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Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet

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Table of Contents

Abstract.....	2
Chapter 1: Introduction	4
1.1 Project Objectives	4
1.2 Achievements.....	5
1.3 Report Structured	6
Chapter 2: Background.....	8
2.1 Present Online Art Appreciate Platform for Porcelain.....	8
2.1.1 White as Jade.....	11
2.1.2 Thin as Paper	12
2.1.3 Bright as Mirror	12
2.1.4 Sound like Chime	13
Chapter 3: Design and Implementation	14
3.1 Platform Requirements Analysis.....	14
3.2 Prototype design	14
3.2.1 Methods and Environment.....	15
3.2.2 Online Exhibition platform design	17
3.3 Model Implement	18
3.3.1 3D Model Loading.....	18
3.3.2 “Sound like Chime” Effect Realization	18
3.3.3 “Bright as Mirror” Effect Realization.....	19
3.3.4 “White as jade, Thin as Paper” Effect Realization.....	20
3.4 Webpage Development.....	24
Chapter 4: Results and Discussion.....	28
4.1 Platform Establishment Results	28
4.2 Experiment and Evaluation	28
4.2.1 Experiment Design.....	28
4.2.2 Experiment Process	29
4.2.3 Experiment Results	30
Chapter 5: Conclusion and Further Work.....	33
5.1 Conclusion.....	33
5.2 Further Work	33
References	35
Acknowledgement.....	37
Appendix	38
Risk and environmental impact assessment.....	56

Abstract

At present, with the spread of the Internet, people's lifestyles have been changed and improved, and more and more daily behaviours occur online, which forming a variety of platforms and industrial chains. Furthermore, due to the covid-19, online art platforms gradually become a good way to spread culture and meet people's spiritual needs. Recently, museums and art institutions develop kinds of online exhibition platform to provide users with rich functions and a good lifelike virtual experience. However, although porcelain has tens of thousands of years of historical and cultural accumulation in China, on most online platforms, it is only displayed in a simple way as a short part or a limited link of the whole platform. Hence there is a lack of platforms that are specialized in porcelain exhibition and cultural dissemination. This project aims to implement a Chinese porcelain online exhibition platform through website construction, three-dimensional modelling and other technical methods, through reasonable planning and selection of technical routes, to make up for the gaps in the current porcelain platform, and to provide users with a way to understand the history of porcelain and learn the core of porcelain appreciation. After requirement analysis and prototype design, through the usage of HTML5, JavaScript, WebGL, three.js and Shader, this project realized a basic online exhibition platform specialized in porcelain, allowing users to understand the history of porcelain development in the order of the timeline, and accurately understand Chinese porcelains' "white as jade, thin as paper, bright as mirror, and sound like a chime" through light simulation, HDR mapping, Stereo sound, Subsurface scattering, Microfacet model, as other methods. What's more, it is possible for users to interact with 3D models and understand porcelain deeper. Finally, a platform is developed and the purpose is achieved to some extent after a user experiment.

摘要

目前，网络的普及改变和提升了人们的生活方式，越来越多的日常行为发生在了线上，形成了各种各样的平台和产业链。进一步的，由于新冠疫情，出行受到了阻碍，人们对于线上平台的需求进一步增加。其中，线上艺术平台是一种很好的传播文化、满足人们精神需求的方式。近年来，全世界的博物馆、艺术中心等也在着手于发展线上的艺术展示平台并给予用户丰富的功能和良好逼真的体验。然而，作为蕴含中国上万年历史文化积淀的瓷器，目前在大多数线上平台，仅仅是在一个环节中以平面的方式简单的二维罗列展示，缺乏针对于瓷器展示和文化传播的专项网站。本项目正是想要通过网站搭建、三维建模等技术手段，通过合理的规划和技术路线的选择实现一个中国瓷器线上展示平台，弥补目前瓷器平台的空白，提供一个可以让用户了解瓷器历史、学习瓷器鉴赏的渠道。经过需求分析和原型设计，通过使用 HTML5, JavaScript, WebGL, Three.js, Shader, Microfacet 模型，本项目实现了一个基本的跨平台的陶瓷专项艺术展示平台，能让用户以时间轴的顺序了解瓷器发展历史，通过光线模拟、HDR 环境贴图，立体音量计算，次表面散射，Microfacet 模型等技术手段，生动了解瓷器“白如玉，薄如纸，明如镜，声如磬”的鉴赏要素，并能与 3D 模型进行一定的交互。最终，平台被成功搭建且通过用户实验证明可以一定程度上满足预期目的。

Chapter 1: Introduction

1.1 Project Objectives

As a practical project, the final output of this project is an online exhibition platform specialized in Chinese porcelain that has its practical significance, overlaps space that is insufficient in present platforms to some extent, and exercises technical and analytical skills in the process of the project. Whether the progress of the process is smooth and reasonable determines the quality of the results. Therefore, industry research, requirement analysis, prototype design and the selection and realization of technical routes, every step in the process is crucial. It is through the evaluation of the art industry and the online exhibition platform industry to find the perspective that can be improved, and to achieve it by choosing a feasible technical route, so as to obtain a practical and meaningful online art exhibition platform. In this way, make users have a chance to experience a platform and demonstrate the feasibility and adequateness of the selected angle in the project to relevant industry personnel.

In the actual project progress, first, through the evaluation of online exhibition platforms at home and around abroad, divided the functions of the current online exhibition platforms. And then, use the mainstream online art exhibition platforms such as the Panorama Palace Museum as a reference to discover their current limitations- there is a lack of a platform specialized design for Chinese porcelain, and at the same time the display form is too limited, which means that the existing platforms couldn't express the important appreciation core of porcelain- white as jade, thin as paper, bright as mirror, and sound like chime. Then, by understanding the design of platforms such as the China Porcelain Museum and understanding the history, cultural value and appreciation of porcelain furthermore, the expected output of this project was determined-an online digital media art exhibition platform centred on the history and appreciation of porcelain[1]. After determining the direction of the project, through further investigation and understanding of the theoretical knowledge of porcelain, it was determined that the history of porcelain should be introduced in the order of the timeline and combines multiple display methods, as well as the core appreciation points to be satisfied- white as jade, thin as paper, bright as mirror, and sound like chime. The follow-up requirement and prototype design and the technical route determination should also focus on these elements.

So far, through the investigation and understanding of the current status of online platforms, porcelain history and appreciation element, the core goal of this project has been determined-to output a platform dedicated in Chinese porcelain that makes up for the disadvantages in current online art platforms. The core requirements of the project can also be determined. On the one hand, it is the realistic display of the appreciation characteristics of porcelain: white as jade, bright as a mirror, thin as paper, and sound like a chime; on the other hand, the platform can have certain cross-platform capabilities and potential, in this way, to be compatible with different browsers. The realization of these two core requirements is inseparable from technical means selections. It is necessary to evaluate and learn related technologies before project implementation to ensure the rationality and feasibility of the technical route. Finally, HTML5 was chosen as the technical core. HTML5 is able to connect WebGL, three.js and Shader, so as to ensure that the platform is operated cross-platform, and meanwhile, three-dimensional models are loaded, debugged, and obtained expected results.

The technical implementation of this project consists of two parts, one is platform construction, and the other is to achieve the effect of porcelain appreciation points. In terms of platform construction, HTML, CSS, and JavaScript are used to realize the expected functions. A total of 5 web pages have been developed, namely the main page, the porcelain history page, “white as jade, thin as paper” effect pages, “bright as a mirror, sound like chime” page, DIY page. In different pages, design different and proper modes and add relative contents. Meanwhile, build links between different pages by buttons. In terms of achieving the effect of porcelain appreciation, the determined core appreciation points- white as jade, thin as paper, bright as a mirror, and sound like chime determine the high-quality needs that the platform needs to meet: music playback, gesture function, user interaction, 3D effect realization, and the technical goal of this part is to simulate the effect of jade, paper, and mirror by introducing 3D models and adding effects. In terms of technical route, after investigation and evaluation, we chose to use three.js to achieve the effect of bright as mirror and sound like chime, and use the shader of WebGL to achieve the effect of white as jade and thin as paper. At the same time, through the addition of a visual interactive interface, users have the opportunity to debug the effects of porcelain by themselves, thereby further deepening their understanding of porcelain appreciation. Hence, these technical routes can satisfy the project objectives.

In the end, the project implemented an online art platform specialized in porcelain in accordance with the technical route and the prototype design. The platform is divided into two parts: porcelain history and porcelain appreciation. The history of porcelain is displayed through a timeline and use a combination of text, video, and pictures to display the development process of porcelain in China. For particular periods or dynasties, design their description mode depends on their own characteristics. In the aspect of the appreciation of porcelain. Through two 3D porcelain models to describe the core points. Firstly, three.js was used to achieve the effects of clear mirror and chime. In detail, calculate the voice volume by the real-time distance between the camera and the model, in this way, the realize 3D music effect. And then, use light effects and HDR mapping to realize the bright effect. However, when I hope to go on the next part and to realize the white and thin effect in three.js, I found that three.js was unable to achieve translucency and simulate the texture of jade. The effect is so limited that I decide to choose to use the shader in WebGL. Through the Microfacet model, comprehensively adjust the diffuse reflection, specular reflection and Microfacet material, and set parameters include Light Color, Backlight Color, Light Power, Backlight Angle, Backlight Proportion, Diffuse Color, Interior Color , Ambient, Distortion, Shader Power, Scale, Index of Refraction and Beta to realize the effect of white as jade and thin as paper, and then add a visual interface for users to adjust these parameters to obtain different porcelain effects. Hence, through the realization of the two aspects, the goal of the art exhibition platform has been achieved.

1.2 Achievements

This project is a relatively complete practical project. Taking the "online digital media art platform" as the entry point, through research and resource collection, I can confirm the targeted industry in the project, the platform's functions needed to be realized and innovative points. This process requires self-thinking and speculative abilities.

Then, after determining the direction and innovation points of the platform, in order to be able

to truly land, detailed and comprehensive requirements determination and prototyped design are required. The determination of requirements is an important part of software engineering and project implementation, which determines the smooth and reasonable implementation of the following parts of the project. Therefore, scientific methods are needed to determine requirements and their priorities, and follow-up prototype design and implementation are planned on the basis process. In the prototyping stage, it is necessary to ensure that all requirements are integrated into the platform, while paying attention to the rationality of the interface and the smoothness of use. During the project, I carried out the requirement design and the output of the prototype design as the basis for subsequent realization.

Next, in the core practice link, first, I determined the technical route. In this process, I read related projects and papers as reference, hence, to select technical routes that are applicable, moderately difficult, and reasonable in effect. This process requires reading the literature to accumulate the understanding of the relevant possible technical routes. After determining the technical route, it is necessary to apply these technologies to project to achieve the desired purpose and meet the needs of the project. In this process, there will inevitably be problems in the application of the expected technical route or the effect is not as expected. Therefore, it is necessary to purpose alternative solutions in a timely manner to balance the technical difficulty and effect of realization, so as to improve the technical ability and the ability to solve problems. In this project, through literature reading and similar practice, I chose three.js as the technical means to load the porcelain model and realize the core elements of porcelain appreciation. But because the effect of "white as jade, as thin as paper" is achieved only through three.js, the effect and texture are not in line with jade, so I chose to use WebGL and Shader to achieve the expected effect through the Microfacet model. At the same time, widely used HTML, CSS, and JavaScript to build platform pages. Thus, basically completed the project.

After the project is realized, in order to evaluate and confirm whether the project can meet the expected demand, a crowd experiment is required. Therefore, it is necessary to design experiments and evaluate project reasonably. In addition to assessing the rationality and accuracy of the process and results, it is also important to consider how to better cooperate with people to obtain their true experience of the platform while ensuring that they are not harmed. As the result, I organized 5 users to make an experiment and then prove the effectiveness and possible disadvantages of the platform.

All in all, since this project is a comprehensive and complete project, through the planning and realization of the entire project, an online art exhibition platform with certain actual functions and application scenarios can be finally obtained.

1.3 Report Structured

The entire process of this project is described in the report. The structure of the report is as follows:

First, introduce the background and the motivation of the project, and then, the main innovations of the project. Through the introduction of the current online art exhibition platform to analyse the existing shortcomings in this field, and then through the exploration of the

aesthetics and historical value of porcelain to discuss the significance of the special appreciation website of porcelain. Then, it analyses the core elements of porcelain appreciation in detail—white as jade, thin as paper, bright as mirror, and sound like chime. This is also the important information that the platform mainly wants to convey to users through technical means in the appreciation process.

After introducing the background of the project, the report will introduce the implement situation of the platform in reality. Just like the order I complete the project, first is the requirement analysis, then is the prototype design, and the introduction of the technical means needed in the process of platform construction, including WebGL, Shader and programming languages that need to be used in website construction.

Basic introduction of the technical means used in the project is not enough, it is necessary to describe the technical realization in details, from model loading to effect realization. Last, introduce the establish situation of website. Also, there is a brief discussion about the basis result of the project, and analyse the effect and the function of the platform by experiment. Finally, summary the conclusion of project and the possible directions the platform can improve in the future.

Chapter 2: Background

2.1 Present Online Art Appreciate Platform for Porcelain

Science and technology are advancing at an increasingly rapid pace and the ways in which they interact with economy, society and environment are becoming increasingly complex. The advancements in computer and telecommunication technologies have made the World Wide Web a vibrant place. Museums worldwide have recognised this phenomenon and are tapping the multimedia and interface technologies to present their contents online and in a more interesting manner[2]. In order to determine the exhibition mode, exhibition focus and technical route of the target digital media exhibition platform, it is necessary to understand and investigate the current online art platform.

In the aspect of functions, the current existing online digital media art platforms can be applied to different scenarios and for different purposes. Take "Tsinghua University Academy of Fine Arts 2020 Online Graduation Exhibition" as an example, the main purpose of this type of online digital media art exhibition is to display art works. The scope of display can be personal art exhibitions of emerging artists, student group work exhibitions, museum collections exhibitions, etc. The core requirement is to fully demonstrate the artistic connotation and personal characteristics of the exhibition. The function is relatively simple, but there are higher requirements for booth layout and product classification. It may be designed to introduce panoramic technology or even virtual reality technology, such as the "Panoramic Forbidden City". At the same time, because the online digital media art exhibition has a significant effect on aesthetics and art education. Therefore, some online digital media art exhibitions can be used mainly for education[3]. In order to satisfy the function of education, these platforms may need to extend the cultural, historical, and style connotations behind the artwork through text, audio recording, short film and even animation while exhibiting artworks. It is also possible to quantify the effect of education and improve the efficiency of education by adding certain interactions, such as comments, bullet screens, and quizzes. In addition, with the development of e-commerce platforms, e-gallery has gradually emerged. The auction of paintings and surrounding objects through online art platforms is also a gradually mature direction[4]. For this kind of art exhibition platform, it is necessary to add pricing, shopping cart, payment, order and other pages while displaying, and even enrich the types and possibilities of e-commerce sales through methods such as "customize peripherals".

