

APPLICATION LIDAR AND POINT CLOUDS FOR 3D MODELING OF MUSEUM OBJECT

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Abstract

A museum is an institution intended for the general public that collects, cares for, presents, and preserves the community's cultural heritage for study, research, and pleasure or entertainment. The museum is undoubtedly one of the educational places for the community because it has many historical objects. It provides an opportunity to make the museum a vital place to be developed in a virtual form, such as Augmented Reality or Virtual Reality. However, one problem in developing virtual media is the 3D modeling of objects for interior design in museums. LiDAR (Light Detection And Ranging) is a near real-time 3D positioning technology. A point cloud collects data points in a 3D coordinate system, generally defined by x, y, and z coordinates. Both of these technologies can be used to create 3D object models quickly. The final result of this research is applying LiDAR & point cloud as a 3D modeling technique and assessing the accuracy of using these techniques for 3D modeling of the museum object.

Keywords: Lidar, Point Cloud, 3D Modelling, Museum Object

Abstrak

Museum merupakan lembaga yang diperuntukkan untuk masyarakat umum yang memiliki fungsi mengumpulkan, merawat, dan menyajikan serta melestarikan warisan budaya masyarakat untuk tujuan studi, penelitian, dan kesenangan atau hiburan. Museum tentu saja menjadi salah satu tempat edukatif bagi masyarakat karena memiliki banyak objek-objek bersejarah. Hal ini memberikan peluang untuk menjadikan museum sebagai tempat yang penting untuk bisa dikembangkan dalam bentuk virtual seperti Augmented Reality atau Virtual Reality. Namun salah satu permasalahan yang muncul dalam proses pengembangan media virtual yaitu tahapan pemodelan 3D pada objek-objek hingga desain interior pada museum. LiDAR (Light Detection And Ranging) adalah teknologi penentuan posisi secara 3D yang hampir mendekati real time. Point Cloud pada dasarnya adalah sekumpulan titik data dalam sistem koordinat 3D, umumnya ditentukan oleh koordinat x, y, dan z. Kedua teknologi ini dapat digunakan sebagai pembuatan pemodelan objek 3D secara cepat. Hasil akhir dari penelitian ini yaitu penerapan LiDAR & point cloud sebagai teknik pemodelan 3D dan menilai akurasi penggunaan teknik tersebut terhadap pemodelan 3D pada objek museum.

Kata kunci: Lidar, Point Cloud, Pemodelan 3D, Objek Museum

INTRODUCTION

A museum is an institution intended for the general public. Museums have the function of collecting, caring for, presenting, and preserving the community's cultural heritage for study, research, and pleasure or entertainment (Khoirotun, 2014). Most Indonesian people consider museums only as places where a collection of ancient antiques is boring and less attractive to visit. It is because the information conveyed to visitors is less informative

and interesting. The information contained in the object in the form of the object name, object origin, and object function is only in the form of static text with small letters, so it looks less informative and interesting. The museum is undoubtedly one of the educational places for the community because it has many historical objects. Even Google has recently issued a viewing feature in the form of 3D and Augmented Reality for its search. It provides an opportunity to make the museum or essential objects in the museum as a 3D product in a virtual

form such as Augmented Reality or Virtual Reality. However, one problem in the virtual object development process is the 3D modeling stages of objects for the museum's interior design.

The problem faced in making 3D objects or 3D interior design is that it requires expertise in creating 3D designs so it will take longer.

Historically, 3D models of buildings were created manually using digital photogrammetry workstations. Manual 3D processing, however, requires time and effort. Therefore, it is desirable to build fully or partially automated processes (Fitri, 2009). LiDAR is one of the most attractive options for 3D building modeling because of its ability to directly derive dense 3D point clouds from the observed building surface (Fitri, 2009). Using LiDAR sensor technology will produce a product in the form of a collection of point clouds (points clouds), resulting in a three-dimensional (3D) representation of the object's surface. The resulting 3D objects can later be developed into Augmented Reality applications (Borman; Imam Ahmad; Yuri Rahmanto; Devin Pratama; Rohmat Indra, 2021) (Alifah et al., 2021) (F. D. B. S. Putra et al., 2021) (Fritsch & Klein, 2018) atau Virtual Reality (Fauzi, 2021) (Basofi, 2021).

