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PRESERVING CULTURAL HERITAGE WITH iPHONE 3D SCANNING

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Abstract

In the recent twenty years that have passed, technology had exponential growth in a short period. Some devices included LiDAR sensors that are as old as thirteen years today, which would have cost an arm and a leg, and today we find it as a novel feature on the new iPhones. But even though they are present in our lives unknowingly, they are vastly underexploited. In this research we aim to present both advantages and disadvantages of using such complex systems in fields like surveying and terrain modeling, and if a simple iPhone 12 Pro Max using 3D processing software can replace, in the lon g run, the bulky but reliable 3D scanners. The building chosen is rather a complex one, of historic importance, with many statues and a decorated Art Nouveau facade, from the interbellum period: Casa Mita Biciclista.

***Key words**: 3D model, 3D scanner, Art Nouveau, evolution, heritage building, iPhone, Romania.*

INTRODUCTION

LiDAR (Light Detection and Ranging) technology, introduced in the 2010s, has emerged as a novel approach for measuring and augmenting information in various fields, including surveying and building measurements. This technology enables the capture of 3D views and colour data, enhancing traditional measurement methods. However, assessing the current accessibility of LiDAR technology presents a complex picture that requires careful examination.

Lidar technology integration in mobile phones has gained significant attention in research and industry due to its potential applications. (Velasquez et al., 2021) discuss the expansion of spatial perception and augmented reality possibilities through mobile LiDAR. They highlight how lidar sensors enhance depth sensing, enabling more realistic and immersive Augmented Reality experiences.

Evaluation of LiDAR scanners on mobile phones is also explored in the literature. (Kuang et al., 2020) evaluate the iPhone 12 Pro's LiDAR scanner for applications in 3D modeling and virtual reality. Their findings contribute to the discussion of LiDAR's potential impact on photography capabilities, such as enhanced portrait mode effects and low-light photography, Another significant application of LiDAR on mobile phones is in spatial mapping and 3D scanning. The depth information captured by the lidar sensor can be used to create detailed 3D models of objects and environments. This can have practical uses in architecture, interior design, and virtual reality applications, where accurate measurements and reconstructions are crucial.

While LiDAR technology on mobile phones is still relatively new, its potential impact is already being recognized. Major smartphone manufacturers have started integrating lidar sensors into their flagship devices, and developers are actively exploring innovative use cases. As the technology continues to advance and become more accessible, we can expect to see further integration of LiDAR into everyday mobile experiences, unlocking new possibilities for creativity, productivity, and interaction.

The objective of this research was to investigate the viability of employing alternative methods for 3D scanning, specifically exploring the potential of utilizing portable devices equipped with integrated LiDAR scanner capabilities to obtain reliable and usable results.

For the study conducted, a monument representative for the Interbellum Bucharest was chosen: Casa Mita Biciclista (Figure 1). The house belonged to the demimonde Maria Mihaescu, who received it as a gift from Ferdinand, King of the Romanian Kingdom. Its structure was finalized in 1910 and it is a combination of Art Nouveau and Belles-Artes styles. Representative and important for this study is the facade, which is highly ornated around the entrance and windows, and adorned with detailed statues. By selecting Casa Mita Biciclista, the study aims to highlight the efficacy of the alternative scanning method in capturing and preserving the architectural heritage of this iconic building.

Figure 1. Casa Mita Biciclista

MATERIALS AND METHODS

For the purpose of capturing detailed scans of the building to generate a comprehensive 3D model, the scanning phase involved utilizing the built-in LiDAR sensor of an iPhone 12 Pro Max. The obtained LiDAR data was then processed using the Polycam software, which harnessed the capabilities of the device's camera and advanced algorithms to facilitate efficient and accurate data processing.

The scanning area was carefully chosen in accordance with traffic regulations and visiting hours (Figure 2). Permission was obtained to conduct the fieldwork on the selected site, which falls under the public domain. Specifically, the front facade of the building was identified as the target area for scanning.

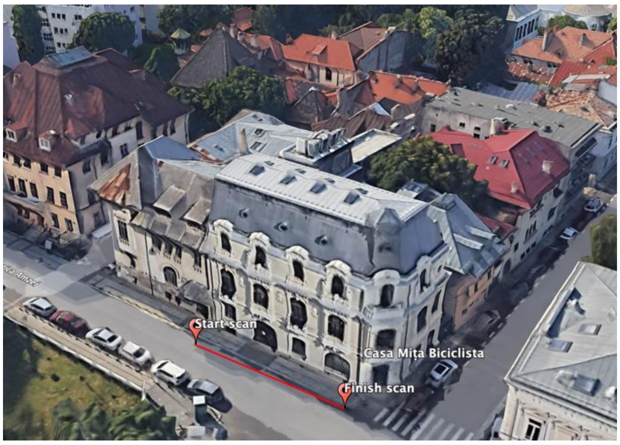

Figure 2. Area for scanning

Two scanning distances were considered for data acquisition: 10 meters and 3 meters from the house. These distances were strategically determined to capture the necessary level of detail while maintaining appropriate spatial coverage (Figure 3).

