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To cite this article: L Gopal and S A A Shukor 2023 *J. Phys.: Conf. Ser.* **2641** 012005

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Modelling Small Artefact for Preservation – A Case Study of Perlis Heritage

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Abstract. Heritage preservation is essential for preserving historical sites and cultural artefact for future generations. However, they are prone to damages and destructions due to weather conditions and other factors. 3D models and reconstructions can aid in the conservation of historical sites and artefact. LiDAR (light detection and ranging) technology can be utilized to obtain accurate 3D representation of object or area of interest. This project aims to preserve one of the historical artefact in Perlis, Malaysia which is known as ‘Batu Nisan Acheh’ or the Acheh Gravestone by using 3D model and reconstruction. iPhone 13 Pro Max LiDAR scanner is used to collect the raw dataset of the artefact with Scaniverse application. MATLAB is employed for data processing which includes data filtering, noise reduction, downsampling and 3D surface reconstruction. In addition, a GUI application is also developed in enabling users to upload their desired point cloud files and produce its 3D model for future usage. Results show that the accuracy, effectiveness, and usability of heritage preservation initiatives are improved by combining iPhone 13 Pro Max LiDAR scanning with MATLAB processing, which is useful for virtual displays, restoration, and future study.

1. Introduction

Historical preservation has always been essential in recording respective old buildings and artefacts because they demonstrated important development in architecture, construction as well as human lifestyle; furthermore, because they were connected to a significant time, movement, or individual. They serve as examples of a generation's potential and what those people were capable of. Today, preserving and protecting cultural heritage is a crucial part of our life. Thanks to such a heritage, we learn more about our ancestors' lives, techniques of manufacturing, and modes of living [1].

One of the best techniques to preserve cultural heritage is through 3D visualization and the most utilized method used to gather a thorough data is light detection and ranging (LiDAR). LiDAR is designed with light reflection as its primary design principle [2]. This concept entails illuminating a surface with a light beam and timing the amount of time it takes for the light to return to its source. In order to ascertain the change in wavelength and time of arrival, the LiDAR system beams laser light onto the goal and measures the light that is reflected [3].

This paper demonstrates the usage of LiDAR from Apple iPhone 13 Pro Max to preserve Perlis artefact, the Acheh Gravestone. The next section (Section 2) will highlight on the methodology used, including the LiDAR itself, software and data processing method, plus more information on the artefact. After that, Section 3 will show the results and discussion, and concluded with Section 4.



2. Methodology

Figure 1 shows the block diagram summarizing the overall methodology applies here. The preservation work starts off with scanning the artefact to collect its raw point cloud data before it can be processed and modelled. In this case, the iPhone 13 Pro Max and its iOS application, Scaniverse, were used. The LiDAR, located beneath its rear-facing cameras, was used to scan the artefact. This capability is limited to rear-facing cameras and cannot be used independently due to iOS's lack of direct access. Instead, an application supporting LiDAR scanning is often paired, i.e., Scaniverse. The Scaniverse application was downloaded from the Apple Store and is preferred compared to other applications like Polycam, 3D Scanner, Heges, EveryPoint, and SiteScape due to its fast scanning process and detailed output, plus smooth process of exporting the data into various file formats, including .ply, which is used here.

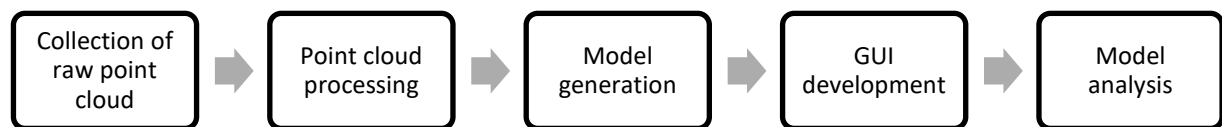


Figure 1. Overall methodology

The selected artefact chosen to be further analyzed here is the Acheh Gravestone, which is also known as ‘Batu Nisan Acheh’. It is a unique and interesting gravestone found in Peninsular Malaysia. Originating from Acheh, Indonesia, it was primarily used for royal or aristocrat tombs between the 15th to 19th centuries. The stones come in various shapes and are made from sandstone, which is soft and mouldable. The decoration on these stones is divided into written and symbol parts. The Tomb of Tok Tina Aluih in Perlis is an example of an Acheh gravestone, where locals believe the deceased was from Acheh but his family members never returned [4]. Figure 2 shows the Acheh Gravestone used to be analyzed in this paper.