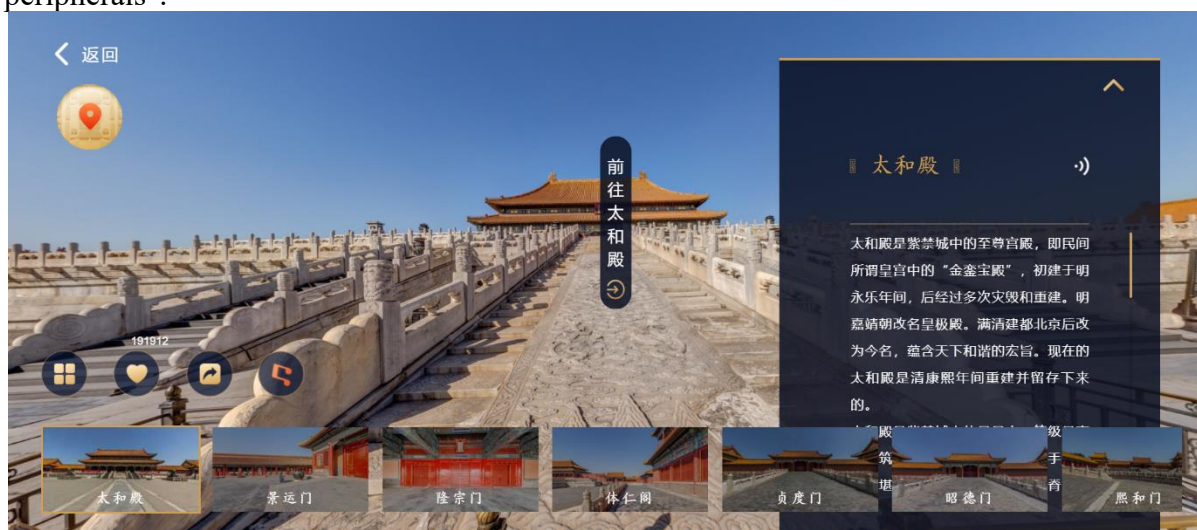


Figure 1 Panoramic Forbidden City

In these different functions and application scenarios, this project chooses to supplement the existing problems of the current art exhibition platform by designing an online digital media art exhibition platform to meet people's needs and optimize the experience. Therefore, by further detailing the understanding of the exhibition platform and the determination of the technical methods, it is found that although the current 3D user interface is common and mature in game industry; however, in other aspects such as museums, historical societies and libraries, the current digital exhibition is still limited to 2D interface display[5].

In addition, the current mainstream online art appreciation websites are all based on museum collections or institutional art exhibitions. Porcelain is often only one link or part in the whole platform with only several exhibits, and there is no art platform dedicated to describing the history and appreciation of porcelain. From the perspective of display methods, authoritative art exhibition websites such as "Panorama Palace Museum" focus on shaping the atmosphere of the entire venue, and lack the popularization of single-sample details and appreciation theories. Therefore, an art exhibition platform that combines 2D and 3D and specialized in porcelain is a gap that has not yet been realized in the existing platforms, and has its innovation and significance to realize.

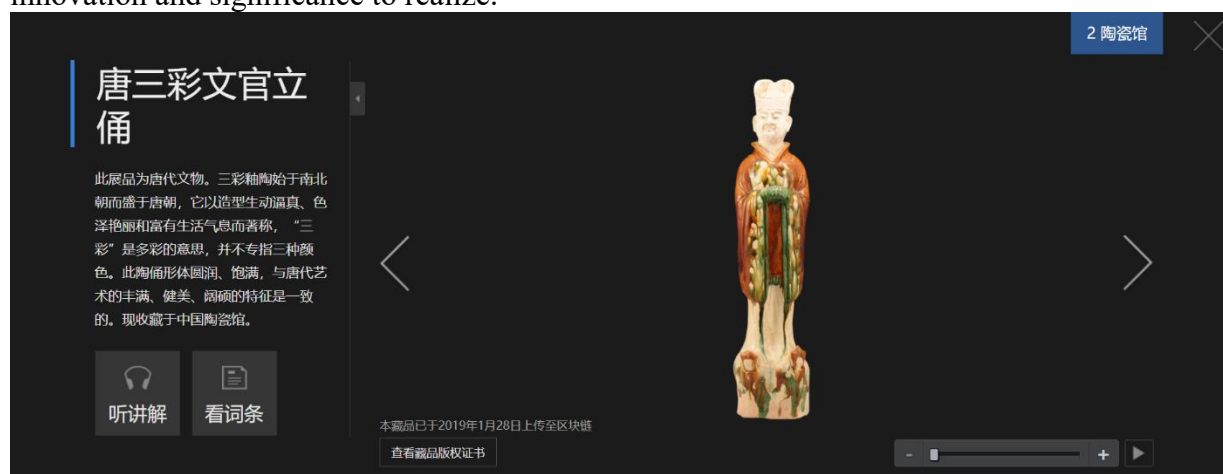


Figure 2 2D China Porcelain Museum

China is the first country in the world to invent porcelain, and it is also one of the few countries that has an emperor's official kiln. The invention of porcelain is not only an invention of material materials, and also not only represents science, technology and productivity, but also contains a choice of cultural values[6]. Therefore, through the history of Chinese porcelain, we can learn and understand Chinese society and Chinese culture, and examine the development characteristics of Chinese culture and Chinese society. That is the reason why hard-fired ceramic shards have always fascinated scholars and artists because they give tantalising clues to the past. This is especially so in relation to social, cultural and technological perspectives[7].

Porcelain first appeared in the Neolithic period. During the Qin and Han dynasties, the development of porcelain accompanied China's transition to a feudal society. In the Han Dynasty, with the change from aristocratic society to civilian society, low-key porcelain entered the lives of every household. The imperial examination system in the Tang Dynasty changed

the promotion of rural talents, and porcelain was invisibly become naturalized and combine elements in countryside and mountains. Then, due to the further development of literature and art, the artistic level of porcelain has also improved. The Song Dynasty began to use porcelain for various sacrificial ceremonies, because porcelain originated from soil, which is closer to the natural artistic essence. At the same time, the porcelain craftsmanship at this time reached its peak. It can be seen that porcelain has always been accompanied by changes in Chinese social values.

Chinese porcelain is the essence of Chinese culture, the precious cultural heritage of mankind, and the superposition of the material civilization and spiritual civilization of the Chinese nation. The appearance of porcelain can reflect the aesthetic value and aesthetic cultural psychology of people in different periods. Chinese porcelain has rich historical research value and aesthetic value. Not only is it beautiful, white and smooth in appearance, pure and hard in texture, but it can also shape a variety of appearances and change their appearance according to different folk customs and aesthetics. In terms of decoration and utility, porcelain has a unique value and outstanding achievements.

Since ancient times, porcelain has always been a means of global communication. Because porcelain culture is a special cultural form, it is a kind of arts and crafts, and also a kind of folk art and folk culture. It can broadly reflect our people's social life, world conditions, and our people's aesthetic concepts, aesthetic values, aesthetic tastes and aesthetic pursuits. "China" is translated into English as "china", and "china" means "porcelain". From this perspective, porcelain can be said to represent the image of China. Since the Han Dynasty, Chinese porcelain has been continuously spread to many countries in Asia, Africa, Europe and the Americas through the "Land Silk Road" and "Maritime Silk Road". This is important factor for Chinese porcelain culture being absorbed by European culture.

Therefore, from the perspective of the historical development, the concept of values, and the aesthetic value of porcelain, the transmission of porcelain history and cultural information has important significance and benefits for its inheritance and cultural exchanges. Furthermore, at present, with the improvement of people's living standards, modern people's individual pursuit of daily necessities provides huge space for the development of porcelain products. Daily ceramics with both appreciation and functionality will gradually become a high-quality life. Indispensable part[8]. Therefore, the online exhibition and cultural dissemination of ceramics are of great significance. An effective porcelain exhibition platform can reflect the commercial space of ceramics in real life, and reflect the powerful appreciation and emotional connotation of ceramics. Moreover, Daily ceramics with both appreciation and functionality will gradually become an indispensable part of high-quality life. Therefore, the online exhibition and cultural dissemination of porcelain are of great significance. An effective porcelain exhibition platform can reflect the commercial space of porcelain in real life, and reflect the powerful appreciation and emotional connotation of porcelain.

However, the physical properties of ceramics, such as surface quality, patterns, textures, colors, contours and proportions are important information transmitted by ceramics[9]. But subjective experience will make the current artificial art aesthetics analysis degrade, so the restoration of colors and details in the appreciation of porcelain is of great significance[10]. It should be as realistic as possible, and reduce the influence and deformation of the

environment and the outside world on the visual characteristics. These elements need to be considered in the website design, how to determine the objective aesthetic characteristics of porcelain and think about the technical route to restore the characteristics of porcelain as much as possible. Hence, in the next part of project design, I searched and determined the core appreciation elements of porcelain.

"Green as the sky, bright as mirror, thin as paper, and sound like chime" was originally used in "Museums Guide" to praise the legendary Chai kiln[11]. No one knew when and how long it was transplanted to praise the porcelain in reality. The sentence "green as the sky" was changed to "white as jade" and has been passed down to this day[12]. Whether it is "green" or "white", in fact, it refers specifically to the characteristics of Jing Porcelain which is both blue and green. But "white as jade" is not only a display of aesthetics, but also a feeling of soul and sustenance of value.

In this project, I hope it can be reflected in the porcelain appreciation part that is white as jade, thin as paper, bright as mirror, and sound like a chime, and regard it as the core element that I want to transmit to the outside world through the platform. However, in addition to the determination of the element, it is also necessary to conduct a certain argument, in-depth understanding of these elements and ensure whether existing platforms have already satisfied these characteristics, so as to better grasp and control the process of realization, and to ensure that this reduction and simulation is meaningful. By observing the restored clay pots and other forms of porcelains, it can be found that the porcelain fragments convey the intermittent narrative factors including surface quality, patterns, textures, colors, contours and proportions. These factors are also the key focus when porcelain is appreciated and can become auxiliary basis or adjustment indicators in the project realization process.

2.1.1 White as Jade

In the distant ages, the ancestors of Jingdezhen put a lot of energy, delicate emotion and higher imagination into the creation of jade porcelain[13]. The half-pottery and half-porcelain of the Southern and Northern Dynasty marked the transition from porcelain to jade, revealing its own charm in addition to the texture of Jing porcelain. The Yingqing carved porcelain of the Song Dynasty is unique in Jingdezhen, which deeply excavated the creation of the aesthetic realm. The texture of Yingqing carved porcelain is crystal clear, with moist colour, the farsightedness is permeated with tranquillity, and the close-up makes people feel subtle ingenuity. The effect of jade is so elegant and pure that it is called "fake jade". At the same time, advocating the elegance and purity of literati in Chinese history also began in the Song Dynasty[14]. In the Southern Song Dynasty, Li Qingzhao's "Jade pillow and cupboard", where "Jade Pillow" refers to the blue and white porcelain pillow. Later, because the nobles of Genghis Khan in the Yuan Dynasty did not seem to understand the aesthetics of the Han nationality, they simply did not interfere, and let the scenery porcelain develop[15]. The quiet and elegant blue and white porcelain hit sparks in the blue and white visual aesthetics of the Yuan Dynasty, so it was born. The blue and white which is born as the treasure of the world.



Figure 3 “White as jade” porcelain

However, in the online exhibition of the China Porcelain Museum, although the white porcelain is introduced and exhibited as an important link, the effect of the picture is still far from "Jade". As can be seen from the picture, its display is more of showing the characteristics of white other than the jade-likeness. Therefore, in this project, technical means will be used to reflect the jade-like characteristics of ceramics as much as possible.

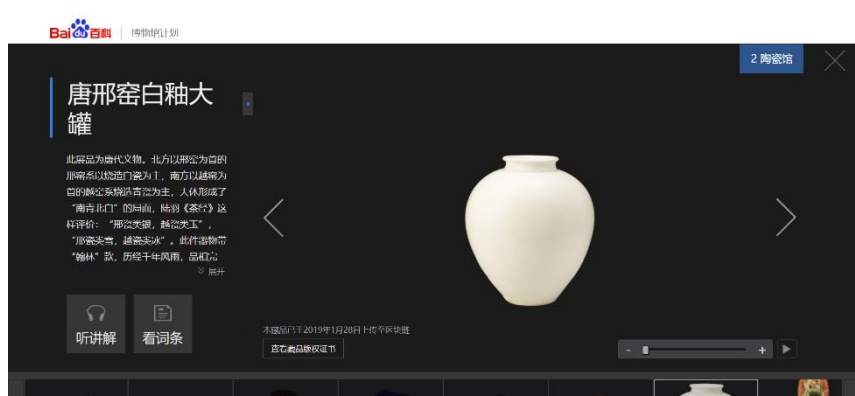


Figure 4 White Porcelain in present platform

2.1.2 Thin as Paper

Thinness is also an important texture in some porcelains. Thin porcelain is also called botanical porcelain. Since ancient times, it has the reputation of being "thin as a cicada's wings, bright as glass, as light as cloud"[16]. The high production requirements and the complexity of the production process are breath-taking. The production of thin porcelain is quite characteristic, it needs to go through more than 40 processes, each process is completed by hand, and it needs to be divided into three times to be successfully fired. Thin and translucent ceramics are unique in beauty, and are both ornamental and practical.

2.1.3 Bright as Mirror

As a kind of artistic carrier, porcelain can be given new vitality from thin porcelain through light access or other forms. Potters paint blue and white patterns on thin porcelain, which they call blue and white thin porcelain. As a new artistic attempt, the thin porcelain lamp combines light and porcelain, uses the thin and light-transmitting characteristics of the lamp ceramic body, enrich the internal texture effect and make the light and porcelain perfectly blend together. In

addition, Jingdezhen porcelain, which has the reputation of being "thin as paper", has no shortage of thin porcelain tea sets. They are as white as a moon and as thin as paper, soaked in tea juice, the fragrance of tea and beautiful utensils complement each other and shine. Nowadays, potters have combined the craftsmanship of thin porcelain to create a batch of handcrafted thin porcelain tea sets, which are simple and diverse in shape, and are characterized by lightness, thinness and lightness to highlight the feeling of returning to simplicity.

The bright and thin effect is essentially the result of the combined effect of various of environmental light and the material of the object itself. The light refracts on the surface of the object and obtain a complex effect, showing a bright and clear texture. Although the shooting of real pictures can retain a part of the effect of light on the object, which reflects a certain degree of texture. However, as a dynamically changing factor, light should also be "dynamical". Different light changes from different angles bring different effects, but at the same time, they consistently reflect the characteristics of porcelain's "thin as paper, bright as mirror". This is what this project wants to achieve, and it is currently not available on online platforms. To achieve this effect, it is necessary to perform a simulation, comprehensively using three-dimensional model and real-time light effect transformation to truly reflect the bright effect of light acting on the surface of the porcelain. In the same way, the realization of this effect can, to some extent, bridge the gap between online exhibitions and on-site observation of porcelain, and enhance the experience of authenticity.

2.1.4 Sound like Chime

The connection between porcelain and music can be traced back to primitive society. Tao Xun is one of the earliest musical instruments used by mankind[17]. At present, there are 14 types of ceramic musical instruments represented by Jingdezhen, not only have the characteristics of ethnic musical instruments, but also has the characteristics of porcelain musical instruments[18].

