UAV Measurement Technology and Flight Training

What is a UAV?

The acronym UAV stands for Unmanned Aerial Vehicle, and the term drone is a general term for autonomous unmanned vehicles because they are autonomously controlled and remotely operated.
Although widely known as a tool for taking pictures and videos, usually operated without a human on board and equipped with a camera and sensors, it has many other uses.
Examples include surveying, inspection, surveillance, disaster investigation, agriculture, delivery, and many others.

Features of UAV

Drones are characterized by their ability to be accessed remotely, making them suitable for activities in hazardous or inaccessible situations.
They can also be flown utilizing advanced technology and can obtain accurate location information through automatic control and GPS, allowing for efficient operation.
Drones are used in a variety of industries and sectors, offering significant advantages in terms of efficiency and data collection.

Surveying using UAV

Drone surveying is widely used to collect, analyze, and map geospatial data on land, buildings, terrain, and the environment.
There are two types of methods used in drone surveying (photogrammetry/laser surveying).
The general flow of use is the same for both: "flight planning" → "data collection" → "data processing" → "analysis and application."

Flight plan

Data collection

Data processing

Application

Differences between drone photogrammetry and laser surveying

Drone photogrammetry and laser surveying are two different techniques used for surveying and mapping, each collecting data in different ways. The differences between the two are described below.

	Photogrammetry	Laser surveying
Principle	Photographs are taken from the air and the data is used to record features and expanses of the earth's surface to generate maps and 3D models.	A laser beam is directed at the earth's surface and the time taken for the beam to strike an object and be reflected back is measured. This accurately measures the altitude information of the ground surface and the position of the object.
Field of application	It is used in a wide range of fields, including land use planning, property valuation, construction projects, environmental monitoring, and agriculture.	It is used in fields requiring precise topographic information, such as terrain modeling, 3D modeling of buildings, forest management, road design, and flood modeling.
Advantage	It produces high-resolution photographs and is suitable for capturing detailed features of the earth's surface. It is efficient, cost-effective, and can cover large areas.	It can generate 3D models of the ground surface with a high degree of accuracy. It is an excellent choice especially when detailed topographic information is required.

Photogrammetry provides visual information and is used in a wide range of fields, efficient and cost-effective, while Laser surveying provides precise 3D information and is used in areas where highly accurate data is required, such as terrain modeling and building design.
Which one to use depends on the application.

UAV Laser Surveying Methods

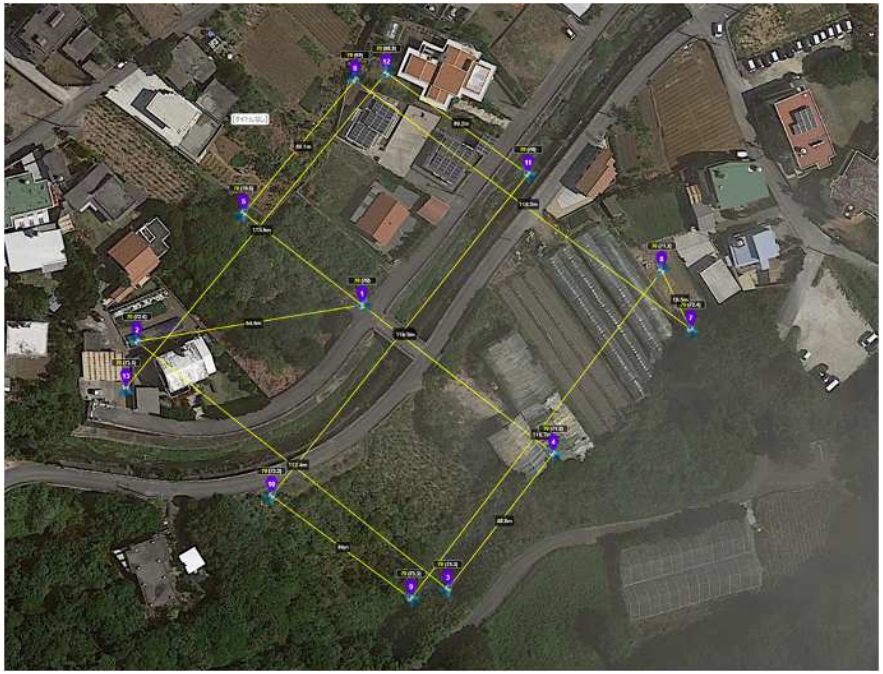
This section describes the procedure for laser surveying using a drone.

