Research on the Application of 3D Restoration Technique to Tombs and Carved Stone in Lu County (Song Dynasty)

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Abstract: This paper focuses on the principle of using shadow to restore shape, and the collected tomographic depth data of Song Dynasty through the Photoshop software are classified and extracted. With the help of Zbrush 's powerful layer tools and mask functions, the matching between plane images and 3D models can be precisely achieved. Through the transformation function of Zbrush, the 3D transformation from two-dimensional to 3D model can be achieved. Finally, a fast, efficient and accurate method of making 3D reduction tombs and carvings is realized, and a key problem of 3D visualization from theory to practice is solved. Experiments show that this method can restore the 3D cultural relics with a production efficiency of up to 70% and contribute to the completion of a large-scale rebuilding of cultural relics. It is a successful and effective method for the restoration of 3D cultural relics.

1. Introduction

Historical relics are incessantly undergoing the baptism of nature and human destruction, some are fast, some relatively sluggish. From the moment they were excavated, the colorful Terracotta Warriors and Horses were instantaneously oxidizing [1] d. The frescoes of the Mogao Grottoes in Dunhuang have been stained with traces of old-fashioned beauty that have forced us to accelerate the restoration of cultural relics. The traditional restoration of cultural relics is mainly based on the video, photographs, and copywriting of cultural relics to reveal the history of the past. However, with the rapid development of multimedia technology, this relatively old form of presentation has made it more difficult for the general public to pay attention to the diverse needs of people in terms of artistic appreciation, historical research and information collection, which makes the 3D visualization of cultural relics and historic sites come to the front of the times. In recent years, computer technology and hardware have developed rapidly, people can get the planar image information through various means and combine the 3D reconstruction technology to realize the effects of digital image, VR and holographic imaging for the mass groups, research institutes and government departments to learn to use and popularize [2]. Thus, the 3D reduction technology has a very broad space for development.

Over the years, due to the rich variety of cultural relics and various materials, relics rehabilitated by previous restoration methods must rely on huge manpower, financial resources and material resources with low quality precision and can only achieve results similar to "line drawing". Through the study of the 3D cultural relic model, a method of efficient and accurate 3D image production is realized. Based on digital images, it is converted to high resolution Alpha masks, and ZBrush and PS software are applied to achieve realistic and efficient 3D cultural relics renderings, which makes the restored 3D cultural relics more practical and universal.

2. Restore Principle and Software Introduction

The 3D reconstruction technique used in this paper is based on Shape from Shading in 3D reconstruction. This is a method to calculate the surface depth of an object by using the feature information extracted from the shadow boundary of the image. Because the images can be restored under various illumination conditions, the application of this method is very extensive, and it can

restore all kinds of 3D models except for mirror objects. However, it should be noted that the brightness of photo pixels is limited by factors including light source parameters, camera parameters, and target surface materials. Insufficient information may cause the reconstruction results to be subtle. Then combined with the 3D model of the traditional production ideas, shape first reconstruction artifacts, another step further, using shadow information, the main structure layer by layer thinning and local cultural relics outline, the final adjustment of the strength parameters of each layer in detail, the best effect to complete the reduction of cultural relics.

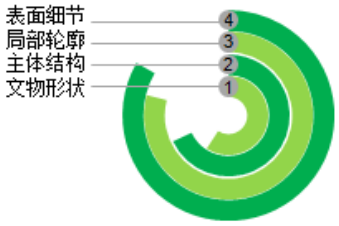

Figure 1 Ideas of 3D reconstruction

ZBrush is a world-renowned digital engraving and painting software. It subverts energy consuming role modeling and mapping work easily, not only supports low precision models, but also controls high-precision models with large number of faces. As the data of historical relics are very large, ZBrush is very suitable for the reduction of 3D model. At the same time, the software has many powerful modeling support technology, can increase or decrease the subdivision level, multi dimension mask shape, strong layer strength record adjusting system and diversity of the model deformation module, so the use of this tool can be transformed into two-dimensional cultural 3D stereo.

3. Reduction of Tombs and Carved Stone

3.1 Collecting the original photos

In the initial stage of the 3D restoration of the cultural relics, we need to obtain the most authentic original figure of the cultural relics. Usually, the reduction ratio of two dimensional photo is close to the perspective effect of the camera's 50-degree focal length in 3D space, which requires us to set the focal length of camera to 50 when we take the original photos. In addition, in order to make the contrast of the light and shade of the photo relatively unified, it is suggested to use a scene with soft lighting for shooting. The angle of view is perpendicular to the object, and it is not obscured, and the proportion of the photo is consistent with the original object.