However, the characteristic of sound has not been taken seriously in porcelain. For example, the representative instrument of bronze chimes, although no longer common in modern music, is indeed regarded as an important part of bronze culture by many museums and platforms. In the Nanjing Museum, users can even experience the shock and the beauty of the sound of the chimes. However, the introduction of porcelain musical instruments is rarely mentioned in museums and related platforms. Furthermore, the increase in music not only allows users to further understand the characteristics of porcelain appreciation, but also enriches the display form of the platform, reflects the sense of hearing on the basis of vision, and enhances interactivity.

Chapter 3: Design and Implementation

3.1 Platform Requirements Analysis

Through the research on the online art media exhibition platform and Chinese porcelain, the core requirement of this project platform is to allow users to understand the development and appreciation of porcelain through the platform, so as to popularize the culture of porcelain and promote the development of modern porcelain.

First of all, as a complete and multi-functional platform, it needs to have a main page to navigate users to select functions and jump pages. Therefore, the main page needs to reflect the theme of the platform, clearly display the entry and content of each page, and also needs to have a certain picture display to meet the needs of the main page.

Then, in the description of the history of porcelain on the platform, in order to ensure the accurate communication of information and increase the attractiveness to users, different expressions need to be set for different time periods, and components such as text, pictures, videos and buttons are integrated to improve the page. The readability of this page allows users to obtain more information through this page and build an understanding of the overall development history of porcelain in their hearts.

On the page of porcelain appreciation, users need to meet the three prior requirements of seeing, learning, and doing by oneself. In seeing, by inserting a three-dimensional model and gestures, users can use the mouse to debug and see different sizes of porcelain from different angles. In terms of learning, a certain text description is required on the page, and at the same time, the core appreciation elements of porcelain are reflected through the effect of the porcelain itself, so that users can truly understand the main points and characteristics of porcelain appreciation.

What's more, with the purpose of museums has shifted from merely providing static information of collections to providing personalized services to various visitors worldwide, in a way suiting visitors' personal characteristics, goals, tasks and behaviours. Personalization enables changing the museum monologue into a user-centred information dialog between the museum and its visitors[19]. In the next part of design in the project, by adding a DIY debugging interface, users can debug various indicators by themselves, so as to obtain their own personalized porcelain effects, and further deepen their understanding and perception of porcelain.

3.2 Prototype design

This art exhibition platform is mainly composed of five interfaces, namely: main interface, porcelain history interface, blue and white porcelain interface for porcelain appreciation, jade porcelain interface for porcelain appreciation, and DIY interface for porcelain appreciation. Before the actual implementation, the following prototype design was carried out respectively. Of course, the follow-up realization is based on these prototypes, but I do not pursue the exact same reproduction, especially in the history of porcelain, this part will combine the actual development of porcelain in different periods to make customized designs.

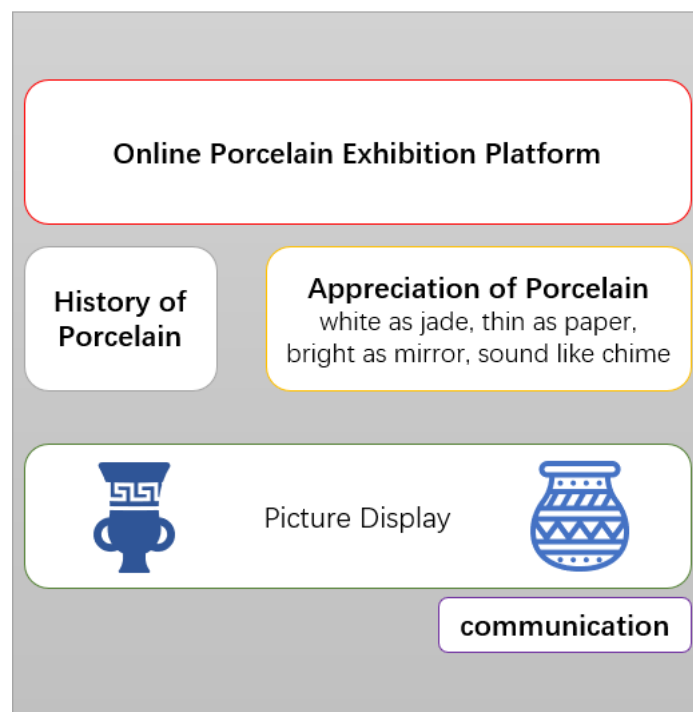


Figure 5 Prototype of the main page

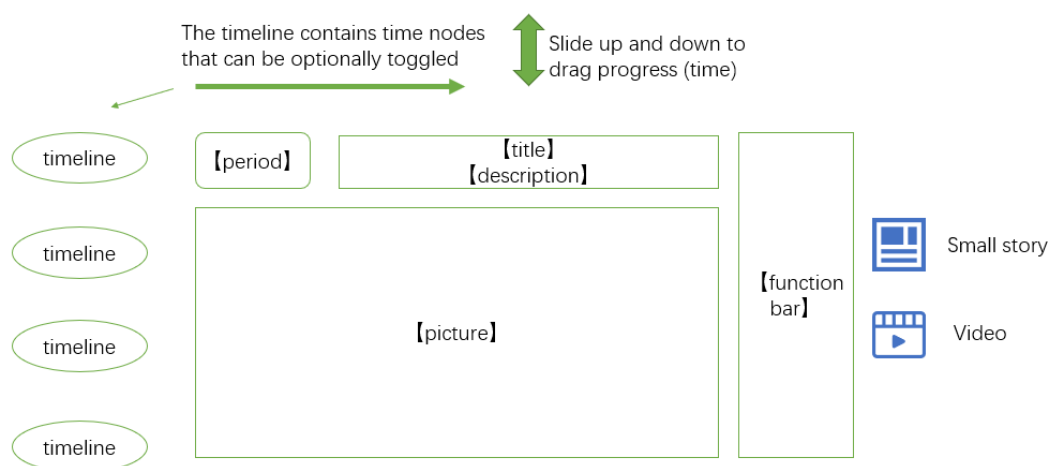


Figure 6 Prototype of porcelain history

3.2.1 Methods and Environment

3.2.1.1 HTML5

HTML5 (Hyper Text Markup Language 5) is a language description method for constructing web content. It is the latest and mature HTML standard and one of the core technologies of the Internet. Without additional plug-ins, HTML5 can carry rich web content. As a widely used language for web page development, HTML5 can give web pages better meaning and structure. HTML5's web multimedia features can be used to set and implement various of audio effects. Meanwhile, its three-dimensional, graphics and special effects features enable developers and users to obtain amazing and rich visual effects based on the 3D functions of SVG, Canvas,

WebGL and CSS3. In addition to richer web development effects, HTML5 also provides web application developers with more functional optimization options, bringing more experience features. Therefore, HTML5 provides an unprecedented open interface for data and application access. External applications can be directly connected with the data inside the browser, so that HTML5 developed web pages can have strong cross-platform compatibility, which greatly reduces the developer's repetitive work and operating costs.

In this project, not only the basic webpage construction, but also the core requirements of the platform which are appreciation effect and the cross-platform capabilities, all rely on the performance of HTML5 itself. The technologies such as WebGL, three.js, and Shader that will be applied in the project are all protocols and development kits based on HTML5 standard as the core.

3.2.1.2 WebGL

In the development of WEB technology, the graphics technology in the page is particularly important. At present, graphics technology has evolved from traditional two-dimensional to interactive three-dimensional images[20]. WebGL (Web Graphics Library) technology came into reality under this background. It can overcome the constraints of system, development environment and browser, and meanwhile has a better rendering effect. WebGL is a 3D drawing protocol. This drawing technology standard allows JavaScript and OpenGL ES 2.0 to be combined together. By adding a JavaScript binding to OpenGL ES 2.0, WebGL can provide hardware 3D accelerated rendering for HTML5 Canvas, with the help of the system graphics card, so that 3D scenes and models can be displayed smoothly in the browser, and even complex navigation and data visualization can be created. Therefore, the use of WebGL does not require the development of special rendering plug-ins specialized for web pages, but by mobilizing GPU for hardware-accelerated display, and the model can present 3D models on multiple platforms and perform multiple interactive operations, thereby providing a unique interactive experience[21]. In terms of practical applications, WebGL can be used not only to create website pages with complex 3D structures, but also to design advanced scenes such as 3D web games.

The process of drawing graphics in WebGL mainly includes the following three steps: First, obtain the graphics coordinates, and then transfer the coordinates of some graphics vertices and other data (colours, etc.) to the memory for usage in GPU drawing. Then, primitive assembly is performed, and the acquired vertex data is transmitted to the vertex shader, and the vertex shader converts these three-dimensional coordinates into projection triangles on the two-dimensional plane through the coordinate change matrix to form the target image. Since there is no color inside the target image generated by the primitive assembly, it is necessary to obtain the coverage area of the primitive based on the vertices of the generated primitive, and then transfer the fragments (pixels) in the coverage area to the GPU for rendering processing.

3.2.1.3 Three.js

WebGL has a strong vitality, but WebGL also has its certain shortcomings: its drawing standard is biased towards the bottom, and many detailed processing tasks are required when using it, such as vertex coordinates and transformation matrices, they need to be defined by

themselves. This feature makes WebGL difficult to use. Therefore, there are many 3D graphics engines for secondary packaging to enhance its ease of use. Among them, three.js is the most popular 3D rendering JS engine for web pages, which mainly encapsulates WebGL programming in an object-oriented manner[22].

The operating principle of three.js is basically the same as that of WebGL. The difference is that three.js does a lot of work for developers, such as directly exporting model data and generating change matrix when passing in model information. Therefore, the use steps are greatly simplified. Three.js has the following characteristics: It can easily realize the human-computer interaction with other elements in the webpage through JavaScript; it can directly call WebGL to realize various functions when in use; the ease of use is improved without losing flexibility; supports loading a variety of format files, when loading different types of files, call the corresponding built-in loader tool class. Three.js also inherits many features of WebGL, such as open source, cross-platform, hardware acceleration, etc.

Three.js can achieve a good and simple visualization effect on the scene. Similarly, it can guarantee compatibility on the basis of 3D programming language in mainstream web browsers. In general, three.js is a 3D engine that can be biased towards a comprehensive display model and has good performance in small scene applications.

3.2.1.4 Shader

Shader is actually a technology specifically used to render graphics. Through shader, we can customize the graphics card rendering algorithm to achieve the desired effect. If we want to render 3D graphics, you need to go through a series of steps, which are called the rendering pipeline. When developing a WebGL program, it is necessary to communicate with the GPU through the shader language to set the graphics that need to be rendered and displayed. There are two types of shaders in WebGL, vertex shader and fragment shader. The function of the vertex shader is mainly to transform the position data through a matrix, calculate the light to generate the vertex color, and transform the texture coordinate. And output the generated data to the fragment shader. The role of the fragment shader is to calculate the final element of each fragment generated in the rasterization stage. By debugging the shader parameters in the shader, different effects can be obtained.

3.2.2 Online Exhibition platform design

All web development languages used in this project, such as HTML5, CSS, and JavaScript are mature and widely used. The function of the basic digital media design website is to display relevant information through the combination of text and pictures[23]. After summarizing the history of ceramics and reading the literature, I found that "narrative" can greatly show the characteristics of porcelain history information[24]. Through research on related art exhibition websites and mini programs, I think that a "timeline" can be added to the platform. Elements to enhance the logic and individuality of the narrative. Timeline adds the personalization and interactivity of the website when users use the platform and makes the characteristics of HTML and the digital media art platform function a good combination.

3.3 Model Implement

3.3.1 3D Model Loading

In the actual operation, I obtained a glTF format model of blue and white porcelain on the online network platform. In order to adjust the subsequent effects, first of all, the blue and white porcelain model needs to be loaded into the page for debugging through three.js. Then I set the basic three elements of three.js: scene, camera, and renderer. In this way, the 3D model of blue and white porcelain was loaded through GLTFLoader in three.js as the physical basis for porcelain appreciation. Then, through OrbitControls.js in three.js, a screen self-adopting function is added as an event to the program and a controller is set to control the track so that the camera can rotate around the target, so that every time the screen resolution changes, the event is triggered to update the screen size, thereby achieving the screen size adaptive gesture effect. At the same time, the gesture effect of zooming in and out dragging with the mouse is added. So far, the target model has been loaded through three.js in the page, but the "modelling sense" of the model is very strong, there is no realistic lighting and reflection effects, hence the authenticity still needs to be significantly increased.



Figure 7 The model effect after loading

3.3.2 “Sound like Chime” Effect Realization

Although the effect “sound like chime” is just a simple effect describing the timbre of a porcelain musical instrument, it can be basically achieved through audio playback alone. But considering that this page wants to show the effect of porcelain through a 3D model, in order to maintain the consistency of the effect, while adding the music playback effect, to increase the three-dimensionality of the effect in three.js. The realization method is to determine the playback volume in real time by calculating the distance between the camera and the model, so as to increase the three-dimensionality of the sound effect. Therefore, as the user adjusts the size and angle of the 3D model through the mouse, the sound played will also change accordingly, thereby achieving the effect of "sounds like chime".

```

aa = Math.abs( controls.target.x - camera.position.x);
bb = Math.abs( controls.target.y - camera.position.y);
cc = Math.abs( controls.target.z - camera.position.z);
dd = Math.sqrt( aa*aa + cc*cc );
ee = Math.sqrt( bb*bb + dd*dd );

if( ee <= 2000 ){
    music.volume = 1 - ee/100 ;
    console.log(music.volume)
}

```

Figure 8 Formula to calculate volume

3.3.3 “Bright as Mirror” Effect Realization

The realization of the bright mirror effect is essentially through the rendering of light to obtain a bright reflection effect. To achieve a mirror-like effect, it is necessary to simulate the real-world lighting as much as possible. In three.js, because of the importance of the authenticity of 3D rendering effects, a variety of light sources are provided for selection, including ambient light, point light, spotlight, and parallel light. A factor closely related to the light source is the material. In the rendering process, the material is the combination of the visual properties of the surface, including the surface's color, texture, smoothness, transparency, reflectivity, refractive index, luminosity, etc. In order to achieve the "bright as mirror" effect, the 3D scene is rendered by combining ambient light and HDR maps to achieve the reflection effect, which basically achieves the "bright as a mirror" effect. Through the investigation of different methods and the comparison of different practical effects, I chose to achieve a "bright as a mirror" effect by comprehensively using ambient light and point light sources, plus the HDR environment map enhancement effect. High dynamic range (HDR) is a dynamic range higher than usual. The term is often used in discussing display devices, photography, 3D rendering, and sound recording including digital imaging and digital audio production. HDR reflects the details of the darkest and brightest parts of the scene at the same time, thereby preserving the contrast details of light and dark as much as possible, making the final rendering effect more realistic. The counterpart of HDR is LDR. In WebGL, in LDR, all color values are limited to the range of [0,1], and HDR breaks through this limitation and uses data over 1.0 to represent color values. The integrated use of light sources and HDR environment maps has achieved a blue and white porcelain effect that is more realistic and brighter than the ordinary 3d model effect.

In actual practice, first I set the perspective camera and renderer, then I set the point light source and ambient light and then determined their intensity and color. Then, through the resource searched from related websites, I found a HDR reflection map file in “.hdr” format which can be applied to blue and white porcelain, so I loaded it on the page and set it as the background color. After setting the reflection map, I loaded it into the 3D model through GLTFLoader and set the reflection intensity in the model. In order to ensure the real-time update of the reflection effect, I added a loop rendering, through a callback function, to update the controller and make the point light source follow the camera. During the whole process, the adjustment of position and intensity is mainly based on subjective reasons. Through the setting of different values, I can obtain better results that meet the realistic expectations as much as possible. Finally, the following effects are obtained, which basically achieves the realization of "bright like mirror" porcelain reflection effect.

