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PROCEDURES EXPERIMENTS USING PHOTOGRAMMETRIC METHOD

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ABSTRACT

Tangible objects are actual objects that can be touched and have a physical form. Therefore, the existence of tangible objects cannot be separated from the potential of damage and even disappearance. At the same time, tangible objects can be an essential source of research and can be a historical source that needs to be preserved. With the development of technology, objects can be recorded in digital forms, 2D Documentation, such as photos and videos, and increasingly sophisticated technology makes object recording developed in 3D Documentation. An easy method with good data quality results is photogrammetric. The implementation of the photogrammetric method has many advantages, some of which are straightforward procedures, portable equipment, and relatively low prices. This study uses a qualitative method based on photogrammetric experiments with various lighting settings and different needs. The results of this research are trying to breakdown of photogrammetric procedures that can applied according to field conditions.

KEYWORDS 3D Documentation; Photogrammetric Method; Tangible Objects

INTRODUCTION

All tangible objects that exist can be called artifacts or cultural objects. It means all human creations (Setiadi, 2017). It is undeniable that cultural objects become exciting

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objects to study because they are rich in knowledge, especially culture (Khoirina, Suyitno, & Winarni, 2017). For this reason, it is necessary to carry out preservation activities so that the object does not disappear in the crush of time (Sudarsono, 2017). Preservation is the integrity of the effort to preserve the object's history, such as maintaining the physical object itself or documenting it, and will be helpful for future generations (Zain, 2014). (Syaifullah & Wibowo, 2017) said that relics that can be interpreted as ancient and rarely used could attract several people's attention for a purpose. An example is in the contribution of science; research on cultural objects is the target of researchers in the development of science (Hartati, 2020).

Then when human interactions are digitally integrated into real and virtual spaces and change the state of our existence (Giannini & Bowen, 2019). Digitization has shaped a new arrangement that makes humans and technology coexist. Digital transformation is the entry point for change, and humans are the agents in that transition (Wijanarko, 2019). Now appears a method of recording or documenting 3D using laser scanner technology and digital photogrammetry. The advantage of 3-dimensional documentation compared to 2-dimensional lies in representing data in 3-dimensional form digitally (Astuti, 2012). Thus, the documentary results of cultural objects in the form of shapes, colors, textures, materials, and other information can be represented and monitored from three axes simultaneously (Sukmana, 2011). The advantages of this method make 3-dimensional laser scanning and digital photogrammetry a standard method of 3-dimensional documentation of cultural objects around the world since the 1990s (Dostal & Yamafune, 2018). Meanwhile, photogrammetry is superior in producing better texture data with high mobility but requires a longer data acquisition time than laser scanners (Saputra, Rahardianto, & Gomez, 2016).

The documentation process is the main stage in the maintenance of cultural objects (Prasetyo, 2019). This process can be helpful as a form of archiving whose information can later be used for various purposes, such as research and even the development of cultural object designs (Samosir, 2021). Documentation for digital museums in 2D in the form of photos and videos has been widely used, and as technology advances, documentation has taken to the 3D level. This 3D documentation method is broadly divided into laser scanners and digital photogrammetry. This method has advantages, including presenting data in a three-dimensional form which is then used as a standard for three-dimensional documentation of cultural objects worldwide since the 1990s. This three-dimensional form is also helpful in the realm of design and research. By using the 3D form, it is hoped that users can learn about shapes, dimensions to textures, which can be additional knowledge about objects and cultural values that can stimulate the creative process in designing so that the physical characteristics of the object can provide cognitive stimulation in the creative thinking process (Younan & Treadaway, 2015).

A study conducted by (Samosir, 2021) proved that photogrammetry on representative objects (samples) has good data quality. However, this study has not been explained in detail regarding the selection and arrangement of space to implement photogrammetry. For this reason, this study will discuss experiments on the application of photogrammetric procedures in several different room setting conditions. These experiments aim to analyze the effect of other spatial arrangements on the 3D reconstruction of objects' results.

