Design and Production of Digital Interactive Installation for the Cultural Theme of the Belt and Road Initiative

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Abstract. Chinese traditional culture provides an endless source of ideas for the digital creative cultural industry. Nowadays, in the cultural industry chain, IP contains a huge potential value. The combination of digital interactive technology and cultural content as well as industry is one of the paths of cultural innovation. This paper takes the Dunhuang caisson patterns under the cultural theme of the Belt and Road Initiative as the subject of expression. By integrating the pattern elements into digital animation and digital interaction, its design and production with the digital interactive installation display form finally show the historical and cultural connotation of the traditional silk road. Through the performance of the interactive installation in the form of digital art display and the application analysis in the design fusion of digital media, this paper explains the construction and implementation of the digital visualization and digital interactive installation of Dunhuang art, aiming to raise awareness. It also hopes to enhance the viewer's sense of integration and participation with interactive technology of digital media, thus helping the protection and inheritance, dissemination and promotion of traditional culture.

1. Introduction
With the continuous and rapid improvement of social civilization and computer technology, traditional installation art is endowed with a more free and unique expression mode. Especially comparing with the single expression form of traditional media, digital installation art design not only is an innovation of traditional works, but also takes into account the emotional needs of the audience. It brings viewers unique emotional feelings and vibrant virtual experience through the use of digital interactive technology. Incorporating interactivity into the digital installation art helps to improve viewers' interest and perceptive experience, and change people's usual aesthetic sense and artistic cognition.

The works of digital installation art not only help to attract the audience, but also deepen the audience's perception and experience. The works boost the promotion of traditional culture, protect cultural heritage, explore traditional culture and reasonably transform it to form a multi-platform cultural creative display, so as to achieve the purpose of exploring and discovering traditional aesthetics and promoting the cultural content of the Belt and Road Initiative.

The reason why digital media technology is the optimal means to protect and spread cultural heritage is that its digital image can be permanently saved and recorded. The digital media technology is employed to show artistic aesthetics of Dunhuang. The static patterns are transformed into physical dynamic installations combining installation art and dynamic visual effects, so that visitors can subjectively immerse themselves in the visual dynamic aesthetics. The digital media interactive
technology is used in works of art, whose interactive participation stimulates the audience's interest, gives full play to the audience's subjective initiative to experience the connotation and value of installation art design, narrowing the distance between the work and the audience, spreading and promoting traditional culture and also integrating digital media technology into the practical actions of cultural innovation.

2. Applied analysis of interactive installation art in digital media design
In the creation of digital media design projects, designers no longer convey and express content and ideas unidirectionally, but try to create immersion. Interactive installation art makes full use of modern scientific and technological means to create a virtual environment space, so that participants can experience it in depth. Such environmental space converts the audience from passive to active, and fully mobilizes all the senses to feel the works. [1]

2.1. Kinect digital interactive installation
American interactive installation artist, Daniel Rozin, created an interactive "mirror" - showing the audience's inverted image with small pompon toys. The Kinect dynamic motion catcher and 928 small pompon toys are connected by 464 electric machines, so that the mirror can create the mirror reflection of the audience in real time, as shown in Figure 1.

![Figure 1. Kinect Display Drawing](image)

This interactive installation art mainly adopts Kinect dynamic capture technology to feed back the dynamic information of the characters in real time, and visualize the information data into an interactive visual experience. Artistic expression changes and unique aesthetic taste of interactive installation art are formed with this multi-media unification. The advantage of interactive device is that it provides artistic creators with more expressive expressions, the compatibility and organic combination of various arts, and the diversity to realize artistic expressions as well as the diversity of artistic languages.

2.2. Rain room digital interactive installation
The Rain room interactive installation is produced by Random International. The Rain room interactive installation provides visitors with a seemingly impossible experience. In a space of more than 400 square meters, continuous rainfall has caused a turbid indoor rainfall space. The audience can move freely, but the rain falls around them without wetting them. The scene is shown in Figure 2. The audience can pass through this raining area. The device can detect where the person is and stop raining. In this way, people seem to have superpowers that allow them to control the rain freely without being exposed to it.

![Figure 2. Rain room Display Drawing](image)
The interactive installation of the Rain room mainly adopts the "ground interactive projection technology", with sensor and projector on the top. The sensor is an infrared camera or a depth sensor with fill light lamp. The water curtain replaces the camera in this device. Many 3D sensors are installed in the "rain room", which can detect the motion of the person and make the "raindrop" stop at where the person is. When the person leaves, the rain continues to fall. The drying radius of each rain switch is 90cm. The visitors to the rain room cannot exceed a certain amount, or otherwise the rain will stop.

