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Photogrammetry to maintain heirloom authenticity

Miftah Amirul Amin[1], Muhammad Emir Ghiffari[1], Muhammad Arham Irsyad[1], Umar Ali Ahmad[1], Reza Rendian Septiawan[1], Fussy Mentari Dirgantara[1], R Rogers Dwiputra Setiady[1]
[1]Department of Computer Engineering, School of Electrical Engineering, Telkom University, Indonesia

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ABSTRACT

Heirlooms are very valuable items because they have a strong historical value. But in reality, many heirlooms are damaged as a result of the negligence of visitors who want to see the heirlooms or because of a disaster. Photogrammetry is a technology that is developing and is often used for today's industrial needs so that it offers an alternative solution for documenting heirlooms in the form of 3D models. This study aims to implement photogrammetry to document heirlooms. With the application of this technology, it is hoped that it can be used as a prevention or solution if heirlooms are damaged because we can make new duplicates of heirlooms based on 3D models that have been made. This research was conducted at Kanoman Palace, Cirebon City. The results of photogrammetry after it is implemented show that all needs are met and can be used as needed. The results of the questionnaire to the Kanoman Palace and people in Cirebon City showed a figure of 73.7% strongly agree that the photogrammetry results are similar to the original heirlooms and strongly agree that making 3D models of heirlooms can be used as prevention and solutions if the heirlooms are damaged.

Corresponding Author:

Miftah Amirul Amin
Department of Computer Engineering
School of Electrical Engineering, Telkom University
Bandung, Indonesia
Email: miftahamirulamin@student.telkomuniversity.ac.id

1. INTRODUCTION

Heirloom is a term used to describe an object that is considered sacred and has its history. In Indonesia, many heirlooms have an important history. An heirloom is an important investment for a region or country because an heirloom object, a functional investment, or just a sign of one's decrepitude[1]. Heirlooms are usually found in museums. One of the means of learning is by exploring the history of an heirloom. we can learn science, history, and culture from one heirloom.

The problem is that heirlooms are objects that will inevitably experience fragility until they are damaged and this causes the loss of detail. It will be very unfortunate if the heirloom is damaged, especially if the heirloom has a strong history such as the war equipment.

It was found that there were many cases of damage to heirlooms in museums by careless visitors, not only cases of damage to heirlooms but also cases of heirloom theft. This caused the heirloom gone missing in the museum.

Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring, and interpreting photographic images and recorded patterns of electromagnetic energy radiation.[2]. Photogrammetry does not cost much and is easy to implement. The museum does not need to add new workers to do photogrammetry because anyone can do it.

Based on that problem, the solution is to maintain the details and authenticity of the heirloom by documenting it. The right way to document it is to create a 3D model of the heirloom. With photogrammetry, the original heirloom which is very sacred can be stored in a safe place and the details or authenticity of the heirloom can still be seen without having to spend a lot of money on cleaning or restoration process if the heirloom is dirty or damaged. Photogrammetry has been widely used and studied by several researchers such as [3]–[6]. The result of the photogrammetry should be as close as possible to the original. This research takes a case study at the Kanoman Palace Museum in Cirebon City Indonesia involving museum staff to be used as input data for data validation.

2. METHOD

The stages carried out in this research are requirements analysis, photogrammetric and finishing processes as shown in Figure 1.

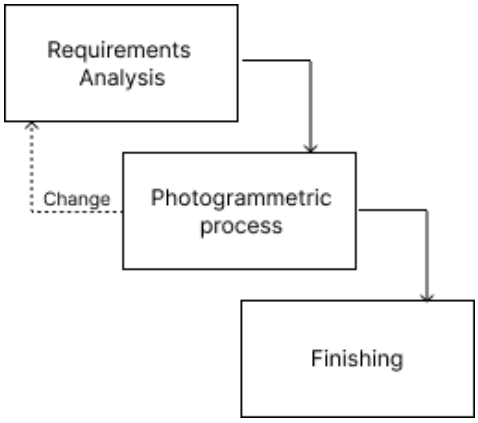

Figure 1. Overview of The Stages

The stages are used because it is flexible when accommodating changing needs. To ensure that the research carried out has met the existing needs, this research will use a quantitative survey method by distributing questionnaires to the Kanoman Palace and the people in Cirebon City. This method is used to ensure that the 3D model is similar to the original. The questionnaire consists of 2 statements with a rating scale of 1 to 5.

