



Terrestrial Laser Scanning

Agenda Overview

- Fundamentals of Terrestrial Laser Scanning
- Data Acquisition and Processing Workflow
- Applications of Terrestrial Laser Scanning
- Challenges and Limitations
- Advancements and Future Directions

Fundamentals of Terrestrial Laser Scanning



Basic Principles of Laser Scanning Technology

Laser Pulse Distance Measurement

Laser scanning measures distances by timing laser pulse reflections with high accuracy.

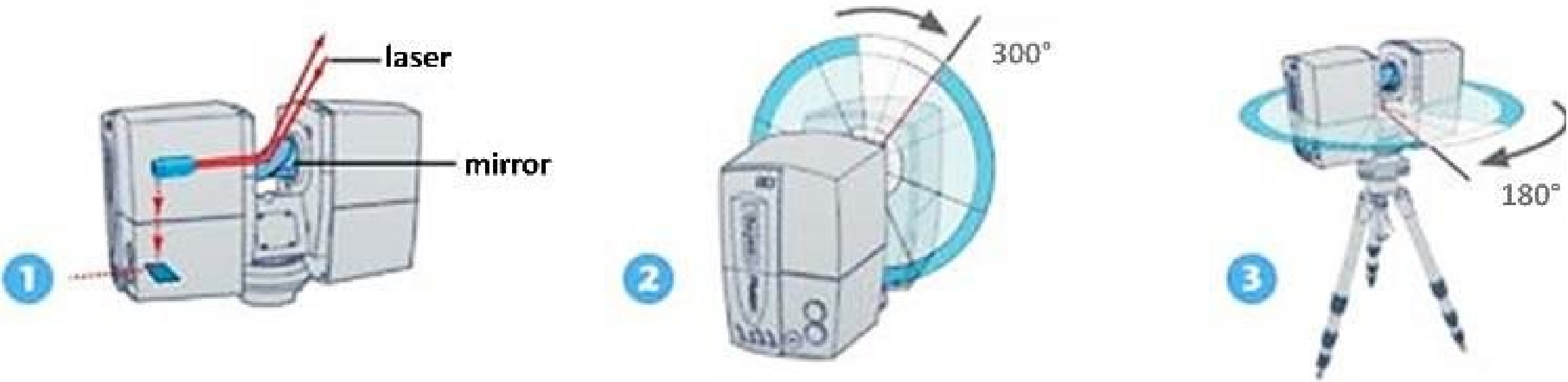


Basic Principles of Laser Scanning Technology

Laser Pulse Distance Measurement

Laser scanning measures distances by timing laser pulse reflections with high accuracy.

Components and Operation of Terrestrial Laser Scanners



Inertial Navigational System (INS)

- The solution for positioning and orientating the system whilst the laser scanner component is recording data is critical to the accuracy of the final output.
- The INS relies on blending information from Global Navigation Satellite Systems (GNSS) receivers and an Inertial Measurement Unit (IMU), to generate highly accurate positional and orientation estimates for the trajectory of the system, commonly referred to as SBET (Smoothed Best Estimate of Trajectory).
- This commonly involves the use of the latest GNSS base station technology to allow differential processing



Camera

- Most mobile LiDAR systems can be mounted with multiple cameras.
- These can collect imagery at various frame rates to ensure overlap and coverage of the area of interest.
- If cameras are used with systems that have an INS then the images can be precisely time-stamped using the onboard GNSS signal.



Types of Terrestrial Laser Scanners

Time-of-Flight Scanners

Measure distance by calculating the travel time of laser pulses, ideal for long-range scanning.

Phase-Shift Scanners

Use phase difference to determine distance, offering high accuracy in short to medium ranges.

Triangulation Scanners

Employ geometric triangulation for precise data in close-range and controlled environments.

Data Acquisition and Processing Workflow

Site Preparation and Scanner Setup

Optimal Scanner Location

Choose scanner locations that ensure clear line-of-sight and cover the entire target area effectively.



Site Preparation and Scanner Setup

Equipment Stability

Stabilise scanning equipment to prevent movement and ensure accurate data collection during operation.



Data Collection Techniques

Optimising Scanner Settings

Adjust scanner resolution and range to capture detailed and accurate data effectively.



Data Collection Techniques

Multiple Scan Positions

Use multiple scan angles to minimise obstructions and ensure comprehensive data coverage.