Figure 2. The Acheh Gravestone

MATLAB is used to process and model the data. Firstly, the .ply data of the gravestone is plotted in 3D in understanding its spatial distribution, structure and complex geometries, which 2D or numerical tables could not provide. Then, pre-processing of denoising and downsampling are conducted to remove unwanted points / outliers as well as reducing the number of points while maintaining key features. This is due to the fact that 3D point cloud data can be very huge in size due to the LiDAR specification that able to capture highest level of detail of the object. Next, the data is modelled and reconstructed using Poisson surface reconstruction algorithm. Poisson surface reconstruction is a noise-resistant method for reconstructing triangular surfaces using a three-dimensional point cloud model. The algorithm involves discretization, sub-data solution, extraction of equivalent surfaces, and optimization, including pre-

processing of input point cloud information with normal vector information [5]. It utilizes global and local methods for 3D surface reconstruction, solving the Poisson equation and extracting the equal value surface. This technique produces a watertight, geometrically accurate model with good features and detail [6]. The mathematical representation of the Poisson equation used in the context of surface reconstruction is as shown in equation (1):

$$(\nabla^2)f = \nabla \cdot (\hat{n} *) \quad (1)$$

where:

- ∇^2 represents the Laplacian operator
- f is the unknown surface function (the reconstructed surface)
- ∇ is the gradient operator
- \hat{n} is the estimated normal vector at each point

After that, a Graphical-User Interface (GUI) is developed for future use so that modelling and reconstruction of object of interest via LiDAR data can be done by just uploading the data. It provides a visual and informative way for users to operate the application, where all the previously mentioned processes can be done before analysis like basic measurement can be performed to ensure the accuracy of the model. Figure 3 shows the developed GUI / application. Equation (2) is adapted to measure the accuracy:

$$Error = \left| \frac{actual-model}{actual} \right| \times 100 \quad (2)$$



Figure 3. The developed GUI / application

3. Results and Discussion

Figure 4 shows the raw dataset of the artefact that was collected using the Scaniverse application. As can be seen in the figure, the raw dataset contains many unwanted points and noises, thus appropriate pre-processing can be applied. Figure 5 shows the results of applying pre-processing as mentioned in Section 2. From here, it is modelled and reconstructed using Poisson surface reconstruction algorithm and Figure 6 shows the fully reconstructed gravestone.

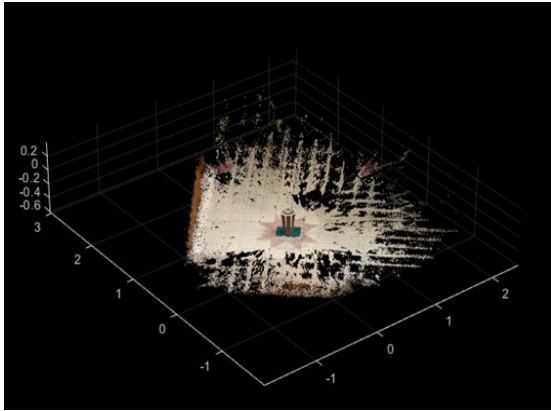


Figure 4. Raw point cloud data of the artefact

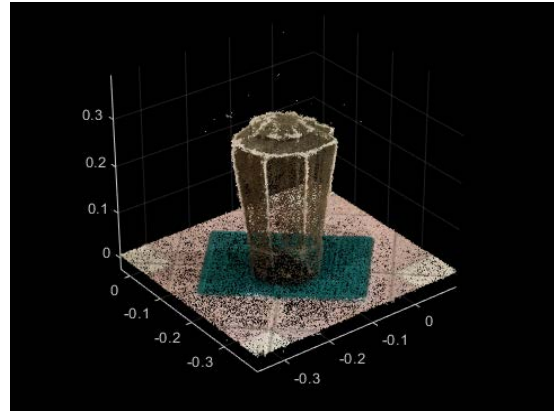


Figure 5. Pre-processed data

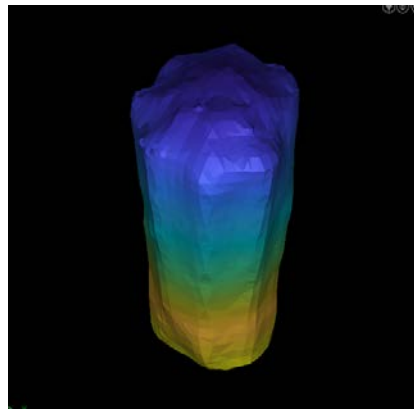


Figure 6. Fully reconstructed gravestone using the Poisson surface reconstruction algorithm

