

# THREE DIMENSIONAL MODELING USING CLOSE RANGE PHOTOGRAMETRY FOR HISTORICAL ARTIFACT

Nurul Hafizah H., Halim Setan, & Zulkepli Majid

Department of Geomatic Engineering

Faculty of Geoinformation Science and Engineering

Universiti Teknologi Malaysia (UTM) Skudai Malaysia

Tel:+607-5530830 Fax+:607-5566163

e-mail:

[nhafizah43@siswa.utm.my](mailto:nhafizah43@siswa.utm.my)

[halim@fksg.utm.my](mailto:halim@fksg.utm.my)

[zulkeplimajid@utm.my](mailto:zulkeplimajid@utm.my)

## Abstract

*Nowadays, historical artifacts are very valuable to our country. Most museum in Malaysia keep the high value historical artifacts in two dimensional (2D) recorded documentation and cannot give the specific measurements for reconstruction or research purposes. The main objectives of this research are to record and develop the high quality three dimensional images of historical artifact for data documentation so that, the data will be easy to access either for the reliability, accuracy, precision and ensure the originality of the shapes and textures for reconstruction purposes. The implementation of this research is using two techniques which are photograph and laser scanner. This research will focus on the preliminary stage of data recording and processing, digital reconstructions and visualization of artifacts.*

Keywords: historical artifact, 3D modelling, photograph, laser scanner

## 1. INTRODUCTION

For the past few years, the development in science and technology were giving a big impact to three-dimensional (3D) modeling industry. The increasing demands of making the various kinds of replica models were leading this three dimensional (3D) industry to be used in wide variety of fields to promote their products or for other uses. For instance, the detailed models of organs is used in medical industry, the science sector used them as highly detailed models of chemical compounds and the engineering community uses them as designs of new devices, vehicles and structures as well as a host of other uses .

In this research, the focus will be on the development of the three-dimensional modeling for historical artifact. From the previous information, most museum in Malaysia keep the high value historical artifacts in two-dimensional (2D) recorded documentation and in many cases, the recorded data cannot give the specific measurements and information for reconstruction or research purposes. As technology advances, one must look to the future and possible methods of recording, comparing and sharing data in the easy way and in the same time. So the three-dimensional (3D) modeling is one of the best solution for data recording that can be used to visualize 3D model and acquire 3D model

measurements which is one can access to get the information such as the reliability, accuracy, precision, the exactly shape and originality of the artifacts texture.

## **2. CLOSE RANGE PHOTOGRAMMETRY**

Close-Range Photogrammetry is an accurate, cost effective technique of collecting measurements of real world objects and conditions, directly from photographs. Photogrammetry utilizes digital images to obtain accurate measurements and geometric data of the object or area of interest, in order to provide spatial information for engineering design, spatial surveys or 3D modeling. The benefits of close-range photogrammetry over other field procedures are purported to be increased accuracy, complete as-built information, reduced costs, reduced on-site time, and effective for small and large projects. (Mangold, 2005).

There are several methods and techniques can be used in generating the three dimensional models for artifacts. Three dimensional modelling and visualization of historical objects are very sophisticated and complex procedure in the job of documentation the cultural heritage. The need for documenting small objects such as archaeology, museum collections and industry may be accomplished using close range photogrammetric techniques (Kulur, 2005). The 3D models objects must visualized and must have metric characteristics and depending on these conditions the information obtained from the artifacts must be reliable. Therefore metrical methods like photogrammetry must be used and a complete and thorough geometric recording of the object must be carried out.

Three-dimensional (3D) Laser Scanner technology was known as “real-scene copying technology”, and it can be used as scanning operation in any complex environment or space (Chen et al, 2005). The development of 3D modeling has brought a completely new landscape to the recording, and preservation. For example, the laser scanners can automatically digitize the 3D coordinates of the complex shape of an object like footwear product. The detailed of any 3D model object is easier to create with the 3D point cloud. One of the drawbacks of laser scanners is that colour images of an object cannot be obtain or, if it is possible, the quality of the color images is worse than that of the photographs (Kadobayashi et al, 2002). To record the true colour of an object more precisely, photographs need to be taking.

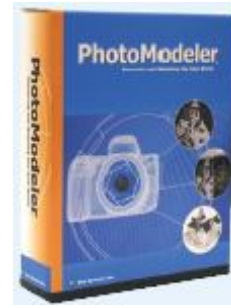
## **3. INSTRUMENTATION AND PROCESSING SOFTWARES**

For this study, the PhotoModeler software is used for processing the data from digital camera Sony Cyber shot DSC-F828 and Rapid Form 2004 software is used for processing the data from Vivid Minolta 910 3D scanner. The Sony Cyber shot DSC-F828 (Figure 1.0) is digital camera with a resolution of 8.0 mega pixels.