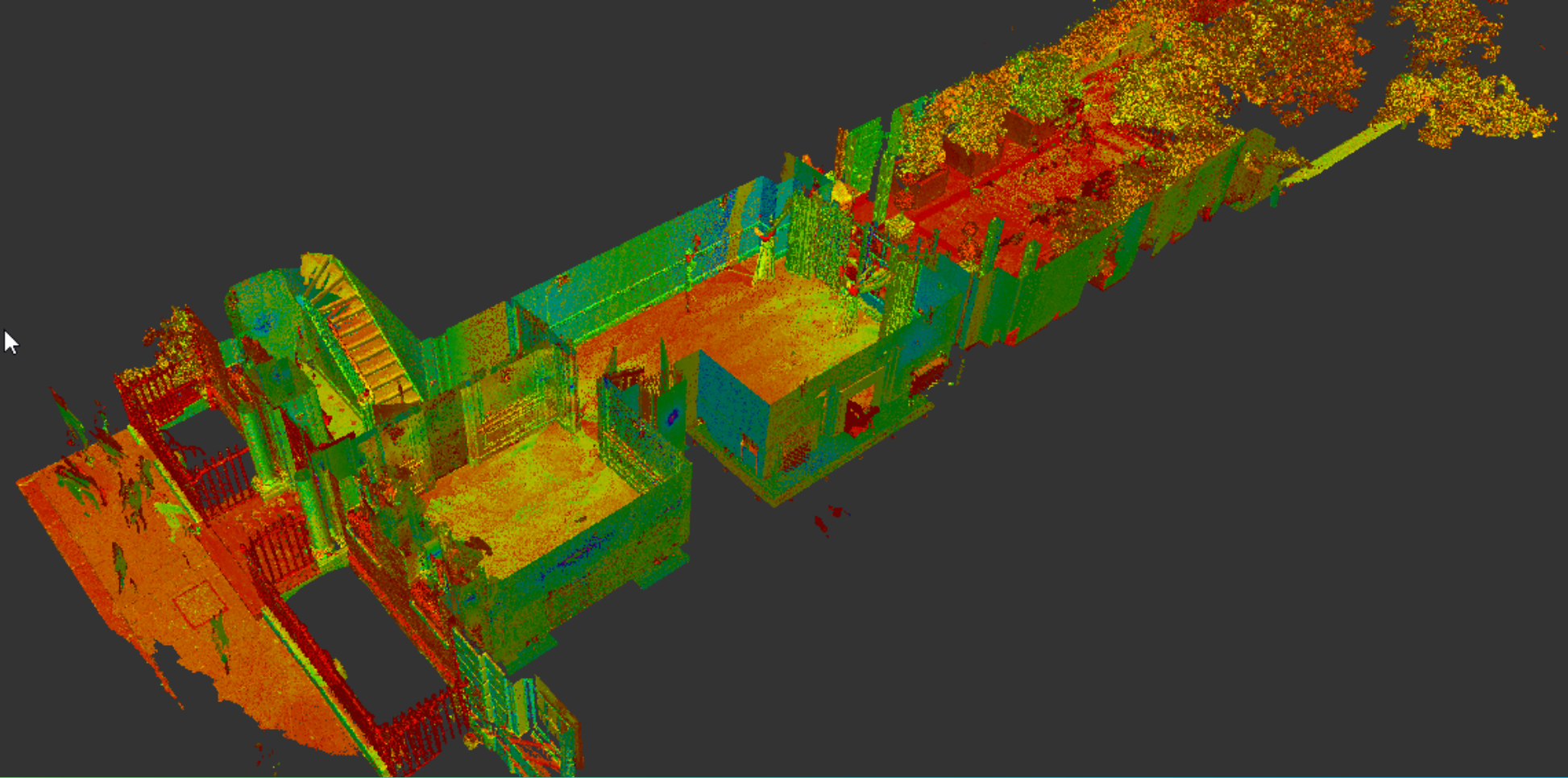


Data Collection Techniques

Multiple Scan Positions

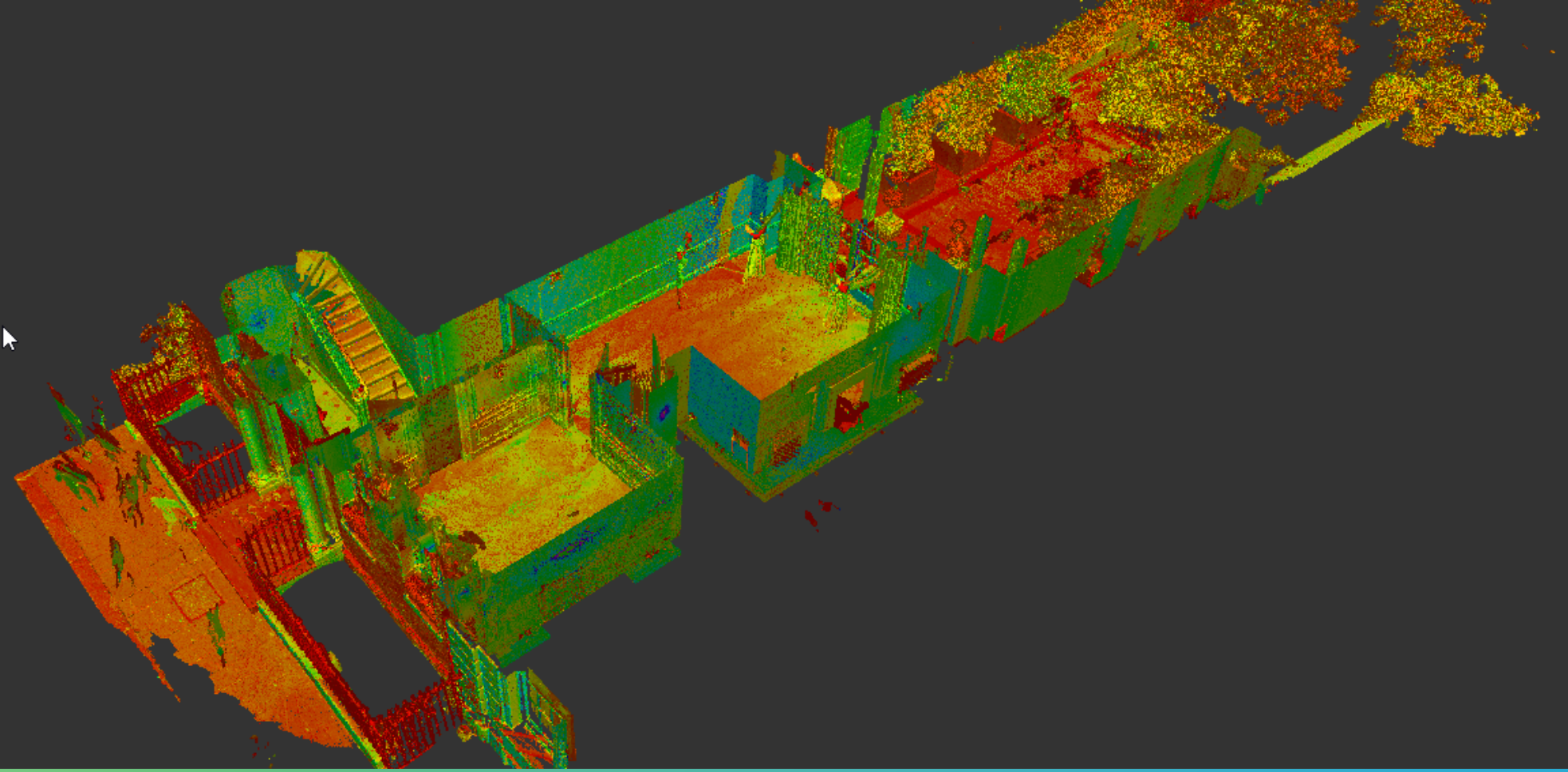
Use multiple scan angles to minimise obstructions and ensure comprehensive data coverage.