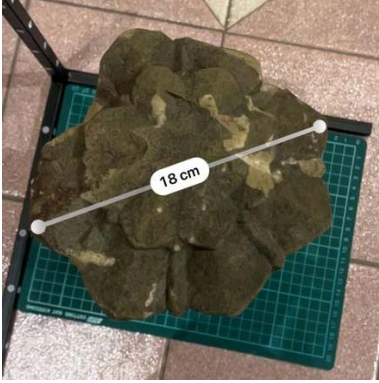
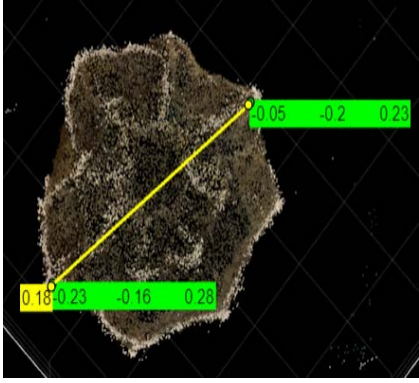

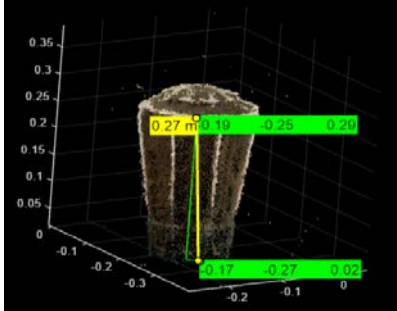

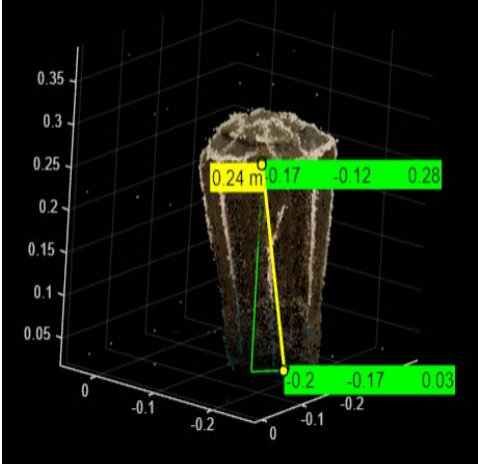
Based on the results obtained, some comparisons were done between the actual measurement of the artefact and the ones obtained from the model. This comparison was done to investigate on the accuracy of the model for preservation purpose. Table 1 summarizes the measurements and their accuracy, while Table 2 shows all the measurements conducted with respect to their actual measurement is being made.

From the results, it can be seen that there is no any difference between the actual length of the artefact and the measured length from the model. Thus, it can be summarized that the built-in LiDAR scanner of the iPhone 13 Pro Max along with the iOS application (Scaniverse) used is really effective in producing accurate 3D model of objects and thus, able to preserving the artefact.

Table 1. Percentage of error for the measurements

No	Actual measurement (m)	Model measurement (m)	Percentage error (%)
1	0.18	0.18	0.00
2	0.27	0.27	0.00
3	0.24	0.24	0.00

Table 2. Measurements conducted for accuracy analysis

No	Actual measurement of the artefact (cm)	Measurement of the model (m)
1		
2		
3		

4. Conclusion and Future Work

In this project, the Perlis artefact of ‘Batu Nisan Acheh’ has successfully been modelled and reconstructed and the measurements of the artefact were compared and analyzed. By harnessing the power of LiDAR technology and advanced data processing, this approach enhances the accuracy, efficiency, and accessibility of preserving and documenting cultural artefacts and historical sites, ensuring their longevity and cultural significance for future generations. Further testing can be done to other artefacts as well as small objects utilizing the developed GUI for more analysis.

Acknowledgement

The authors would like to acknowledge the support from the Fundamental Research Grant Scheme (FRGS) under the grant number of FRGS/1/2022/TK07/UNIMAP/02/23 from the Ministry of Higher Education Malaysia, as well as cooperation and contributions from Muzium Kayang, Perlis, through its Director, Mrs. Siti Munirah binti Kasim and Sr. Dr. Ismail bin Ma'arof, Fellow, Kursi Institusi Raja-raja Melayu, Universiti Teknologi MARA, Malaysia.

References

- [1] Zhang S 2018 *Built Heritage* **2** pp 4-16
- [2] Reutebuch S E, Andersen H E and McGaughey R J 2005 *J. of Forestry* **103(6)** pp 286-292
- [3] Raj T, Hanim Hashim F, Baseri Huddin A, Ibrahim M F and Hussain A 2020 *Electronics* **9(5)** p 741
- [4] Muzium Kayang *Archaeology Gallery – Aceh Gravestone* 2023
- [5] Kazhdan M, Bolitho M and Hoppe H 2006 *Proc. of the 4th Eurographics Symp. on Geometry Processing* vol 7 p 0
- [6] Kazhdan M and Hoppe H 2013 *ACM Trans. on Graphics (ToG)* **32(3)** pp 1-13