The PhotoModeler software is based on the photogrammetry concept that is the science of extracting measurements from photographs. It is used successfully wherever 3D models and measurements from photos are required, and in many areas where high-accuracy, non-contact measurement is required. PhotoModeler software allows to create accurate, high quality 3D models and measurements from photographs and it can be used for different types of archeological applications include flexible and well-organized user interface. This software also can create accurate 3D and texture model of artifacts (PhotoModeler, 2007)



**Figure 1.0:** Sony Cyber shot DSC-F828



**Figure 2.0:** PhotoModeler

The Konica Minolta Vivid 910 operates like a digital camera. The scanner is fully automatic, adjusting laser power and focus on its own. The object to be scanning just only need to be point by the scanner and the viewing area can be adjusted using live video feedback before hit the scan button. Users can also manually control the settings, just like a standard digital camera. A 3D image is generated within seconds

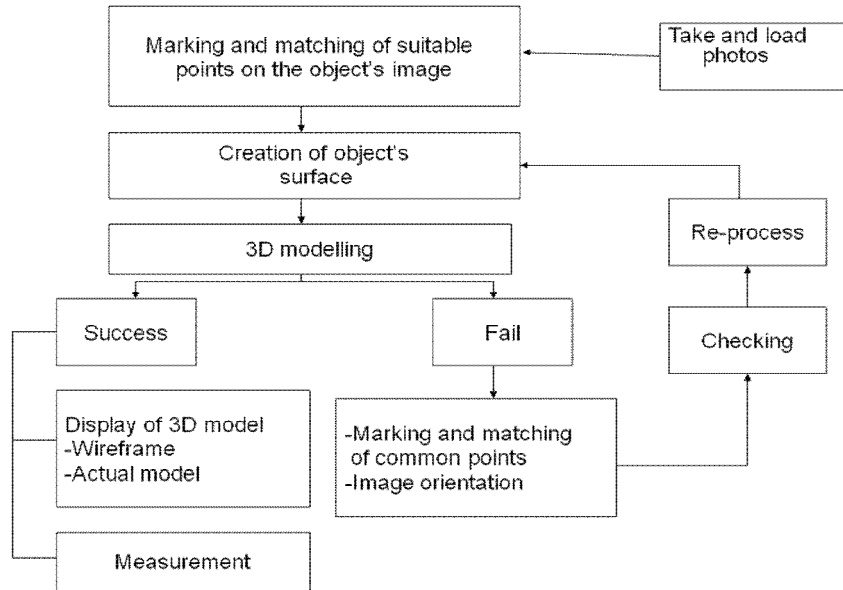
This RapidForm software can obtain the complete 3D model using the different faces of the object by integrating the related point clouds to reconstruct the surface. This software will give the best-fitted surface. RapidForm is a comprehensive reverse modeling tool for all 3D data to be process into polygons, curves and surfaces for the applications. The different workbenches of RapidForm have effectively met all the different needs from a wide variety of possibilities. The RapidForm software allows users to clean up data from different providers, align multiple point clouds to each other, and triangulate the point clouds into polygon meshes and as the most important feature to merge multiple 3D point clouds from different sources into one complete 3D model. RapidForm also, offers colour management, including virtual painting, blurring, smoothing and more. Text can be adding to any model, and brightness and contrast can be adjust to achieve the perfect photorealistic 3D model.