For interactive installation art works, it mainly consists of some objective entities represented artistically by the works and control systems. Among them, the control system can be regarded as the nervous system of the installation, which is used to perceive humans' response and environmental changes, and drives the installation to produce motion, sound, and visual images. [2]

3. Design and production of digital interactive installation
The original work Dunhe Huangsheng comes from the words "Dun means hugeness, Huang means prosperity" in the Book of Han noted by Ying Shao in Eastern Han. In addition, the theme draws on the Dunhuang fresco painting, music and dance exhibition of Harmonious and Prosperous Echo of Millennium Mogao at the Xuhui Art Gallery in Shanghai in 2018, and expresses a good expectation for Dunhuang's future, hoping that Dunhuang can be harmonious and prosperous. The design inspiration comes from foreign mechanical power installation Kinetic Sculpture, chaotic pendulum and kinetic sculpture, Teamlab digital art and other works. The combination of entity pattern sculptures and digital media interaction methods breaks the passive and one-way information transmission display method in the traditional market, and breaks the situation of simplification of display interactions. It adopts the display methods of dynamic entity sculptures combined with pattern interactive visualization, the means of distance measurement interaction, understanding the pattern interaction scheme from the visual sense. This kind of display is not only innovative, but also gives people an amazing visual effect and makes them understand the charm of the pattern changes. [3]

3.1. Design concept of digital interactive installation
The original work Dunhe Huangsheng adopts a brand-new way of animation and installation interaction to develop and expand the Belt and Road Initiative and Dunhuang culture. In this way, it not only has a modern sense of science and technology, but also can integrate Dunhuang culture into modern design, to attract people and achieve cultural inheritance and application.

The design concept highlights the "environment" factor. With the help of the "environment" creativity, the patterns in the Dunhuang caisson are chosen to make interactive installation knots, animations and sound, showing the audience a three-dimensional spatial art effect and giving them a picture experience of expandable space and perception. When the audiences integrate into the work and become a part of it, this cross-space experience will inevitably change the relationship between the audiences and the works, so that the audiences can understand Dunhuang's art and culture through patterns and installation interactions, and thereby developing and expanding the history and achieving protection and inheritance.

3.2. Design sketch and plan of Dunhe Huangsheng digital interactive pattern
Inspiration source - Three Hares Caisson Drawing, as shown in Figure 3. The Three Hares Caisson Drawing is located in the Cave 205 of Mogao Caves. The three hares represent "previous life", "present life" and "afterlife", which means that the three lives are in an infinite cycle. Inspired by the Three Hares Caisson Drawing, combined with other caisson patterns, the pattern is reduced to simple geometric lines, giving the connotation of the reincarnation through circulation, reciprocation and superposition, and making the installation pattern that belongs to this subject.
Figure 3. Apsara Caisson Drawing in the Cave 205 in the Early Tang Dynasty

In the early stage, the patterns of installation and the simulative presentation of visual effects are selected in the Photoshop image processing software and Animate animation producing software. The results are shown in Figure 4.

Figure 4. Simulative Effect of Patterns

Considering the different patterns and changing effect of patterns at different speeds during the actual display, the pattern with the best performance was selected from them. The actual patterns cannot give a good presentation effect when being too complicated. They need to reflect the characteristics of Dunhuang caisson with smooth and dynamic lines, which are mainly used to attract the audience's attention and enhance fun and interaction. During the design, the following patterns were finally selected after many attempts and combined to form the final textures, as shown in Figure 5 below.

Figure 5. Final Effects after Testing

Dunhuang caisson is usually located above the interior of buildings. According to the FengSuTongYi: "the palace hall is shaped into a well. The well refers to the image of the East Well. Ling (water chestnut) is a plant that grows in water. Therefore, they are incompatible with fire." East Well refers to the Well constellation, one of the twenty-eight constellations, which was regarded as a symbol of water by ancient people. Therefore, wells were dug at the top of palace halls and pavilions, and decorated with aquatic plants such as lotus and ling to suppress the fire devil and protect the buildings. [4] In combination of reference with the content with the design practice, a lotus shape combined streamline geometric pattern is eventually determined.

3.3. Design and manufacture process of digital interactive installation
3.3.1. **Design conception.** The two patterns are mirror-symmetrical and overlap to form a lotus-shaped pattern, which rotates in opposite directions. When the audience is far away from the installation, the installation is still. However, when the audience approaches, the installation rotates and generates a dynamic pattern immersion effect. Combined with the Kinect dynamic capture instrument, the rotation rate of the peripheral pattern is regulated by adjusting the height of the right hand to give them visual effect experience and thinking environment.

3.3.2. **Manufacture process.** Considering the weight, size and final effects, it is decided to select the laser-cut three-layer wood board with a thickness of 9mm and a diameter of 90cm, which can print the longest size on the market, as the material of the final installation. Compared with the 3D printing photosensitive resin material, the wood board is better. As shown in Figure 6.

![Figure 6. Real Objects Made of the Above Materials](image)

Considering the size of the wood board, its weight and the operating safety of the installation, a permanent magnet synchronous AC slow-speed single-phase 220V miniature gear reduction motor that is relatively stable and safe, and a lengthened changed-diameter connecting rod by 6-10mm are adopted to connect the motor and the wood board. Considering the stops and turns in the process of inductive interaction and the large inertia generated by the mass size of the installation, if the rotation direction is consistent with the thread tightness direction, the rotation inertia will make nut loosen and fall off, resulting in safety problems. Therefore, the connecting rods whose directions are opposite to the rotation direction and the thread direction are selected respectively, and the effects are shown in Figure 7. Compared with the coaxial counter-direction mechanical structure, the dual motor structure is more stable and easy to manufacture, as shown in Figure 8. The advantage of the coaxial counter-direction mechanical structure lies in that only one motor is needed, and the spacing between the two wood boards is smaller. However, the complex structure and large rotation stop inertia of the installation mass will lead to mechanical structure material failure, which is difficult to realize in practice and has poor effects. Therefore, a dual motor counter-direction structure that is relatively simple and stable shall be adopted.

