Research on the Collection and Display of Taiwan's Gaoshan Traditional Clothing by Virtual Simulation Technology

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Abstract: The main purpose of this research project is to simulate and display the traditional costumes of the Gaoshan people in Taiwan from the perspective of design by the use of 3D scanning and virtual modeling technology, and to analyze the important design techniques and visual features that influence the public perception of the traditional clothing of the Gaoshan people.Firstly, six typical sets of Taiwan's Gaoshan traditional costumes were selected. Then, the model with high degree of reduction was generated by 3D scanning. Secondly, a MAYA modeling software was applied to build a clothing model and optimize the texture so that the virtual simulation of clothing model can be preserved based on the 3D design software. In the display system, Unity3D was used as a production platform to create the virtual display scene of the clothing museum. Finally, it took the Unity3D as an engine to build a virtual museum display system platform for presenting the Taiwan's Gaoshan traditional clothing.The research has realized the systematic display of the traditional costumes of the Gaoshan people, broken through the limitations of the realistic display, and pushed forward the display of traditional costumes to be terminalized, mobile and convenient. And the further ergonomics research can also be carried out on the platform.The abstract should summarize the contents of the paper and should contain at least 70 and at most 200 words. It should be set in 9-point font size, justified and should have a hanging indent of 2-centimenter. There should be a space before of 12-point and after of 30-point.

1 INTRODUCTION

In order to better preserve the culture of traditional clothing in Eurasian, and solve the problem of the easily damaged traditional clothing as well as the digital preservation of some existing clothing, VR (Virtual Reality) technology can be applied, through which a virtual 3D exhibition hall is created, producing a lifelike "virtual environment" and making users immersed in it by compiling realities into a computer.

The digital collection of Gaoshan traditional clothing in Taiwan is an advanced form of displaying its culture and a significant form of technology innovating, which promotes the integration of VR with culture and education.

In this work, we are expecting to better inherit the culture of traditional clothing with the help of VR technology, which conforms to the future trend of information technology innovation. Meanwhile, combining culture preservation with VR is also a new form of art and a new field of art.

2 OVERVIEW OF VR FEATURES AND HARDWARE

2.1 VR Features

Existence：VR technology is a 3D image designed by computer based on various sensory and psychological characteristics of human beings. With its stereoscopic and realistic nature, VR makes it as if you were in the virtual environment when wearing an interactive device. The most ideal virtual environment is that one can not identify reality and virtuality.

Figure 1:Virtual scene (picture from this study).

Interactivity. Interactivity in VR refers to the natural interactions between human beings and machines, in which people perceive everything in virtual environment through the mouse, keyboard or sensing devices. VR system can synchronously display images and sounds according to the user's feelings and movements which is a real-time process where users can manipulate things in the virtual environment based on their needs, natural skills and senses.

Creativity. Created by artificial design, virtual environment in VR is not real, however, actions of objects in the virtual environment are executed conforming to the laws of physical motion in the real world, for example, the virtual scenes of a street are designed and created according to the laws of street motion in the real world.
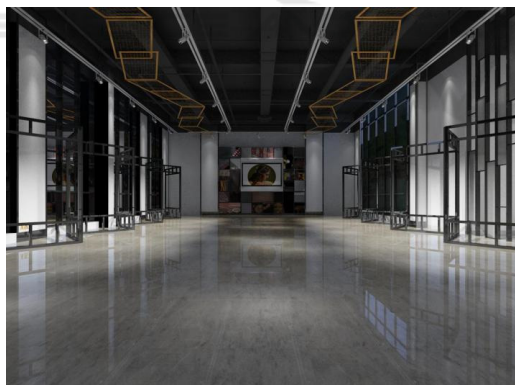

Figure 2: Virtual exhibition hall (picture from this study).

Multi-sensory. VR system is composed of various sensing devices including visual, audible, and tactile devices that enable it to have multi-sensory functions, allowing users to obtain a variety of perceptions in virtual environment as if immersed in it.

