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Archives Development of Cultural Objects based on 3D Documentation Method for Digital Museum
(Case Study: Pottery and Ceramic Center in Plered, Purwakarta)

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ABSTRACT
Cultural objects are essential resources to manage because they show the identity of society. Therefore this is one of the crucial aspects that are the target of researchers. As tangible objects, cultural objects cannot separate from the potential for damage or even loss. So far, it has been archived through physical museums, and with the help of technology, museums are developing in digital form nowadays. The existence of a digital museum is motivated by the development of documentation methods applied in archiving cultural objects—this study discusses 3D documentation using the photogrammetric method in the field. Photogrammetry is a 3D documentation method that is easy and economical, in which information is retrieved by taking pictures of objects from every angle. In previous research, experiments with this method were carried out on representative samples and proved that photogrammetry produces good data quality and can be used as a standard for digital preservation. This study aims to support previous results according to real-world conditions for digital preservation purposes and used on cultural objects and to help other researchers collect data in the field for digital preservation purposes. Plered, Purwakarta, pottery and decorative ceramics chosen as an object study. The existing variety of objects are developed following the production technique of the Plered community. The objects' varieties that exist now result from developing production techniques that the Plered community has owned from generation to generation. The study suggests alternatives method that supports the documentation process, in which photogrammetric procedures are suited for different field conditions. The process to archive cultural objects based on samples of study are discussed.

Keywords: *3D Documentation, Cultural Objects, Digital Archiving System, Digital Museum, Photogrammetry*

1. INTRODUCTION

Culture includes all patterns of behaviour or ways of thinking of humans rooted and adapted from generation to generation in society. One form of culture itself is a cultural object, or often also called an artefact. Artefacts have a physical form, the result of human activity that can be touched. These tangible artefacts need to be preserved, which function as assets of a society or as studies in the academic realm. Preservation is a series of efforts aimed at preserving the history of an object, both in terms of preserving the physical form of the object itself or in the form of documentation that will be useful in the future [1]. In this case, artefacts cannot deny the attention of several groups of people for any purposes. One example is the contribution of science. Research on cultural objects is the target of researchers in the development of science [2]. These cultural objects are usually archived in museums, so that museums play an important role in the preservation of cultural objects. Civilization of society can be reviewed through the museums because the history and its characteristics reflected through the culture that embodies [3].

When human interactions are digitally integrated in real and virtual spaces, then change the state of our

existence [4], digitalization has shaped a new order so that humans and technology coexist. Digital transformation is the gateway to change. One form of innovation in the field of culture is a digital museum. It is a museum that is packaged digitally, starting from the archiving process to the presentation of data through digital media so that the wider community can access it.

In digital preservation efforts, documentation is the main stage in maintaining cultural objects. Documentation for digital museums in 2D in photos and videos has been used, and as technology advances, documentation has taken to the 3D level. For example, 3D documentation has been widely applied in archaeology or related fields that require visual studies. However, in Indonesia, this method has not been fully utilized, even though one method, namely photogrammetry, is easy to apply considering that many cultural objects in Indonesia are rich and require digital preservation efforts. 3D documentation methods are broadly divided into laser scanners and digital photogrammetry. This method has advantages, including presenting data in three-dimensional form, which is then used as a standard for three-dimensional documentation of cultural objects worldwide since the 1990s [5]. Using 3D forms hopes that users can learn about shapes, dimensions, and textures that can become additional knowledge about the object. Cultural values can stimulate the creative process when designing [6]. This study chose the photogrammetric method because the application is easy to apply in the field with minimal equipment, a camera. Photogrammetry that uses a DSLR camera as its primary tool tends to be superior. The existence and use of cameras in human life are known to be more common than lasers, especially in Indonesia [7].

This research aims to support the data collection process, in this case, the 3D documentation process in the field. Field conditions can be different from each other and require different needs, so this study will discuss photogrammetric procedures applicable in the field. In this paper, we will discuss various factors that can affect the documentation process so that it affects the results of photogrammetric reconstruction based on the selected case study location. Then sample objects will be digitized and archived in a simple and easy to understand manner.