RESEARCH METHODS

This study uses a qualitative method based on photogrammetric experiments, which tested various field conditions with several different needs. In general, this study uses the following initial procedural design:

1. **Selection of documentation location points.** In selecting the location of the documentation, the point must consider the lighting conditions, weather, availability of space, and easy accessibility.
2. **Preparation of documentation equipment and environmental adjustment.** At this stage, we are setting the environment for the preparation of documentation. Some of the standard equipment used in the documentation process is as follows.
    1) Camera. There is no standard literature that mentions a minimum specification for photogrammetry but is based on research that has been done previously, and it has at least a resolution of 13 MP. In this study, a DSLR-type camera with the Canon EOS 800D type, which has a resolution of 24.2MP, will be used. The higher the specifications of the camera, the better the 3D data will be (www.photomodeler.com).
    2) Photo background. The use of photo backgrounds intends to make object recording more focused and facilitate the 3D reconstruction process.
    3) Other supporting equipment by adjusting environmental conditions such as lighting, tripods, rotary plates, and tables.
3. **The process of taking pictures.** The photogrammetry process carries out by photographing all visible parts of an object. However, to obtain efficient data, it is recommended that two patterns of shooting methods are recommended, namely parallel or parallel shooting and circular shooting.
4. **The process of storing raw data after documentation.** This process expects so that the documentation process up to the 3D reconstruction process can be appropriately stored.
5. **3D reconstruction process.** In this section, photos of objects that have been photographed will be processed and the information data retrieved by the 3DF Zephyr software. In this section, the refining process is also carried out to support the results of 3D objects.
6. **Final storage stage.** At this stage, raw data storage carry out in the form of a collection of two-dimensional photos of objects and 3D data storage that has been constructed to be carried out to the next stage of digital preservation. This section is the final part of the reconstruction, and the archiving process continued after the storage of the previous raw data.
    - 3D model data format: .obj and .mtl
    - Map texture: .png

RESULTS AND DISCUSSION

An essential element that can affect the photogrammetric results is the arrangement of space and lighting. Therefore, several simulations of different lighting settings identify the need and suitability of procedures that could be applied in the field. The simulation process is also an exercise in testing shooting techniques according to the complexity of the object's shape. Simulation experiments carried out in 4 different experiments, namely:

1. Experiment I: Object as Axis & Indoor Arrangement.
2. Experiment II: Objects as axis & Outdoor Arrangement.

3. Experiment III: Rotating Objects & Outdoor Settings.
4. Experiment IV: Rotating Objects & Indoor Arrangement.

Table 1. Setting and Needs of Experiment I

Setting	Needs
- The object as the axis, does not change, but the image is taken rotating.	- Lighting 2 x 9 Watt LED - Room 4 x 5 m2
- Indoor, light, object is in the middle of the room.	- Pedestals (chairs and multiplexes) for placing objects

In the first experiment, objects arrange as an axis, which is taken in parallel and diagonal rotation of the object to be documented. The experimental simulation was carried out in an indoor room with the help of lighting from LED lights on the ceiling of the room.

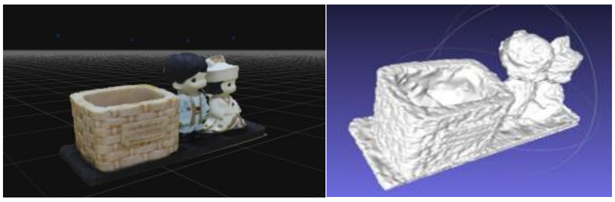

Figure 1. Result of Experiment I, Texture Data (left) and Geometric Data (right)

From the first experimental results, it can be seen that the object can be said to be successful in 3D reconstruction, and it works well, especially on the results of texture data.

Table 2. Setting and Needs of Experiment II

Setting	Needs
- The object as the axis does not change, but the image is taken rotating. - Outdoor, sunlight, the object is in the middle of the room.	- Sunlight at 9am - Free space to take pictures - Pedestals (chairs and multiplexes) for placing objects

Not much different from the first experiment, in the second experiment, the object was arranged as an a-axis, and the object image was taken in parallel and diagonal rotation of the object to be documented. However, this experiment uses an outdoor setting.