2.2 Experimental Equipment Selection

3D modeling of VR is an important part of the whole system, which are often built by graphic libraries such as OpenGL. However, there are many irregular objects in practice. As a result, it is impossible to build models easily like that, hence 3D modeling devices for auxiliary modeling are needed, such as 3D scanners.

3D scanner, also known as 3D stereo scanner, is a high-tech product that combines light, machine, electricity and computer technology, which is mainly used to obtain the three-dimensional coordinates of outer surface of the object and the three-dimensional digital model of the object. With the developing of 3D scanning technology, more and more industries have begun to use 3D scanners to create a digital model of objects such as 3D film and television animation, digital exhibition hall, costume customizing, virtual reality simulation and visualization. Through the non-contact scanning of the objects by the 3D scanner, accurate 3D point cloud data on the surface, is obtained and then the digital model is created efficiently and precisely, realistically reproducing the real world in digital form.

Figure 3: Artec 3D scanner.

At present, 3D scanners are widely used in the field of medical and preservation of cultural relics. The 3D scanner applied in this study was a hand-held Artec 3D scanner weighed 850g. The portable device can be easily used outdoors or carried to the object that cannot be moved such as objects in a museum.

The use of 3D scanner is to create a point cloud of the geometric surface of the object that can be used to present the surface shape of the object. The denser the point cloud, the more accurate of the model. Furthermore, if able to obtain the color of the object surface, the scanner can present the color on the reconstructed surface, also known as texture mapping.

The 3D scanner can be modeled as a camera, both of whose information collecting is constrained

in a conical range. The difference between them is that the camera captures the color information, while the 3D scanner measures the distance. As a result, it is also called the 3D camera since the measured results contain information of depth, with which one can scan an object with 16fps and get the color information with 1.3 megapixel and 24-bit true color. However, in order to obtain an overall model, it is often necessary to change the relative position of the scanner and the object or place the object on the electric turntable due to the limited scanning range. The technique of integrating multiple models is referred as image registration or alignment, which involves multiple methods of three-dimensional alignment.

Figure 4: Artec 3D scanner for scan artwork.

Considering all the aspects, Artec Eva 3D scanner is the best choice, which is a customized product for fast, accurate and textured scanning. There is no need to mark or calibrate, as it can quickly capture the shape of the object with high resolution and efficiently reproduce the lifelike colors of the object with no limited application range. The auxiliary software, Artec Studio, is a powerful and evolving software that can be used to scan objects, fill holes, optimize grid data, apply textures, fair and measure.

3 DIGITAL COLLECTION AND MODELING OF TRADITIONAL CLOTHING

3.1 Process of Digital Collection and Repair of Traditional Clothing

In the process design of this research, six sets of Gaoshan costumes were selected. It takes about one

or two days for each to go from digital collection to repair and modeling. Moreover, because of serious fading and damage caused by long preservation, there will be problems such as chromatic aberration. Based on some literatures, fine tunings have been made to achieve the original colors as much as possible. Color tuning different from the original colors were also performed for some certain costumes to present innovations. The specific steps are as follows:

First, each costume needs to be arranged and ironed before scanning. However, as some of the collections are too old and exist too many and deep wrinkles, a long time will be taken to iron. Meanwhile, for costumes with high drapability, it's necessary to unfold them in advance to reduce the wrinkles and put them on the mannequin to prepare for scanning, which will cost about half an hour.

Figure 5: Clothing finishing by ironing.

Figure 6: Clothing finishing by hanging.

Second, Collect data and model the scanning objects using the Artec Eva 3D scanner connected to the computer.

Figure 7: Collect digital models with scanner.

This is the preliminary scanning result of the long blue shirt of the Gaoshan nationality. After several times of scanning, there are many misaligns in the structure due to the large area of the costume. The scanning difficulty increases with the area, consequently requiring a high configuration of the computer, otherwise the scanner will be unable to be calibrated during the process and the computer running memory will be overloaded arising flash backs. To avoid these problems, multi-scanning and real-time saving are needed during the collection process.

Figure 8: Preliminary scan result (front).