3.2 De-noising photo

Figure 2 Deformable tool

The real picture collected from the cultural relics site is imported into the computer for revision and adjustment, including image shading, perspective distortion, color saturation and lateral longitudinal symmetry. In this case, the graphic design software, Photoshop, plays an important role, which provides a new means of repair for the restorer. Due to the uneven distribution of color and the

poor visual effect of images, it is necessary to use the "curve" tool of the software to partially homogenate the photos, so that the overall contrast of the photos can achieve an ideal state. Secondly, using Photoshop software to make some of the highlighted areas and dark areas in the photo correction, the color balance can be achieved by using photo "color gradation" tool. By Photoshop software "cloning" tool to make the background map relatively uniform shading. Finally, the "deformation" method can be used to adjust the sense of space perspective in the picture. The proper handling of the original pictures of cultural relics is conducive to more coordination of the depth of restoration and improvement of the final 3D model.

3.3 Make Shadow Recovery Map

The purpose of shadow restoration is to gradually restore the shape of artifacts by using black and white images of different levels of light and shade. Black and white in the figure is related to the distance between objects. The closer the color is to white, the closer it is to the repairer, the higher the degree of protrusion; the closer the color is to black, the farther away from the repairer, the more the model does not change.

Figure 3 5 different kinds of shadow recovery maps

Remediators need to rely on the original color map to create a variety of shadow recovery map, the main role of them are as follows, respectively. The original color map: After the treatment of the original artifacts, it is the ultimate guide to the recovery effect; fuzzy darkness map: The picture shows a drop-like spot pattern, lack of detail, used to generate the basic prototype of artifacts, the repairer can use the "Gaussian blur" tool in Photoshop to make the map; fine darkness map: high-intensity contrast of black and white, rich in detail, mainly used to achieve the main structure of the model lofting and forming; fine brightness picture: The picture is brighter and the details are sharper and richer, used to build detail on the model, relying on the Curves tool in Photoshop to brighten the color. Boundary Detail Map: Get this black-and-white edge effect with the Find Edge tool in Photoshop, which is designed to enhance edge detail missing from a model.

3.4 Create 3D Cultural Relics Prototype

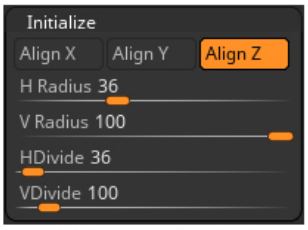

Figure 4 Initial state regulation

Here we use the ZBrush 4R8 version as a demonstration tool to rebuild the 3D relics model. First create a tablet in ZBrush and press shortcut key T to enter its edit mode. Then set the size and subdivision of the tablet in the Initialize column of its Tool section to make sure that the size is consistent with the original color image and the horizontal and vertical subdivisions are the same.

After modifying the parameters, be sure to click the "Make PolyMesh3D" command under the Tool section to convert the current flat panel into an editable polygon mesh. Otherwise, engraving can not be performed. Then we press the shortcut key "Shift + F" check the number of models and found that the current number of faces is too low to support the creation of the details of graphics, so it is also required to subdivide the model more than 3 times by the shortcut key "Ctrl + D" to ensure that such a subdivision model can effectively become the platform for building the initial shape of cultural relics. At the same time, in order to make the reformer increase more subdivision number later, we need to create four layers corresponding to the four layers of shadow recovery map and create four layers in the layers column of the tool for each layer to adjust the effect of shadow restoration. The concept of ZBrush middle level is very similar to the level of Photoshop. It allows us to record different model subdivision level and deformation effect separately in each layer, so as to see the effect of superposition, which greatly improves the overall controllability of the model.

3.5 Adding Mask Details

In general, all the images that are processed in Photoshop are bitmaps and are not penetrable. At this point, we need to transform the color data in the bitmap into different levels of transparency information, so that we can get different levels of shading and graphics on the surface of the model. The implementation method is to import "fuzzy darkness graph" into ZBrush, then use the "MakeAlpha" tool in the texture window of the software to transform it into Alpha channel graph, so as to complete the extraction of the stereoscopic depth data.