Table 1. list of statements for the questionnaire

No	Statement
1	3D models that are made very similar to the real thing or look real
2	In your opinion, making 3D models of heirlooms can be used as a preventive measure if the heirlooms are damaged intentionally (damaged by ignorant visitors' hands) or accidentally (hit by a disaster) so that we can still see the original form of the object.

The statement in table 1 is used to determine whether the 3D model made with photogrammetry is appropriate to be used as an effort to maintain the authenticity of the heirloom starting from the shape to the texture.

Table 2. description of the rating scale for the questionnaire

Scale	Description
1	Strongly disagree
2	Disagree
3	Just agree
4	Agree
5	Strongly agree

2.1. Requirements Analysis

Requirements analysis was carried out using observation at the Kanoman Palace Cirebon City. In addition, interviews were also conducted and asked the museum staff for permission to find out information about the heirlooms to be photographed and which were allowed to be photographed.

2.2. Photogrammetric Process

Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring, and interpreting photographic images and recorded patterns of electromagnetic energy radiation.[2]. In the photogrammetry process, photos of heirlooms will be taken and photogrammetric processes will be carried out with photogrammetric applications. Photogrammetry is done because it does not cost much and is easy to implement.

2.3. Finishing

In this stage, the 3D model that has been completed in the process in the previous stage will be refined with the 3D maker application. This is done so that the finished 3D model is ensured that it is ready to be used for other needs such as augmented reality.

3. RESULTS AND DISCUSSION

In this section, we will discuss requirements analysis, photogrammetry, finishing processes, and also the result of the questionnaires.

3.1. Requirements Analysis

From observations and interviews as well as studying the history of heirlooms in the Kanoman Palace, Cirebon, it is known that the heirlooms in the Kanoman Cirebon Palace are around 600 years old. Because of this, not all heirlooms in the Kanoman Palace can be photographed. After observation, the heirlooms that will be sampled in this study are several sacred wells in Kanoman Cirebon Palace. Because the sacred well is located in a place that has sufficient lighting, no additional lighting is needed.

From the results of observations and interviews, it can be seen what is needed by the museum staff. The museum staff hopes that the results of the 3D models that are made are similar to the original ones and are expected to later be used as assets in the development of the museum to be more advanced.

Figure 2. Witana Well as A Sample of This Research

3.2. Photogrammetry Process

What is needed in carrying out the photogrammetric process is taking photos of heirlooms. The photogrammetric process requires photos taken around heirlooms. Photos taken must have a consistent orientation. At least 100 photos should be taken so that the results of the photogrammetric process are good. The more photos you take, the longer the processing time and the better the results, as research has been done by[7]. There are 639 photos of sacred wells taken in this study. Visualization of the camera position during the photo-taking process can be seen in Figure 3.

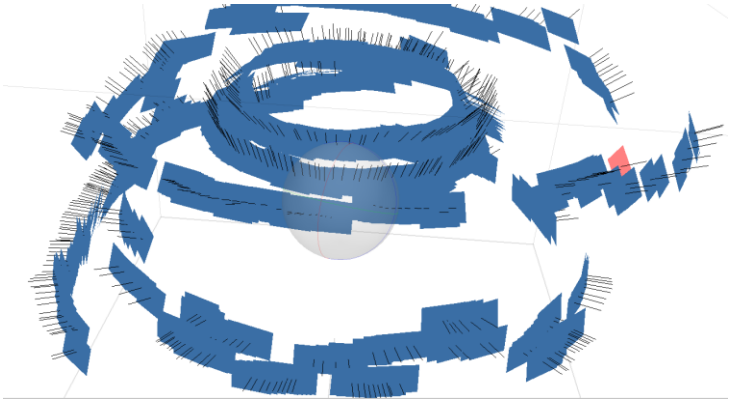

Figure 3. Visualization of the camera position

For the photogrammetry process using the help of the Agisoft Metashape application. In the photogrammetry process with the Agisoft application, it is enough to do the steps in the workflow tab, starting from adding photos, align photos, build dense cloud, build mesh and build texture as you can see in [8].