Figure 9: Preliminary scan result (obverse).

There are about 15 scanning results that need to be aligned one by one. Looking for 3 identical structural points or texture patterns between two scans for alignment will take about 2 hours if the costume structure is not that obvious.

Figure 10: Scan object alignment.

Figure 11: Scan object alignment.

This is the effect of the overall registration, fairing and sharp blending of the model, the whole process will take 1 or 2 hours depending on the file size and difficulty of each scanning.

Figure 12: Scanning object after fusion.

The system software will automatically fill some areas after the integration and the extra parts need to be erased by the eraser tool. Generally, the filling points are connected with the edge of the costume, where the demarcation is difficult to identify because of the color. If part of the costume is erased, multiple selections are generally necessary to make, which will take 1 hour to go.

Figure 13: Select the extra part of the scanned object.

After grid simplifying and file downsizing, texture mapping process is carried out during which computer flash backs often occur, so it's essential to save the file step by step in case the file is gone. Depending on the size of the costume, the mapping process generally takes roughly one or two hours.
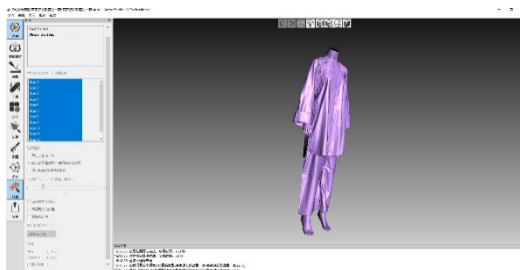
Figure 14: Texture map.

A clear chromatic aberration arises after the texture mapping, hence it's of great importance to tune the color according to the reviewed data by adjusting the color, brightness and saturation, keeping the original color and making a change in color design at the same time.

Figure 15: after the texture mapping.

Figure16: adjusting the color, brightness and saturation.

3.2 Collection and Arrangement of Clothing Models

Clothing model collection. Considering the unit of data collected by 3D scanner doesn't match that in Unity, some models need to be imported into 3dmax for axial adjustment after the models are collected and repaired.
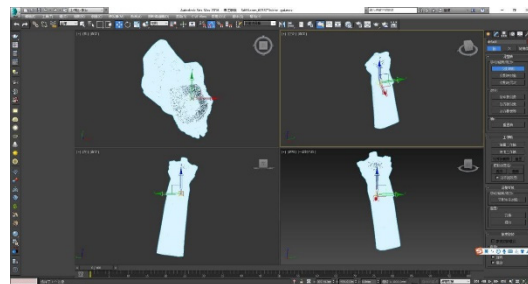

Figure17: imported into 3dmax for axial adjustment.

Inspection and adjustment of 3D clothing models. Given the low degree of matching between the collecting software and the virtual simulation software, a secondary inspection is required and scanning should be performed again if there is a

problem. The axial issue will cause running errors when the collected data is imported into virtual software, generating much more trouble in debugging. Therefore, the data is generally adjusted in advance in 3dmax and then export a fbx file to import into Unity.
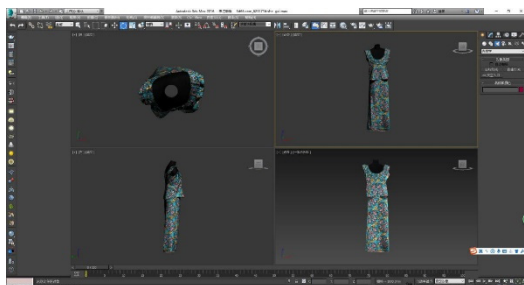

Figure 18: adjusted in advance in 3dmax.