2. CONTENTS

The contents divided into two sections. The first part is a field photogrammetric method which contains the requirements to support the documentation process. In contrast, the second part contains the steps of the photogrammetric procedure in the field. This research uses a qualitative approach based on photogrammetric experiments on the object study. Then continued the analysis based on the comparison of the experimental results by photogrammetric procedures.

2.1. Field Photogrammetry Needs

The basic principle of photogrammetry is to take information in the form of points created on the surface of photos of objects and then convert them into three-dimensional forms. In the application of this method, several requirements must be considered.

Table 1. Equipments of Field Photogrammetry

Type of need	Function	Description
Hardware	Field documentation process	• A Camera (DSLR/mirrorless) • Pedestal (suitable for small objects) • Lighting (natural/artificial) • Notebook and other stationaries (manual/digital)
	3D Reconstruction process	• Computer with minimum specifications: Quadcore/AMD CPU 2Ghz, Intel HD 4000, GPU & RAM 8 GB
Software	3D Reconstruction tool	3DF Zephyr
	3D Format Viewer	MeshLab

Like applying this method as it has been applied so far, the photogrammetric documentation process

requires a DSLR or a mirrorless camera. There is no definite minimum standard for cameras, but the better the camera resolution, the better the photogrammetric data quality [7]. This research uses a Canon EOS 800D DSLR camera, where camera is classified as a semi-professional camera. This research uses a Canon EOS 800D DSLR camera, where camera is classified as a semi-professional camera. When documenting objects in the field, a supporting product/pedestal is needed to place small objects (under 1 meter) so that the documentation process continues smoothly. It is related to the principle of ergonomics. Ergonomics is concerned with understanding humans and human behaviour, human anatomy, physiology and psychology to design work that suits human needs [8]. In photographing each object that requires at least 40-60 shots, a position or support is needed so that photographic activities can run effectively and do not cause injury. Good lighting conditions will significantly impact the result of a photogrammetric. The last thing that must be prepared when documenting the field is a notebook and writing utensils. It can also be circumvented through recording or digital writing. This requirement aims to obtain information related to artefacts using participatory methods.

The hardware used to process the documentation results into 3D form is a computer with the minimum specifications, as shown in table 2.1. In this study, the author uses NVIDIA GPU support so that the reconstruction process runs more smoothly. This study uses 3DF Zephyr's software because this software is licensed for free and easy to use. In general, Agisoft Photoscan is commonly used by highly skilled users with a deep understanding of photogrammetry [7]. To view the 3D format object documents in this study using MeshLab software because this device is relatively easy to operate, especially in displaying the results of 3D objects and their textures.

2.2. Stages of the field photogrammetry procedure

This section contains easy and adaptive steps for photogrammetric procedures in the field. It is considers field conditions and convenience so that processes and requirements can be carried out concisely. In this paper, the photogrammetric method is broadly divided into two ways, namely rotating objects and objects as the axis. Rotating objects can use additional equipment, namely in the form of backgrounds, tripods and turntables. The object method as an axis does not require additional requirements.

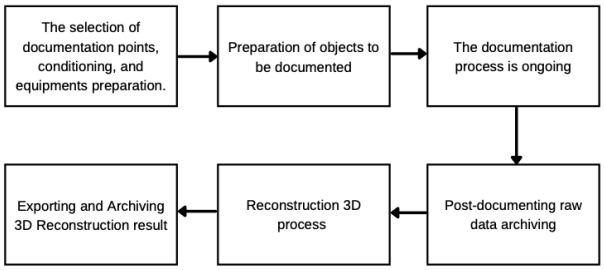

Figure 1 Stages of Photogrammetry Schemes

The first step is to determine the point where the documentation will be located. Ensure that the location will not interfere with community activities. The character of the place of documentation is divided into indoor and outdoor settings.

