FIG WORKING WEEK 2023

28 May - 1 June 2023 Orlando Florida USA

Protecting Our World, Conquering New Frontiers

Application of Laser Scanner based on SLAM Technology in Urban 3D Digitization

SATLAB GEOSOLUTIONS

Junwei Hoang

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Background

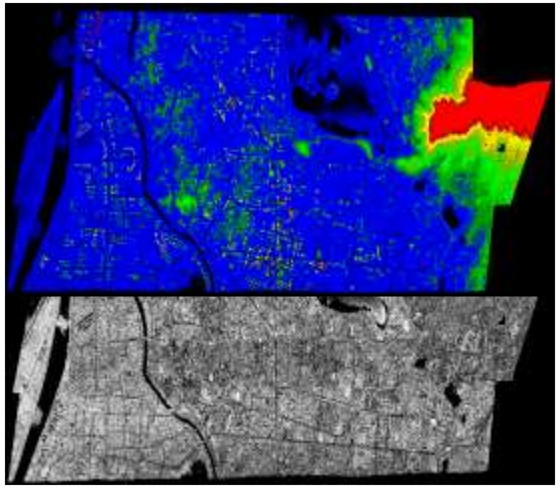
- 3D Digitization

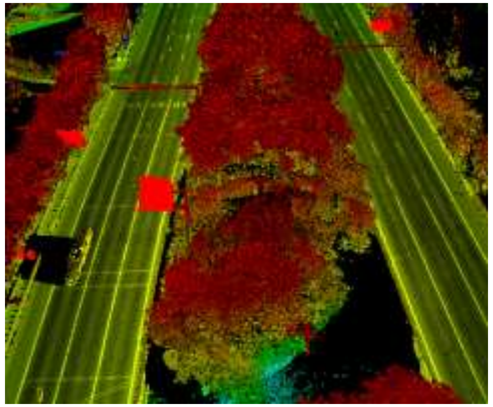
For 3D Information Digitization, it is to reflect the real 3D world into a computer through a series of earth observation technologies for virtual 3D representation, analysis and application in various fields.

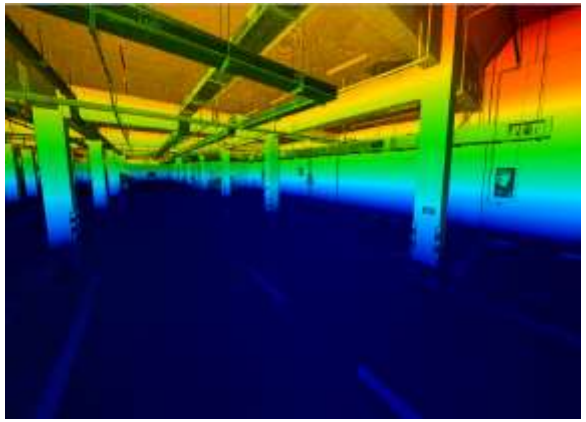
Background

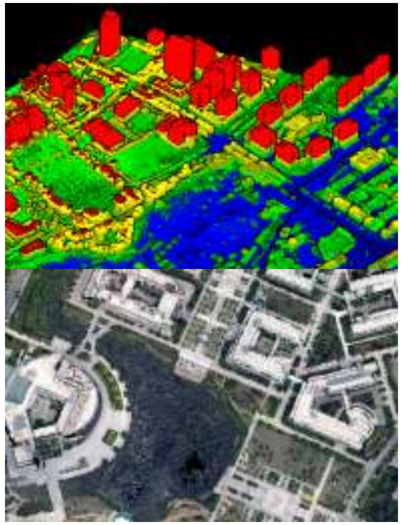
- **Ubiquitous Point Cloud**

Indispensable and important data resource for mapping the real world to the digital world


UAV LiDAR/ALS point cloud


MLS point cloud


TLS point cloud


Dense image matching point cloud

Background

- **SLAM (simultaneous localization and mapping)**

is the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of an agent's location within it.

sensor
- Camera
- LiDAR
- Millimeter-wave radar
- Sonar

position
- GNSS
- INS (Inertial Navigation System)
- Wheel odometry

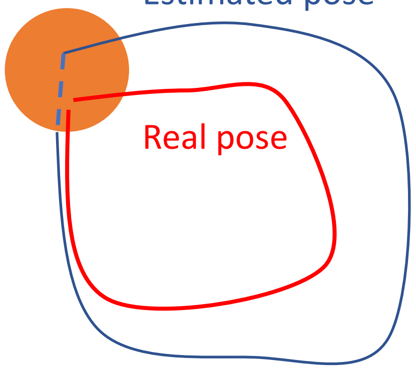
• 3D SLAM Algorithm

Front-end: Odometry → Close-loop → **Back-end**: Optimization

- Point to plane ICP
- NDT
- Feature-based:LOAM
- Deep learning:LO-net, DeLORA

…

- GTSAM
- G2O
- Ceres



- **Handheld Laser Scanner**

Speedy and Accurate

- 120m
- 320,000/640,000 points per second
- FOV 360°×285°
- 0.5~2cm

Real-time Preview

Light-weight, Durable and Versatile

- -30-60°C IP65
- Handheld, backpack, drone, vehicle, etc.