3.3 Clothing Models Importing and Debugging

Models importing and parameters setting. Generally speaking, the imported clothing models are dozens of times larger, which have exceeded the size of the space model, as shown in the screen shots. Design process of the latter five models are basically the same, therefore, only one of them is taken as an example for description.
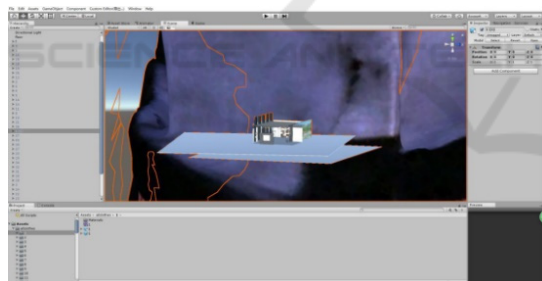

Figure 19: exceeded the size of the space model in Unity3D.

Size and orientation design. The model size should be adjusted to the proper size using scale tool due to the mismatch between size and space as well as the orientation which is often tilted and reversed when imported.
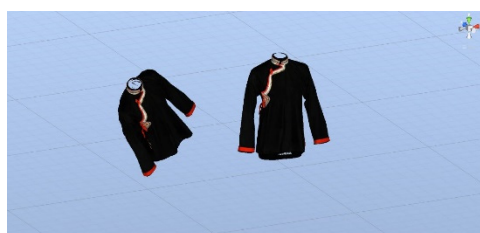

Figure 20: using scale tool due to the mismatch in Unity3D.

Design of clothing model base. Considering some half-length clothing models are not tall enough to achieve a better experience for users, it is necessary to design a pedestal for the suspended clothing model given that the optimal view angle for a person is about 1.4 meters. The base should be simple and inconspicuous with a round bottom, looking much more realistic when the model is rotating.

Figure 21: using scale tool due to the mismatch in Unity3D.

Collision body and audio commentary of clothing models. Similar to the space model, it is necessary for clothing model to add a collision body so that the model can be controlled in real time when the user is playing, and it is convenient for the logic writing later as well. The design logic of this study is to control the audio commentary through a handle. Generally, it is essential to check the Play On Wake, the real-time play button, to avoid the audio commentary playing immediately when entering the scene.
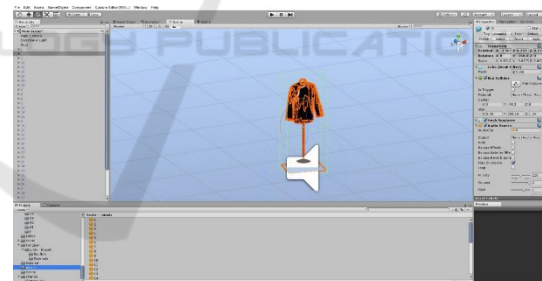

Figure 22: add audio commentary in Unity3D.

4 MATCHING DESIGN OF HALL AND CLOTHING MODEL

4.1 Size and Angle Design of Virtual Hall and Clothing Model

It demands a constant Game test to achieve the coordinated design, the size of a clothing model is first determined and the others are basically the same, the size results are obtained as shown in the screenshots after repeated testing.
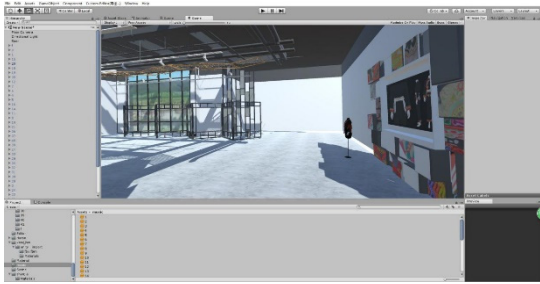
Figure 23: repeated testing in Unity3D.

4.2 Light Effects between the Virtual Hall and Clothing Models

In the design of the exhibition hall, the overall lighting should not be too strong, since the lighting of the exhibits is the most important, attentions should be paid to the coordination between the virtual hall and the clothing model. The clothing model is basically determined in this step, the other five models are imported in the same way.
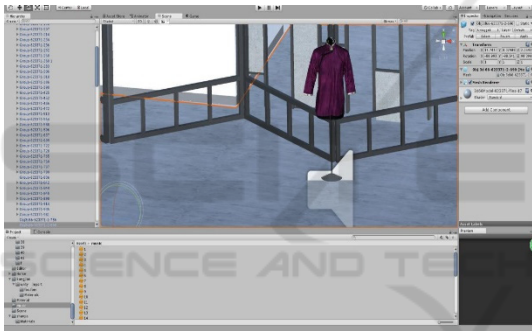

Figure 24: Light effects testing in Unity3D.