Figure 2. Result of Experiment II, Texture Data (left) and Geometric Data (right)

From the results of this photogrammetry experiment, the object was successfully reconstructed in 3D perfectly when viewed from the quality of the geometry data and the texture data.

Table 3. Setting and Needs of Experiment III

Setting	Needs
- The object rotates, the camera is in one position using a tripod - Outdoors, sunlight -3DF Zephyr process using masking tools	- Solar lighting - Pedestal (table), green screen background (optional) - Paper tape / background stand (optional)

In the third experiment, this time, it was different from the two previous experiments, namely using a rotating object technique while the camera position remained in one position. This technique is carried on outdoor and the object does not have to be in the middle of the room, but the location of the object and camera and other equipment such as a tripod or photo background is adjusted.

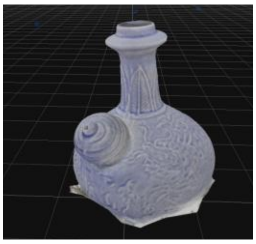
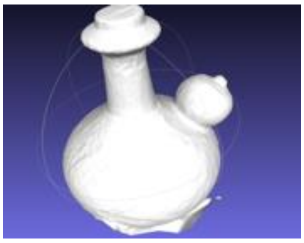

Figure 3. Result of Experiment III, Texture Data (left) and Geometric Data (right)

The experiment using this technique was successfully carried out and resulted in good quality texture data and geometric data. However, using this technique, photogrammetric processing requires a masquerade tool in the process, so it takes longer. The masquerade tool is a photogrammetric processing option found in Zephyr's 3DF software. With this option, select which object to be photogrammetrically, but this method needs to be checked on each masked image to minimize reconstruction failure.

Table 4. Setting and Needs of Experiment IV

Setting	Needs
- The object rotates, the camera is in one position using a tripod - Indoor, lighting from lamps. - 3DF Zephyr process using masking tools	- Lighting 2 x 9 Watt LED - Room 4 x 5 m2 - Alas (table), green screen background background - Paper tape/background stand

The last experiment was not much different from experiment III. it is just that this experiment was conducted indoors. Experiment IV was tested on objects that have a hole in the object.

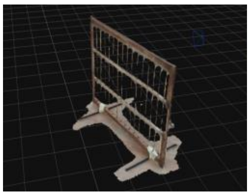
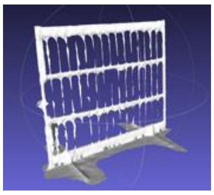

Figure 4. Result of Experiment IV, Texture Data (left) and Geometric Data (right)

From the results of the 3D reconstruction obtained with this experimental setting, it has good detail and quality on the legs and edges of the object, but for the shape of the spokes, which has a thickness of under 2mm and the holes in each gap have complexity and the quality of the resulting data is not good enough, the masking process also takes time. Significant time because it has to be done on every photo of the object.

CONCLUSION

In the conclusion of the four experiments, several conclusions were obtained, among others, as follows that the use of photo backgrounds does not prove a significant difference in the 3D reconstruction of objects. On the other hand, the composition of light during documentation is fundamental to note. If the space in the object has sufficient light intensity, the object will be reconstructed successfully. Both methods, both the axis of the object and the rotating object, have no significant effect on the results of 3D reconstruction. However, it uses the rotating object method, and it will need masking tools (masquerade tools) which can be done on the 3DF Zephyr software. The use of masking tools certainly requires much more time because each image needs to be checked for masking so that there are no errors in the selection process. Use of masking tools: masquerade has difficulty depending on the shape and details of the object that it wants to reconstruct. Suppose the objects have many holes; extra time would be required and needed, so using this method is not recommended for objects that have many holes. The shooting time of each object varies depending on the detail and complexity of the shape. Meanwhile, the number of photos varies for each set of objects, not less than 30 photos and no more than 90 photos per object. The 3D reconstruction time of each object using Zephyr's 3DF software generally ranges from 20 – 30 minutes using the default settings. 3D reconstruction using masquerade tools can reach 2-3 times the time of 3D reconstruction without using masquerade tools.

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