1. Selecting the right equipment

The drone must be fitted with a sensor for laser surveying.
Typically, a LiDAR (Light Detection and Ranging) sensor is used.
This sensor is used to measure distance by emitting a laser beam toward the ground surface and measuring the reflection time.

Drone Laser Surveying Methods

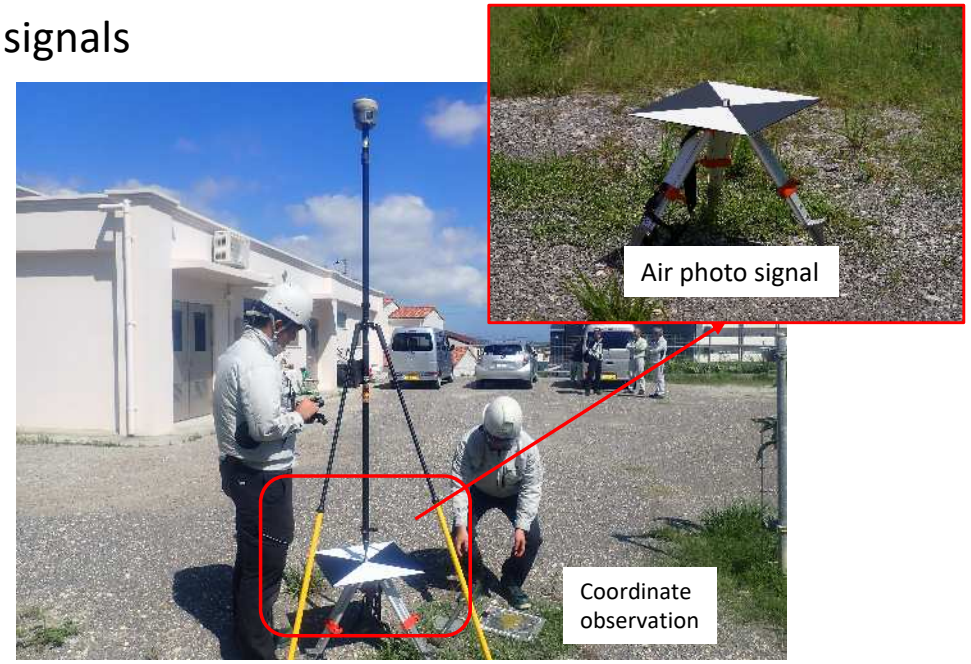
2. Flight planning



Develop a flight plan for the drone.
This includes setting the flight path, flight altitude, speed, and lap rate.
The flight plan is designed to fit the characteristics of the survey area and the project objectives.

Drone Laser Surveying Methods

3. Installation of fixed stations, observation of coordinates of fixed points, and installation of air photo signals



Install a fixed station to accurately acquire drone location information.
Install an air photo signal for accuracy verification and data adjustment.
(GNSS surveying equipment will be used to observe the coordinates of the air photo signal.)

Drone Laser Surveying Method

4. Flight operation

The drone flies according to a planned flight path.
Laser sensors send laser beams to the ground surface and collect distance data by measuring the reflection time.
In the process, the surrounding terrain and object geometry are recorded in detail.