5 INTERACTIVE DESIGN

5.1 Overview of Interactive Design

Without customized scripts, it is difficult to implement complex functions only through a graphical interface, though Unity is a powerful graphic editing software. First of all, the purpose of this study is to achieve an interactive effect—showing the traditional culture of Gaoshan costume, which will need the interaction between the user and the costume model, such as real-time control of the movement of the clothing model, user's motion in the scene, the audio commentary of the clothing model.Create a script, click [Assets] → [Create] → [C#Script], or in the Project.

5.2 Overview of UI Control Interface Design

Principles of the interface design can be summarized into three points: making the user control the interface, maintaining consistency of the interface, and reducing the burden of user's memory, mainly including the user principle, the minimum information principle, helping and prompting principle, and the best combination principle.
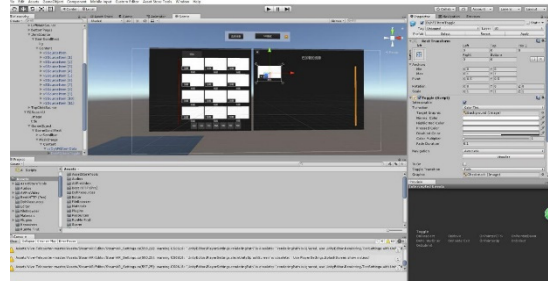

Figure 25: UI control interface design in Unity3D.

In the human-machine interface design, design analysis should be performed first, and the type is determined after determining the task. At present, there exist a variety of human-machine interface design types with different qualities and performances, and the creative use of multimedia will greatly enhance functions of the application.

5.3 Get the SteamVR Plugin

To develop SteamVR, the SteamVR plugin should be first imported, which can be downloaded from the Asset Store.
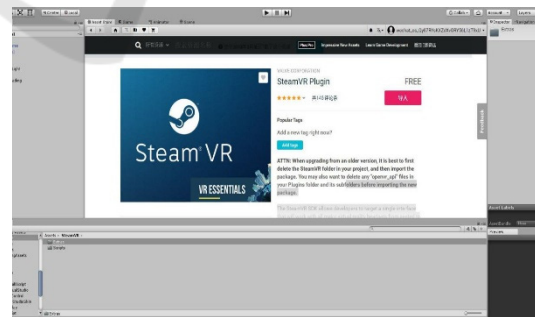

Figure 26: add SteamVR plugin in Unity3D.

5.4 Logic of HTC Vive Handle

Set the handle event through the SteamVR component, realize the function of manipulation model by colliding with the collision body. The main logic code is in the DyhVREvent.

5.5 Logic Design of Clothing Model

Control the rotation direction and position of the clothing model as well as data exporting by the logic.

5.6 Logic Design of Model Exporting

This virtual interactive project is equivalent to a platform that can change the virtual model, where the virtual hall and the clothing model can be replaced by changing the model without altering the logic in case there is any supplement afterwards.

Figure 27: Loading resources in Unity3D.

Figure 28 Show virtual Taiwan Gaoshan costumes in VR

6 CONCLUSIONS

In this work, taking six sets of Taiwanese Gaoshan traditional clothing as the object, through 3D scanning and virtual simulation, a rapid generation process of virtual reality scene suitable for art design is proposed. Integrated with 3Dmax, Unity and other virtual scene producing software, as well as combined with other 3D modeling and virtual simulation software, the 3D scanning technology will greatly simplify the process from the design to prototype and final display, increasing the efficiency of the design industry.

This research should have good research and application prospects, which will help theoretically and empirically understand the further application of VR technology in the field of design education,

especially the international design education. Meanwhile, it is also possible to probe an immersive design process based on VR technology, which will not only promote the efficiency of design education but also can be applied to enterprise training and a wider domain of industrial design.

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