

# THE COLORED COMPARISON OF THE WALL SCULPTURE WITH 3D LASER SCANNER AND ORTHOPHOTO

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## ABSTRACT:

Now, the experts and the technician with special knowledge and professional skills have investigated the important cultural heritage and have maintained them using traditional techniques. We are sure that these techniques and skills will mainly help us to investigate and maintain the heritage in the future too. However, this day those experts and technician are going way down. So, they should utilize high technologies, which will be rapidly developed more advanced and more efficient for the investigation and maintains.

In order to support them, we took a data with the advanced technologies like 3D laser scanner. With the information processing technologies, it's possible to plan maintenance and a repair of the heritage. So, we can consider the reinforcement and the coloring of the structure. In addition, we build the support system that is available for a disclosure and presentation.

The example, we introduce in this paper, is a practical use for the coloring of the structure about the restoration of the important cultural heritage, "KANKIIN". We introduce four practical uses concretely.

- 1) A make of constructive model with 3D laser.
- 2) A make of orthophoto with 3D laser and photogrammetry.
- 3) A photograph mapping which it is possible to show the section.
- 4) A support system of the colored comparison.

## 1. INTRODUCTION

The important cultural heritage of "KANKIIN" was built within 25 years from 1735. It is one of the temples, which have high formal architecture in Japan. A great feature of the temple is excellent sculptures. The wall around the temple is full of them. The Sculptures were richly colored when it was established, but now, the most are damaged. Therefore, the colored restoration was begun from 2003.

First, The line drawing traces the actual thing and is made. Next, the colored comparison is implemented by the color expert and the chemical analysis and creates a colored picture. Based on the colored picture, the painters accomplish the wall picture with original color using the material and the technique.

The experts of coloring can imagine the original color and shape of the architect from the colored picture and so on. But people can't imagine. Also the sculptures have depth difference on 10cm and damaging. We must make the line drawing without touching the sculptures. Therefore, we made orthophoto and CG correctly from the point 3D laser scanner and pictures (Kato, 2003; Nishimura 2002; Japan Association of Surveyors, 2004), and simulation to people understand the restored appearance easily. In this paper, we describe a case that we examined coloring to restore using 3D mapping model.



Picture 1. KANKIIN

### 1.1 The 3D Modelling

About the shape that has the drawing at the temple, we build the 3D shape model base on the original drawing that show us the size of basic objects. The other hand, about uncertainly objects, we use the cloud data that measured with 3D laser scanner. Even if we don't know the original drawing, 3D laser let us know it correctly now.

(3D modelling Software: 3ds max 7)