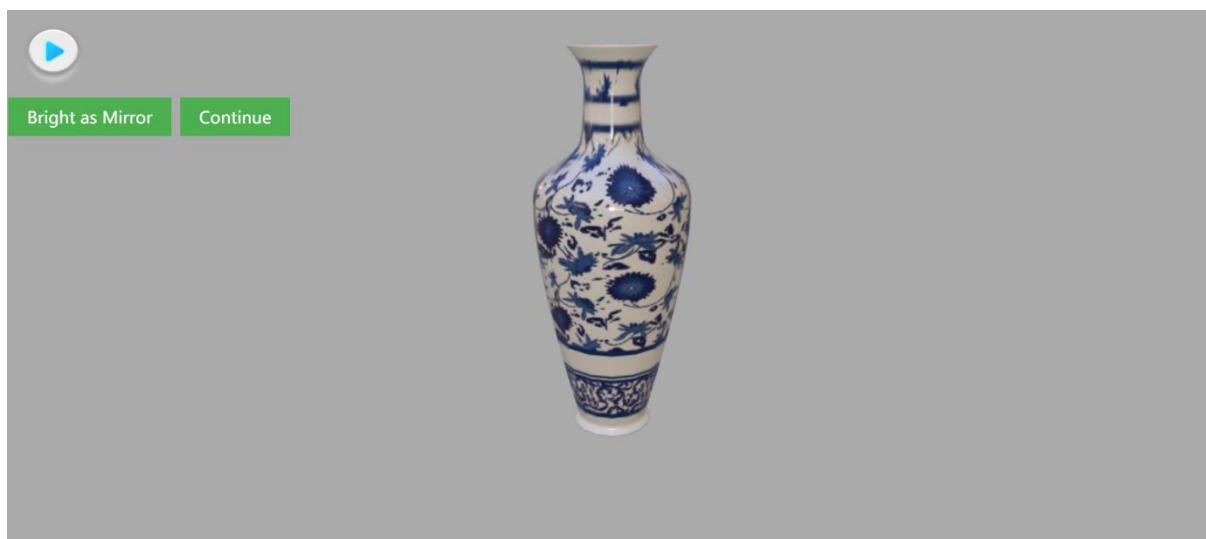


Figure 9 “Bright as mirror” effect

3.3.4 “White as jade, Thin as Paper” Effect Realization

When achieving the effect of white as jade and as thin as paper, I wanted to achieve the effect of translucency at first, so I tested it with the built-in translucency function and blending effect in three.js. However, I found that the result was not satisfactory. The porcelain is seriously distorted, which is not enough to reflect the expected effect while ensuring the texture. The purpose of this part of the project should be to highlight the thinness, transparency and jade-like nature of the porcelain while ensuring the texture and authenticity as much as possible. Due to the physical characteristics of the porcelain itself, the reflections that occur in the environment are actually a combination of multiple situations and multiple levels. The light is not only scattered on the surface of the object, but first refracted into the object, and then scattered inside the object several times, until it is emitted from a certain point on the surface of the object. The implementation of translucency in three.js is too simple to reflect the real situation. So, I consider using other alternatives and different pages to achieve the effect of white as jade and as thin as paper.



Figure 10 Translucent effect by three.js

Therefore, alternative solutions are needed to solve the problem and achieve the desired effect. Since three.js is a 3D engine that re-encapsulates WebGL, which is suitable for 3D development

of small scenes. So, when the built-in effect of three.js alone is not enough to satisfy the effect, I try to solve the problem from the bottom-level WebGL. WebGL draws and renders graphics through the vertex shader and fragment shader. Through the communication between the shaders and the GPU, deeper and more complex effects can be realized. Therefore, I tried to debug various related attributes through WebGL Shader to get a porcelain effect close to jade.

Shader, as a solution to complete complex effects, can carry a specific model or algorithm. Therefore, I searched papers and related projects, and learned about the practice of complex translucent effects including Transcut, OIT (Order-independent Transparent)[25], and found that this jade, thin and transparent effect is closely related with "subsurface scattering". This kind of optical phenomenon, in other words, can achieve the goal by realizing the effect of "subsurface scattering". Subsurface scattering is mainly used to simulate a kind of real light and shadow effects displayed inside incompletely transparent materials. It is a complex and high-quality rendered material. Generally, it is most obvious on semi-transparent materials, such as candles, marbles, jade grade etc. In subsurface scattering, light not only scatters on the surface of the object, but also refracts to the inside of the object first, and then scatters inside the object several times, until it is emitted from a certain point on the surface of the object. Therefore, the position where the light exits is different from the position where the light enters. The brightness of each point depends on the brightness of all other positions on the surface of the object, the shape and thickness of the object, etc.

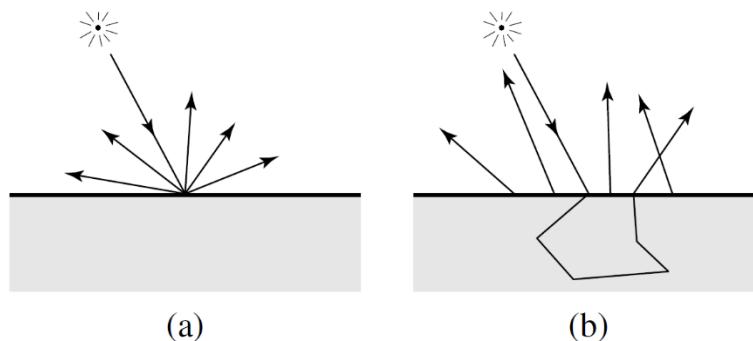


Figure 11 Diagram about normal reflection and subsurface scattering

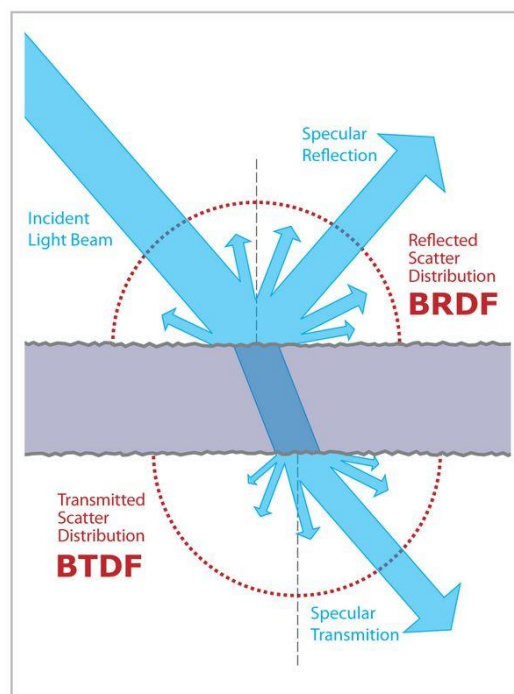


Figure 12 The track in subsurface scattering

In this project, I performed debugging in the shader based on the Microfacet model. Speaking of the Microfacet model, we first need to understand the Microfacet texture. The Microsoft texture is specifically designed to simulate rough specular reflection effects, such as plastic, ceramic, and car paint. In the Microsoft model, the coloured area is considered to be a rough area composed of countless tiny surfaces that are smaller than the coverage of the incident light. All these tiny surfaces are smoothly specular reflective surfaces. Therefore, in the Microfacet model, the shaded area cannot use a normal vector to represent the direction of the surface, but only a probability distribution function. In order to simulate the effect of multi-layer materials, the Microfacet model comprehensively applies diffuse reflection, specular reflection and Microfacet texture to decompose and integrate light, the weight of energy is calculated with the Fresnel term of the dielectric material so as to achieve subsurface scattering and have the ability to simulate the effect of similar jade porcelain.

In actual practice and debugging, I implemented Microfacet in Shader. Shader can be simply understood in WebGL as: first define vertex shader and fragment shader, and then define the related objects. By debugging the properties of the object, different rendering effects can be obtained. In this project, the attributes I set can be divided into three levels. The first level is light, including the attributes of light and back light. The attributes are Color, Power, Angle, and Proportion respectively. The second level is the lighting system, including the attributes of Diffuse, Interior, and Ambient. The attributes are Color, Power, and Scale respectively. The third level is the attributes of the shader, including Refraction, Beta. After that, the Microfacet model is implemented in the shader by expressing the change of light and the mixing of materials through multiple functions. Including the function D (Microfacet distribution function) about the normal vector m to describe the distribution of the microplate, which determines the shape and properties of the BRDF of the Microfacet model, the G function (Shadowing-Masking function G) and the energy conservation for surface reflection and refraction BSDF (Bidirectional Scattering Distribution Function).

```
<script id="shader-vs-light" type="x-shader/x-vertex">
    uniform mat4 uPMatrix;
    attribute vec3 aVertexPosition;

    void main(void) {
        gl_PointSize = 10.0;
        gl_Position = uPMatrix * vec4(aVertexPosition, 1.0);
    }
</script>

<script id="shader-fs-light" type="x-shader/x-fragment">
    precision mediump float;

    void main(void) {
        gl_FragColor = vec4(1.0, 1.0, 1.0, 0.5);
    }
</script>

float D(vec3 N, vec3 H)
{
    float cos4 = pow(dot(N, H), 4.0);
    float tan2 = 1.0 / pow(dot(N, H), 2.0) - 1.0;
    return (uBeta * uBeta) / (3.14159 * cos4 * pow(uBeta * uBeta + tan2, 2.0));
}

float G(vec3 L, vec3 V, vec3 H)
{
    return G1(L, H) * G1(V, H);
}

float rand(vec3 co)
{
    return fract(sin(dot(co.xyz, vec3(12.9898, 78.233, 23.23234))) * 43758.5453) - 0.5;
}
```

Figure 13 Microfacet model related formula in shader

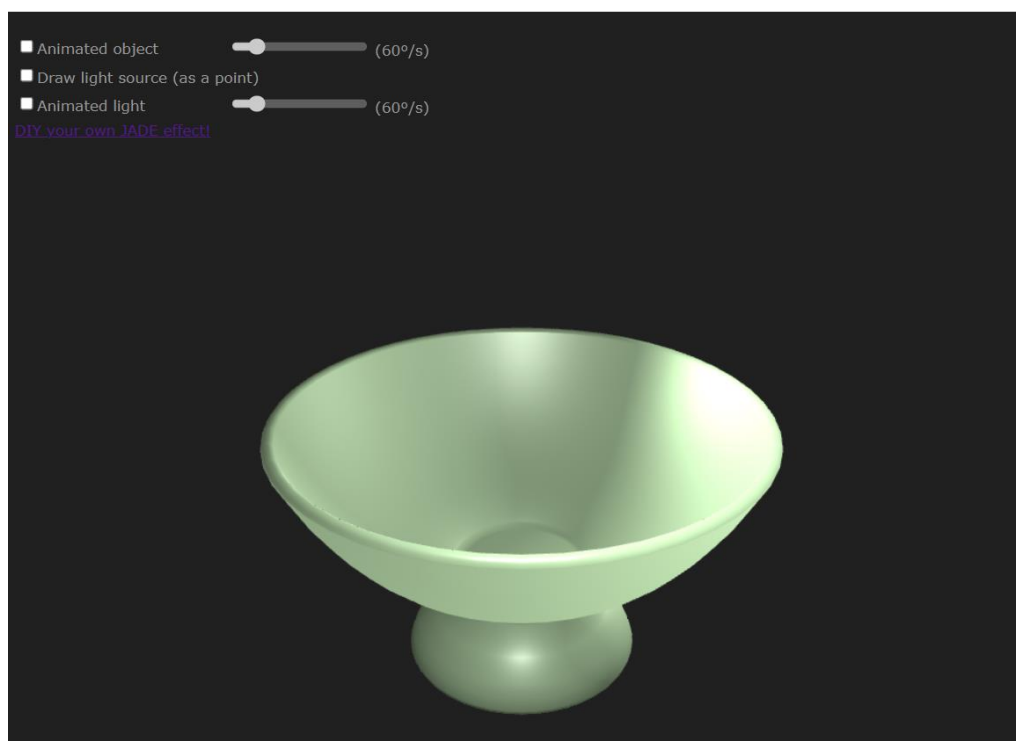


Figure 14 “white as jade, thin as paper” effect

Finally, through debugging and adjustment of all attributes, the expected jade porcelain effect was basically obtained. Further, in the debugging of various attributes of the programming language, I think that a certain amount of interaction can be added to this link, and the debugging link can be reflected on the platform interface, so that users can freely set the

effect. Users can imitate the effect of jade porcelain for simulation, or they can customize other porcelain effects according to their wishes. Therefore, by adding a function to change attributes in the file and adding corresponding buttons to the page, a visual interface is realized. As a DIY porcelain page, the page also retains the attributes originally debugged in the shader, giving users an opportunity to participate and practice.

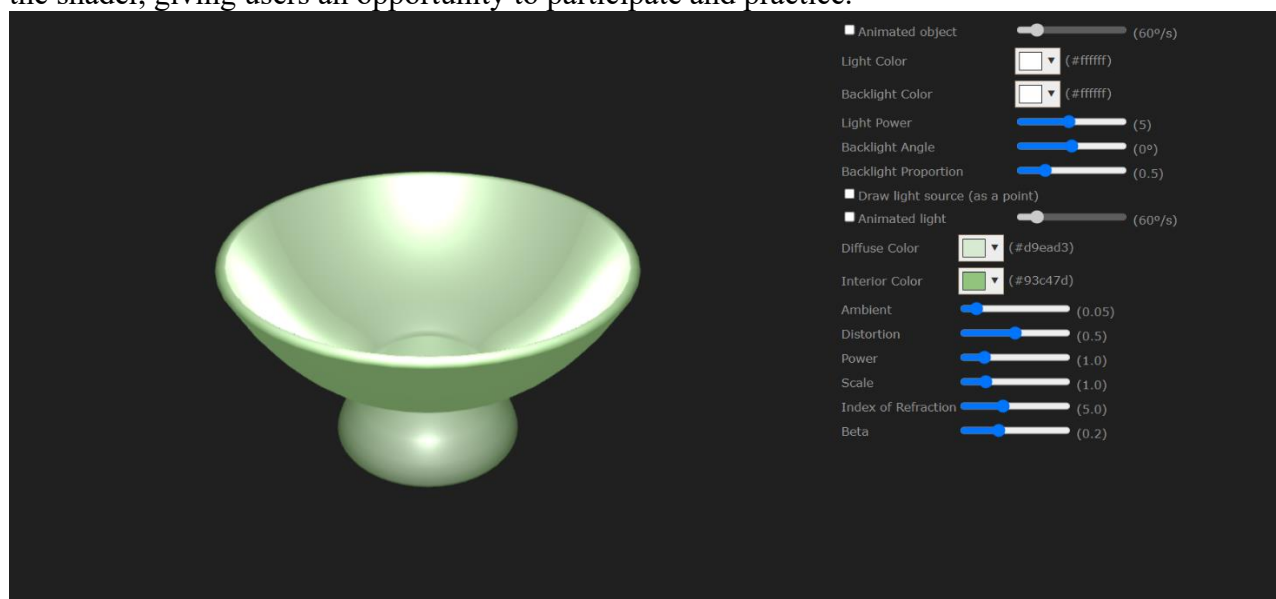


Figure 15 DIY interface

3.4 Webpage Development

Since this project is an exhibition platform, the most important purpose of the website is to be able to carry the 3D model and the information that the platform wants to convey. Therefore, the focus of this project's website is front-end display, and there is no need to add back-end, database and other functions. In the course of practice, through the use of HTML, CSS, and JavaScript language, combined with the rich pages of Bootstrap plug-ins, the five pages needed in the project were realized, which met the needs of the project for the platform. Among them, there are also certain highlights and richness. For example, the picture display of the main interface has a certain degree of fluidity. The interface of porcelain history has selected different display methods according to the characteristics of porcelain in different periods and times. The descriptive elements. Due to the many milestones in the development of porcelain in the Qin and Han dynasties, the gallery-style list was used for display. Because the colours of secret colour porcelain have endless mysteries, documentary videos are used to express vividly; because there were five famous official kilns in the Song Dynasty, Ru, Guan, Ding, Ge, and Jun, they were introduced in order in a column-by-column presentation. Therefore, it is also avoided to a certain extent that the user loses interest due to the similar display modes in different periods when browsing.