Computer-aided design (CAD) or computer-aided design and drafting (CADD) is a form of automation that helps designers to refine drawings, specifications, and design-related elements using special graphic effects and computations by computer programs. LIDAR (Light Detection And Ranging) is a near real-time 3D positioning technology. The final result of LIDAR is a point cloud, the laser shot points to the earth's surface, and each point has 3D coordinates (Timur, n.d.). A point cloud is a collection

The study (A. R. Putra, 2016) used the Structure from Motion method, which uses the same basic principles as photogrammetry. Namely, 3D is obtained from several overlapping images. Moreover, the Terrestrial Laser Scanning method creates 3D objects from polygon mesh data. In comparison, this study makes 3D visualization modeling from polygon mesh data using the LiDAR sensor on the iPad pro2020 camera. In research (Khairunnisa & Yusian, 2018), the manufacture of 3D modeling was designed using Sketchup 2013, and the final result of the research was in the form of images and animations (videos) of the 3-dimensional spatial model of the Aceh Market Shopping Center Building. While in this study, LiDAR technology is applied for 3D modeling so that 3D objects will be obtained in the form of polygon mesh data. Research (Waljiyanto & Chintya, 2020) made 3D modeling using Point Cloud data from Terrestrial

Laser Scanner recordings. While in this study apply the LiDAR Sensor technology found in the iPad Pro 2020 camera to produce 3D objects from the results of 3D mesh data recording. Moreover, apply the registration and filtering method. Where in the registration method, there are three types of methods, namely the target-based method (target to target), sensor-based registration, and cloud-based registration (cloud to cloud).

Based on the description above, this study will discuss the application of LiDAR and Points Cloud technology for the 3D modeling of museum objects. Several similar studies have carried out the application of Lidar and Point Cloud to create 3D modeling of a building (Cooper et al., 2018)(Altuntas, 2015)(A. R. Putra, 2016). However, in this study, the object that will be used as the material for this research is based on the nature of the object, namely Transparent, Translucent, and Opaque (Motoyoshi, 2010). The benefits of this research can be used by practitioners and further researchers in doing 3D modeling of objects with lighting levels and materials on objects.

RESEARCH METHODS

Research Flow

The research flow used can be seen in Figure 1.

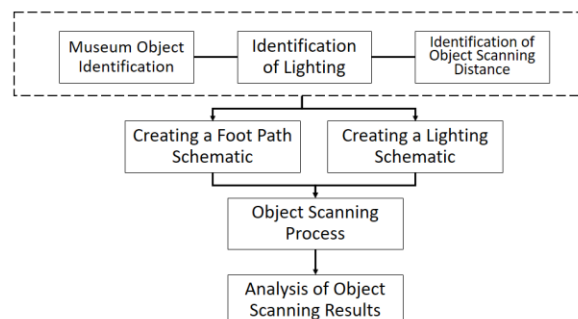


Figure 1. Research Flow

The research begins by identifying the object used as the research sample. After that, the identification of light measurements around the object is carried out. Making CAD footpaths and lighting visualizes the experimental scenario used. The object scanning process is carried out using the required hardware and software. Finally, the scanning results analysis uses a qualitative descriptive analysis method.

Hardware and Software Requirements

The hardware and specifications for scanning the Yogyakarta Sandi Museum room are as follows.

1. iPad Pro 2020 11 inc.
2. Chipset, Apple A12Z Bionic
3. CPU, Octa-core (4x2.5 GHz Vortex + 4x1.6 GHz Tempest)
4. GPU, Apple GPU (8-core graphics).
5. Three Main Cameras:
 - 12M, f/1.8, (Wide), 1/3", 1.22um, dual pixel PDAF.
 - 10MP, f/2.4, 11mm (Ultrawide).
 - TOF 3D LiDAR scanner (Depth)

The software and technology used for scanning the Yogyakarta Sandi Museum room are as follows.

1. Operation Systems, iPadOS 14.4
2. Software Polycam version 2.2.10
3. Software Arduino Science Journal version 6.0.1

RESULTS AND DISCUSSION

Museum Object Identification

In this study, one of the objects in the Yogyakarta Sandi museum was used. The selected object is an object that has three properties of the object, namely Transparent, Translucent, and Opaque. The selected object is a password machine located on the first floor of the password museum, namely the archipelago space, as shown in Figure 2. The glass section is an example of a transparent object, a wooden table is an example of an opaque object, and a tile floor is a translucent object.