Table 2. Things to consider before starting documentation

Indoor settings	Outdoor settings
• Ensure that there is sufficient light to capture the image. • Check the photos using the camera first. • The room area is quite spacious; the experiment can be carried out first before the documentation is carried out. If the object and environment do not have sufficient colour contrast, the background will be necessary.	• Ensure sufficient light, no less and more and predict weather conditions, avoid cloudy or likely rain. • Check the photos using the camera first. • Photo spots do not interfere with community activities, especially those who are passing by. If the object and environment do not have sufficient colour contrast, the use of background will be necessary.

Lighting is an important element as one of the determinants of the success of 3D reconstruction. For this reason, it is necessary to pay attention to the composition of light during documentation. After determining the right point and preparing all the

equipment, the next step is to prepare the object to be documented. Object preparation includes recording and numbering objects to make it easier to organize. Clean objects (dry cleaning, without water so as not to damage the object), cleaning is carried out so that when it is documented, dirt attached to the object does not damage its texture.

The next stage is the documentation process. This process is recommended to be carried out by photographers or at least people who understand the world of close-range object photography. This process can also be done in parallel to collect data using participatory methods to obtain information related to the object to be documented. For this reason, it is recommended to use different human resources to carry out these tasks.

Post-documenting raw data archiving. This stage requires a laptop for archiving raw data; here will also be checking related to the photos before entering the 3D reconstruction stage to ensure all parts are appropriately recorded. This process can be carried out on internal or external storage (it is recommended to use external storage/HDD to simplify moving data and data capacity). Folder creation can be tailored to the needs, or in this study suggest creating folders from general to specific categories.

The next step is 3D reconstruction. as explained in the previous section that this research uses 3DF Zephyr to generate photos into three-dimensional forms in digital form. After the reconstruction process is complete, the next step is the data exporting process, which includes 3D files (.obj and .mtl), texture map files (.png). All three data formats must be placed in the same folder with the same document name because different names can cause errors, and textures cannot appear using MeshLab.

3. RESULTS

3.1. Implementation of photogrammetry in Plered, Purwakarta

The documentation was carried out in the case study area, the Plered pottery and ceramics center, Purwakarta. More precisely, the documentation process is carried out at three different locations. The three location points were chosen based on information from the surrounding community and are representative of objects that are currently developing in Plered. The first documentation was carried out in the Krapel Craft UKM workshop room. The second documentation was carried out at the Plered Ceramic UPTD. The third documentation was carried out at the Dodol Bedebah workshop and showroom. The three points have different location characters. The Krapel Craft UKM Workshop is semi-outdoor, the UPTD Plered is indoor, and the Dodol Bedebah UKM is outdoor. However, the three of them still use natural light in the sun because the documentation is done from morning to noon when the weather is sunny. All three also use the method of documenting objects as an axis by considering convenience, especially the mobility capacity of the luggage that can be transported.

3.2. Implementation of photogrammetry in Plered, Purwakarta

Overall, this study succeeded in documenting in 3D 24 representative objects with various production techniques, of which 3 of them experienced reconstruction failures. In this section of the paper, we will specifically analyze the factors behind the failure of the 3D reconstruction.

3.3. Digital archiving of cultural objects based on object samples in Plered

Archiving through digital media is not a new thing, but in Indonesia itself, digital media as an alternative to archiving has not been fully utilized. One of them is based on case study observations in this study; it is known that Plered itself does not have a database or object storage space. Whereas Plered itself since 1900 has been known as a ceramic producing area, objects of this culture have developed until now. Therefore, this study also tries to archive sample objects that have been documented as an early form of building a cultural object archiving system in Plered.

Archiving system using google drive. The ease of access and some features on Google Drive can be used as limitations, such as the view-only feature or setting as an editor, so there are limitations as an accessor or operator. The archiving system in this study can be accessed in full at: https://drive.google.com/drive /folders/1lf4JdxDWMClYxA9y4r4_tSjgI-vY64u?usp=sharing

4. DISCUSSION

In the implementation of photogrammetry in the field, the authors experienced some difficulties. Here

are some evaluations of the results of this study. Unpredictable field conditions, so it is required to prepare backup plan, in this case, is the location of documentation. The selection of location points must pay attention to access to not make it disturb for people to pass by.