![Figure 7. Constant Speed Motor](image)
3.4. Design of digital interactive program

Arduino's UNO single chip microcomputer is adopted to develop the data board, and Arduino HC-SR04 ultrasonic distance measuring sensor is adopted to input in the interactive design, as shown in Figure 11 below. HC-SC04 sensor can provide non-touch distance detection from 2cm to 400cm, and the measuring accuracy is best when the measuring distance is within 300cm. Therefore, the detection distance is set to be 3m in the design. When a person enters the detection range of 3m and the inputting value of the ultrasonic distance measuring sensor is less than 3,000mm, the logic circuit will switch on the power supply to make the installation rotate. When there is no target within the detection distance of 3m and the inputting value of the ultrasonic distance measuring sensor is more than 3,000mm, the logic circuit will cut off the power supply to prevent the installation from rotating. [5] Circuit connection diagram, as shown in Figure 12. Part of the interactive program's main modes in this section are shown in Figure 13 below.
3.5. *Interactive displays of the pattern on the digital interactive installation*

Installation pattern is adopted as the entry point between animation and interaction; interactive installation is adopted to arouse the audience's interest in animation; animation stories are employed to reveal the implication and connotation of the installation, which can trigger the audience's thinking and create a feeling environment. Interactive installation is integrated with graphic animation organically to immerse the audience in the work. During the production, the colors in the selected works are selected to form the interactive texture on the periphery of the installation, which is projected on the device by the technical means of combining Kinect and Processing to create an atmosphere for visitors, as shown in Figure 14. Visitors can regulate the rotation rate of the peripheral pattern animation by adjusting the height of right hand. [6]

![Figure 13. Part of the Interactive Program's Main Modes](image)

**Figure 13.** Part of the Interactive Program's Main Modes

The representative color of the animation display content is selected as the matching color of the work, and the graph similar to curling grass pattern is selected for the work, as shown in Figure 15 below. When drawing patterns with Bezier curve in Processing software, importing PNG picture into the software will lead to frame dropping and make the software stuck, so the programming language is used for pattern drawing. [7]

![Figure 14. Human-machine Interaction Effect](image)

**Figure 14.** Human-machine Interaction Effect

![Figure 15. Display the Pattern and Color Effect](image)

**Figure 15.** Display the Pattern and Color Effect
Kinect2SDK driver is downloaded, installed and operated (exclusively on the systems that are no more behindhand than win8), then the two library files of KinectPV2 and Kinect v2 for Processing are imported into the processing library and installed. Kinect interactive pattern program codes are shown in Figure 16 below.

3.6. Key points and difficulties in the construction of digital interactive installation

Based on the integration of interactive installation with digital media technology and traditional culture, the key point and difficulty of this subject lie in the expression effect form of the new dynamic interaction on-site interactive installation art. The final significance of this study lies in the new feelings of the audience resulting from the changes caused by human. In the research, a solid caisson model was constructed, but the overall performance was too conservative and there was a mode only changing the form with the same content. Therefore, abstract patterns were adopted in the later period, focusing on color changes, enriching connotation, colliding and merging modern elements and traditional elements to produce new visual effects. The real-time audio-visual visualization effect was carried out on the installation, Video Mapping, but did not achieve the expected effect due to the large crowds and noise in the display space during the final field test. Finally, one-way constant rate projection mapping was combined with Kinect dynamic character capture technology for human action interaction. The work initially realized the interaction between participants and the work, and improved the sense of artistic interactive experience, but how to realize the completely free control of the work content is an unsolved difficulty and will be the next research direction of the subject.

4. Conclusions

Interactive installation art aims to explore the new relationship between human and the world, which changes due to human and enhances the sense of human existence. The development of digital technology releases art from framework, breaks the boundaries between works, and makes human behavior an element of works. Finally, human is released from physical medium and truly integrated into artistic works.

In combination of reference to numerous historical data related to Dunhuang culture, learning various human-computer interaction cases, researching and analyzing interactive installation art, writing program codes, as well as researching mechanical structure principle and other theories with the manufacture of works, the deeper exploration is carried out in this paper on the relationships between human and nature, ourselves and the world. We feel no boundaries between ourselves and nature, ourselves and the world. Everything in the world exists in a long, fragile and incredible continuation of life without borders. Digital art keeps us away from the physical environment, so digital technology provides a new way for creation. It is believed that the logic structure of super subjective space is adopted to explore the Dunhuang culture of the ancient silk road again, which will be a better perceptive way to carry forward, inherit and ponder over artistic culture.

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