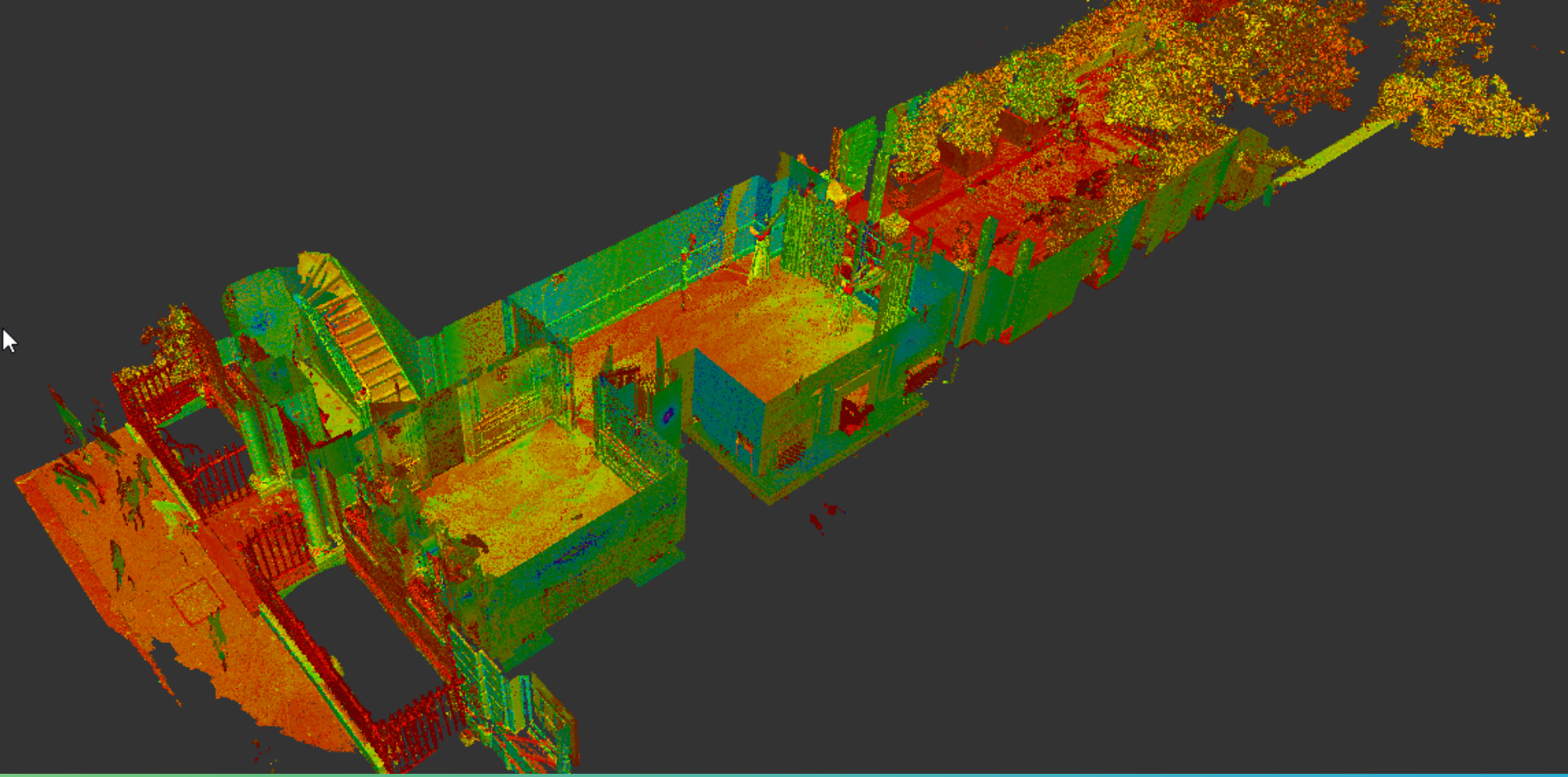
Point Cloud Generation

Raw scanned data is processed to generate a point cloud representing the surfaces of the scanned object or environment.



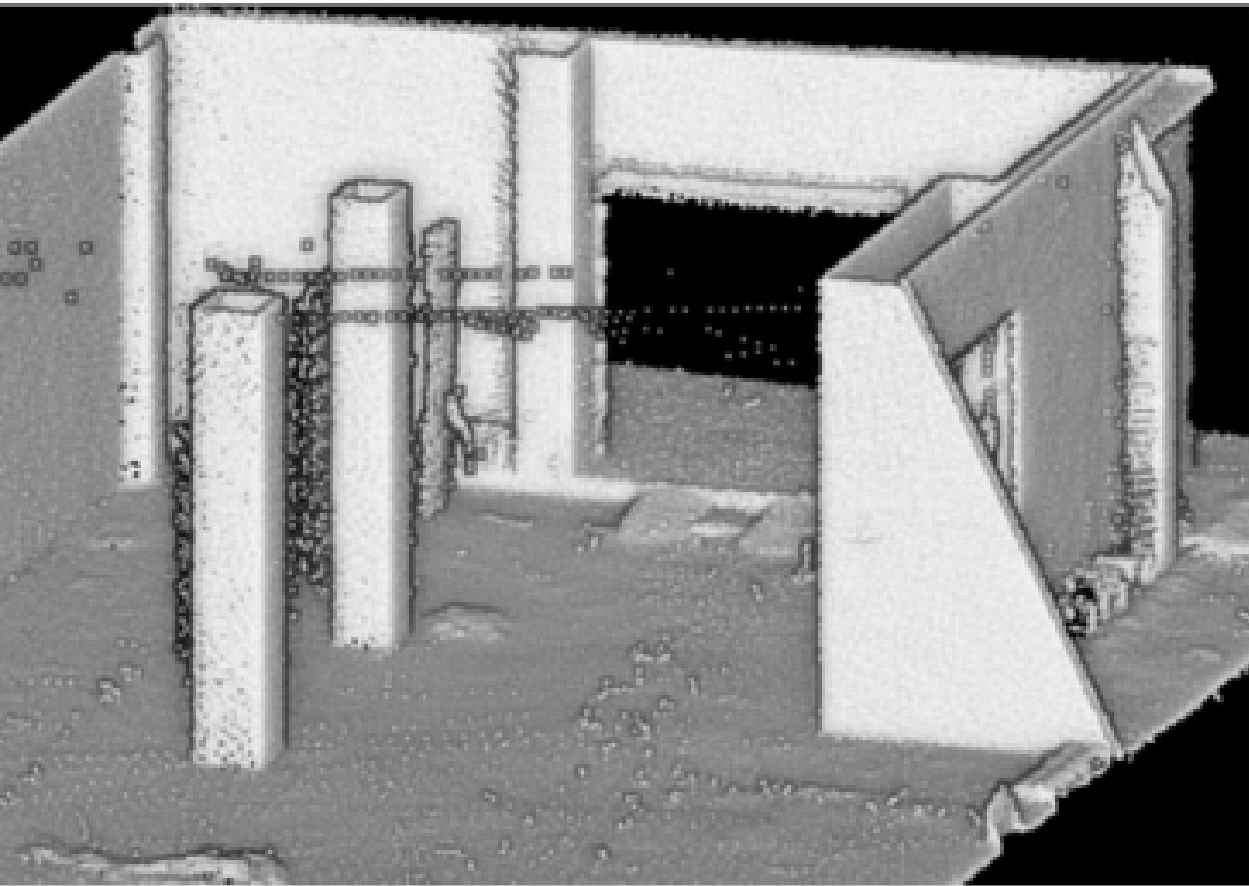
Point Cloud Generation

A point cloud is basically a big collection of tiny dots in 3D space, where each dot represents a specific point on the surface of an object or environment