Hybrid Solving for Rapid Data Processing

- Exported for direct use

SATLAB Cygnus Handheld Laser scanner

- **Handheld Laser Scanner**

LiDAR Sensor	HESAI-16/32
Laser Class	Class1,Eye Safe
Range	120m
Measuring rate	320,000 or 640,000 pts/sec
Accuracy	0.5-2cm
FOV	360°×285°
Scanner Weight	1.5kg, 227×98×98mm




• Advantages of SLAM in Urban survey

High efficiency & Simple work flow

Single man solution

No GNSS signal required

Indoor, underground, urban building occlusion

Lightweight and flexible

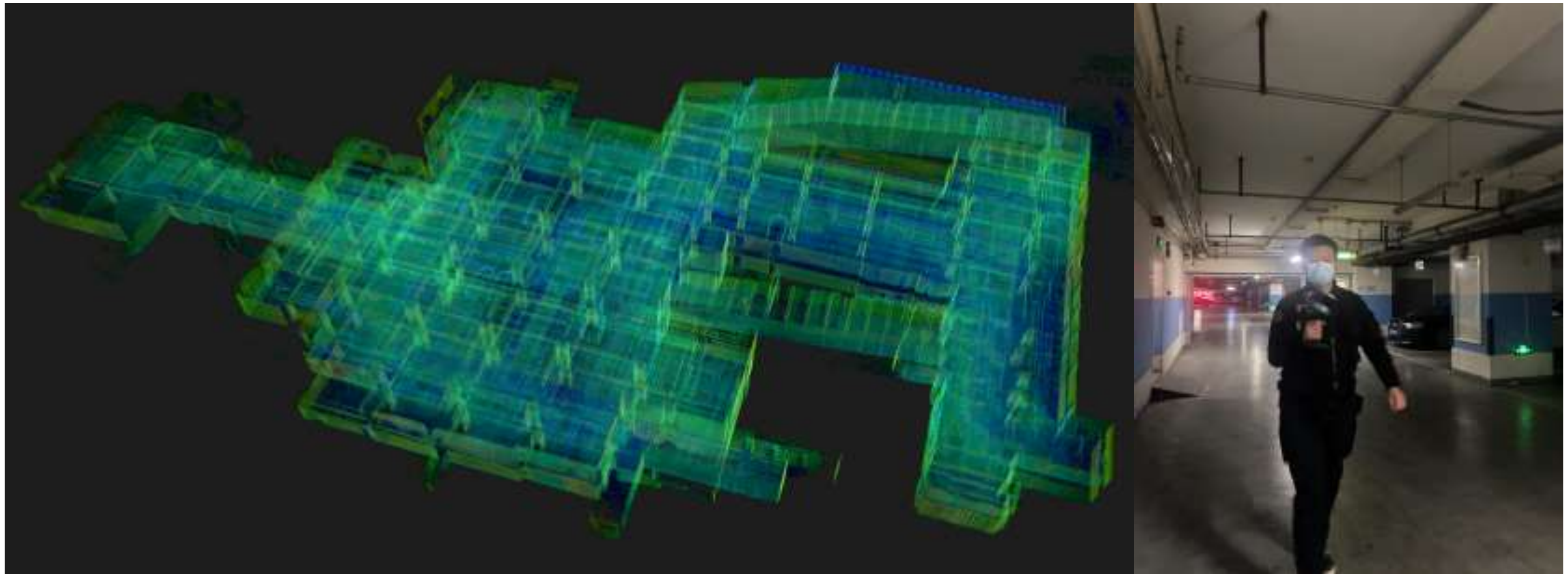
no-fly-zone or difficulty applying for airspace