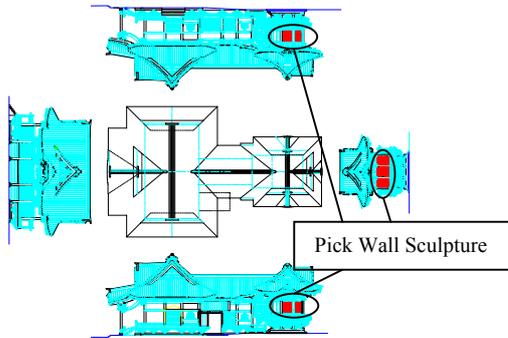


Figure 5. Original Drawing

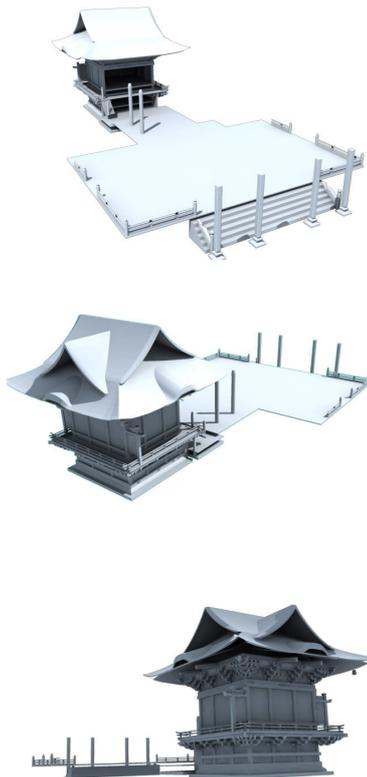


Figure 6. KANKIIN CG model

## 2. THE 3D LASER SCANNER

### 2.1 The Principle of The 3D Laser Scanner Measurement

The measurement of the distance to the object is the phase shift method. The 3D laser scanner irradiates continuous wave to the object, gets a distance by phase differences between the irradiation wave and the reflected wave. 3D coordinates are decided by the direction of the instrument and the distance to the object. And the resolution depends on turn speed of the motor because laser beam irradiate constantly. As another point of 3D laser scanning system, it's possible to get intensity by the differences of color or materials.

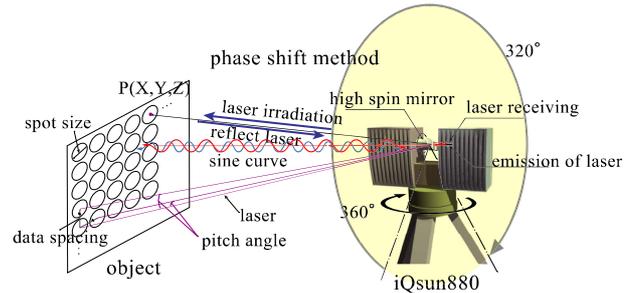


Figure 1. Measurement principle

### 2.2 The Characteristic of The 3D Laser Scanner

The name of 3D laser scanner we used is iQsun880 that is made by the iQvolution Inc. The remarkable point of the scanner is an accurate scanning with high resolution, and we can do it immediately. Single scan of 8mm on spacing (@10m) can be measured within about 5 minutes. Also, it is possible to measure detailed shape because the laser spot size is 7mm(@10m). This scanner adjusts well to an indoor measurement and a data acquisition in detail.

Topic	Comment
Performance	1~76m
Range	
Data sample rate	120,000 points/second
Linearity Error	<=3mm at 10m and 84% reflectivity
Laser Spot Size	$D = 2 \times R \times \tan(0.012^\circ) + 3$ , where
Minimum Spot Spacing	$S = 2 \times R \times \tan(0.01125^\circ \div 2)$ , where
Control interface	via Ethernet on external PC or Laptop
Power input	24V DC (Battery Pack or AC converter)
Scanner Size	L400 W160 H280mm
Scanner weight	16kg
Eye Safety	Class IIIR (DIN EN 60825-1)

Table 1. Specifications



Figure 2. Scanning Sample (Bridge and Tunnel)

### 2.3 3D Laser Scanning

We used iQsun880 to acquire the external appearance of KANKIIN. First, we set up more than four reference points in every scanning as the following picture. We use them as an index point to transform the public coordinate. Moreover using them, we can also compound with another scanning data together.

(Laser Scan Processing Software: iQscene)

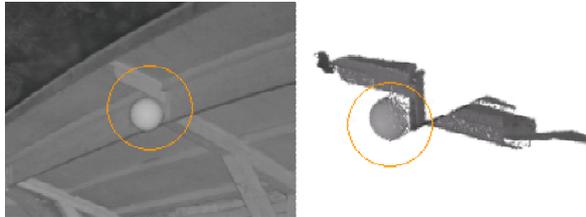


Figure 3. Reference point

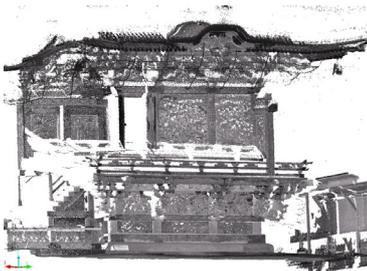


Figure 4. Single Scanning Result

## 3. THE ORTHOPHOTO

### 3.1 The Principle of Photogrammetry

Basically orthophoto has been made by the technology of photogrammetry. The principle of stereo photogrammetry is based on technology to acquire the geometric relationship on profile information of a photographic subject that was projected on CCD plane. However, we need a lot of photograph setting up the reference points for the stereo photogrammetry. That's why it takes long time to analyse the data and make orthophoto. If we have to do such a process, because the data we get by 3D scanning already have 3D coordinate. So, we use reference point and surface of projection directly without any complicated work. It means simple procedure and small cost.