The light is too bright, or even the backlit photo can interfere with the reconstruction results and even be a factor in the failure of the 3D reconstruction.

The composition of the light at the time of the documentation was very influential on the reconstruction results. Overexposure and may affect the results of 3D reconstruction.

Figure 2 Failure 3D reconstruction of object Dekorasi Ikan (a) front view; (b) side view; (c) back view.

As in Figure 2, the reconstruction results show that one part can be appropriately reconstructed, but the other part cannot be reconstructed at all.

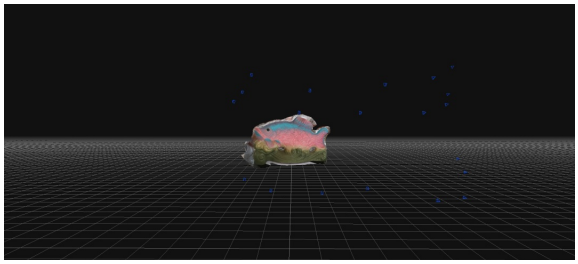

Figure 3 Projection Angle Captured 3DF Zephyr

If you give attention to Figure 3, the angle that has been captured is only one side of the object; this is what causes the other angles to fail to be reconstructed. The images that fail to be reconstructed are images that do not have a balanced light composition, so forming information in the image cannot be reconstructed correctly.

Figure 4 Sample images that failed to reconstruct

When viewed through the photo results, the composition of light in the photo, on average, does not have a balance of light; in other words, the light turns back to the object so that the documented object becomes less clear/focused. Application of photogrammetric methods; object as an axis is easier to apply.

Table 3. Two methods of photogrammetry and its impact to 3D reconstruction process

Rotating Objects	Objects as an axis
If using this method, then a masking process is required. In this process, you can use two options, namely using external software: Photoshop or internal 3DF Zephyr software: Masquerade tool	The reconstruction process can be carried out directly using 3DF Zephyr following the workflow on the software.

It can be seen from Table 3 that the use of the rotating object method will more take time to process the reconstruction, will also cost money, space, and flexibility where much equipment must be prepared.

The pedestal as a supporting product in the field can be circumvented by utilizing unlimited products around. As long as the pedestals are of sufficient height to assist the photographer in an ergonomic posture.

The three locations also use pedestals by utilizing products around because using the object method as an axis means that photographers must consider the proper posture when taking pictures.

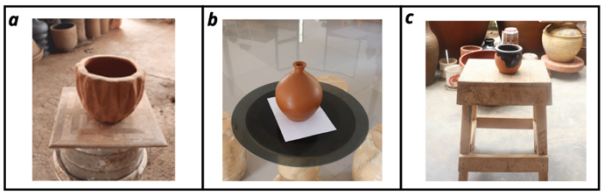

Figure 5 (a) documentation pedestal at Krapel Craft; (b) documentation pedestal at UPTD Plered; (c) documentation pedestal at Dodol Bedebah.

While at Krapel Craft, use piles of empty buckets and pieces of ceramic tiles as a base. Still, make sure the pedestal is stable and strong to put the object to be documented. At the time of documenting at UPTD Plered, a spot for documentation was chosen with ample space with supporting pedestals and a marble table. In comparison, the documentation at Dodol

Bedebah utilizes a wooden stool. Based on photogrammetric experiments conducted at these three location points, the application of the object method as an axis can be circumvented and implemented at the three location points.

In selecting objects to be documented, several things need to be considered. The object must have a heterogeneous shape complexity or have a three-dimensional texture on the entire surface or have a heterogeneous two-dimensional texture spread over the object's surface.

Based on that, the results' evaluation of 3D reconstruction influenced by three things; objects' textures, shape complexity of the object and the composition of the light when doing the documentation process.

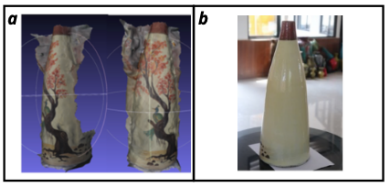

Figure 6 (a) 3D reconstruction failure of object Vas Botol Lukis; (b) the back of the object that failed to reconstruct.

