which reduces the probability of failure of packet backhaul, and thus the request success rate is somewhat improved.

In virtual reality scenarios, the most common interactions to address the problem of space limitations are panning and scaling. Panning refers to making smooth and continuous movements of the viewport over a larger piece of space. In virtual reality, panning also refers to a shift in the viewer's perspective, which in theory is just a change in perspective and does not modify the content or description of the information itself. The operation to achieve panning can be sliding on a touch screen, or using an external device such as a simulated helmet to achieve a smooth movement of the viewpoint.

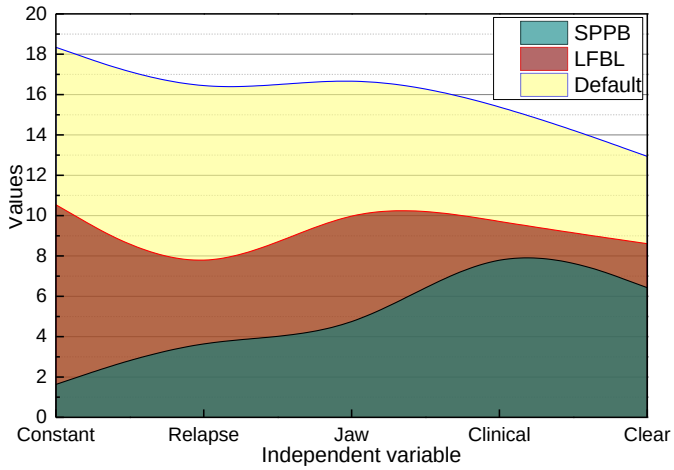

Figure 5: Average request delay experimental results.

Zooming is the smooth and continuous zooming in or out of a section of a fixed window. Apart from the inevitable filtering of contextual information out of the window during the zooming process, zooming also has little impact on the content of the message itself. During interactions, we generally pan to determine the perspective and then zoom to achieve a smooth transition of detail.

3.2 Computer-Aided Ceramic Design Results Analysis

User interfaces also have temporal properties. In virtual visualization, the time attribute of user interaction is easily overlooked, firstly, because it is often presented in the form of animated videos or steps, and secondly, because people will interact with each other according to their perceived order or placement of interaction points. However, even if it is possible to present information with a timeline, such as a moving video, there is a limit to the amount of time it can be presented. This is the time constraint of the user interface. The main reason for this is that the

viewer's patience for experience is limited, especially in virtual visualization, often with the help of external devices such as VR headsets.

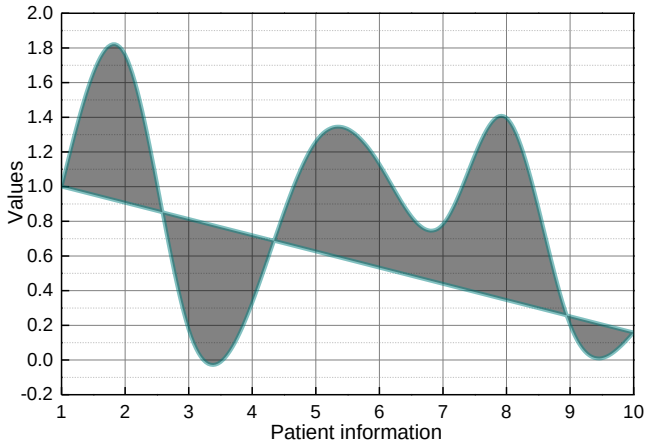

Figure 6: HDR image synthesis.

The heaviness of the device will make the audience gradually lose the initial freshness and patience in the process of experience. We investigate multiple exposures to obtain images of HDR data. We perform different sets of exposures on the same scene to obtain multiple data images with different exposures, and then we process these data images using specific algorithms to obtain high dynamic range images. The general methods to control the exposure include setting the shutter speed, adjusting the aperture size, and using a neutral filter. The first two methods are usually used to obtain high dynamic range images by compositing the data images, as shown in Figure 6.

The hue mapping display method for HDR allows the visualization of irradiated pictograms with high dynamic range, and the main technical idea is to preserve as much image data, brightness and contrast, and other image details as possible by compressing the dynamic range of the radiometric illuminance of the HDR image. There are many algorithms for hue mapping, but algorithms are not the research direction of this topic, nor the focus of this thesis discussion. It is only introduced here to pave the way for the later introduction of a manual solution to the problem of high dynamic range scene processing in digital photography that I have created. The experimental tools used are the HDR compositing plug-ins in PS.