Application Cases

- Underground Space Survey

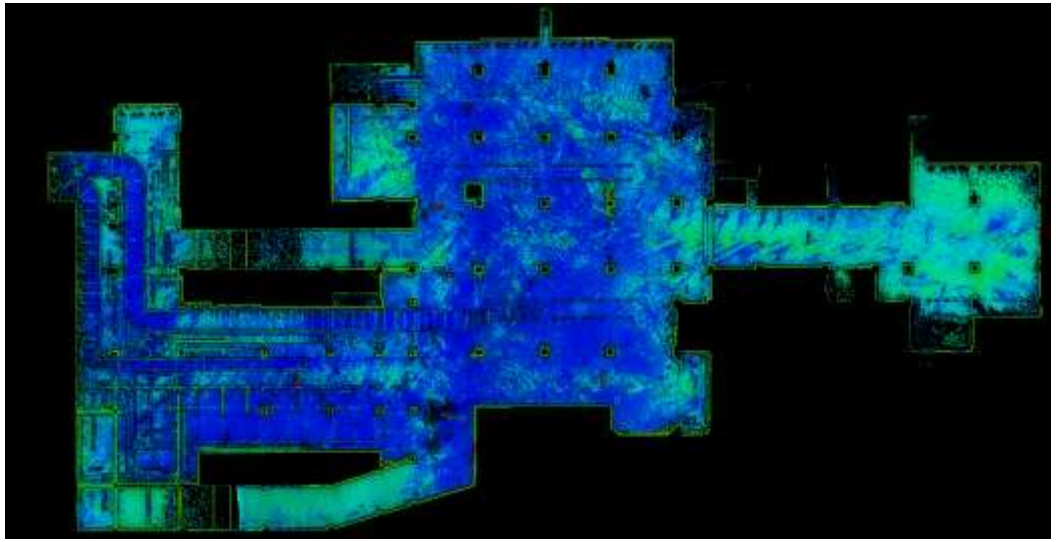
40min scanning

Area of each layer around 4566m^2

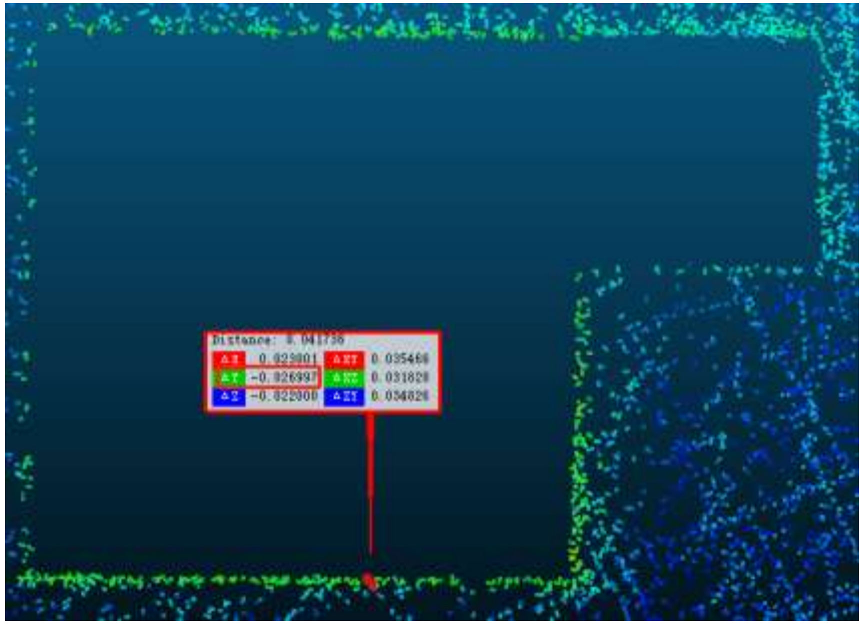


Two layer of underground park

- Underground Space Survey

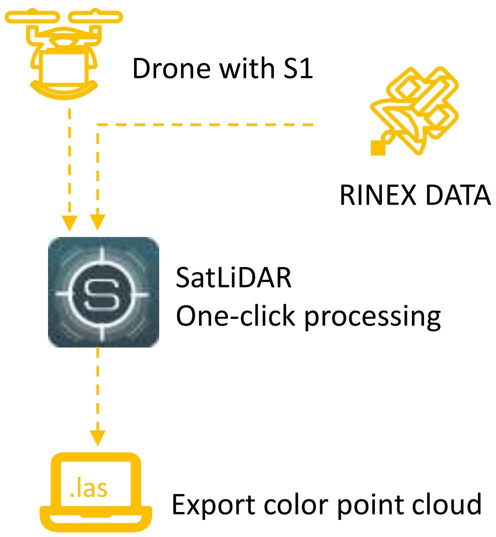


Point cloud Slice

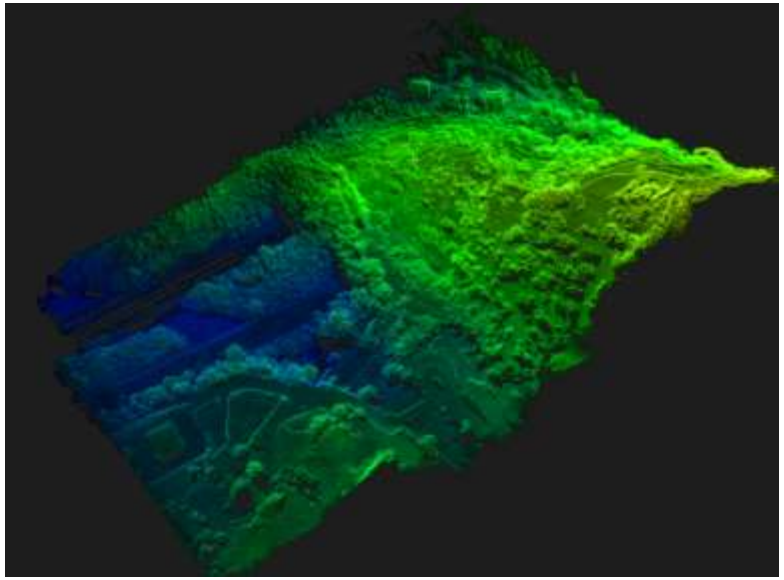


The measurement of point cloud thickness around each column or wall mostly results in a range of 2 cm to 3 cm

- **Topographic Survey**



SATLAB S1 UAV LiDAR