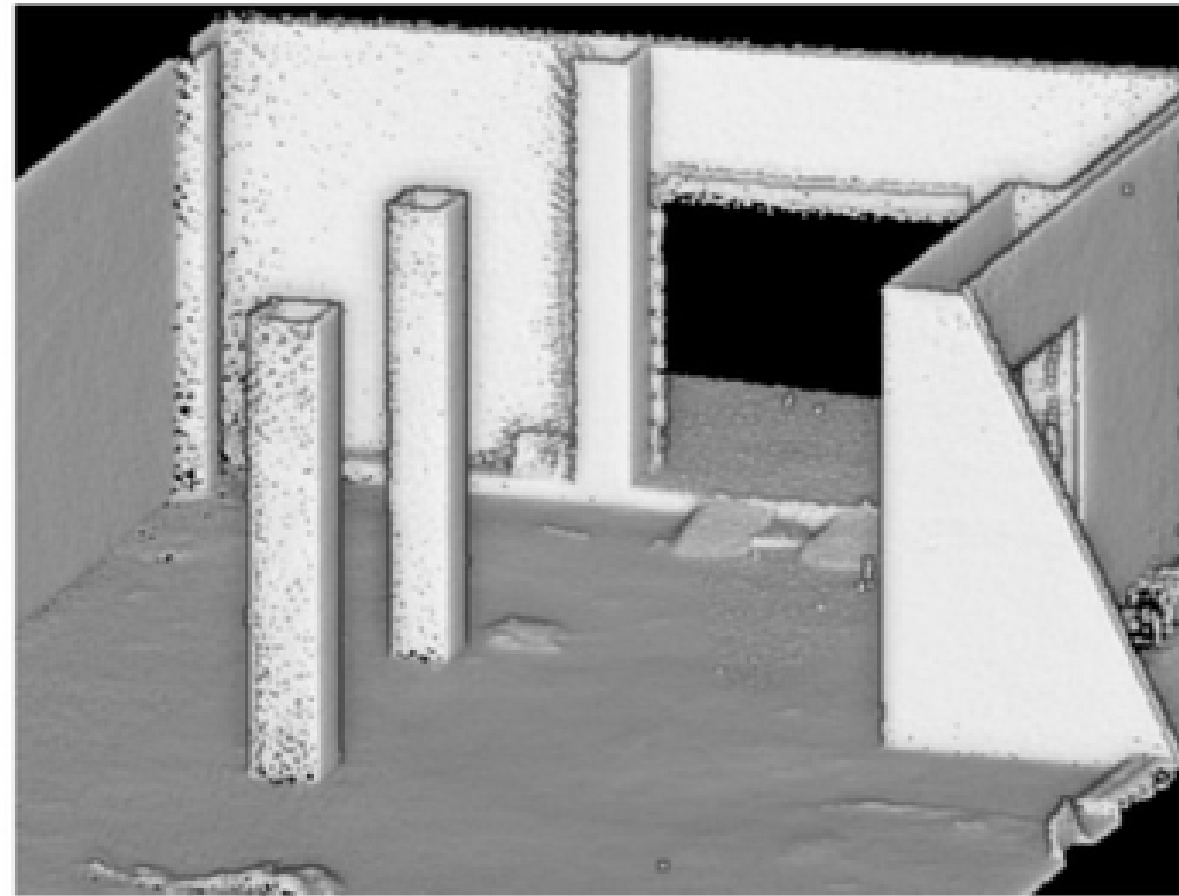


Point Cloud Generation

Each point comes with coordinates like (x, y, z)



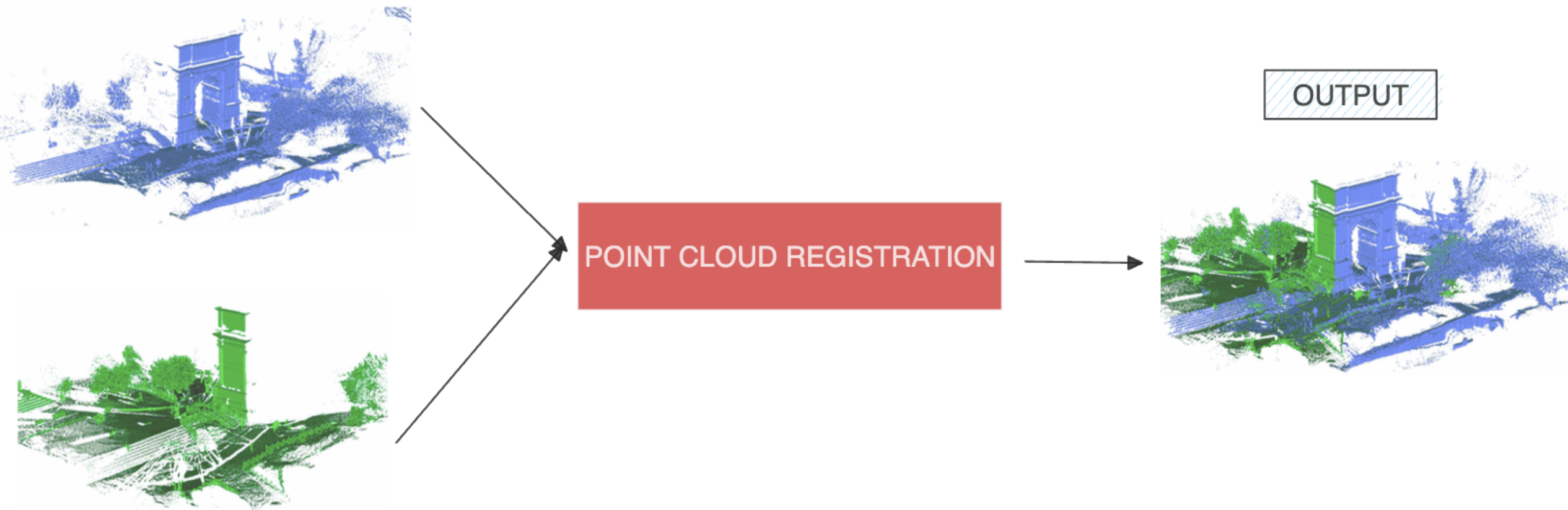
b)