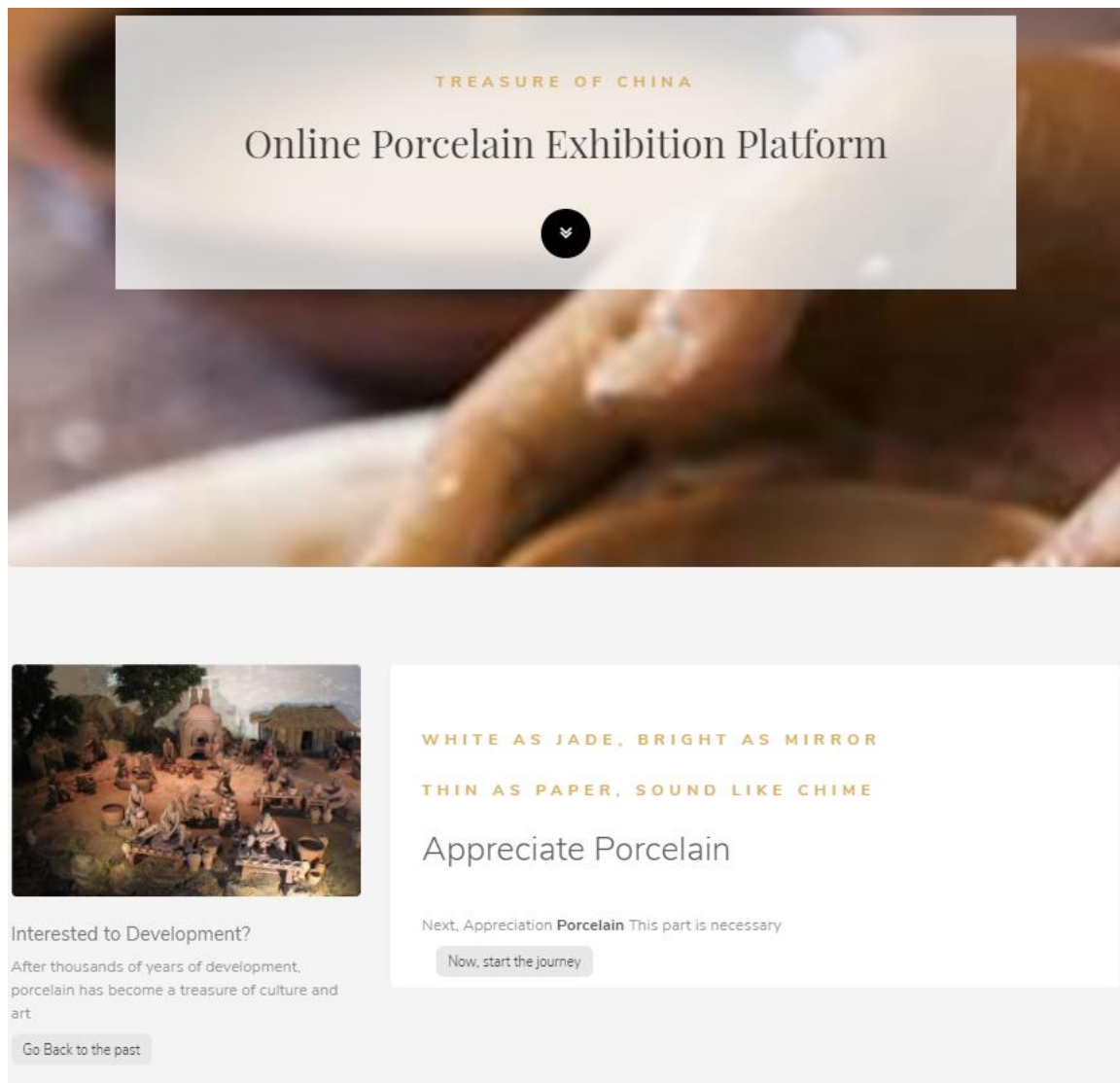
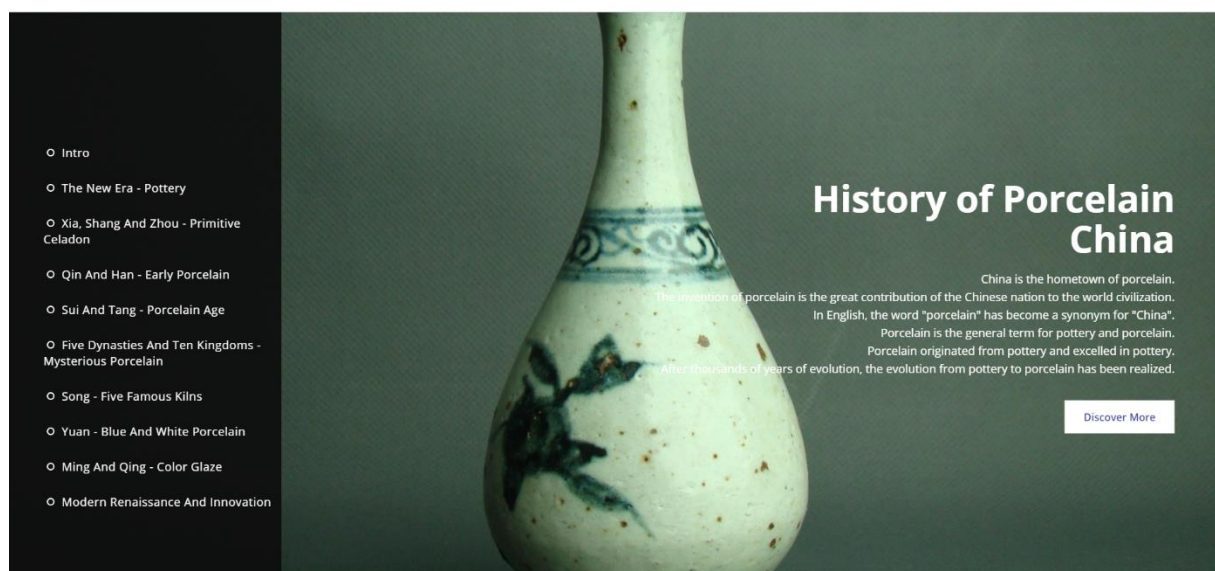
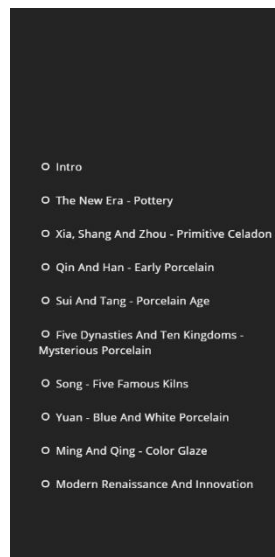


Figure 16 Main page



Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet



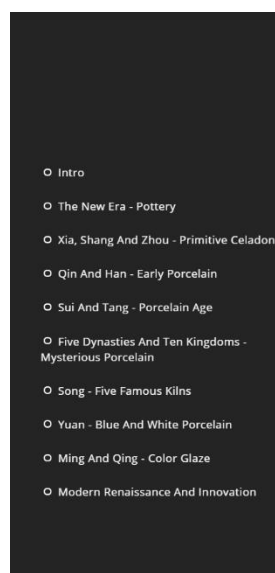
The new era Pottery

Early in the Neolithic Age, our ancestors began to make pottery. At that time, the social productivity of human beings was very low, and the material civilization of society was not high. Pottery was probably first made by coating a basket with clay and then burning the clay outside the basket and making it hard.



Qin and Han Early Porcelain

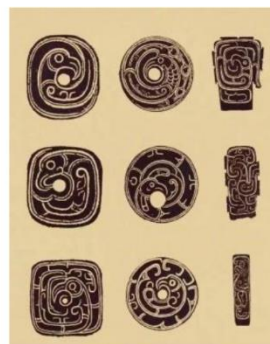
In the Qin Dynasty, pottery making reached its peak. The production of pottery and plastic is prosperous and unique. During the Eastern Han Dynasty, the real porcelain of China appeared.



Eaves tiles

The tile at the top of a roof

The design is beautiful, the font is flowing, very varied, and it is a fine artwork



Han brick

Use patterns to represent a miniature of the society

Han brick is all-encompassing, complexly beautiful, lively, with flexible lines



The Terra Cotta Warriors

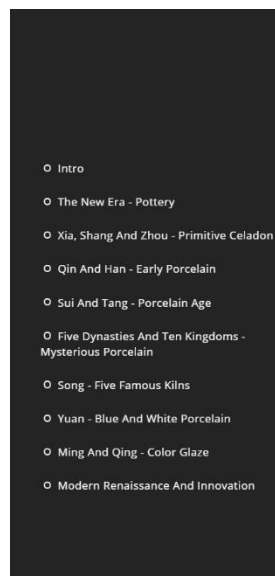
Pottery can be hidden forever, making the best burial objects.

The terra-cotta warriors are usually made by moulding. The first shape is made from a clay mould and then covered with a layer of fine mud for processing, carving and coloring.

Five Dynasties and Ten Kingdoms **Mysterious Porcelain** - Porcelain fine works

The poet Lu Guimeng of the late Tang Dynasty said in "Secret Color More", "The autumn wind dew more kiln opened, won a thousand peaks to emerald green."

You have to see it to know it's true. The bowl is hollow and empty, but it seems to be filled with spring water. The bottom of the bowl is concave from the outside to the inside, forming a tiny cambric. Under the light, the bottom of the bowl reflects a bright white light, like a cloud of water.



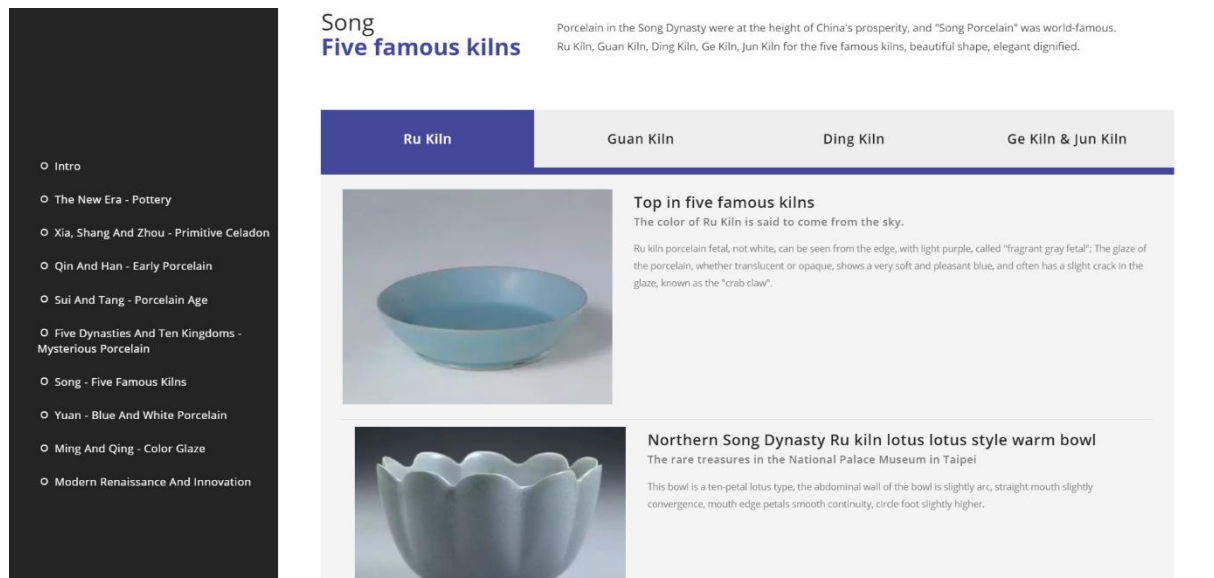


Figure 17 Porcelain history page

Chapter 4: Results and Discussion

4.1 Platform Establishment Results

Through design and practice, this project finally completed an online art exhibition platform website that can basically meet the expected functions. On the main page of the website, users can see the theme of this website and choose to jump to a different page. On the porcelain history page, they can “narratively” understand the important nodes of porcelain development and the corresponding important events or features through the timeline on the left. On the porcelain appreciation page, the core aesthetic elements of porcelain "bright as mirror, sound like chime" and "white as jade, thin as paper" are embodied through two pages respectively. Among them, the realization of "bright as a mirror" is through the HDR environment map and ambient light setting in three.js, and the realization of "sound as a chime" is to update the sound playback volume by calculating the distance between the porcelain model and the camera in real time, thereby obtaining a three-dimensional sound effect. The effect of "white as jade, thin as paper" is difficult to achieve directly through three.js, so the shader in WebGL is used, the Microfacet model is used to comprehensively debug the light, lighting system and shader attributes, and the diffuse reflection, specular reflection and Microfacet texture are used to achieve It simulates the subsurface scattering in reality, thereby simulating the "jade porcelain" effect. In terms of the interaction between the platform and the user, by visualizing the parameters in the "white as jade, as thin as paper" effect on the platform page, users are given an opportunity to customize the porcelain effect by themselves.

From the perspective of website effects, the platform can run in mainstream browsers without modifying any script codes during the test process, the model can be loaded normally, and the content and effects can be displayed normally. In the DIY page, when the porcelain model is loaded by the browser, it can be rendered by the graphics card. The tester can adjust the parameters through the buttons on the page and reflect the changes in the effect of the porcelain. The whole process is relatively smooth without obvious lag.

In summary, this platform has basically fulfilled the needs of online communication of porcelain art, history, and aesthetics.

4.2 Experiment and Evaluation

4.2.1 Experiment Design

As a practical project to meet the requirements and make up for the current shortcomings in the industry, applied to the external crowd. In addition to demonstrating the rationality of the platform's function and design from the developer's perspective, it is necessary to design externally-oriented experiments. Therefore, after the development of the platform, I designed a crowd experiment to test whether the platform can improve the understanding of porcelain culture, art, and history for a wide range of people from different angles.