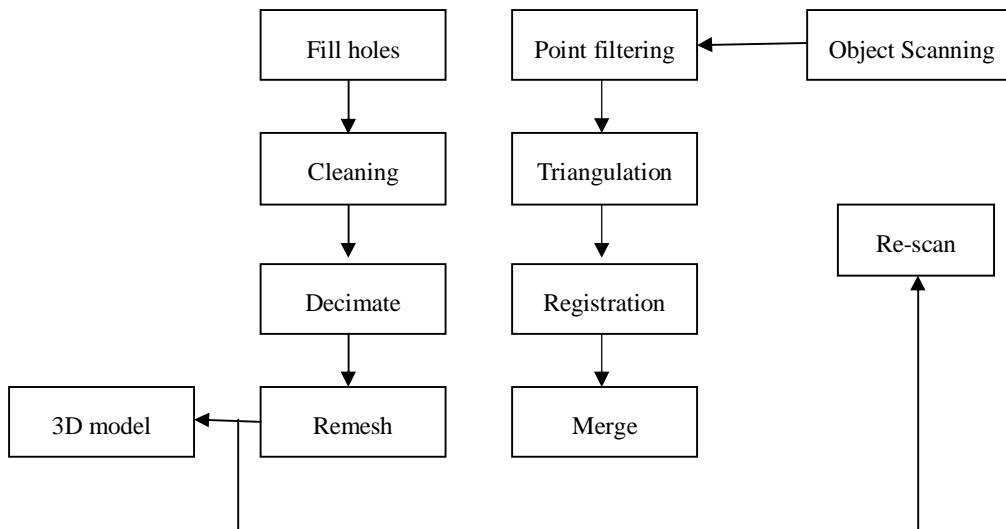
**Figure 3.0:** Vivid Minolta 910

#### 4. METHODOLOGY

The research methodology comprises of two main phases; data acquisition and data processing. For data acquisition, several photos were obtained using digital camera Sony Cyber shot DSC-F828 and Vivid Minolta 910 laser scanner. In data processing phase, the photo and images were downloading and register in PhotoModeler and Rapid form 2004. PhotoModeler uses marking and matching of the suitable points on the image for image orientation processing while Rapid Form uses point processing and polygon optimization to generate 3D model. The photogrammetry process between PhotoModeler and Rapid Form are shown in **Figure 4.0** and **Figure 5.0**.



**Figure 4.0:** Work methodology via PhotoModeler



**Figure 5.0:** Work methodology via laser scanner

PhotoModeler processing stages depends on many factors to improve and get the best results such as:

- i. The calibration must be done on a flat surface
- ii. The camera must be precise and high resolution
- iii. Try to get the angles between the shots as close to right angles as possible
- iv. Take at least three photograph and try to get all important points
- v. Try to get as much overlap between adjacent photographs as possible
- vi. The image need to properly mark during the orientation process
- vii. The object's image must be fully capture and covered as possible as it can.

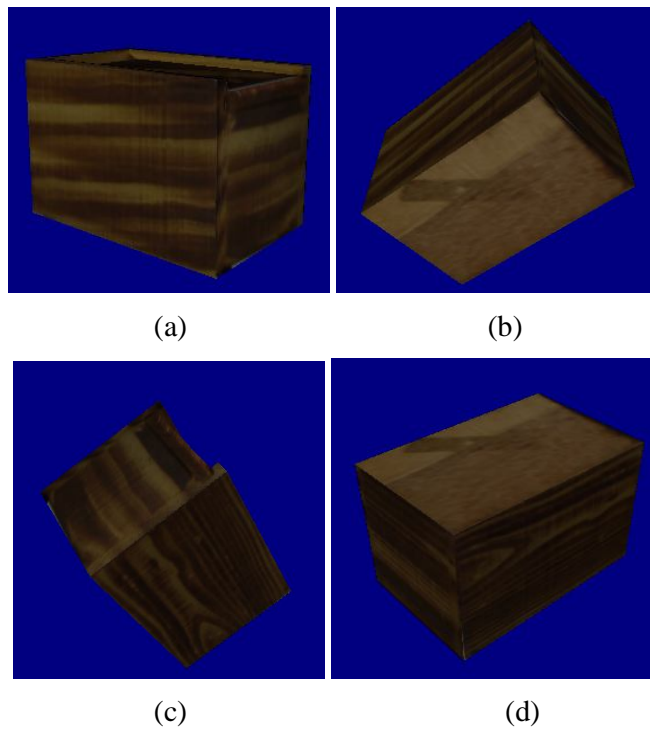
For processing stages using Rapid Form 2004 software, the points cloud were imported into RapidForm 2004 and then these points cloud need to be filtered in order to remove noise. All the data is then registered and merged to get one united polygon shell.

Both of these method can generated the three dimensional model and can visualize in many mode such as shaded view, wireframe view or texture view.