### 3.2 The Characteristic of The Camera

We made the result article of the orthophoto 1:1 scale to utilize for the colored comparison at the actual size. So, to make the orthophoto that was seen from the front of the wall sculpture about 4m<sup>2</sup>, we had to take about 30 pictures. The camera we used is as follows:

Topic	Comment
Camera	HasselBlad 503CX
Lens	CarlzeissM50mm F4.5L
Film Scan	Phase One H 20
Digital resolution	0.009mm/pixel
Wall Sculpture	7
Picture	About250

Table 2. Specifications

### 3.3 Reduce The Point Cloud

The point cloud scanned by 3D laser has a lot of data. So we have to reduce a number of data because we can't use the data directory in use for photogrammetry (Chikatsu, 2003). How to process the data is as follows:

- 1) We leave necessary points by brake-line extraction method (I-Site Studio have the function "Edge Detector").
- 2) We cull out the points at regular intervals (I-Site Studio have the function "Minimum Separation").
- 3) At last we make surface model by using these two processes.

(Laser Scan Processing Software: I-Site Studio)



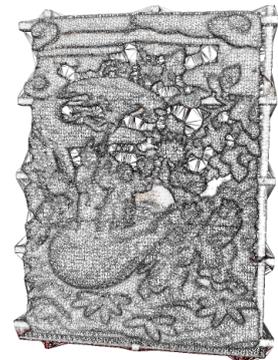
0) Point Cloud



1) Edge Detector



2) Minimum Separation



3) Create Surface

Figure 7. Process of the Point Cloud

### 3.4 Create The Orthophoto

We made orthophoto with 30 pictures we took. Until now technician had traced a drawing on an object. However we can trace a drawing in details and easily by using orthophoto. We don't worry about damage to the object.

(Orthophoto Processing Software: PI-3000)



Figure 8. Pictures



Figure 9. Orthophoto

### 4. THE 3D MAPPING MODEL

The 3D mapping model means the reflection the picture to the 3D surface model. This mapping model is possible to check image and shape. Mapping model is made by surface model and pictures. Surface model is made by the cloud data or the drawing. It is necessary that pictures took position and direction. But, in the technique to map each picture to have taken pictures are problems that the resolution are different pictures and the capacity of the mapping model becomes big in photography range's overlapping.

Therefore, the author made the orthophoto-mapping model on same resolution orthophoto in projecting 3D surface model to little textures. And the present sculpture can be easily understood about anyone. But, because the orthophoto mapping model of the present situation is one sheet of mapping texture from the direction of being specific and is processing, the side part becomes a condition with dull tone of color.

Also, we developed the system that it is possible for the cross-sectional form that displays this mapping model by the trim to be understood and to review.