The origin ALS point cloud data

• Topographic Survey

✓ Convert the RTK observation and SLAM trajectory to obtain the point cloud with absolute coordinate

✓ RTK observations can be used as ground truth values to verify the absolute accuracy of SLAM;

✓ RTK observations can be added as global observation value (similar as closed-loop constraint) to correct the SLAM cumulative error

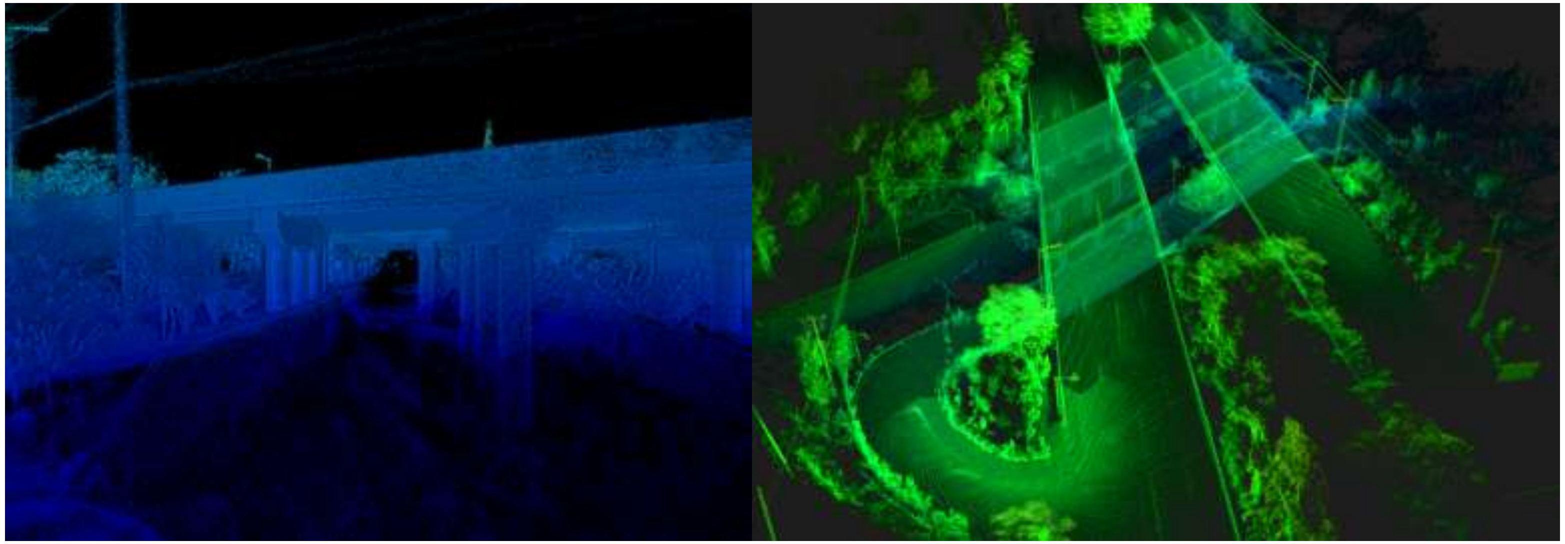
✕ GNSS limitation

- Underground or GNSS signal blocked
- invalid solutions, floating point solutions