## 5. RESULT AND ANALYSIS

### 5.1 Three Dimensional Model Generated From PhotoModeler

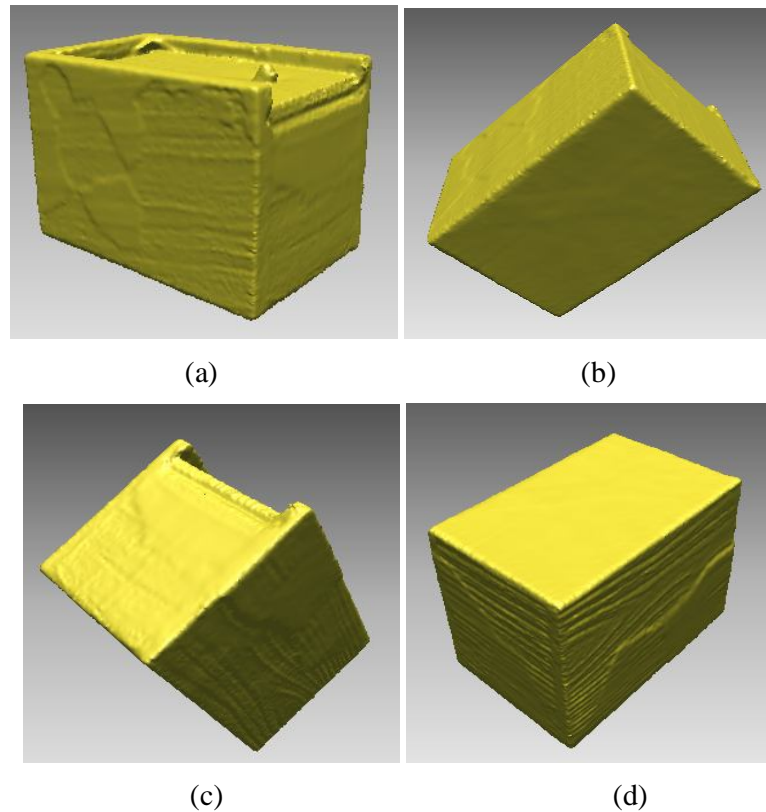
The three dimensional model of an object were generated from PhotoModeler using the several number of oriented photos .**Figure 6.0** shows the different view of generated 3D model.



**Figure 6.0:** (a) Front View, (b) Left View, (c) Right View, (d) Bottom View

## 5.2 Three Dimensional Model Generated From Rapid Form

The three dimensional model that were processed using Rapid form are shown in **Figure 7.0**



**Figure 6.0:** (a) Front View, (b) Left View, (c) Right View, (d) Bottom View

The comparison measurements were made between the conventional tape and PhotoModeler. The results were shown as **Table 1.0** below:

**Table 1.0:** Comparison between conventional tape and PhotoModeler

No	Item	Tape Meas. (m)	PhotoModeler (m)	Differential (m)
1	Length	0.0960	0.0951	0.0009
2	Wide	0.0620	0.0621	-0.0001
3	Height	0.0655	0.0648	0.0007

The comparison measurements were made between the conventional tape and Rapid Form. The results were shown as **Table 2.0** below:

**Table 2.0:** Comparison between conventional tape and Rapid form

No	Item	Tape Meas. (m)	Rapid Form (m)	Differential (m)
1	Length	0.0960	0.0947	0.0013
2	Wide	0.0620	0.0624	-0.0004
3	Height	0.0655	0.0637	0.0018

According to the **Table 1.0** the comparison measurements between conventional tape and PhotoModeler, the results show the differences ranging from a minimum of 1 mm to a maximum of 9 mm while in **Table 2.0** shows that the comparison of differences between conventional tape and Rapid Form are from 4 mm for minimum and 18 mm for maximum.

From the results, it shows both of these methods are possible in generating the three dimensional model with good accuracy. However, for generating the accurate model, some of the factor in observation the images and marking the control points have to be done in the many way.

## 6 CONCLUSIONS

In this study, it shows the comparison of measurements between two generated three dimensional models from the different methods; PhotoModeler and Laser Scanner. Both of the methods gave the good accuracy where all the measurements of the model were compared to the conventional tape measurements. For comparison purpose, tape measurements are assumed as the “true” value.

For the future study, this research using both of the methods will be apply to the real historical artifacts to generate the three dimensional model and develop the digital documentation to provide the easy access for the museum. This three dimensional documentation will contain the full information of the artifacts as well as the attractive visualization. This on-going research on the development of the database will be applied through the Open Source DBMS software.

## 7 AKNOWLEDGMENT

This study is a part of the firstauthor’s master degree research. The first author would like to show her gratitude to her supervisors for their concerns, patience and encouragement throughout her research. She also would like to extend her appreciation to Mr Khairulazhar and Mr Farid for their opinion, attention and support in carrying out this study. This research is part of research vote 79256.

## 8 REFERENCES

1. Minolta Co., Ltd.(2003). *3D Digitization MINOLTA Non-Contact 3D Digitizer: For art and cultural heritage*.  
  
Internet : [www.minolta-3d.com](http://www.minolta-3d.com)
2. R. Kadobayashi, N. Kochi, H. Otani and R. Furukawa (2002). *Comparison and Evaluation of Laser Scanning and Photogrammetry and Their Combined use for Digital Recording of Cultural Heritage*
3. R. Mangold, (2005). *May, 2005 edition of the Spatial Resources E-Letter*.
4. S. Kulur F. Yilmaztürk (2005). *3D- Reconstruction of Small Historical Objects to Exhibit in Virtual Museum by Means of Digital Photogrammetry*. CIPA 2005 XX International Symposium, 26 September – 01 October, 2005, Torino, Italy
5. X.N. Chen , Q. Xia , S.H.Zhang and Y.Zhou (2005). *3D Laser Scanner System For Surveying And Engineering. URBAN*.