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*Article*

# Innovative Use of Mobile Laser Scanning in Design and Reconstruction of Facilities

**Kubaymurodov Davron Ilyasovich[1], Iskandarov Erkin Burievich[2], Tulyaganov Zafar Sunnatovich[3]**

1,2,3. Tashkent Architectural and Construction University, Uzbekistan

**Abstract:** Mobile Laser Scanning (MLS) technology has significantly transformed the construction industry by enhancing the accuracy and efficiency of design, reconstruction, and restoration processes. MLS uses laser pulses to measure distances and generate point clouds, which are the foundation for creating highly detailed 3D models. These models are instrumental in detecting errors in construction documentation before work begins, reducing costly mistakes. Furthermore, MLS integrates with photogrammetry and cloud technologies, enabling the creation of textured models and real-time data processing, respectively, which aid in decision-making and project management. The application of MLS extends beyond new facility design to include the restoration of historic monuments, where it helps document current conditions and study deformations. Despite its advantages, the implementation of MLS faces challenges, including high equipment costs, the need for specialized personnel, and the large volumes of data that require complex processing systems. The research methodology employed in this study includes a detailed review of MLS equipment, case studies, data analysis, cost-benefit evaluations, and expert interviews. The findings suggest that MLS can substantially improve design accuracy and operational efficiency, but its widespread adoption is hindered by financial and technical barriers. The study highlights the potential for MLS to revolutionize the construction sector, provided that the challenges associated with its implementation are addressed.

**Keywords:** Mobile Laser Scanning (MLS), Design, Reconstruction, Architectural Heritage, Point Clouds, 3D Modeling, Technologies, Automation, Monitoring, Photogrammetry, Digital Models, Data, Innovations, Construction Industry, Urbanization

## 1. Introduction

Advanced technologies are already intensively changing practices in designing as well as reconstructing facilities in the construction sector. The most promising approach here is the mobile laser scanning (MLS) – which allows for high accuracy and efficiency of data acquisition, analysis, and modeling. MLS is widely used in the construction of new construction and structures, as well as in the reconstruction or restoration of existing and architectural attractions. This contained the Principle of Mobile Laser Scanning Operation. MLS was designed to rely on using laser pulses as a mechanism of determining distance of the scanner from the object. For instance, SinoLs300 comes with laser, GPS, and INS to allow accurate scanning of objects and actual location referencing. The key activities in MLS are the generation of laser pulses, the determination of response times for distance calculation and point-cloud generation defining the object's outlines [1]. Specific benefits of MLS for the construction industry Probably the greatest benefit of MLS is in the area of increased accuracy in the design of patterns. Point clouds are the basis for generating accurate and integrated models for construction and provide an opportunity to detect errors in documentation before construction work starts. Furthermore, MLS reduces time

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and resources that can be spent on large volumes of data, need for expense on automating work in which time is a factor [2].

Applications of MLS MLS has adopted extensively in different fields. The application of the technology in new facility design facilitates the development of site and territorial models. In repair and restoration of historic monument, MLS is applied for capturing present condition of the object and to study the deformation [3]. Besides, the technology is used in the observation of construction projects and surveying, general Cartography [4]. Innovative Technologies and Functional Capabilities of MLS Accomplishing MLS with photogrammetry can add aerial photographing to MLS to create textured models. Cloud technologies give the opportunity to process and store vast amounts of information with the help of which project participants can track data in real-time.

## 2. Materials and Methods

The research methodology for studying the implementation and effectiveness of Mobile Laser Scanning (MLS) in construction practices is structured as follows:

### A. Data Collection

1. Survey of MLS Equipment and Software: A detailed analysis of MLS equipment (e.g., SinoLs300) and its capabilities, including laser pulses, GPS, and INS, will be performed. This will help in understanding the technical specifications and how they contribute to data accuracy and operational efficiency.
2. Literature Review: A comprehensive review of existing literature on MLS applications in construction, restoration, and surveying [1], [2], [3]. Will be conducted. This will establish a foundation for understanding the benefits, limitations, and challenges associated with MLS technology.

### B. Case Studies

1. Implementation in Construction and Restoration Projects: Specific case studies of MLS implementation in new facility design and the restoration of historical monuments will be analyzed. These case studies will provide real-world examples of how MLS is used to capture current conditions, study deformations, and create accurate models [4].
2. Comparison of Pre- and Post-MLS Implementation: In each case study, the efficiency, cost-effectiveness, and accuracy of MLS compared to traditional methods will be examined [5].

### C. Data Processing and Analysis

1. Point Cloud Generation: Data from MLS will be used to generate point clouds, which will be analyzed for the precision of model generation. This process involves evaluating how MLS improves the accuracy of design patterns and identifies potential errors in construction documentation [6].
2. Cloud Technology Integration: The research will explore how integrating MLS with cloud technologies enhances real-time data tracking and storage capabilities, focusing on the functional advantages of this integration.