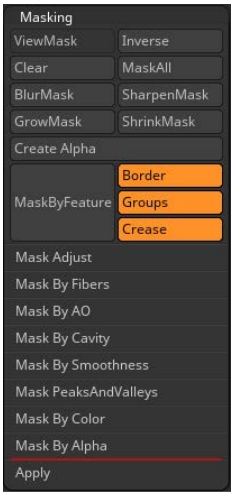

Figure 5 Alpha mask command

Next, the "Fuzzy Shadowgraph", which was just converted to an Alpha graph, is given as a mask to the model surface using the "Mask By Alpha" command under the Masking column in the Tool section and check whether the above operations are recorded in the corresponding layer. The operation of other shadow recovery diagrams is similar to that of this diagram, and it is no longer to be described here.

3.6 Convex mask deformation

After having related mask and shadow, we can realize various special 3D shape reconstruction with various deformation parameters in the Deformation Tool plate. This mainly includes the functions of Offset, Inflate and Smooth. For example, for the "fuzzy dark graph" layer with 3 grades of subdivision, the vertical outward Z axial migration can be used to create the basic embryonic form of the cultural relic; the subdivision degree is 5 grade "fine dark figure" layer, you can use the model expansion along the surface X, Y, Z three axis outward direction, to achieve the main structure of cultural relics; then using the offset function, the subdivision degree is 6 grade "fine brightness map" layer along the Z axis counter dragging raised model details. Finally, the "fine luminance map" layer, which has a subdivision degree of 6, is again offset to strengthen the boundary details corresponding to the white line. For each operation above, the display effect should be modified according to the

Intensity in the corresponding Layers. The intensity value generally ranges from -1 to 1, making the deformation more real and natural.

Figure 6 Deformable command

Although the above offset and expansion operations have made the plate have a relatively accurate 3D large structure, the model has a zigzag non smooth edge. Therefore, the smooth command is needed to smooth the three axes of the flat X, Y and Z axes several times. Note that the smoothing at this point is based on the various types of Shadow Recovery Map masks on the surface of the model. If smooth processing has been removed after the map mask has been removed, it is easy to reduce the details that have been generated, so the smooth processing without cover must be careful.

3.7 Final Texture Coloring

After completing the above 3D reconstruction, we can add a basic material to the object, and then add the color and texture to the object with the original color map, so that we can achieve the 3D imaging restoration of the whole cultural relics, and the effect is as follows.

Figure 7 3D reconstruction steps

4. Conclusions

By using these methods, we can arrange a staff who basically mastered ZBrush and Photoshop complete a two-dimensional photo in 3 hours to reconstruct the 3D model. After comparing the completed high simulation results, although there are some individual flaws in details, it has been very good from the overall input workload and output quality. Of course, this method also has some limitations. For example, the best imaging effect is obtained for the viewing angle of the observer, but if the model is rotated to the oblique side, it will expose the uneven dislocation of the surface of the model. The main reason is the spatial ambiguity caused by the ambiguity of the data in the shadow restoration map. It is not difficult to understand this because when cameras compress stereo objects in real space into two-dimensional images, it is inevitable to lose or even make mistakes in 3D data. If only one photo is restored, the best solution is to use manpower to correct and improve later. We can also solve this ambiguity with the help of many photographs from different angles, but this method of 3D restoration of multi-graph is not the scope of discussion in this paper.

The reduction method in this paper solves the relatively simple 3D reconstruction of cultural relics to a certain extent. The reduction effect is mainly determined by the brightness data of the shadow recovery map, and also depends on the ZBrush and Photoshop's proficiency of the restorer itself. It can effectively accelerate the basic reconstruction of complex cultural relics, and the reduction results are close to 70%. If a high level of 3D model is needed, this method is unavoidable. From the application range, due to the existence of more complex depth information and the coupling with the outside world in all kinds of cultural relics photos, this simple stereoscopic depth replacement method cannot generally be applied to other places. However, from the restoration case of this paper, we have always chosen the uniform light intensity, uniform color as the basis for production, therefore, the final reduction results are valid and worthy of reference.

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References

[1] Gao Yanjian. A Fast 3D Reconstruction Method Based on Single Gray Image [J]. Journal of Mechanical Engineering, 2014.1

[2] Che Xiaoyang. A Method to Produce 3D Terrain Efficiently and Accurately, Journal of Lanzhou University of Arts and Sciences, 2017.5.