Point Cloud Processing

Noise Filtering

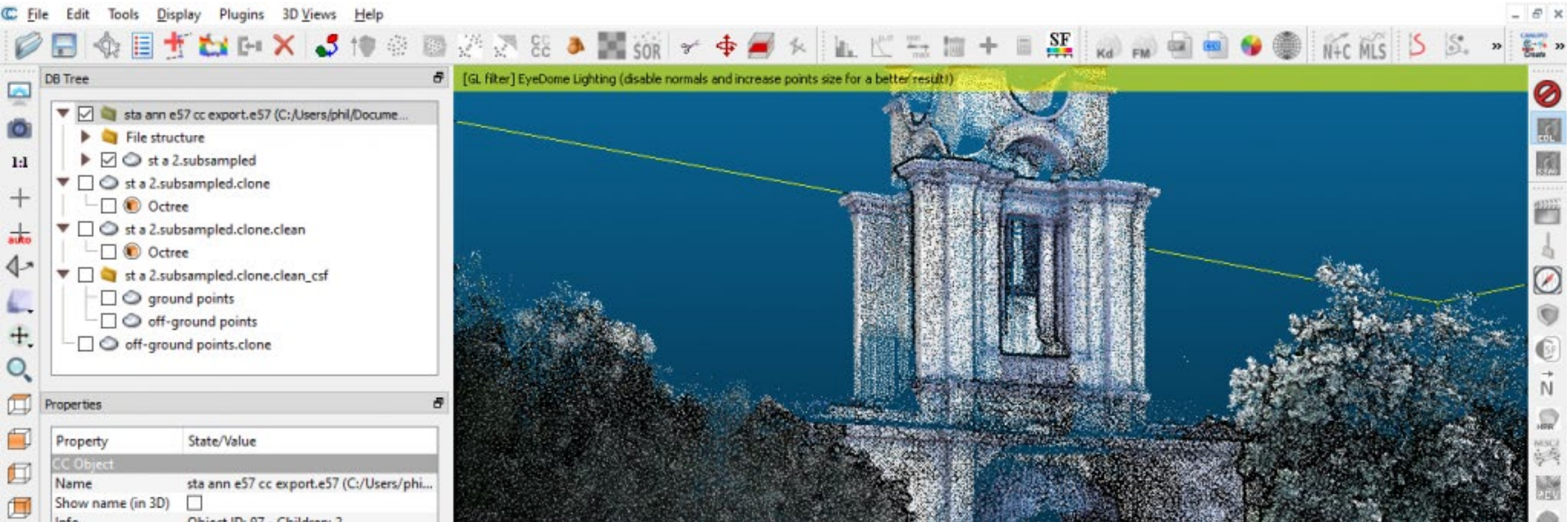
Noise is filtered from the raw data to enhance the accuracy and quality of the point cloud for better analysis.



Point Cloud Processing

Scan Alignment

Multiple scans are aligned and merged to create a comprehensive and continuous point cloud representation.

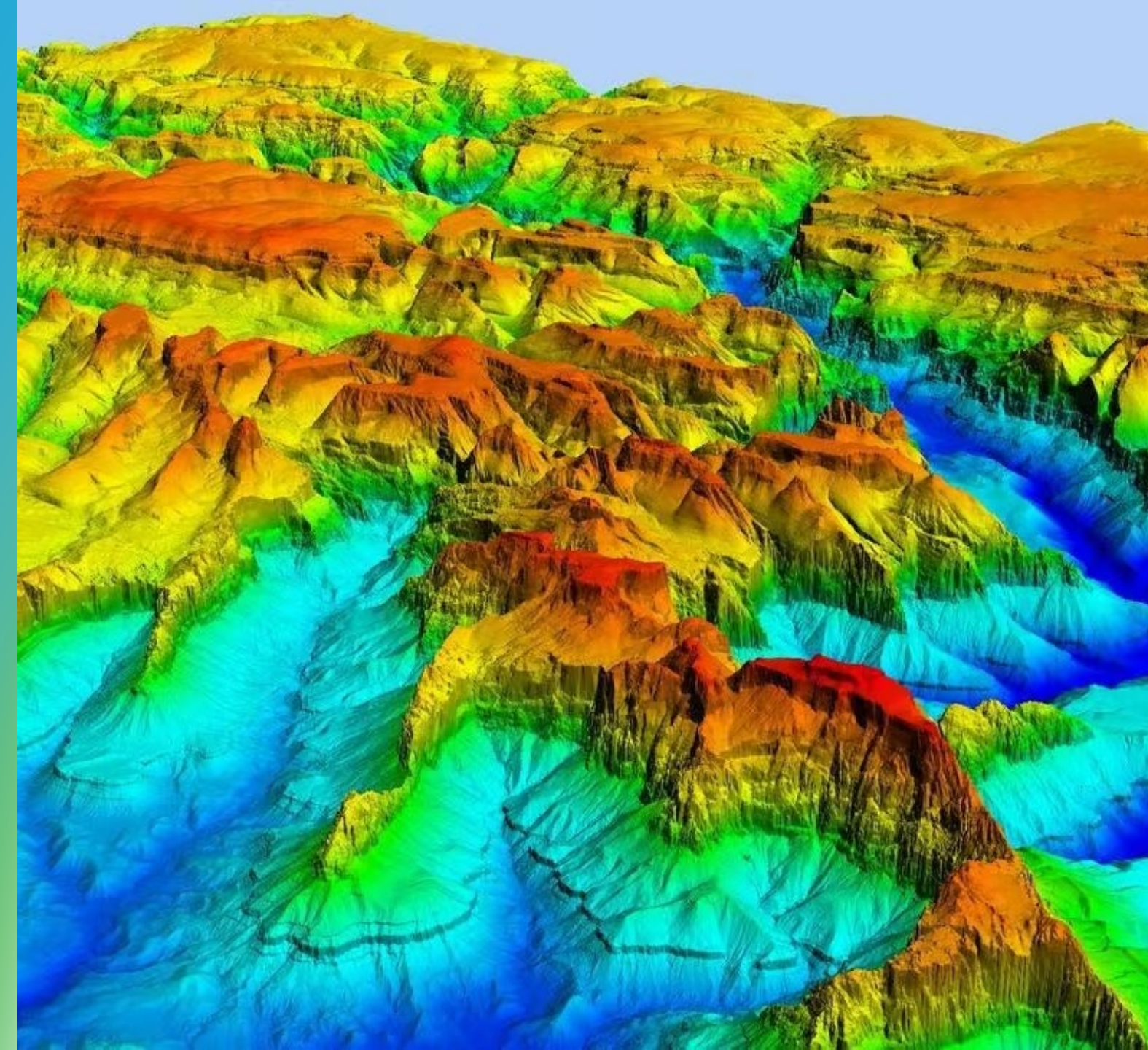


Point Cloud Processing

Data Conversion

Processed data is converted into usable formats compatible with analysis and visualisation tools.