The experiment mainly evaluates from two perspectives: user platform usage situation and platform usage effect. By recording the screen, record the user's track, choice and stay time for

different interfaces on the platform, and compare its performance with similar platforms, so as to obtain the user's platform usage, and then analyse the website's attractiveness to users and whether easy to start and easy to master how to use. Another angle is to evaluate through usage effect. The purpose of the design this platform is to enhance people's understanding of porcelain culture and history, and at the same time have a further interest in the daily use of modern porcelain, so as to promote the acceptance of modern porcelain by a wide range of people and into daily life. It is precisely because of this choice of evaluation angle that it is necessary to conduct detailed investigation and follow-up of each experimental subject. Therefore, in the experimental design, a wide range of people was not realistic to be selected, hence I found five individuals for a more detailed communication analysis.

4.2.2 Experiment Process

First, I refined the indicators that I wanted to use for evaluation. The indicators that evaluated the user's platform usage include the page opening status, page stay time, and the interaction status of the DIY page. The method to evaluate the effect of the user's platform use is to conduct a simple investigation of porcelain knowledge before use, and to investigate the current understanding of porcelain again after using and closing the platform. In addition, through comparison with the "China Porcelain Museum Online Exhibition" and interviews, we can further understand everyone's real feelings about the platform.

In this way, I designed different questionnaires for users before and after using the platform. At the same time, during the application of the platform, I did not conduct any auxiliary guidance to ensure that users can experience the platform independently and decide the time to stop in a quiet and undisturbed environment. After completing the two questionnaires, I conducted supplementary interviews based on the answers from the questionnaires, and used the two platforms "Panorama Palace Museum" and "China Ceramics Museum Online Exhibition" as competing products to compare horizontally with the platform in my project. In this part, I made a table and set relative quantitative standard to record users' experience toward the effect of porcelain core appreciation characteristics of different platforms. After reviewing and using the screen recording, I also obtained detailed platform usage situation and filled it in the designed platform usage evaluation template.

Table 1: Pre-usage questionnaire

Question	Rarely	Often	Always	Note
How often do you visit online museum or exhibition platforms?				
How often do visit online platform specialized in porcelain?				
How much do you know about the history of porcelain?				
How much do you know about the appreciation of porcelain?				
Would you like to take the initiative to use online platform to increase understanding of art?				
Does the existing online art platform make you feel with limitations or deficiencies?				
Have you ever bought porcelain products for daily usage?				

Table 2: Post-usage questionnaire

Question	Answer
Write down the timestamp about history of porcelain that you learnt from the platform.	
Write down the type or characteristics of porcelain you learnt from the page of history in the platform	
Write down the core of porcelain appreciation introduced in the platform.	
Write down the period or part that impressed you most in the page of history in the platform.	
Briefly evaluate the platform and your experience.	
Would you like to introduce such a platform to others?	

Table 3: Usage record form

User	Main page	History page	Appreciation page-bright	Appreciation page- sound	Appreciation page-jade	DIY	Total
A							
B							
C							
D							
E							

4.2.3 Experiment Results

As mentioned above, I used questionnaires and interviews to complete the experiment, and there are 5 users in all. Hence, I summary the usage experiment results in the following tables.

Table 4: Users' grade towards effect in platforms

Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet

Quantitative standards:

1- No effect at all

2- Only a trend, no real effect;

3-Only little effect, not enough

4-obvious effect, although not perfect

5-reasonable and realistic effect

User	White as Jade		Bright as Mirror		Thin as Paper		Sound as Chime	
	platform	competitor	platform	competitor	platform	competitor	platform	competitor
A	4	2	3	3	2	2	2	1
B	4	3	3	3	3	2	3	1
C	4	2	4	3	2	2	3	1
D	5	3	4	4	3	1	3	1
E	4	1	3	2	2	2	2	1

Table 5: Experiment Results after interviewing

User	Knowledge of existing platforms and porcelain	Platform usage situation	Platform usage effect	Evaluation between platform and competitors	Improvement	Others
A	Little known, lack of interests in porcelain	All pages 1min 53s	Keywords: history, jade	For different usage, have their own advantages and disadvantage 8.0/8.0	The jump between webpages can be more smooth	No client login choice
B	Have only use online museum, regard porcelain as an important Chinese culture element	All pages 2min 17s Stay Porcelain History page for longest	Keywords: 5 kilns in Song, Blue and white porcelain, Secret Color Porcelain	Prefer this platform because of learning new knowledge 7.7/6.0	Please introduce in much more details in the aspect of history	The fresh of the webpage is little slow
C	Little Known, think it is worthy and creative to have an online porcelain exhibition platform	All pages 2min 59s	Keywords: Appreciation, mirror, jade, instruments	The platform's exhibition mode is various, not only seeing by eyes 8.2/8.0	More descriptions in the appreciation page	
D	Know about digital media art technology, have watched porcelain exhibition offline in Beijing	All pages 3min 48s Stay DIY interface for the longest	Keywords: Bright as Mirror, White as Jade	The 3D effect is meaningful and brilliant, make it different from its competitors 7.0/6.5	Although there is a DIY interface, there should be more change and instructors	The effect in DIY interface is still limited
E	Like Panorama Forbidden City, but little known in porcelain	All pages 2min 33s	Keywords: Change between time, different kinds	Prefer competitors for its maturity 7.8/9.0	Not all the pictures are clear, the model should be more and famous items	

Through the questionnaires before using the platform, it was found that users had very little understanding of porcelain's history and online appreciation. Only one user had knowledge of the history of porcelain and had experience of browsing related websites because the user used to learn art. All other users had no similar experience. At the same time, the subject of porcelain appreciation is blank among all the surveyed users, and no one had a rich understanding of this

aspect.

Through the questionnaire about platform usage situation, it was found that five users independently chose to browse all the five interfaces, including the main page, the porcelain history page, two porcelain appreciation pages and a DIY interactive page. Among them, the longest average stay time is happened in the porcelain history page, the stay time is 4 minutes and 25 seconds, and two of the five users have opened the introduction video in the page, but none of them watched the entire video completely. At the same time, all five people noticed and used the timeline jump function in the porcelain history page. The average residence time of the two porcelain appreciation pages was over 3 minutes, and there is no obvious difference in usage, but there was a relatively large difference in usage time and method in the DIY appreciation interface. Two of the five people just simply learned the function of the interface and left the interface. And two others tried to adjust the button to change the effect, but there was no obvious purpose, that is, they did not want to achieve any target effect through the adjustment of the button. There was only one user who tried to obtain a white porcelain with special effects through adjustments, and thus obtained the longest DIY page residence time among the five. Generally speaking, in the process of using, there is no situation where the entrance cannot be found, the relationship and function of pages are difficult to understand, so users can make full use of the platform independently without external help.

Through questionnaire about the usage effect of the platform and subsequent interviews, it was found that five users had a positive evaluation of the platform to a certain extent, and believed that the platform could be used to enrich their understanding of porcelain culture and history. In terms of appreciating the core of porcelain, before using the platform, all users are almost completely ignorant of it. After using the platform, they have varying degrees of knowledge and can leave certain relevant memories. The keywords include musical instruments, jade, mirror, etc. Discussing the most impressive part of the website, the five users all focused on the three-dimensional model-related aspects, but the specific perspectives that impressed them were different, including the vivid and bright blue and white porcelain model, and the model effect that resembled jade and porcelain, able to adjust the size with mouse, dynamically watch the change of light surrounding the porcelain, and the DIY page is rich in adjustable elements. It can be said that in terms of porcelain appreciation, this platform can effectively fill the gaps in user knowledge. However, users also gave their own suggestions for the platform. For example, the current platform is still relatively simple, and there is still a certain distance from a mature, engineering, and widely used platform, and it is still at the scale of "project operation". The design is still too singular in the interaction of different interfaces and the design and interaction are relatively simple and direct. Although it makes up for the shortcomings of the current website, it is still far from a mature and exquisite website with consistent aesthetics like the "Panorama Palace". Therefore, it will bring certain obstacles to users in actively choosing and staying on the platform to obtain knowledge and artistic experience.

Chapter 5: Conclusion and Further Work

5.1 Conclusion

Through the investigation of the current online art platform and the cultural, archaeological, and aesthetic significance of Chinese porcelain, this project explores the current online digital media art platform and decide to make up for the gaps in the current online digital media art platform-to meet both the historical popularization and appreciation elements while focusing on porcelain. And then, determined the core appreciation elements realized in the platform, “white as jade, thin as paper, bright as mirror, sound like chime”.

In order to realize such a platform, a timeline-based survey on the history of porcelain was carried out, and the elements of porcelain appreciation were confirmed deeply, and then the main page and each sub-page were realized through the front-end construction of the website, and a variety of types were used in the porcelain history page. The presentation methods and timeline describe the development process of porcelain. In terms of porcelain appreciation, the details and aesthetic characteristics of porcelain are presented three-dimensionally through 3D, and the effect of "bright as mirror and sound like chime" is reflected through the HDR environment map, reflection effect settings and light effect settings in three.js. Meanwhile, through the Shader of WebGL, to use the Microfacet model to achieve the comprehensive effects of diffuse reflection, specular reflection, and Microfacet texture, and simulate the effect of subsurface scattering of porcelain in real life, thereby simulating the effect of "white as jade, thin as paper". On this basis, using the parameters in the Shader debugging process, a visual interface is designed for users to debug parameters and customize porcelain effects. Currently the website can load and run normally.

After that, through crowd experiments, it was found that the platform can enhance users' understanding of the historical development and aesthetic significance of Chinese porcelain. Its design has certain effects in promoting users' stay in the platform and enhancing users' memory about Chinese porcelain. In a word, it is a meaningful and innovative online art exhibition platform website.

5.2 Further Work

The project explored the necessity and requirements of an online art exhibition platform specialized for Chinese porcelain. During the design process, the technical route was determined and practiced based on the historical development process and the appreciation elements, and certain results were obtained. However, there is still a long way for the platform to change to an engineering project that can be promoted on a large scale.

First of all, the introduction to the history of porcelain can be richer and more detailed. At present, it is still a superficial overview of the entire development, and there is no rigorous process of refining the specific conditions of porcelain at various stages. In this way, for every single time period, there is still much space to extend more contents and sub-webpages.

For porcelain appreciation, it is possible to increase the number of models that can be appreciated. Also, to try to combine the effect of "bright as mirror, sound like chime" and "white as jade, thin as paper" in one model, or try more different effects, The effect of porcelain from different factions. Furthermore, if there is an opportunity to cooperate with other platforms or museums, the opportunity to share porcelain model resources and conduct a thematic branch introduction or appreciation introduction will also significantly enhance the professionalism and uniqueness of the platform, so that people can obtain uniqueness through the platform experience and hard-to-obtain information.

From the aspect of the whole platform, there is still a long way to go. Although from the result of experiment, this platform can be used smoothly, it is still a small-scale project instead of an engineering-level product. Meanwhile, it is obviously that this project's key point is in digital media art exhibition methods instead of the cross-platform, hence, this platform can still be improved by use crowd server, add different versions and construct client-server back end functions.

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Acknowledgement

At the beginning of the project, I had no real sense of graduation, but gradually with the project progressed, improved, and ended, I clearly realized that the four-year university life had come to an end. Looking back on the past, my heart is full of gratitude and perseverance.

First of all, I would like to thank my supervisor. From the beginning to the end of the project, he has been careful and responsible for me and kept regular and close communication with me. I still remember at the beginning, because the project can extend in many directions, I encountered a lot of difficulties such as which type of platform, whether it focuses on digital media art technology or cross-platform website construction. It is my instructor who guides me to conduct research. At the same time, he used his rich experience to evaluate and testify my research results. In this process, the detailed information and the choice of direction become clear. Of course, I also encountered difficulties during realization, and once I even wanted to give up. When I have basically completed the effect of "sound like chime, bright as mirror" with three.js, I found it difficult to continue to achieve the effect of "white as jade, thin as paper". What's more, I was troubled by the difficulty and complexity of some possible implementation approaches, thinking that I could not quickly master the new methods. During this process, my supervisor encouraged and helped me a lot. In the end, the expected effect was achieved through shader, which also gave me great encouragement and confidence. Let me believe that as long as you try more and learn more, many seemingly complex tasks can be accomplished.

Meanwhile, I also want to thank people I met in BUPT, including my roommates, my friends, and my teammates. Hence, I feel that the knowledge I gained the ability I improve, and the people I met are all worthwhile. I am grateful for all the help I received.

In addition, here, I want to say a few words to myself. Life in the past has been relatively smooth, and all the hard work has been rewarded. However, due to the covid-19 in the past year and the influence of some international policies, the life trajectory I originally planned could not proceed as I expected, which gave me an unprecedented sense of powerlessness. However, I was still unwilling to give up my own planning, gave up graduate recommendation, and continued to apply for foreign master programs. Although up to now, I still don't see a clear sign of positive, and I don't know where I will go after in the future, but I still want to tell myself, not to have too many worries, try my best to do my own thing, make rational judgments.

Finally, I once again sincerely extend my gratitude to my supervisor, school, classmates, and friends, and I also wish myself no regrets and continue to be wonderful!

Appendix

北京邮电大学本科毕业设计（论文）任务书

Project Specification Form

Part 1 – Supervisor

论文题目 Project Title	Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet		
题目分类 Scope	Software Development	Implementation	Software
主要内容 Project description	Online exhibition has become the main exhibition method of digital media art . The main targets of its design are to restore and display artworks with high precision, and to facilitate the access and appreciation of audience as broad as possible on the other hand. This project first considers compatibility with various digital media art works such as videos, images, 3D models, etc. through loosely coupled exhibition models design; secondly, designs top-level interfaces and data structures to be compatible and integrated with various platforms such as html5, apps, WeChat applets. The third is to design a set of scalable exhibition interactive interfaces to achieve smooth and comprehensive exhibition displays on various platforms; the fourth is to carry out load balancing design and stress testing to establish a ready-to-use and flexible service system for user groups of different sizes.		
关键词 Keywords	Cross-platform, Digital Media Art, Exhibition , HTML5, APP, WeChat Applet		
主要任务 Main tasks	1 This project first considers compatibility with various digital media art works such as videos, images, 3D models, etc. through loosely coupled exhibition models design		
	2 secondly, designs top-level interfaces and data structures to be compatible and integrated with various platforms such as html5, apps, WeChat applets.		
	3 The third is to design a set of scalable exhibition interactive interfaces to achieve smooth and comprehensive exhibition displays on various platforms;		
	4 the fourth is to carry out load balancing design and stress testing to establish a ready-to-use and flexible service system for user groups of different sizes.		
主要成果 Measurable outcomes	1 design patterns for Online Digital Media Art Exhibition		
	2 working Online Digital Media Art Exhibition client (software)		
	3 working Online Digital Media Art Exhibition server (software)		