3.2.1. Align Photos

Align photos is the process of detecting the camera position from photos that have been taken and will produce a point cloud. A point cloud is a set of data points in space. It is a collection of data points defined by a given coordinates system. In a 3D coordinates system, a point cloud may define the shape of some real or created physical system[9]. The time required for this process is approximately 17 minutes. The results of aligning the photos can be seen in Figure 5.

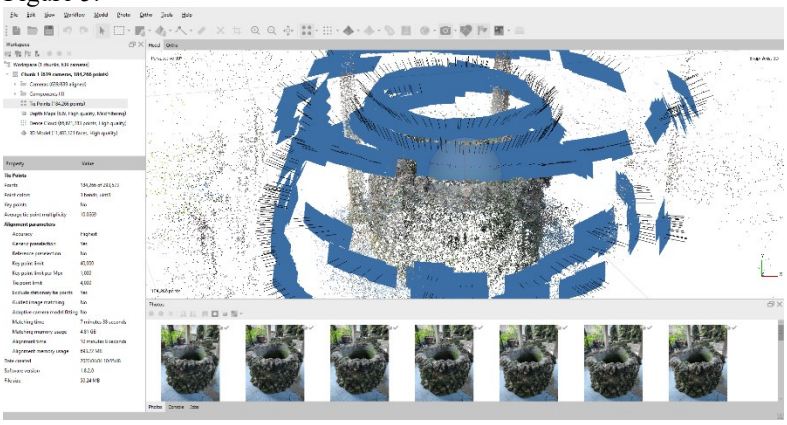

Figure 4. Display of Result From Align Photos

3.2.2. Build Dense Cloud

Dense cloud is a collection of points that number up to thousands which can later be processed further to produce 3D model data. The dense cloud build process takes a lot of time. In a study with a total of 639 photos, the quality used in the dense cloud build was high and took up to approximately 4 hours on a PC with i5 11600KF and RTX 3060. The results of the dense cloud build can be seen in Figure 6.

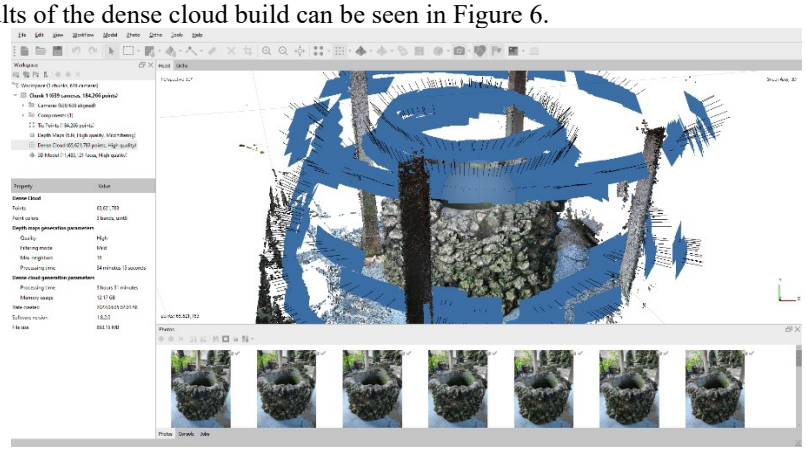

Figure 5. Display of Result from Build Dense Cloud

3.2.3. Build Mesh

This process will connect the dots of dense cloud to become a mesh and become a 3D model without texture and color. This process does not take as long as a dense cloud build, the processing time is 10 minutes. The results of the building mesh can be seen in Figure 6.