Applications of Terrestrial Laser Scanning



Surveying and Topographic Mapping

- Rapid Topographic Mapping
- Accurate Land Surveying
- Detailed Terrain Models
- Environmental Change Monitoring

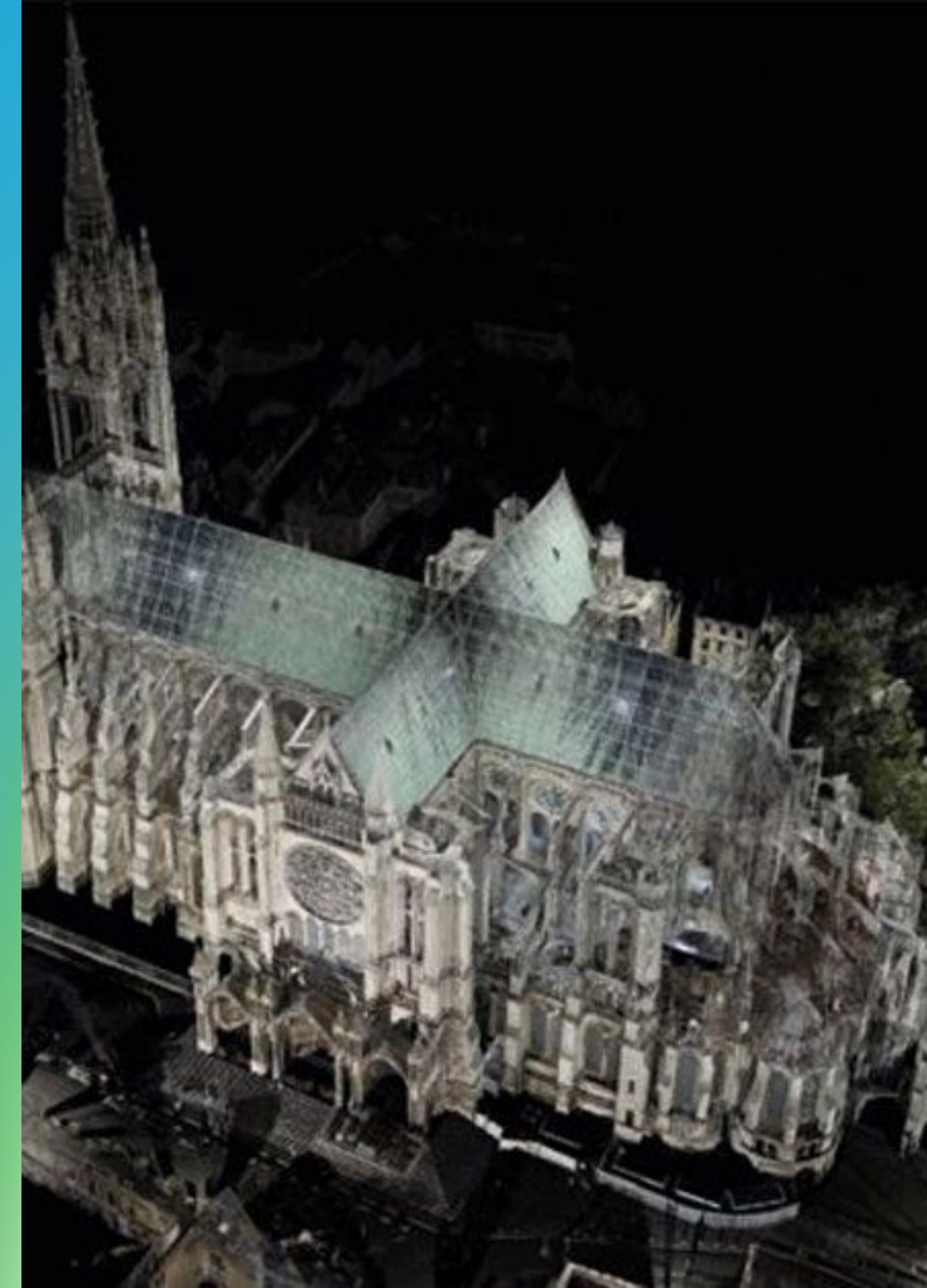


Architecture and Construction

- As-Built Documentation

