Digital Archiving of Large 3D Woven Cultural Artifacts

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Abstract

Recently, research on digital museums received increased attention. We have worked on the digital archiving of the "Gion Festival in Kyoto", focused on the culture of Kyoto, and developed a realtime and direct-touch interaction system for the 3D woven cultural artifact with haptic interface. After the Gion Festival of 2011, the repair work of the Fune-hoko storage was scheduled. Therefore, we created a 3D measurement system for the large 3D woven cultural artifacts with the laser range scanner, and tried to measure and model the 3D woven cultural artifact of the Fune-hoko at high definition in 3D. Most woven cultural artifact of the Fune-hoko is composed of gold thread, glass, cotton, and brilliant embroidery. Thus, 3D measurement is not easy. Therefore, we arbitrarily changed the laser strength according to the material of the fabric and modeled based on the point-based for the real-time rendering. As a result, we could generate the 3D woven cultural artifact models at high definition.

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: Picture/Image Generation—Digitizing and scanning

1. Introduction

In the digital museum project [THY*10], we are working on a digital archive of the intangible cultural heritage "Gion Festival in Kyoto". In order to achieve highly detailed, highly accurate digital archiving of cultural artifacts, their shape and texture must be archived in many aspects, using not only visual information but also haptic information, to allow the creation of highly detailed, highly accurate reconstructions. Also, in order to reconstruct cultural artifacts that have been digitally archived at an ultra-high resolution in a natural and highly accurate way using CG and VR technology, an important issue is how to manage a very large amount of data in real time and display it intuitively. In addition, in order to display cultural artifacts in a more natural way, a direct VR system that takes into account the size of the cultural artifacts is needed [WAIT10].

2. 3D Measurement of the Large 3D Woven Cultural Artifacts

In general, for cultural artifacts that disintegrate over time, touching and handling is not permitted. For this reason, when taking measurements of cultural artifacts, methods that involve no contact and no damage are a prerequisite. In the Yama-hoko float procession Gion Festival, which has been called a moving museum, thirty-two "Yama" and "Hoko" floats adorned with colorful decorations wind their way through the city. The decorations used for the floats include embroidery using various materials, like gold thread, cotton, glass, and felt; their texture is highly complex. In particular, the many of the decorative hangings on the Fune-hoko, or boat-shaped float, are stuffed with cotton, so that they have a very noticeable three-dimensional shape (see Figure 1).

Figure 1: *Fune-hoko and Large 3D Woven Cultural Artifacts*

For this reason, if one simply uses a laser range scanner to take measurements, data may only be collected for certain portions depending on the strength of the laser, and measurement may not be completed successfully. Also, many of the Fune-hoko hangings are extremely large, approximately $1\,m \times 3\,m$, and so measurement must be conducted in sections. The final process of combining the data from measurements of individual sections is therefore time-consuming. Choosing the textile cultural artifacts with par-

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ticularly strong three-dimensionality among the Fune-hoko hangings as our subjects, we have constructed a measurement system that takes into account the process of measurement and ease of combined processing.

Figure 2 shows our constructed 3D measurement system for 3D large woven cultural artifacts. This system uses a Konica Minolta VIVID 910 as the laser range scanner.

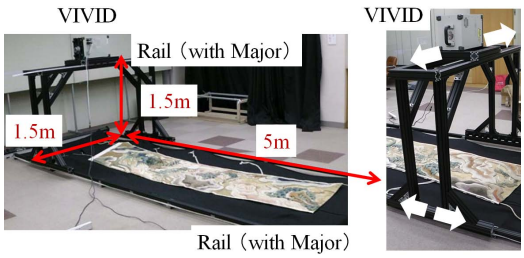

Figure 2: *3D Measurement System for Large 3D Woven Cultural Artifacts*

In one scan, the VIVID 910 can measure 640×480 pixels of distance data and color image. The range for setting a measurement input target is $0.6 - 1.2m$, and it has three types of lens (TELE/MIDDLE/WIDE). We used the TELE lens which was able to be most measured to the high definition as a result of the preliminary experiment, but since this only allows measurement within a narrow range, the required number of measurements increases and integration processing becomes time-consuming. For this reason, in order to simplify the process of integration processing after measurement as much as possible, we laid out a rail so that a wheeled platform could run along it from left to right, and set up the VIVID on another wheeled platform on top of the first; we then conducted the measurements without moving the target object, by moving the VIVID at set intervals and recording the necessary shots.

As described above, the hangings include colorful embroidery in diverse materials like gold thread and cotton, so that measurements cannot be taken successfully unless the laser strength is adjusted to suit the different materials. In order to take thorough measurements, we therefore had to scan multiple times with the laser strength set to several different levels. Figure 3 shows measurements taken with fifteen different levels $(30 - 250)$ of laser strength. The sections done entirely in gold thread cannot be accurately measured without performing $3 - 5$ scans with the laser strength set low, while sections that include dark blue and white thread can only be measured by scanning repeatedly with a wide range of laser strengths.

3. 3D Modeling of the Large 3D Woven Cultural Artifacts

We analyzed the measurement data, and modeled by the denoising, the interpolating of the lost part, the alignment, and

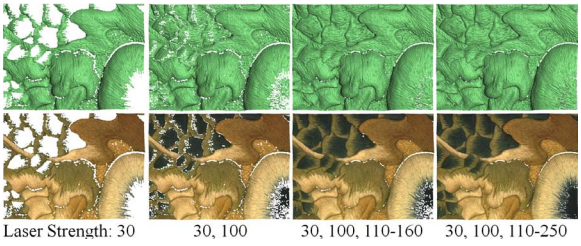

Figure 3: *Measurements with Varying Levels of Laser Strength*

the integration of the overlapped point. Figure 4 shows a 3D digital archived woven particle model. To make this model, we took measurements in 7 vertical sections at $15cm$ intervals and $7 - 18$ horizontal sections at $20cm$ intervals (a total of 103 sections), for a total of about 600 scans and a total time of about 8 hours. The resolution of this model is about 11520×3360 particles.

Figure 4: *3D Model of the Woven Object for Decoration "Shitamizuhiki Unryu Monyou Nikuiri Shishu (Higashi)"*

4. Conclusions

We created a 3D measurement system for the 3D woven cultural artifacts with the laser range scanner, and tried to measure and model the large 3D woven cultural artifact of the Fune-hoko at high definition in 3D. Most woven cultural artifact of the Fune-hoko is composed of gold thread, glass, cotton, and brilliant embroidery. Therefore, we arbitrarily changed the laser strength according to the material of the fabric and modeled based on the point-based for the real-time rendering. As a result, we could generate the 3D woven cultural artifact models at high definition. In future work, we plan to develop a real-time point-based visuo-haptic exhibition system and multi-finger elastic interaction.

References

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