SATLAB Cygnus Backpack System

- **Topographic Survey**

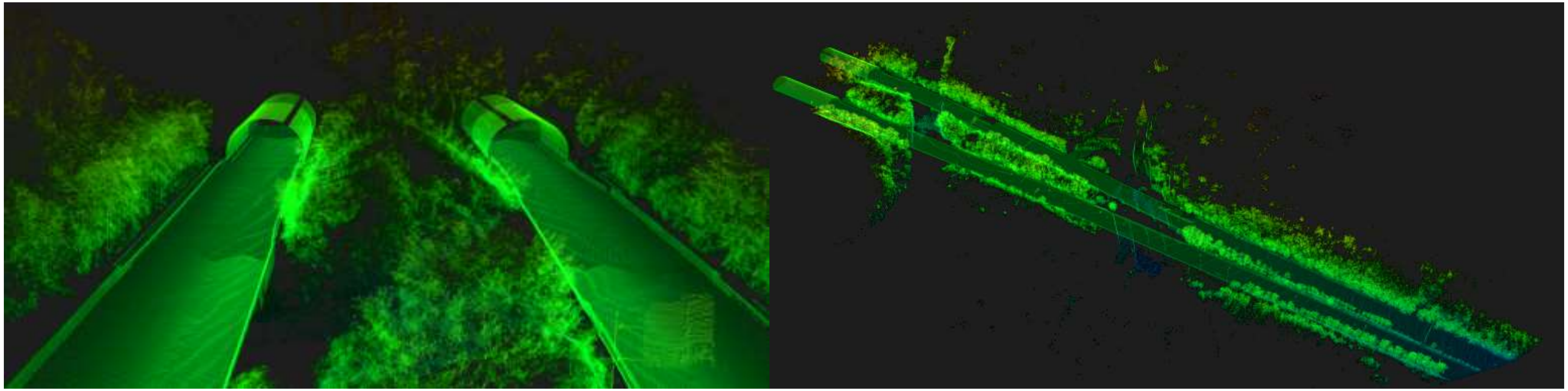
Backpack SLAM Data



Shortcut of bridge area data

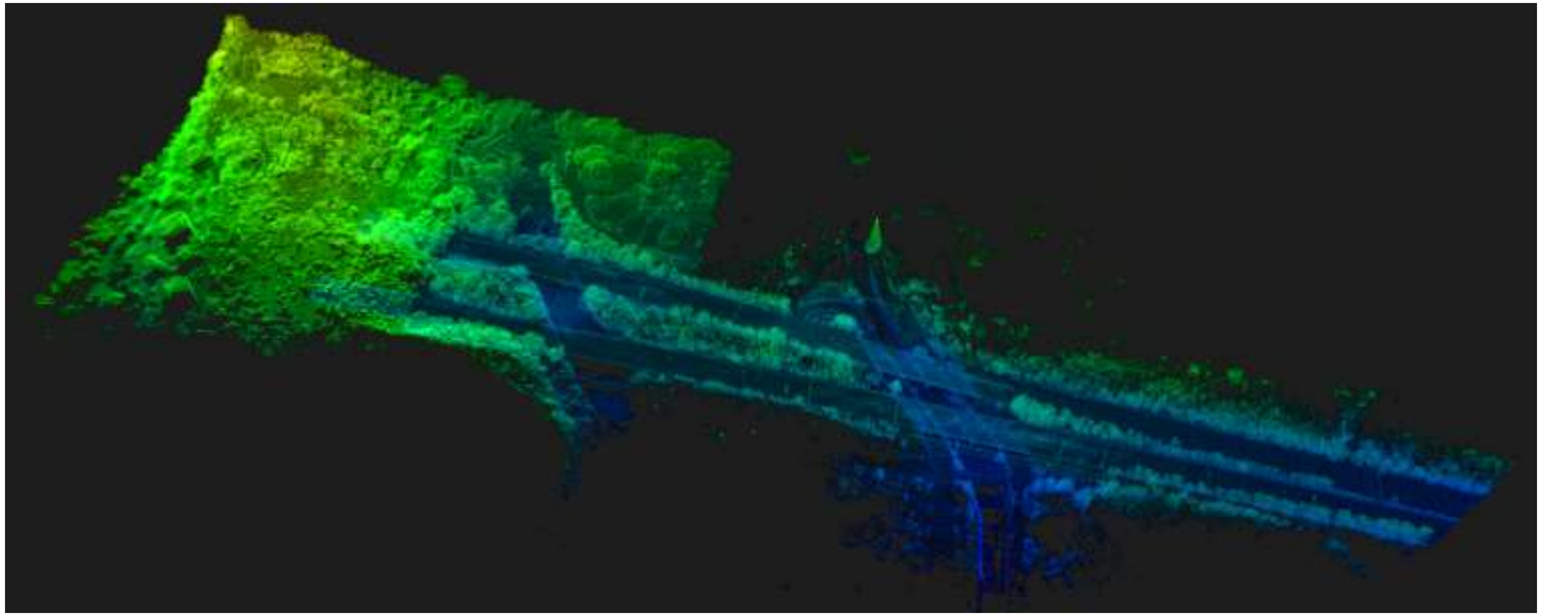