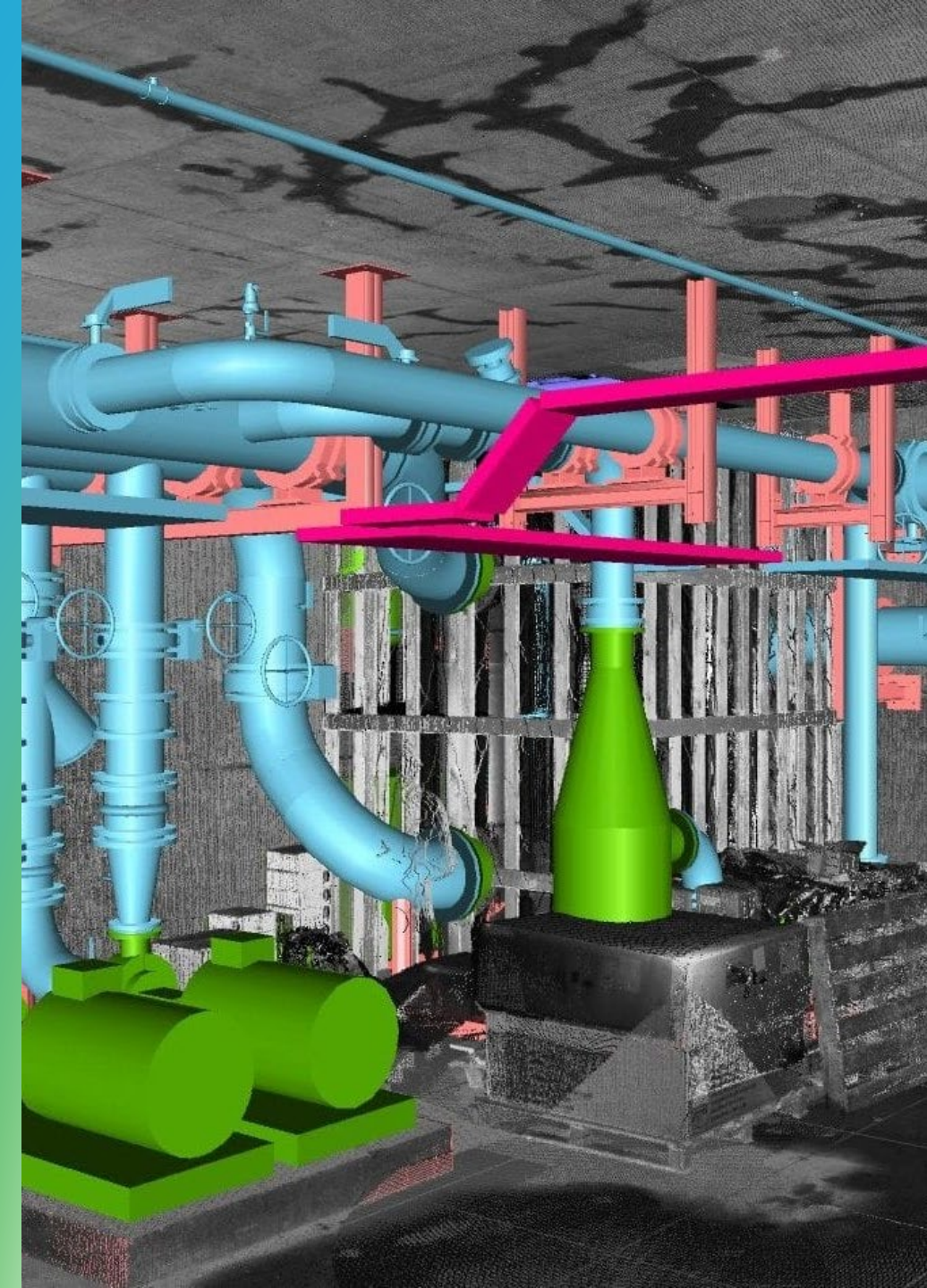
Architecture and Construction

- As-Built Documentation
- Heritage Preservation



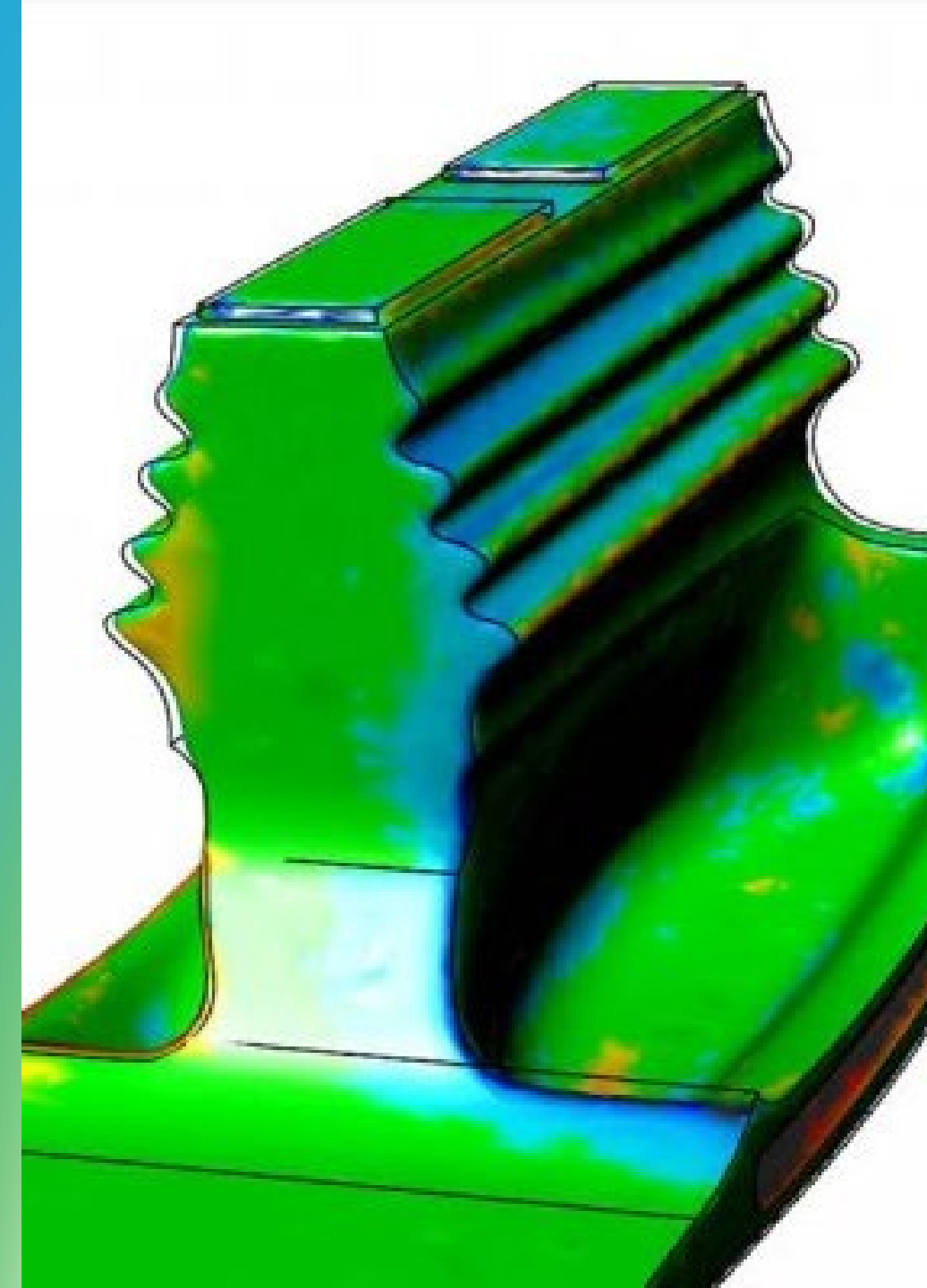
Architecture and Construction

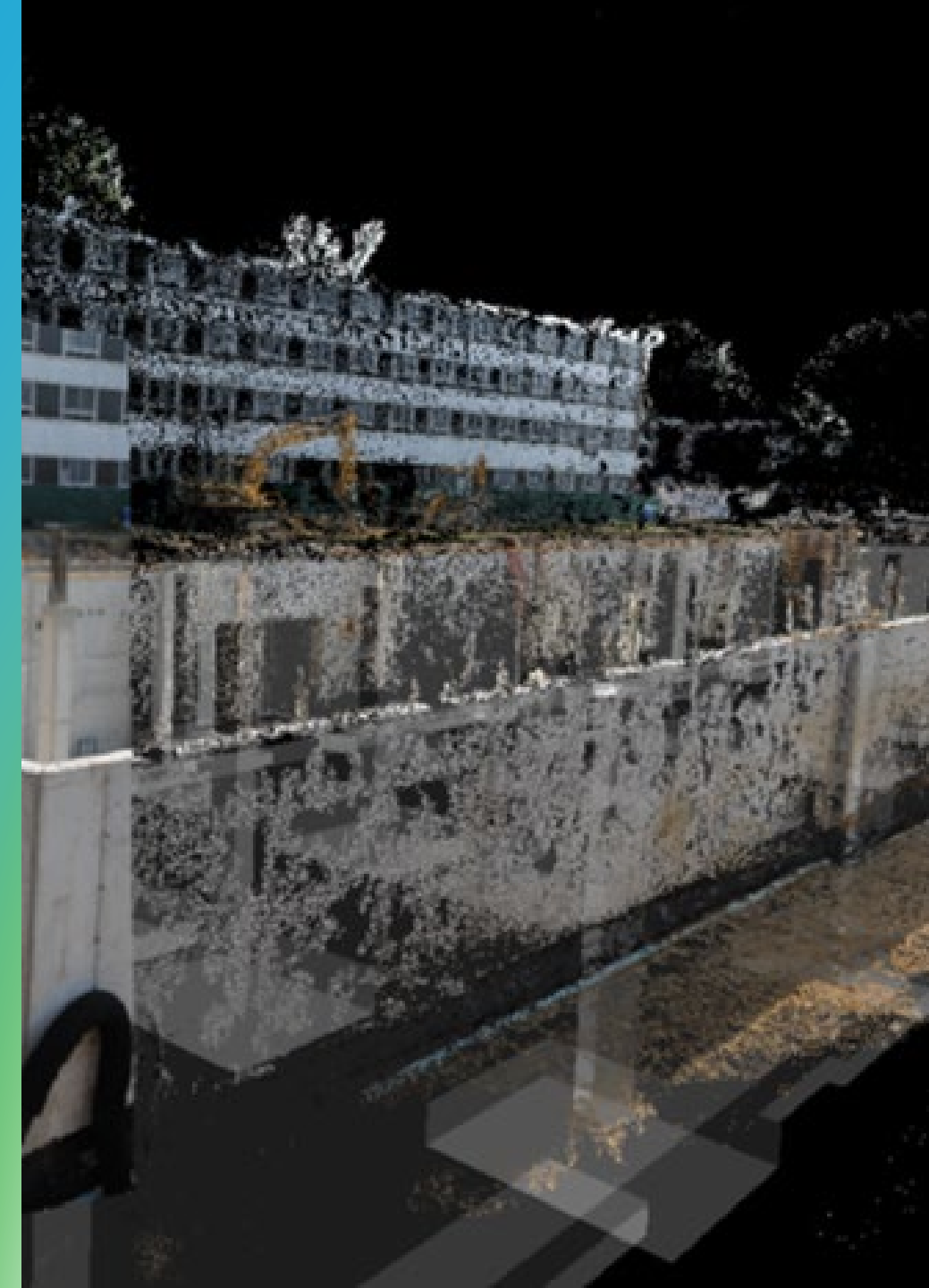
- As-Built Documentation
- Heritage Preservation
- Building Information Modelling