Figure 2. Password Machine in Nusantara Room

Identification of Lighting

The lighting data displays the amount of light intensity in the room that is the object of research with the value in lux units. This data was obtained from measurements using an Android-based Arduino Science Journal application. The

following is an image of the data recorded from the intensity of the room.



Figure 3. Lux Meter Measurement Results

Identification of Object Scanning Distance

The distance identification process is carried out by measuring the distance between museum objects in a predetermined room. The identification results are described in the form of a foot path scheme. Measurements were carried out using a measuring instrument in cm.

Creating a Foot Path Schematic

A footpath is a footpath on the floor that has been determined to be used as a benchmark for researchers in data collection when scanning code machine objects in the museum.

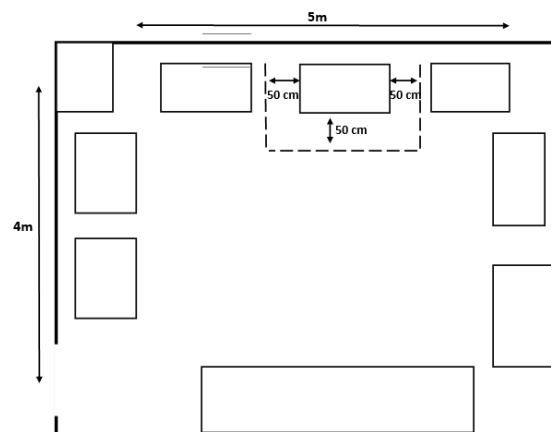


Figure 4. Foot Path Scheme

Figure 4 is a footpath or object scanning path for researchers to scan. The distance from the LiDAR sensor to the cipher machine is 50 cm from the right, left, and front sides.

Creating a Lighting Schematic

The results of these measurements obtained an average room light intensity of 135 Lux, as shown in Figure 5, with a minimum of 44 lux and a maximum of 261 lux of room light intensity. The graph of the visible light measurement results has a significant difference, which happens because the lux meter sensor captures the light intensity of the room that varies depending on the light source that is captured. Measurements are carried out by walking around the room following the footpath on the core point scan so that the sensor captures different amounts of light depending on the room's light source, as shown in Figure 4.6. Based on the figures obtained, the light intensity of the room is sufficient to display room objects so that the LiDAR sensor can capture the required data.

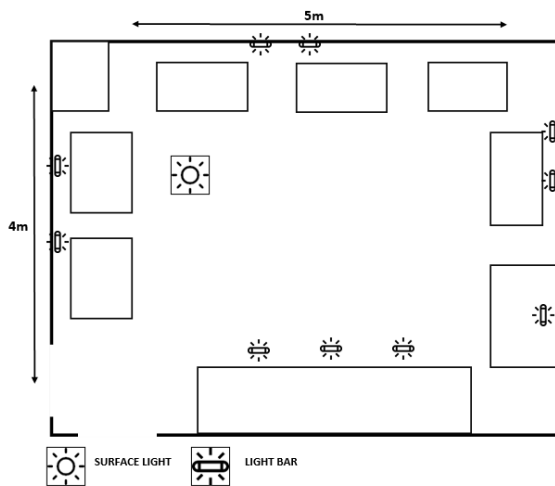


Figure 5. Room Light Source Scheme

Room light comes from several lighting lamps installed in several corners of the room. There are two indoor light sources: surface light and light bar. Surface light is a light source that tends to have a wider beam of light throughout the room; light from surface light spreads in various directions. In contrast, the light bar is a light source with a more focused beam of light in one direction to illuminate the intended object.

Object Scanning Process

Scanning is the initial stage of 3D mesh data collection, which is the initial process of the subject of this research. Scanning is done to retrieve 3-dimensional data in a group of polygons consisting of 3D points and the edges that connect them. Scanning begins according to the path or points determined by CAD (Computer Aided Design). The room scanning process starts by directing the iPad pro camera sensor or the LiDAR sensor in the iPad pro camera to the SRE KG code machine at a distance of 50 cm.