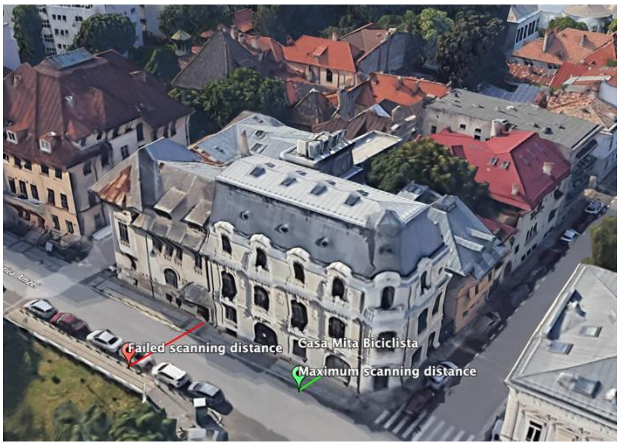

Figure 3. The two scanning distances tested

To minimize potential scanning imperfections caused by light interference, a key consideration was the selection of suitable weather conditions. The scanning process was scheduled to take place on days with direct sunlight or, at a minimum, under cloudy skies. This precaution aimed to ensure optimal data capture, mitigating any adverse effects caused by light refraction during precipitation events.

Prior to commencing the scanning process, a series of thorough checks and assessments were conducted to ensure the smooth and successful execution of the scanning procedure. These assessments involved evaluating the internal memory capacity, ensuring the availability of sufficient cloud storage, establishing a stable internet connection, and verifying the optimal functioning of the camera and LiDAR sensors. Additionally, precautions were taken to ensure the cleanliness and proper maintenance of these sensors, eliminating any potential debris or malfunctions that could hinder the scanning process.

The scanning route was designed to incorporate sufficient overlap between consecutive scans, facilitating accurate registration and alignment of the resulting point cloud data.

For the specific area targeted in the scanning process, the entire procedure was efficiently executed, taking less than 5 minutes to complete. This brief timeframe was instrumental in capturing the required data with minimal risk of encountering disruptions or inconsistencies in the acquired scans. By optimizing the scanning process, the study ensured the swift acquisition of the necessary information while maintaining the integrity and accuracy of the collected data.

Once the scanning was completed (Figure 4), the software Polycam was used to process the cloud point and create the 3D model of the building.

Figure 4. The scanned area

The application uses three simple software settings that we can choose, such as:

- Voxel Size (the size of the geometrical shapes in which the laser from the scanner is emitted),
- Simplification (the clarity of the 3D model)
- Depth Range (the distance from which the cloud point is collected).

For visualisation the 3D Model, Polycam software allows many exporting options for the model, the most used being OBJ, PLY, USDZ, etc. These formats are commonly used for 3D printing of the model and visualisation in Augmented Reality and Computer Aided Design.

RESULTS AND DISCUSSIONS

During the processing stage, Polycam software computed an average of approximately 225,000 points from the captured data (Figure 5).

Although this number may seem relatively low when compared to the average of around 2 million points generated by conventional 3D scanners, considering the specific chipset and sensor utilized, the resulting model achieved an average quality level. This model proves to be suitable for accurate digital measurements, with an acceptable error margin of 1-2 centimeters. These findings hold true specifically for the scanned area, demonstrating the effectiveness of the scanning method in generating a reliable model for precise measurements within the designated region.

Figure 5. Processing the point cloud

The 3D model resulted encompasses approximately 70-75% of the intricate details present in the building. Architectural elements such as statues and window arches were faithfully represented, exhibiting a high level of accuracy in the model. However, it is important to note that there were instances of failed captures, particularly where the environment allowed for laser refraction, notably on windows and glass doors (Figure 6 and Figure 7).

Figure 6. 3D Model generated

Figure 7. Details on the 3D Model

Upon reviewing the result, this method of 3D scanning can be used successfully to scan objects. From statues to large houses and cultural sites, having a fast and reliable method of scanning can not only be used to preserve the information but also for educational purposes of future archaeologists, historians and most importantly, geodetic engineers and architects. The costs of implementing are low since it uses only the smartphone with the LiDAR sensor and an application that can be downloaded easily.

CONCLUSIONS

The 3D model that resulted from the scan of the building is a somewhat functional product. Distances can be measured within the Polycam app and it can be used for projects in Computer Aided Design software. Being a smartphone sensor, it lacks the clarity of a professional scanning solution and pay-for-use software, but it can be used safely for educational purposes or comparisons and exercising 3D modelling. With time, solutions like this will most likely replace the bulky 3D scanners that are now used on a large scale in favour of portability.
Fast 3D scanning can also be implemented into a Building Information Model (BIM). This process involves a database that combines a 3D model of a building with a spatial database and assets, that allows for digital planning. It can be used, for example, for the design and computer modeling of a house, or a civilian building, such as schools, roads, or even entire neighborhoods. This method also is environmentally friendly, and allows for Artificial Reality examination, cost estimates for materials, and many more uses. In the long run, every building that is of importance should implement a BIM, as a standard for cultural preservation and easy restoration.

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