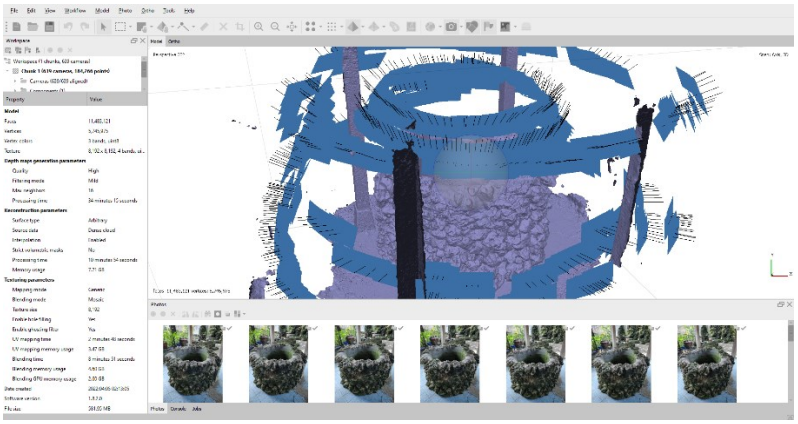

Figure 6. Display of Result from Build Mesh

3.2.4. Build Texture

At this stage, the 3D model will have colors and textures ready for export. The result still needs to be refined because there are still parts that are wavy or do not match its original form. The 3D object is published as a file with the extension. dae (collada) or .obj (object) accompanied by a texture.jpg file [10]. However, the photogrammetry results are not perfect, so it needs to be refined again with the 3D maker application. The time required for this process is about 10 minutes. The results of the build texture can be seen in Figure 7.

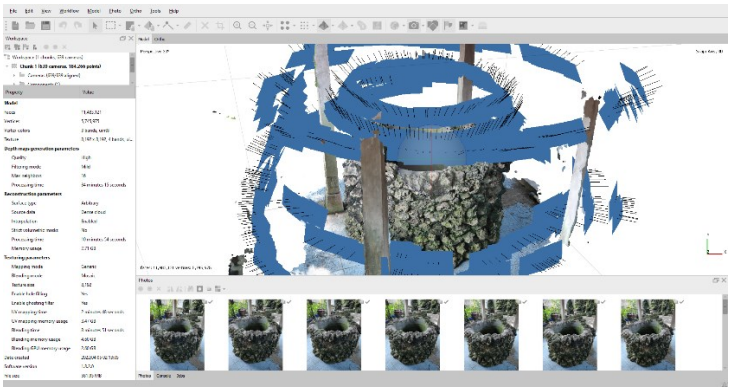

Figure 7. Display of Result From Build Texture

3.3. Finishing

At this stage the 3D maker application used is Blender. This application is used because it is free and has complete features for the needs of this research. At this stage, the refinement process carried out is cutting out unnecessary objects from the photogrammetry results and tidying them up, and then adding shaders to the 3D model. The shaders used are bumps and color ramps so that the 3D model becomes more real. The final result can be seen in Figure 8.

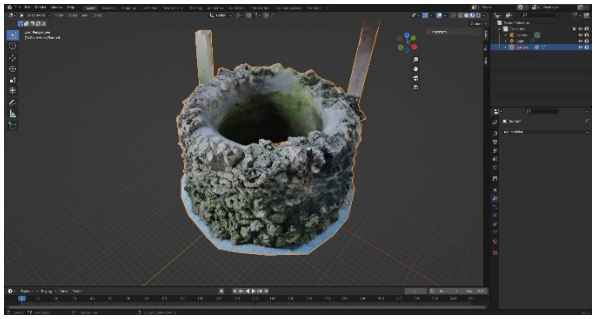

Figure 8. Final Result After Smoothing and Shading

3.4. Questionnaire Results

Based on questionnaires distributed to museums and people in the city of Cirebon, on average of 41 people strongly agree that the 3D model that has been made is similar to the original and strongly agree that it can be used as a preventive measure if heirlooms are damaged intentionally (damaged by the hands of ignorant visitors) or

unintentionally (disaster) so that we can still see the original form of the object. These results mean that photogrammetry can be used as a solution to maintain the authenticity of the form of heirlooms, although it still needs improvement with the 3D maker application. The chart of the questionnaire can be seen in Figure 9.

Figure 9. Chart of Questionnaires Result

4. CONCLUSION

The results of rendering photos that have been taken in a total of 639 using the Agisoft Metashape application still need to be refined with a 3D application by cropping, smoothing, and shaders. The rendering process took a total of about 4 hours and 30 minutes. Based on the photogrammetric process and questionnaire results that have been carried out, it can be concluded that the 3D model of the heirlooms at the Kanoman Cirebon Palace that has been made is by the needs analysis for museum staff and this reaserch. The 3D model that has been made can also be used for museum needs such as making Augmented Reality like [11], [12].

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