The LiDAR sensor on the iPad pro-2020 camera technology in this study can capture polygon mesh data with a 3-dimensional representation of the shape without going through the registration process. A scan result is a large number of polygons with a 3-dimensional image of space. The obtained 3-dimensional object also displays RGB colors according to the color of the object being scanned, as shown in Figure 6.

From the scanning process that has been carried out, it can be concluded that 3-dimensional modeling by scanning using the Polycam application with a LiDAR sensor does not require a long time and does not require long skills or training such as manual or conventional 3-dimensional creation. Although the final results obtained are not as detailed and neat as 3D made manually. The following is an image of the result of scanning one of the password museum rooms using a Polycam with a LiDAR sensor.






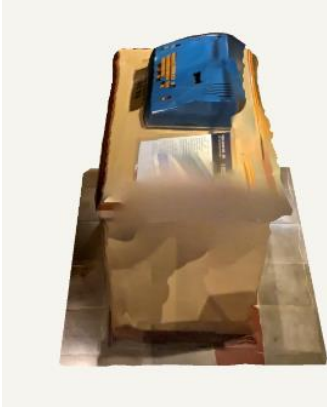


Figure 6. Scanning Results

Analysis of Object Scanning Results

This study aims to determine the results of object scanning from the application of the LiDAR sensor of the iPad pro-2020 camera in 3D mesh modeling of the SRE KG cipher machine at the password museum. Researchers took data using a mobile scanning method. The scan distance to the scanning object and room lighting are parameters in measuring the success of this research. The following is a comparison of the photo of the SRE KG cipher machine with the scanned image of the LiDAR 3D mesh.

Table 1. Comparison Of Password Machine Photos And Scan Results

Password Machine Photos SRE KG	Scan Results
	
	
	

Based on Table 1. In a comparison of Password Machine Photos and Scan Results, it can be seen that the scan results using the polycam application obtained a 3-dimensional object representation from the polygon mesh data. The results obtained are almost identical to the original object, starting from the shape and color close to the original object. It is just that there are still some parts that are still not perfect from the surface shape of the polygon mesh. The glass elements also cannot be captured by the LiDAR sensor, so the glass frame of the cipher machine cannot be represented in a 3D mesh.

The LiDAR sensor on the iPad pro-2020 camera technology can capture polygon mesh data with a 3-dimensional representation of the shape without going through the registration process. The 3-dimensional results from the LiDAR sensor are not as neat and detailed as the 3-dimensional ones done manually. The scan result is a collection of polygons consisting of 3D points and their connecting edges with a 3-dimensional image of space. The obtained 3-dimensional object also displays RGB (Red, Green, Blue) colors according to the original color of the scanned object.

The final scanning result is also influenced by the room's light intensity, which is bright enough so that the laser scanner can capture the scanned object. The scanning distance can also cover the entire surface of the object being appropriately scanned so that the character of the cipher machine is reflected by the LiDAR sensor, which is then represented in a 3D polygon mesh data set.

However, there is one weakness of the LiDAR sensor. The sensor cannot capture transparent objects such as glass elements because of the evident nature of the glass, so the LiDAR sensor cannot reflect the glass surface. This glass element is not represented in the form of a 3D model.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The results show that LiDAR scanner sensor technology on the iPad pro-2020 camera can be used to model the SRE KG cipher machine into 3D visual mesh objects quickly and easily compared to manual or conventional 3D creation using 3D software such as Unity or Blender. The main factor that affects the results of the 3D model is the adequacy of light on the object. Lidar is good enough to scan translucent and opaque objects but cannot detect transparent objects such as glass.

Suggestion

Suggestions for practitioners who will use lidar to do 3D modeling of objects are expected to be able to prepare light above 200 lux. Using a mini studio to reduce the area of an object can also shorten the 3D model editing process.

Further research is used to develop 3-dimensional laser scanner scan results for Augmented Reality or Virtual reality applications. Some additional research is to be able to use a different research scheme regarding the application of LiDAR scanner technology for modeling 3D assets of the Yogyakarta password museum. Furthermore, the LiDAR application analysis method was added

regarding the effect of room lighting or the area of the object/size being scanned.

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