### D. Cost-Benefit Analysis

Economic Assessment: The high initial cost of MLS equipment and software, along with the need for personnel training, will be compared against the long-term savings in labor, time, and resources. The potential for cost reduction through automation and error prevention will also be evaluated.

### E. Challenges and Limitations

1. Technical Challenges: A critical assessment of the technical limitations of MLS, such as the volume of data required for processing, will be conducted. This will involve an analysis of the complexity of data processing systems and how these affect the operational efficiency of MLS in large-scale construction projects.

2. Adoption Barriers: The research will identify key barriers to widespread adoption of MLS in the construction industry, including costs, training requirements, and the integration of MLS with existing construction practices.

**F. Qualitative Interviews**

Interviews with Industry Experts: Interviews with professionals in construction, restoration, and surveying will provide qualitative insights into their experiences with MLS technology. These will help in understanding the perceived benefits, drawbacks, and areas for improvement from the perspective of those directly involved in its application.

## 3. Results

The implementation of Mobile Laser Scanning (MLS) technology in the construction sector has demonstrated significant improvements in various aspects of the design, reconstruction, and restoration processes. The accuracy achieved by MLS allows for the creation of highly detailed 3D models, as evidenced in the building facades generated from point clouds in the views provided. The integration of photogrammetry and MLS facilitates the creation of textured models, enhancing visual representation and aiding in better decision-making during the design phase. Furthermore, MLS helps identify errors in documentation before construction begins, reducing the risk of costly mistakes. The use of cloud technologies enables real-time data processing, which improves project management by providing up-to-date information to all participants.

The detailed 3D models, as shown in the axonometric views and facade representations, showcase the level of precision MLS brings to the construction industry. The section of arches and 3D model construction from a point cloud further demonstrate the capabilities of MLS in capturing complex architectural details. In terms of restoration, MLS has been successfully applied in documenting the current conditions of historic monuments, allowing for a better understanding of their deformation and aiding in restoration planning.