The creation of dynamic elements of the underglaze porcelain crafting scenario is mainly the animation of the operations of the craftsmen in the respective processes in each crafting session. The animation session is divided into two parts, the first is the skeleton binding of the character models, and the second is the animation of the process steps of the character models. For example, the mud kneading technique can be divided into sheep's head mud kneading and chrysanthemum mud kneading, as shown in Figure 7, when animating the character model, the shoulder and hand joints of the character model must be very flexible, which requires the model to make the joints very flexible when matching the skeleton files. If the parts are subdivided enough, the animation effect will be more realistic and the experience will be more vivid.

The method of gripping the pencil focuses on the palm dummy, thumb, index finger, and middle finger of the hand, assisted by the ring and little fingers. The pencil grip of the model figure is shown in the figure. The standard degree of movement is determined by the skinning of the finger joints and the skeletal binding effect of the pencil grip method in the creation of the character model.

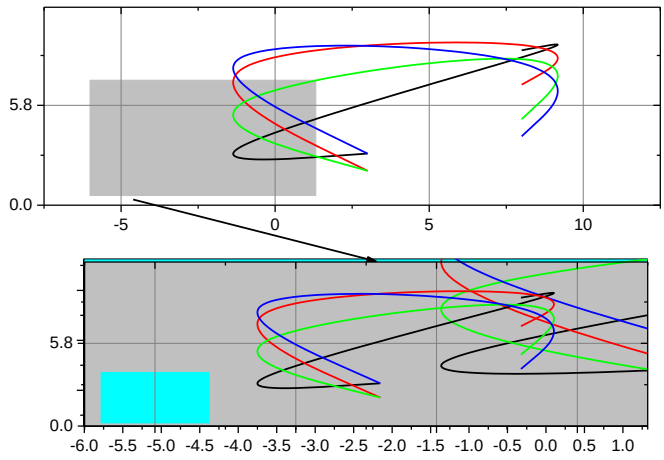

Figure 7: Grip method for outlining.

The main purpose of the character model is to sit in a seated position, and the larger hooks need to stand. The character model context creation and character skinning effect are shown in the figure. The method of animation effect is still to restore the movement of the figure when hooking a line to create a frame by frame, adjusting the movement of each frame, linking each frame to form the animation effect of hooking a line technique, as shown in Figure 8.

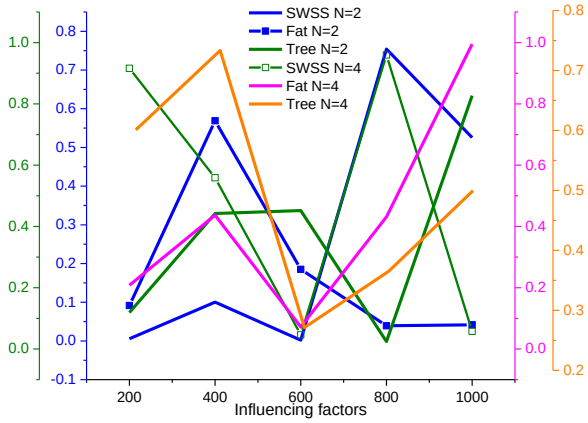

Figure 8: 3D visual result through line creation.

As shown in Figure 8, the subtle variation of the sparse and dense relationships of line groups brings numerous possibilities to the three-dimensional space. Three-dimensional visuals can also be created by interweaving patterns of horizontal and vertical line clusters with warp and weft, and the regular pattern can be created using folding, thickening, and stretching to produce a variety of rich spatial depths to explore on a flat chessboard pattern. Point, line, surface, and body are the basic elements of ceramic modeling, and any basic image in 3Dmax is composed of these basic elements. Understanding the characteristics of these elements helps us to model ceramics easily, quickly, accurately, and effectively. In the specific ceramic modeling elements and ceramic forms are complementary to each other, there is an inner connection.

4 CONCLUSION

This paper analyses the curriculum, hardware, and faculty of ceramics through the study and research of ceramics under five colors, and draws out the aspects of the program that are inadequate in terms of student competence development and inadequate traditional teaching methods of teachers. The help and advantages of having a computer-aided design course for ceramic art and design education are brought out, and the advantages and disadvantages of ceramics, a traditional craft, are found, and then innovative designs are made in response to these advantages and disadvantages. However, the limitations of the traditional craft itself and the limitations of the author's profession, for a long time, have been stuck in the search for methods and innovative paths, and have been slow to find a way to effectively integrate the traditional craft with modern technology, while also being able to combine the author's expertise in innovative design. After going through and looking up the traditional craft in the mobile application case, finally found a breakthrough in the ceramic under the colorful porcelain process link. As a visible and tangible national resource, the traditional craft can be explored and utilized in-depth, which requires a long period of trial and accumulation, efforts to find the right method, dedicated research, and continuous attempts to gain something.

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