- **Topographic Survey**

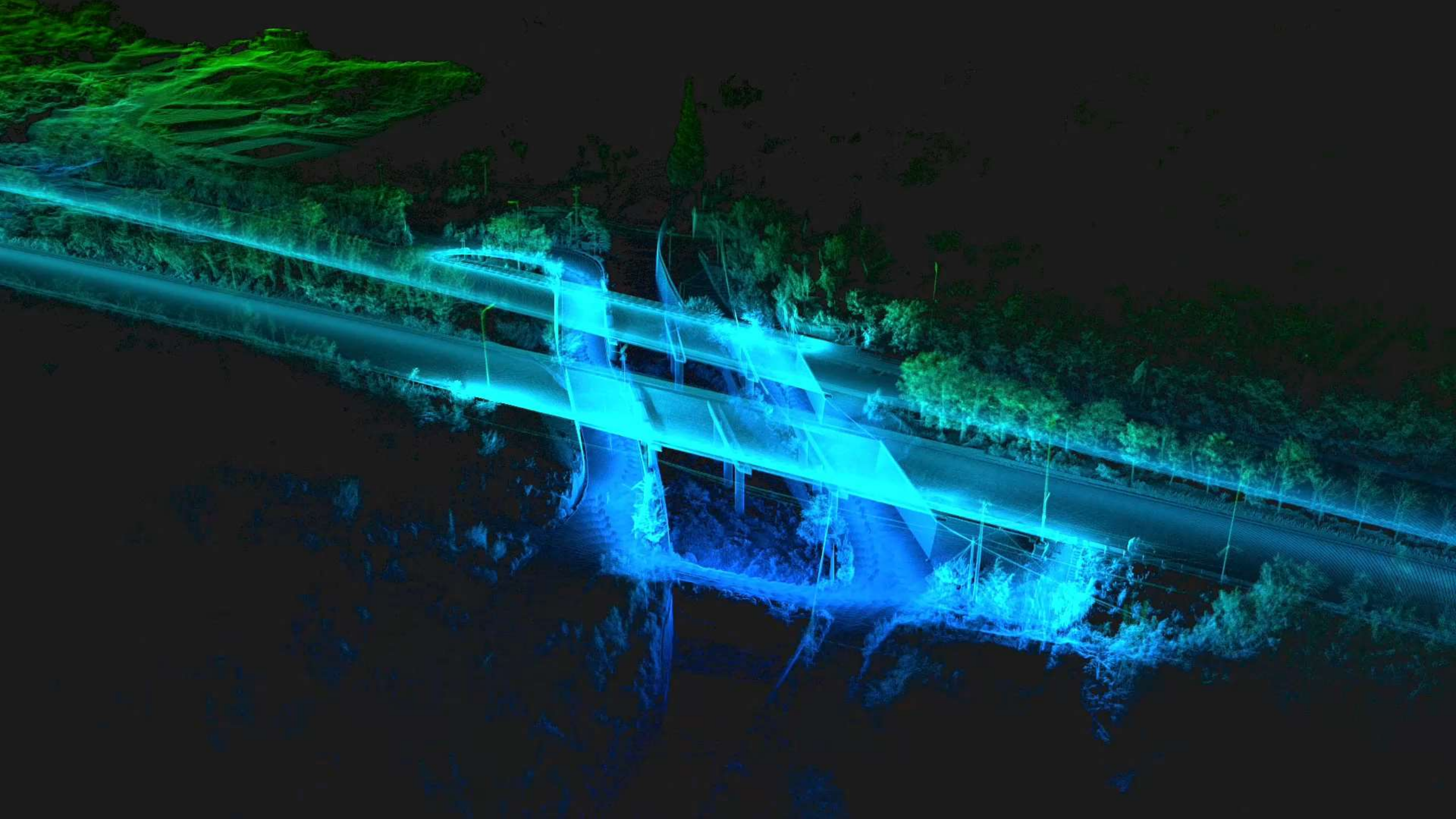
Vehicle-mounted SLAM data



- **Topographic Survey**

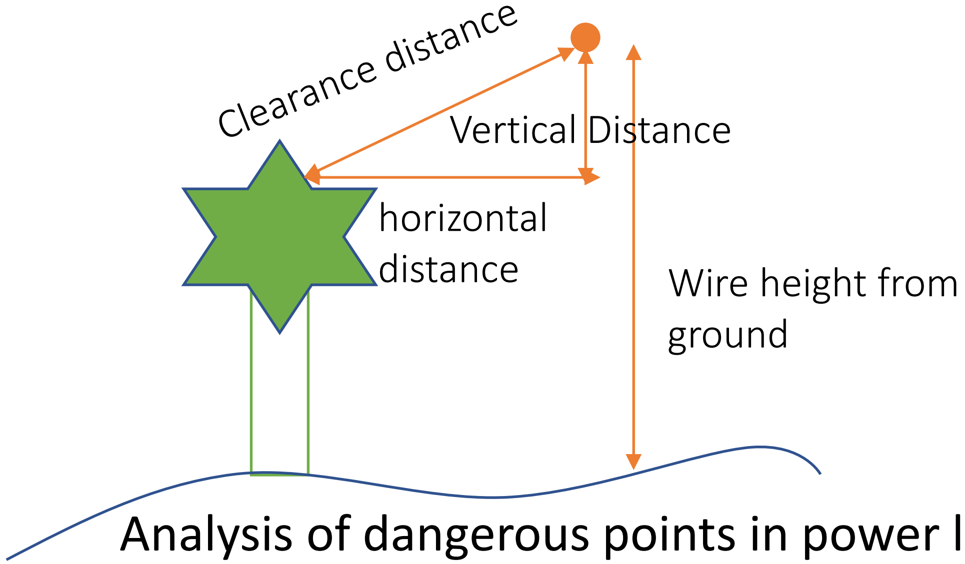
The data fusion of ALS data and SLAM data