北京邮电大学 本科毕业设计（论文）任务书

Project Specification Form

Part 2 - Student

学院 School	International School	专业 Programme	Telecommunications Engineering with Management		
姓 Family name	Tan	名 First Name	Yafang		
BUPT 学号 BUPT number	2017212695	QM 学号 QM number	171045998	班级 Class	2017215105
论文题目 Project Title	Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet				
论文概述 Project outline	<p>With the development and popularization of the Internet, online digital media art exhibitions have broken the constraints of time and space and have gradually become a mainstream method to exhibit art and disseminate culture [1]. Different online digital media art exhibitions have different functions, applied to different scenes, and of a high aesthetic and education value [2]. Porcelain is an immortal monument in the history of human art. It not only has extraordinary aesthetic value, but also occupies an important position in world cultural exchanges [3]. However, China currently lacks an online platform dedicated to porcelain display. Meanwhile, international porcelain-related websites are mainly focus on trading, hence there are few online display platforms that can reflect the artistic value of porcelain [4]. Furthermore, as a comprehensive art device of sculpture and painting, porcelain cannot reflect all its details only through plane. Therefore, combining modern information technology and cultural creativity to design an online media art platform that can reflect the development process, artistic connotation and appreciation of porcelain can help the inheritance and promotion of porcelain culture, allowing experiencers to intuitively feel Chinese porcelain's historical treasures and alternative charm [5]. In this way, users can easily get valuable knowledge about porcelain by sliding fingertip over webpage.</p> <p>From the first appearance of porcelain more than 20,000 years ago, to its peak during the Qianlong period of the Qing Dynasty, porcelain has undergone dozens of iterations and innovations [6]. Chinese porcelain works of art that represented by "Jingdezhen Porcelain" embodies extremely high aesthetic taste and artistic standards [7]. This research will base on the online display of porcelain, and focus on the online appreciation of porcelain. And taking Jingdezhen porcelain as a typical research object to realize the core appreciation points of Jingdezhen official kiln porcelain "white as jade, bright as mirror, thin as paper, sound as chime", through advanced 3D digital media technology such as ray tracing [8]. Design and establish an online comprehensive display framework for porcelain art from the level of optics, acoustics, and touch, and conduct user experience evaluation on the effectiveness of the experimental system through questionnaires.</p> <p>This research will integrate art theory, digital media technology and interactive design, and elaborate the development points of an online</p>				

	<p>porcelain art exhibition. The steps of this study include:</p> <ol style="list-style-type: none"> 1. Determine the history of Jingdezhen official kiln porcelain and the method to appreciate porcelain by reading documents and historical records. Design interactive pictures, sound effects, and light effects that can assist artistic display as the artistic content displayed on the platform. And design corresponding display prototype. 2. Select specific representative Jingdezhen official kiln porcelain as the object of online porcelain appreciation. First, perform high-precision modeling of porcelain, and completely reconstruct the spatial information and color information of the surface of the object at one time [9]. Then import it into the WEB VR engine to achieve 3D auditory effects and light transmission and reflection effects [10]. In the WEB VR engine, an interactive appreciation algorithm based on gestures and pressure feedback is established to achieve different sound effects when experiencer clicks on different positions of the porcelain [11]. The transparency and reflection effect can be realized by the real-time ray tracing algorithm within the WEB VR engine [12]. Finally, integrate the model, auditory content, and visual content to obtain a porcelain online art appreciation model. 3. After the realization of the porcelain online art appreciation model, enter the platform design stage. Using the knowledge of Jingdezhen official kiln porcelain, summarize the types of porcelain and the needs of art appreciation, design and establish a general framework for the online porcelain art appreciation platform, use the web development language for implementation and then complete the platform design through new exhibit tests. Especially, in order to implement functions and utilize webVR engine, the project will use threejs for developing. <p>This research uses modern digital media art as the form of expression, develops an online display platform, in order to disseminate the knowledge of porcelain appreciation. So that the experiencer can deeply experience the porcelain on the basis of understanding the porcelain culture, thereby enhancing the strength of artistic expression and value of displaying online porcelain digital model. It will provide a cross-cultural online display platform for the network communication of porcelain culture in China and the world.</p> <p>Reference:</p> <p>[1] Jiang Zhiyu. Analysis on the innovative use of digital media art in display design [A] (in Chinese). China Global Culture Publishing House, Huajiao Innovation (Beijing) Culture Media Co., Ltd. Proceedings of the 2019 Southern China Expo Symposium (3) [C]. China Global Culture Press, Huajiao Innovation (Beijing) Culture Media Co., Ltd.: Huajiao Innovation (Beijing) Culture Media Co., Ltd., 2019: 3.</p> <p>[2] Sugiarto, E., et al. (2019). Virtual gallery as a media to simulate painting appreciation in art learning. Journal of Physics: Conference Series, IOP Publishing.</p> <p>[3] Ning Gang. Porcelain-the messenger of Sino-English exchanges[J] (in Chinese). China Ceramic Industry, 2019, 26(05): 68-71.</p> <p>[4] Chandra, A. and P. Uchil (2017). Art of designing an e-art gallery. International Conference on Research into Design, Springer.</p> <p>[5] Zhao Zijun. The application of digital media art in cultural creativity-Dunhuang Mogao Grottoes[J] (in Chinese). Western Leather, 2020,</p>
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道德规范 Ethics	<p>Please confirm that you have discussed ethical issues with your Supervisor using the ethics checklist (Project Handbook Appendix 2).</p> <p>YES</p>

	<p>Summary of ethical issues:</p> <p>I may invite some participants to test the prototype.</p> <p>1. Will the participants be exposed to any risks greater than those encountered in their normal working life?</p> <p>No.</p> <p>2. Will the participants be using any non-standard hardware?</p> <p>No.</p> <p>3. How will participants voluntarily give consent?</p> <p>Verbal consent.</p> <p>4. Are you offering any incentive to the participants?</p> <p>No.</p> <p>5. Is there any intentional deception of the participants?</p> <p>No.</p> <p>6. Are any of your participants under the age of 16?</p> <p>No.</p> <p>7. Do any of your participants have an impairment that will limit their understanding or communication?</p> <p>No.</p> <p>8. Are you in a position of authority or influence over any of your participants?</p> <p>No.</p> <p>9. Will the participants be informed that they could withdraw at any time?</p> <p>Yes.</p> <p>10. Will the participants be informed of your contact details?</p> <p>Yes.</p> <p>11. Will the participants be debriefed?</p> <p>Yes.</p> <p>12. Will the data collected from participants be stored in an anonymous form?</p> <p>Yes.</p>
<p>中期目标 Mid-term target.</p> <p>It must be tangible outcomes, E.g. software, hardware or simulation.</p> <p>It will be assessed at the mid-term oral.</p>	<p>The medium-term target of the project consists of two parts. The first part is the determination and planning of the comprehensive requirements of the platform, including the overall structure and composition, the design and content of each module, and the display form. This part needs to be visually presented through the prototype diagram. Meanwhile, it is important to fully consider user requirements, usage scenarios as well as human-computer interaction. The second part is the realization and attempt of relevant digital media technologies, including the algorithm selection and reproduction of modelling of porcelain to be appreciated, 3D auditory effect, light transmission effect and gesture feedback, so as to enrich the functions of the platform.</p>

Work Plan (Gantt Chart)

Fill in the sub-tasks and insert a letter X in the cells to show the extent of each task

	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15	Feb 16-29	Mar 1-15	Mar 16-31	Apr 1-15	Apr 16-30
Task 1 Research on Porcelain's history, characteristics and appreciation methods												
Research general information about porcelain	X	X										
Research general scientific methods to appreciate porcelain, especially appreciate contemporary works	X	X										
Summary the history and characteristics of porcelain and confirm critical time nodes and relative representative works		X										
Determine how to display the information directly and how to embody and integrate the knowledge of porcelain appreciation into a platform		X	X									
Task 2 Design the function and prototype on the basis of research and users' requirements												
Collect requirements from potential users and excavate requirements from existing porcelain exhibitions		X										
Design the functions that match both the characteristics and appreciation methods of porcelain			X									
Research on the feasibility of functions and determine the technology and engine			X	X								
Conduct prototype for the platform to implement functions			X	X	X							
Task 3 Implement the 3D effect and functions by webVR and threejs												
Configure environment and learn the utilization and basic functions of webVR and threejs				X	X							
Modelling a particular 3D porcelain precisely					X	X						
Realize the functions by webVR and threejs				X	X	X	X	X				
Combine the functions with model						X	X	X				
Task 4 Conduct the establishment of platform and test												
Configure environment, learn and select basic framework or language to establish platform					X	X	X					

Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet

Establish the basic framework of the platform according to prototype						X	X	X				
Add the 3D model and other materials into platform and integrate together									X	X		
Test the functions and stability of webpage and ensure it can run in different environments										X	X	X

北京邮电大学 本科毕业设计（论文）初期进度报告

Project Early-term Progress Report

学院 School	International School	专业 Programme	Telecommunications Engineering with Management		
姓 Family name	Tan	名 First Name	Yafang		
BUPT 学号 BUPT number	2017212695	QM 学号 QM number	171045998	班级 Class	2017215105
论文题目 Project Title	Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet				
<p>已完成工作 Finished work:</p> <p>In the early stage of the project, I mainly determined the exhibition mode, presentation focus and technical route of the target online digital media art platform by combining the preparatory work and the recent further understanding and excavation of relevant fields. During this process, I further proved the feasibility and significance of the design of online digital media art platform centring on Chinese porcelain art, as well as the content and technical points in the design through the search of materials and the reading of papers as theoretical and practical support.</p> <p>With the improvement of people's living standards, modern people's personalized pursuit of daily necessities provides huge development space for porcelain products. Daily use ceramic is a design art combining appreciation and utilization, and an online digital media art platform is needed to enhance people's understanding of porcelain history and appreciation[1]. My target online digital media art platform will also be designed around these two aspects, to meet user's understanding of the history and appreciation of Porcelain.</p> <p>Through summarizing and understanding from the resources of the museums and books, I learned about porcelain history and divided development process into time stages depended on its different characteristics, to embody its past glory, modern revival and today's innovation. In this way to determine the requirements and functions of the online digital media art platform in the field of porcelain history. Basic online digital media art platform's design is to present relevant information through a combination of words and pictures. After summarizing the history of porcelain and reading the papers, I found that "diegetic" can well show the characteristics of the information of porcelain. Through the investigation and analysis of related art exhibition websites and mini-programs, I believe that the "timeline" element can be added to the platform, so as to enhance the logic and personalized narrative[2]. Timeline increases the personalization and interactivity between users and platform, which makes the features of HTML well combined with the functions of the online digital media art platform.</p> <p>Then, through further research, I found that the physical properties such as surface quality, pattern, texture, colour, shape and proportion is porcelain's important elements[3]. However, subjective experience can make artificial art aesthetic analysis degrade, so the appreciation of the porcelain's detail in the original significance is meaningful, which should be as realistic as possible, to reduce the influence of environment and the outside world for visual characteristics and deformation[4]. Therefore, I decided to reproduce the characteristics of porcelain and highlighted the characteristics of "white as jade, bright as</p>					

mirror, thin as paper and sound as chime" in porcelain appreciation. This kind of consideration is difficult to be found in current porcelain exhibition platform, because the current platform is basically still stuck in the stage of two-dimensional high-definition pictures listing and describing porcelain[5].



Fig. The online display format of the Palace Museum's ceramic gallery

In order to achieve the core characteristics of "as white as jade, as bright as mirror, as thin as paper and as sound as chime" in porcelain appreciation, I decided to conduct three-dimensional modelling of porcelain and then use Three.js to adjust the model and add effects. So I learned about Three.js and WebGL and practiced some simple examples[6]. In the process, I learned about Three.js's three components, Scene, Camera and Renderer, and then learned about Three.js's different lighting and texture effects and configured the relevant environment. I then decided to try to load a 3D porcelain model in the basis of my practice about the normal geometry for further tweaking. During this process, the choice of model's format and the loading of the model in Three.js was a challenge for me. 3D models are available in a variety of formats, such as .max, .vdk, .glTF, etc. The availability of the model and how it is loaded in Three.js are different for each format. Through the investigation and repetition of the existing cases, I chose .glTF format after trying both .vdk and .glTF formats.

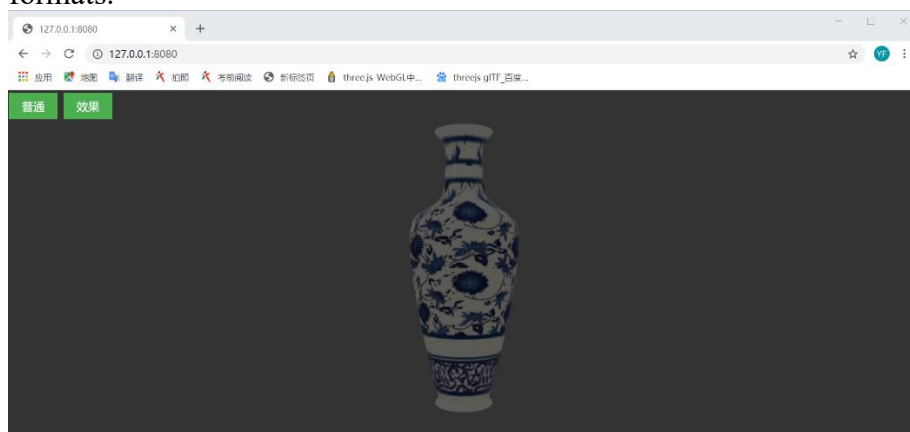


Fig. 3D porcelain model in Three.js

Although I Loaded 3D porcelain model and got the model under the basic light effect, effect is kind of so rigid that the current porcelain model cannot reflect its physical properties, material quality and the interaction with the environment. To follow-up on the basis of this, I need to add gestures, light effect, reflection mode to highlight the "white like jade, bright as a mirror, thin as paper, sound like a chime" characteristics, to let the user appreciation porcelain aesthetic characteristics[7].

On the basis of determining the functions and elements of the porcelain history and porcelain appreciation, I designed the simple prototype diagrams of porcelain history and

porcelain appreciation, in order to represent the target online digital media art platform's layout and requirements. The functions include view, timeline jumps, small story button, modelling zoom, model direction adjustment and sound effects are embodied in a relatively clear way, hence the function configuration can meet users' requirements and enlarge their knowledge networks. This kind of configuration of functions has a certain difference and progressive compared with the existing relative platforms. Subsequent platform design and technical route will also revolve around the idea and element selection in prototype diagrams.

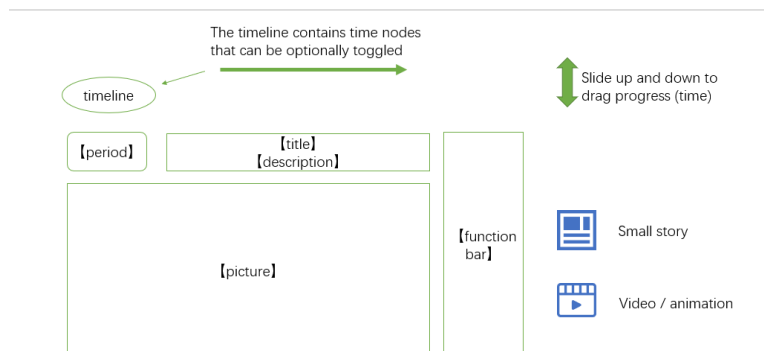


Fig. Prototype diagram of porcelain history

[1] Lv J. Designing and Aesthetics of Daily Ceramics[C]//Advanced Materials Research. Trans Tech Publications Ltd, 2011, 317: 2118-2121.

[2] Wolff A, Mulholland P, Collins T. Storyspace: a story-driven approach for creating museum narratives[C]//Proceedings of the 23rd ACM conference on Hypertext and social media. 2012: 89-98.

[3] McGrath V F. Ceramics: aesthetics of materiality[J]. 2007.

[4] Wang F, Chao H, Leng L. Color Analysis for the Quantitative Aesthetics of Qiong Kiln Ceramics[J]. Journal of Multimedia Information System, 2020, 7(2): 97-106.