There is a failure to reconstruct the object on Figure 3. The front of the vase with a 2D texture can be reconstructed properly due to the information points in the image, while the back of the object that does not have a 2D texture is one factor for the failure of 3D reconstruction.

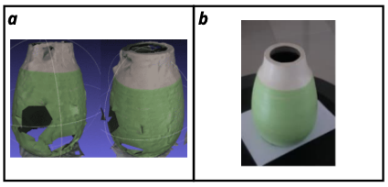

Figure 7 3D reconstruction failure of object Vas Polos; (b) picture of the real object.

The same thing also happened to the object of Figure 7. There was no 2D or 3D texture on the object, so that it failed in 3D reconstruction.

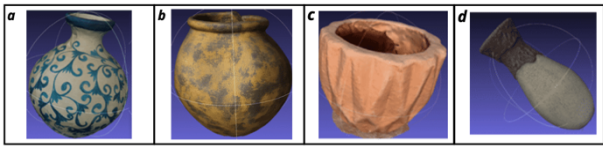

Figure 8 the result of a successful 3D reconstruction (a) Vas Lukis Ornamen; (b) Gentong Rustic; (c) Pot Belimbing; (d) Vas Bownling 2 Textures

The results of the reconstruction of the objects in Figures 8 (a) and (b) produce good 3D data quality; this is due to the two-dimensional texture in the form of paintings that are spread over the entire surface of the object, so that information points are still obtained during the reconstruction process. In Figures 8 (c) and (d), although the three objects have homogeneous colours and do not have a 2D texture, the success of the 3D reconstruction is due to the protruding surface of the object (3 Dimensions) or because it has a rough texture so that the information points on the image is still captured.

Besides that, the shape of the object itself has a significant influence on the reconstruction result—the more heterogeneous the shape of an object, the greater the success rate of the object. In digital photogrammetry, the reconstruction of a 3-dimensional model is done by extracting information from a set of photos in the form of key points. In simple terms, key points are information points in an image/photo that are considered unique and dominant, which will later be used as tie points in the photographs used for the reconstruction process. Therefore, the more unique and dominant information points in each image, the more key points and tie points are generated, and the easier the reconstruction process is carried out. In documentation based on the shape of the object as a whole, it is proven that objects with shapes resembling living things will be more difficult to reconstruct than objects with shapes resembling geometric shapes.

The archiving system of cultural objects is ordered from general to specific. For example, in this study, the filing folder starts with Province down to the smallest unit, namely the documentation location. In addition, other problems were found, where neither the community nor the owners gave names to these objects; for that reason, the naming of objects in this archive begins with a unique code_product function_production technique. A unique code is a number given to the naming of each object that can be adjusted according to each project, or it can also be based on the date and location code of the documentation carried out. The product function contains the purpose of the product or product designation in everyday life, for example, vases, pots, barrels, and others. As for the production, the technique is a technique that is applied to the product, such as painting techniques, burning techniques, or carving techniques. This naming has the purpose of applying the aspect of consistency in the creation of the archive system.

In making the archiving system of cultural objects in this study was made simply using google drive media. Positively, the creation of digital archives through this media is easy to understand by the general public, but the creation of an archiving system requires a more in-depth study.

5. CONCLUSIONS

The preservation of cultural objects has not been optimally utilized in Indonesia even though Indonesia has various cultural objects with different stories that need to be preserved. From the results of the research, it is known that Plered does not have the media to archive their cultural objects, where ceramics and pottery have been developing for a long time ago. With the help of technology, 3D documentation can be a potential that can be developed in Indonesia, seeing how the application of the photogrammetric method in this study can be carried out in almost all locations with minimal equipment and costs. Through this research, it is hoped that preservation activities to archiving cultural objects will begin to be encouraged to become a unified collection of data archives that can be useful for future research. So, if these cultural objects have been documented and archived, then the data can be used to build a digital museum that has many benefits of knowledge with all the ease of access.

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