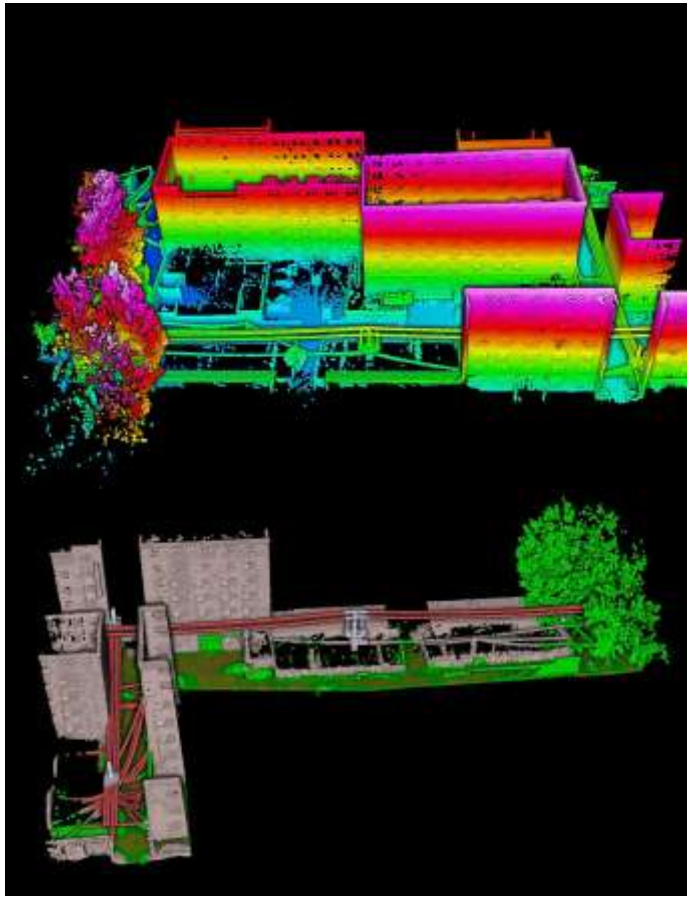


- **Electricity application**

For urban no-fly zone, mobile SLAM scanner can be the ideal solution to collect the transmission lines in the narrow residential area