[5] <https://www.dpm.org.cn/pavilion/23459.html>

[6] <http://www.hewebl.com/article/articledir/1>

[7] Viralingam N, Ramaiah C K. Comparative study of HTML and animated user interfaces of an online exhibition[J]. DESIDOC Journal of Library & Information Technology, 2008, 28(4): 43.

是否符合进度？ On schedule as per GANTT chart?

[YES/NO]

YES

下一步 Next steps:

Currently, although 3D porcelain models have been loaded on Three.js, the present effect is very limited and far from the core appreciation points of porcelain's "white as jade, bright as mirror, thin as paper and sound like chime". Next, through further understanding and practice of Three.js, I will process it from the aspects of light effect and texture to enhance the restoration and presentation of porcelain physical properties. In this process, in addition to considering the embodiment of porcelain appreciation characteristics, I will also pay attention to the efficiency of the model, according to the current understanding, a major difficulty of ray tracing in real life application is the loading capability and large volume, easy to produce overload and delay. It is important to consider that the model should be used smoothly and correctly by wide range of common users.

At the same time, I need to further refine prototype. The prototype of the current figure is

mainly reflected the function of the platform, but also lack of beauty and practical considerations. Hence, I also need to know more about the relevant website design theory and practice, to further determine the details of platform, provide the basis for the construction of the subsequent platform framework and implementation.

As the implementation of Three.js effect and platform design refinement progress, the next step is to learn and practice platform framework. In this process, the choice of framework, programming languages and libraries should be comprehensively evaluated and rationally decided to enhance the possibility of the subsequent platform building process.

The design of online digital media art platform includes 3D model design, website interaction, platform construction and other aspects of knowledge, which requires reasonable design progress, parallel learning and scientific distribution of energy in practical operation.

北京邮电大学 本科毕业设计（论文）中期进度报告

Project Mid-term Progress Report

学院 School	International School	专业 Programme	Telecommunications Engineering with Management		
姓 Family name	Tan	名 First Name	Yafang		
BUPT 学号 BUPT number	2017212695	QM 学号 QM number	171045998	班级 Class	2017215105
论文题目 Project Title	Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet				
是否完成任务书中所定的中期目标？Targets met (as set in the Specification)? YES					
<p>已完成工作 Finished work:</p> <p>To this day, I have basically met the stated targets as I planned. The following is the work content and work ideas I have completed so far.</p> <p>First of all, in order to ensure the rationality, innovation and feasibility of my design, it is necessary to carefully learn about and evaluate the related fields and technologies. Therefore, I have carried out from the aesthetic value of porcelain, the requirements and the necessity of porcelain appreciation platform, and the technical realizability and applicability.</p> <p>Hence, I found that with the improvement of people's living standards, contemporary people's individual pursuit provides a huge space for the development of ceramic products for daily usage. Daily ceramics with both appreciation and functionality will gradually become indispensable in a high-quality life[1]. Therefore, the online exhibition and cultural dissemination of porcelains are of great significance. An effective porcelain exhibition platform can reflect the commercial space of porcelains in real life, and display the powerful appreciation and emotional connotation of porcelains.</p> <p>Furthermore, as the covid-19 has swept the whole world and changed people's lifestyles, it is a basic trend to satisfy people's spiritual and aesthetic needs through online platforms. However, although the current 3D user interface has become common and mature in the game industry, in scenes such as museums, historical societies and libraries, the current digital collection exhibitions are still limited to the 2D interface display[2].</p> <p>In addition, the current mainstream online art appreciation websites are all mainly based on museum collection resources or institutional art resources. Porcelain is often just part of a link or several exhibits, which means that there is nearly no art platform dedicated to describe the history of porcelain and how to appreciate it. From the perspective of exhibit methods, authoritative art exhibition platforms such as "Panorama Palace Museum" focus on shaping the atmosphere of the entire venue, and lack the popularization of single sample details and appreciation theories.</p> <p>In summary, to some extent, the porcelain appreciation platform is an inevitable trend, and has its innovation and significance.</p>					

Before determining the requirements of the platform, I clarified the core aesthetic value of the porcelain itself that I wanted to express in my design: white as jade, bright as mirror, thin as paper, and sound like chime. This is also the core information I hope to announce to users through this platform. In this way, I have also further demonstrated and refined these aesthetic values.

In the beginning, the revert of colours and details is of great significance in the appreciation of porcelains, and subjective experience will inevitably degrade the artificial artistic aesthetic analysis. Computer-aided technologies such as digital image processing and computer vision technology should be as realistic as possible, to reduce the influence and deformation of the environment and the outside world on visual characteristics[3].

Then, by observing the repaired pottery pots and other forms of porcelains, it is found that the factors that porcelain used to fragments convey intermittent narratives include surface quality, patterns, textures, colours, contours and proportions. These factors are also the key points when porcelain objects are appreciated. These considerations are closely related to bright as mirror and thin as paper[4].

Last, the connection between porcelains and music can even be dated to primitive society. Tao Xun is one of the earliest musical instruments used by mankind[5]. At present, there are over 14 kinds of porcelain musical instruments represented by Jingdezhen. They contain not only the characteristics of national musical instruments, but also the characteristics of porcelain musical instruments[6].

Moreover, I made research on the development of museum. At present, the purpose of museum has changed from merely providing a collection of static information to providing personalized services to tourists from all over the world, in a way that suits everyone's personal characteristics, goals, tasks and behaviours[7]. In this design, the core requirements of the platform are established in the foundation to construct the basic knowledge network about the historical development of porcelain, and the understanding of the core points of the porcelain appreciation process, which is white as jade, bright as mirror, thin as paper, and sound like chime, and the webpage design and structure of the platform will also be based on this philosophy.

During this period, I also further confirmed, learned and practiced my technical route. First of all, in the direction of porcelain appreciation, I mainly realized through Three.js. Three.js can achieve a good and simple visualization effect on its scene[8]. Meanwhile, it is a 3D programming language which is able to be compatible in mainstream web browsers[9]. In addition to learning Three.js, I also had kind of comprehension of Unity, WebVR and other related knowledge, which may be used as a supplementary solution when it is not enough to only use Three.js to realize my expectational functions.

In the actual operation process, I first set the basic three elements of three.js, which are scene, camera, and renderer. And then, I used GLTFLoader to load the 3D model of blue and white porcelain which is the material basis for porcelain appreciation. Then, I realized the gesture effects of dragging, zooming in and out by screen automatically adaptation and OrbitControls. Next, I added a music play function, and realized to calculate the volume based on the distance between the camera and the model in real time; in this way, to increase the sense of three-dimensionality of the sound effect. Thereby, achieving the

“sound like chime” effect. Finally, in order to achieve the "bright as mirror" effect, I learned about methods including PBR process, ray tracing, WebVR, etc. which may be related to achieve real-time rendering or light reflection effect. After combining the comprehensive consideration of effect and applicability, I chose to render the 3D scene by combining environmental light and HDR texture creation to achieve the reflection effect, which basically achieved the "bright as mirror" effect.

In terms of platform implementation, the work I have done so far includes the preparation of webpage text content, prototyping design, platform construction related knowledge learning, including BootStrap, Vue framework, HTML, JavaScript, etc., Therefore to build the foundation for the basic framework in the next stage.

[1] Lv J. Designing and Aesthetics of Daily Ceramics[C]//Advanced Materials Research. Trans Tech Publications Ltd, 2011, 317: 2118-2121.

[2] Yeh ST, Rynhart J, Dressler T, et al. 3D Adaptive Virtual Exhibit for the University of Denver Digital Collections[J]. Code4Lib Journal, 2015 (29).

[3] Wang F, Chao H, Leng L. Color Analysis for the Quantitative Aesthetics of Qiong Kiln Ceramics[J]. Journal of Multimedia Information System, 2020, 7(2): 97-106.

[4] McGrath V F. Ceramics: aesthetics of materiality[J]. 2007.

[5] Xu Xiaozheng, Wang Hengyuan. Analyze the connection and combination between ceramics and music[J]. Art Criticism, 2020(06):170-171.

[6] Ding Yushi. An analysis of the development and innovation of ceramic musical instruments from the Tang Dynasty to modern times[J].Northern Lights,2019(10):53-54.

[7] Wang Y, Stash N, Sambeek R, et al. Cultivating personalized museum tours online and on-site[J]. Interdisciplinary science reviews, 2009, 34(2-3): 139-153.

[8] Bergman L. Creating an Appealing 3D-visualization Tool for Baseboards in the Web Browser[J]. 2020.

[9] Liu Y, Liu H, Zhao Y, et al. Teaching of advanced computer graphics with three.js[C]//Proceedings of International Conference on Education and New Developments. 2016: 13-17.

尚需完成的任务 Work to do:

In the next stage, it is necessary for me to realize the “white as jade, thin as paper” effect of porcelains, the construction of the platform, the integration of the appreciation porcelain model and the platform. Then I hope to further rationalize and refine the parameter settings in my design as much as possible, optimize the platform design, and conduct scientific crowd experiments, so as to reflect the degree of the platform in users’ porcelain knowledge network establish and interest cultivation, then to demonstrate the rationality of the platform.

存在问题 Problems:

Although the effect of "bright as mirror, sound like chime" has been basically achieved, the effect of "white as jade, thin as paper" which is currently achieved by using the translucency and blending functions in Three.js is not satisfactory and causes distortion of the porcelain model. It is not enough to reflect the expected effect while ensuring the texture.

拟采取的办法 Solutions:

Alternative solutions are needed to achieve better results, while ensuring both texture and authenticity, I need to highlight the thinness, transparency and jade-like nature of porcelain. Currently, I am learning about the implementation of translucent objects in other studies, such as transcut[1]. And I am also learning about the shader insides Three.js, trying to achieve the goal through one of the possible methods.

[1] Li D, Sun X, Ren Z, et al. Transcut: Interactive rendering of translucent cutouts[J]. IEEE Transactions on Visualization and Computer Graphics, 2012 , 19(3): 484-494.

论文结构 Structure of the final report:

This design combines history, development and aesthetical appreciation of porcelain, as well as web design and model processing. Therefore, I set up the following paper structure to reflect the full story of my project.

- 1 Introduction
 - 1.1 Project Objectives
 - 1.2 Achievements
 - 1.3 Report Structured
- 2 Motivation and Background
 - 2.1 Online Art Appreciation Platform
 - 2.2 The Uniqueness of Porcelain
 - 2.3 Aesthetic Value of Porcelain
 - 2.3.1 White as jade, Thin as paper
 - 2.3.2 Bright as mirror
 - 2.3.3 Sound like chime
 - 2.4 Three.js
 - 2.5 Webpage Development
- 3 Design and Implementation
 - 3.1 Platform Requirements Analysis
 - 3.2 Prototype
 - 3.3 3D Model Loading
 - 3.4 “Sound like chime” Effect
 - 3.5 “Bright as mirror” Effect Realization
 - 3.6 “White as jade, thin as paper” Effect Realization
 - 3.7 Webpage Development
- 4 Results and Discussion
 - 4.1 Platform Establishment Results
 - 4.2 Experiment and Evaluation
 - 4.2.1 Experiment Design
 - 4.2.2 Experiment Process
 - 4.2.3 Experiment Results
- 5 Conclusion and Further Work
 - 5.1 Conclusion
 - 5.2 Further Work
- 6 Reference

北京邮电大学 本科毕业设计（论文）教师指导记录表

Project Supervision Log

学院 School	International School	专业 Programme	Telecommunications Engineering with Management		
姓 Family name	Tan	名 First Name	Yafang		
BUPT 学号 BUPT number	2017212695	QM 学号 QM number	171045998	班级 Class	2017215105
论文题目 Project Title	Cross-platform Online Digital Media Art Exhibition on HTML5 APP WeChat Applet				
Date: 04-18-2020 Supervision type: online meeting Summary: discussed the points in writing report and reviewed the draft					
Date: 04-11-2020 Supervision type: online meeting Summary: shared the way to realize effect in details and integrate different webpages					
Date: 04-04-2020 Supervision type: online meeting Summary: realized the “white as jade, thin as paper” effect by shader in WebGL and Microfacet Model					
Date: 03-28-2020 Supervision type: online meeting Summary: shared the learning situation about subsurface scattering					
Date: 03-21-2020 Supervision type: online meeting Summary: discussed the possibility to realize shader in WebGL					
Date: 03-14-2020 Supervision type: online meeting Summary: solved the problems met in realizing shader in three.js					
Date: 03-07-2020 Supervision type: online meeting Summary: shared the learning situation about shader					
Date: 02-28-2020 Supervision type: online meeting Summary: discussed shader and related platforms					
Date: 02-28-2020 Supervision type: online meeting Summary: discussed shader and related platforms					

Date: 02-21-2020

Supervision type: online meeting

Summary: discussed “thin as paper, white as jade” effect realization route

Date: 02-07-2020

Supervision type: online meeting

Summary: shared the learning situation about webpage establishment

Date: 01-31-2020

Supervision type: online meeting

Summary: displayed “sound like chime” effect achievement

Date: 01-24-2020

Supervision type: online meeting

Summary: displayed “bright as mirror” effect achievement

Date: 01-17-2020

Supervision type: online meeting

Summary: discussed “bright as mirror” realization methods

Date: 01-03-2020

Supervision type: online meeting

Summary: displayed the 3D model loading situation by three.js

Date: 12-13-2020

Supervision type: online meeting

Summary: summarized the evaluation about porcelain core aesthetics value

Date: 12-06-2020

Supervision type: online meeting

Summary: discussed the prototype

Date: 11-29-2020

Supervision type: online meeting

Summary: summarized the evaluation about porcelain history and online exhibition platform

Date: 11-22-2020

Supervision type: online meeting

Summary: got feedback about the project specification

Date: 11-08-2020

Supervision type: online meeting

Summary: discussed the project specification

Date: 11-1-2020

Supervision type: online meeting

Summary: discussed and chose porcelain exhibition as the entry point of the project

Date: 11-20-2020

Supervision type: online meeting

Summary: discussed the comprehension about the project, prepared some kinds of ideas to complete the project and got feedback from supervisor

Date: 11-14-2020

Supervision type: online meeting

Summary: have a basic communication

Risk and environmental impact assessment

The risk and environmental impact assessment is showed by the following table.

Table 5: Risk and environmental impact assessment table

Risk	Impact	Likelihood	Consequence	Available Actions
		Level L	Level C	
Unauthorized use of pictures, models and other resources	Infringe on others' property rights and cause academic disputes	4	4	Use the resources of the public platform, not for commercial activities
A webpage crash occurred during platform loading	Affect exhibition effect and the spread of platform content, as well as the normal user experience	3	4	Ensure a good network environment
The necessary network resources are invalid or maintenance suspension (the format conversion tool of the 3D model is no longer available due to maintenance suspension)	Affect the progress of completing the expected function	3	3	Looking for alternatives
The project contains a lot of files and source code, which may be lost due to viruses or misuse	Affect the normal progress of the project and need time for repetitive work to restore the corresponding resources	2	3	Timely backup, pay attention to the naming of different versions
During the experiment, due to the platform's music and picture effects, the user's body was harmed	Negative and irreversible effects on the user's body	1	3	Debug relevant parameters of the platform before the experiment, and conduct a pre-investigation of the user's physical condition