Architecture and Construction

- As-Built Documentation
- Heritage Preservation
- Building Information Modelling
- Quality Control & Deviation Checks





Architecture and Construction

- As-Built Documentation
- Heritage Preservation
- Building Information Modelling
- Quality Control & Deviation Checks
- Progress Monitoring

An aerial photograph showing a large-scale construction project. The central area is a dense grid of dark, rectangular foundations or rebar structures, indicating the early stages of a multi-story building. Surrounding this central area are various construction materials, equipment, and access roads. The site is bordered by existing urban infrastructure, including roads and other buildings.

Architecture and Construction

- As-Built Documentation
- Heritage Preservation
- Building Information Modelling
- Quality Control & Deviation Checks
- Progress Monitoring
- Site planning & Logistics

Challenges and Limitations



Accuracy and Resolution

Scanner Resolution Impact

Higher scanner resolution improves accuracy by capturing finer details of the target surface.



Accuracy and Resolution

Distance to Target

Accuracy decreases as distance to the target increases due to signal dispersion and loss.



Accuracy and Resolution

Surface Properties

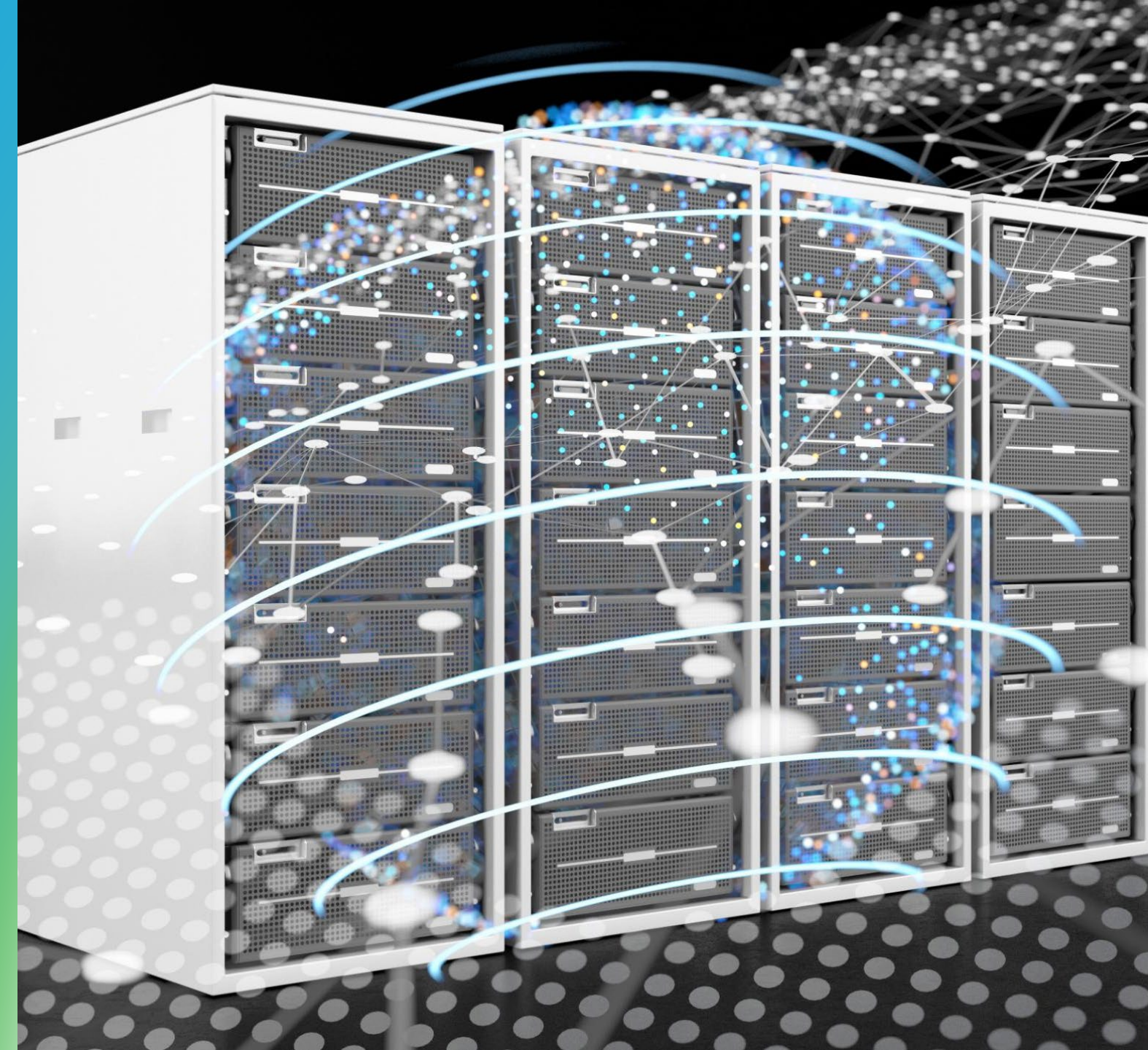
Reflectivity and texture of surfaces affect the scanner's ability to capture accurate data.



Accuracy and Resolution

Atmospheric Conditions

Weather and atmospheric particles can distort signals, impacting scan resolution and precision.



Data Storage & Processing Demands

- Massive Data Generation
- Storage Requirements
- Computational Resources