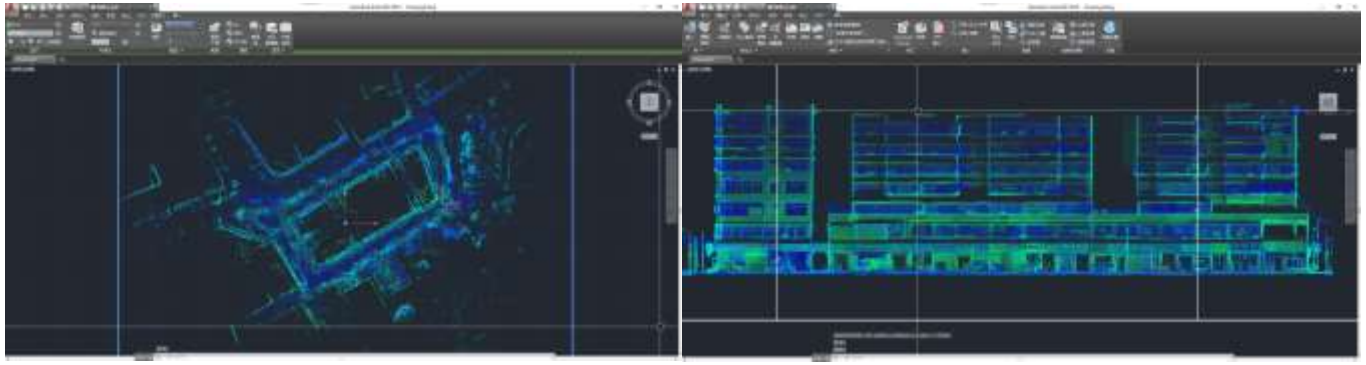


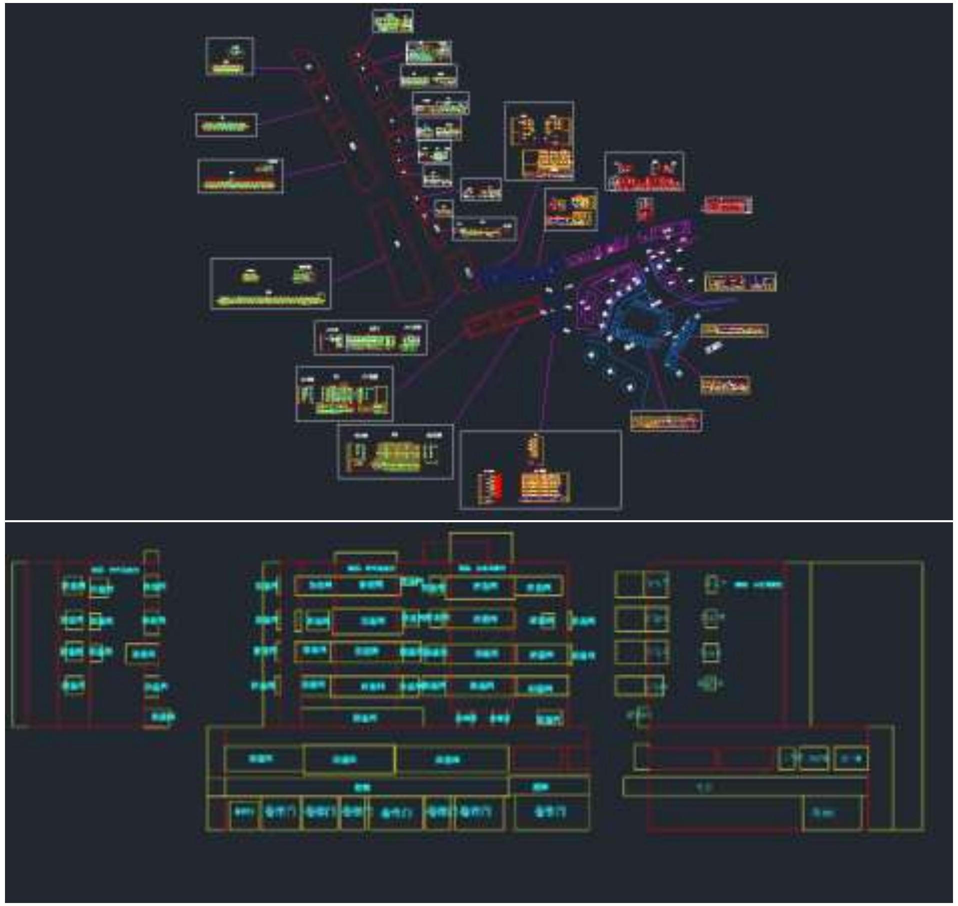
Analysis of dangerous points in power lines



- **Renovation of old building**

Point cloud data can be imported into CAD, rotated and dragged according to the demands, and users can automatically pick up scanned point clouds for 2D drawing.





Conclusion

Several cases of urban 3D information digitization are illustrated, which has certain representative significance.

The point cloud obtained by SLAM technology can be sliced and imported into CAD for mapping or directly modeled.

We take advantage of the SLAM Laser scanner’s versatility such as the backpack and vehicle-mounted to perform a better data collection, and combining SLAM solution with other aerial remote sensing technologies to obtain more complete and detailed three-dimensional urban information.