**Figure 1.** Building Axonometry.


**Figure 2.** Plan.

**Figure 3.** Front Facade of the Building Created Based on 3D Scanning.

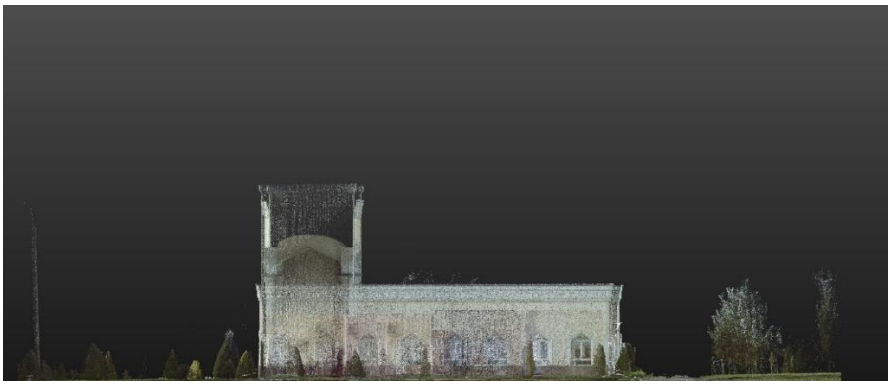

**Figure 4.** Rear Facade of the Building Created Based on 3D Scanning.

**Figure 5.** Rear Facade of the Building Created Based on 3D Scanning.

**Figure 6.** Side Facade of the Building Created Based on 3D Scanning.

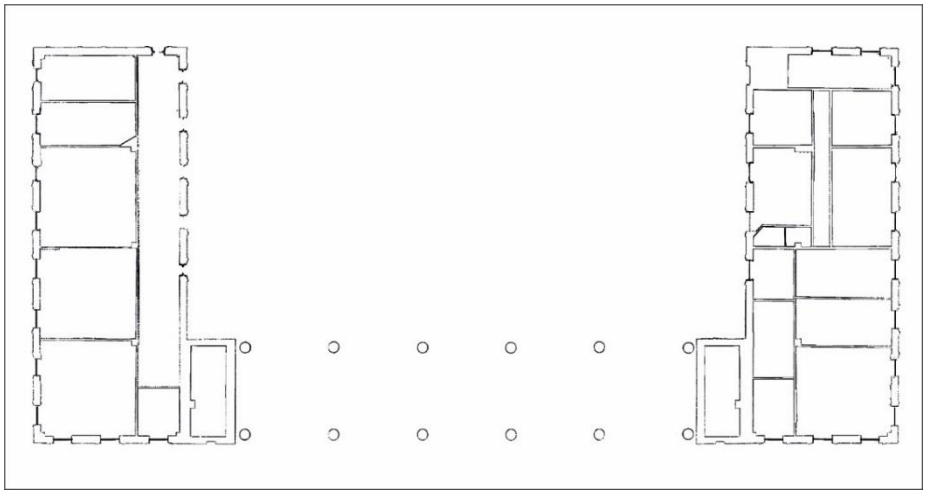

**Figure 7.** Orthophotoplan at Elevation 2500 mm (Floor Level ±0.000 mm). Scale 1:300.

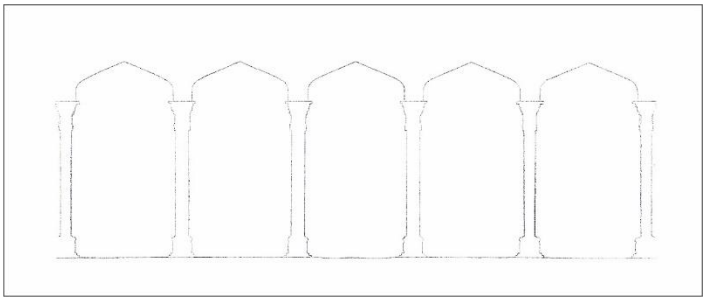

**Figure 8.** Section of Arches Created from Point Cloud Based on 3D Scanning.

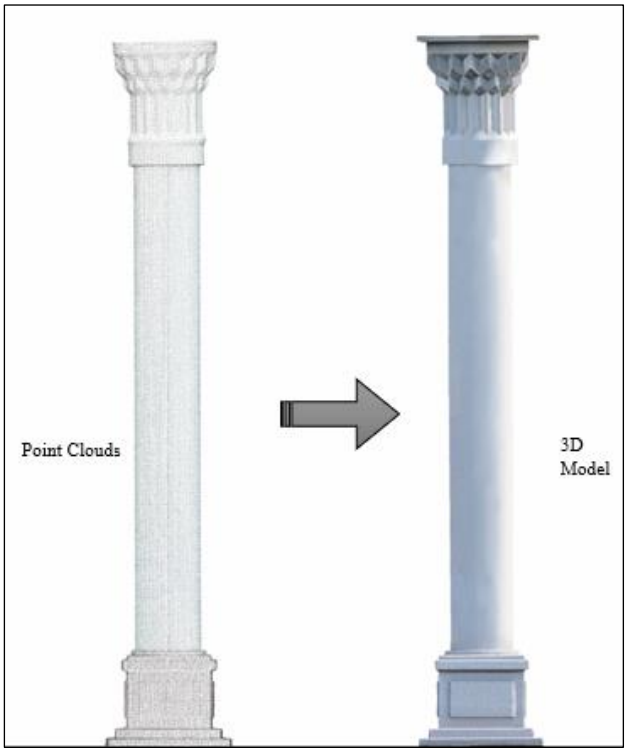


**Figure 9.** Fragment No. 1: Construction of a 3D Model of a Column from a Point Cloud Based on Laser Scanning Results.

Limitations and Challenges of Implementing MLS. Despite its numerous advantages, the implementation of MLS comes with certain limitations. The high cost of equipment and software, as well as the need for personnel training, can pose significant barriers to its adoption. Additionally, MLS requires large volumes of data and complex information processing systems for precise operation.

## 4. Discussion

The adoption of MLS technology has the potential to revolutionize the construction industry by improving the accuracy and efficiency of design and construction processes. One of the key advantages identified is the reduction in time and resources spent on large volumes of data, which is particularly important for large-scale projects. By automating processes such as error detection and documentation verification, MLS allows construction teams to focus more on the execution of tasks rather than on data management.

However, despite these benefits, the widespread adoption of MLS faces certain challenges. The high cost of equipment and software remains a significant barrier, particularly for smaller companies that may not have the budget to invest in such advanced technology. Additionally, the complexity of the data generated by MLS requires skilled personnel for its interpretation and use, which adds to the cost of implementation. These challenges highlight the need for ongoing training and support to ensure that the full potential of MLS can be realized.

Furthermore, while MLS is highly effective in generating detailed and accurate models, the technology still requires large data storage and processing systems to handle the vast amounts of information collected. The reliance on these complex systems may present challenges in terms of infrastructure and compatibility with existing project management tools.

## 5. Conclusion

Mobile Laser Scanning (MLS) is one of the most innovative approaches that has potential of enhancing the processes of design and reconstruction in the construction

sector. MLS application brings high accuracy and efficiency of data acquisition and analysis necessary for 3d models creation and minimal design errors. However, even in the case of mobile laser scanning, which has a large number of advantages like time and resource saving, along with the compatibility with other technologies, several challenges may appear. This application has limited accessibility due to the expensive equipment, the need to train personnel who can manage it and the handling of massive data. However, taking into consideration the continuing expansion of constructed environment, and corresponding growth of engineering difficulties, application of MLS is not only significant but necessary for the further construction of the construction industry. The potential of further advancement in mobile laser scanning technology is an indication that new frontiers in design and reconstruction are on the horizon, mobile laser scanning technology therefore ranks high in the list of important tools in the hands of modern architects and engineers.

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