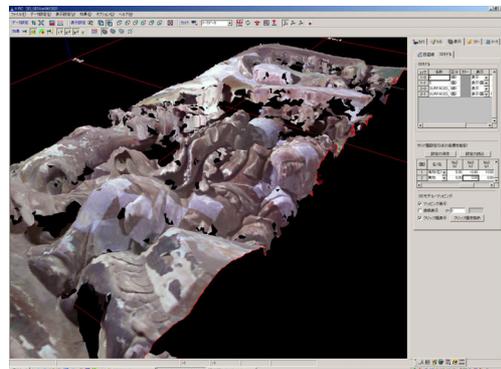
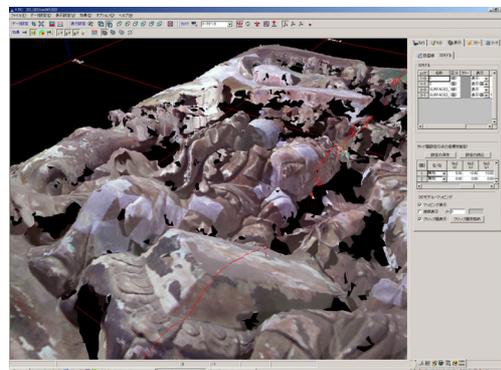
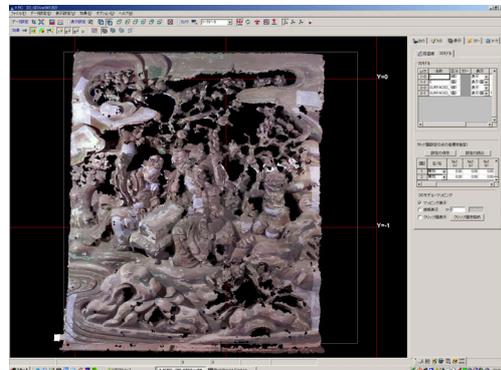
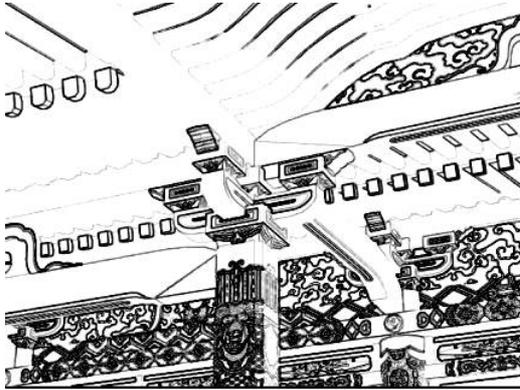


Figure 10. The viewable mapping model in the section

## 5. THE COLORED COMPARISON

We had to adjust tone of color to each part until now. 3D model system makes it possible to adjust suitable color to whole part at once. Basically the experts usually specify original color for the architecture from the rest of the paint. But they couldn't do so if there are no clues. In that case, we can do simulate various using 3D mapping system and we can suggest which color is suitable for the architecture based on original one. A colored type is as follows:



Outline



Colored Type 1



Colored Type 2

Figure 10. Colored Comparison

## 6. CONCLUSION REMARKS

In this paper, we reported on the technique that was proved about the part of the KANKIIN as the case that used the 3D laser scanner technology.

We are sure that 3D laser is a useful tool to take the shape of the architecture correctly and efficiently.

The use of 3D information for the conservation and restoration of cultural heritages provide us a more efficient process for complicated work. And moreover it also means simple procedure and small cost. Another practical uses are as follows:

### 1) The reviewing of a temporary plan

If the construction detail can be comprehended beforehand, the temporary plan is reviewed on the virtual space.

### 2) The explanation of the change plan

It's effective for us to use multimedia technology such as the CG, the animation and the sound, which utilized 3D information in the explanation of a change for a present situation.

### 3) The reviewing reinforcement of structure

In case reinforcement of structure, we have to consider each of reinforcement. If we use 3D CG simulation system we can easily understand the reinforcement between owner and the others.

### 4) The management of constructive information by 3D GIS

In the case of conservation and restoration, we need a vast amount of information like drawings, pictures and documents. We can management efficiently the information by centralizing them to 3D GIS. And it's also possible to grasp the information visually on the 3D model by combing a 3D GIS technology and a database.

## REFERENCES

### References from Journals:

Chikatsu, H., and Yokoyama, H., 2003. Robust Filtering for Topographic Surveying by Terrestrial Laser Scanner, *Optical 3-D Measurement Techniques VI*, Vol. I, Zurich, 2003, pp.338-345.

Kato, J., 2003. Maintenance System Assemblage by Utilizing 3D Laser Measurement Device, *Proceedings of the Second International symposium on New Technologies for Urban Safety of Mega Cities in Asia*, Tokyo, October 2003, pp.247-254.

Nishimura, S., and Sumitro, S., 2002. Utilization of Digital Information on Preservation Management of Culture Properties, *Proceeding Of the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. VI, No.4, Corfu, Greece, September 2002, pp.434-439.

### References from Books:

Japan Association of Surveyors, 2004. *The theory and the practice of the digital photogrammetry*.