Drone Laser Surveying Method

4. Flight operation

Image of measured data

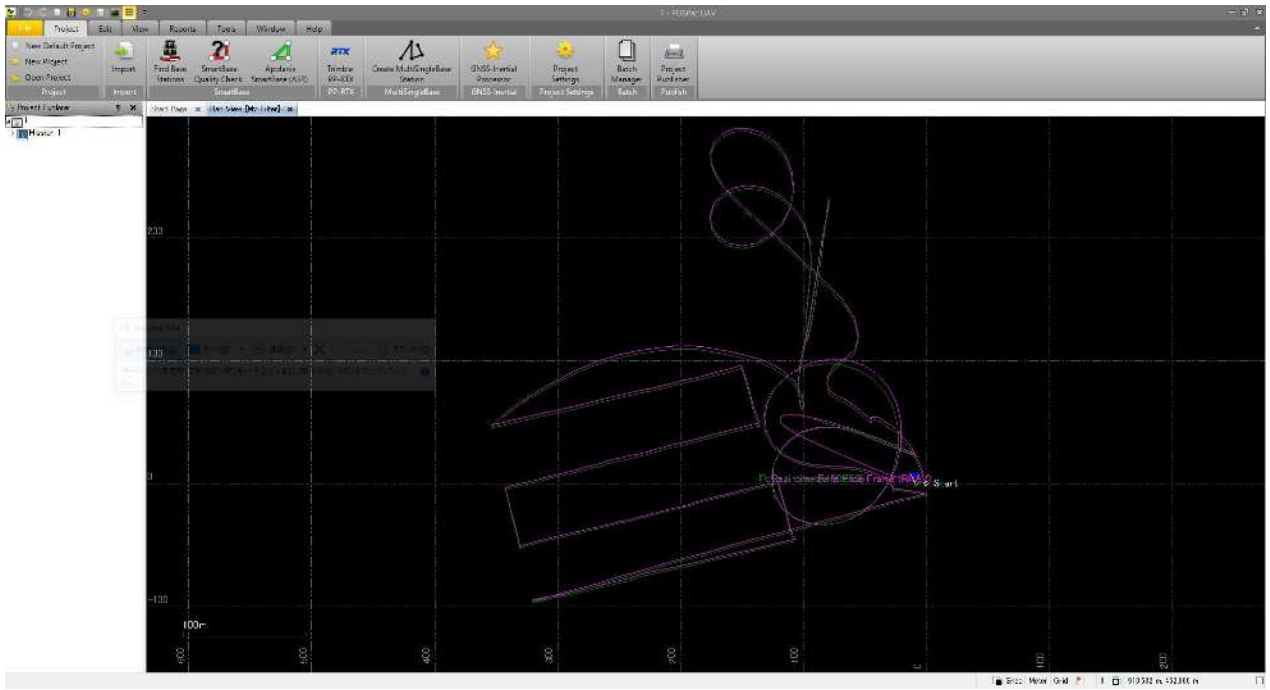
Drone Laser Surveying Method

5. Post-flight process

After the drone collects flight data, the collected information is transferred to a computer for processing.

Drone Laser Surveying Method

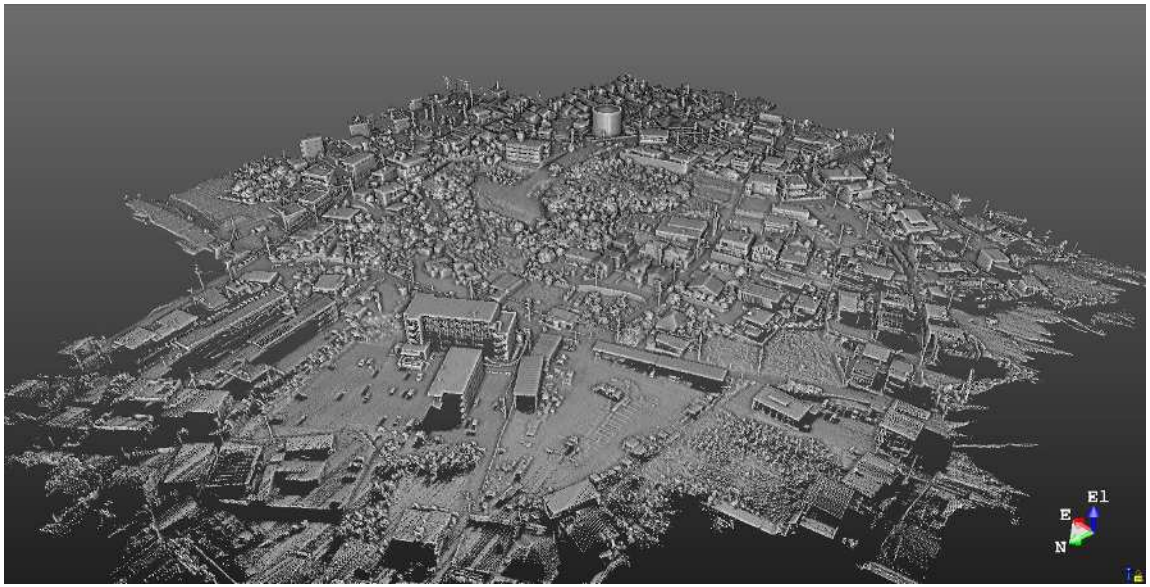
6. Drone position and attitude data analysis



The position data of the drone is analyzed with reference to a fixed station installed on site prior to point cloud generation.

Drone Laser Surveying Method

7. Generation of point clouds



Laser data is represented as a collection of many points. This is called a point cloud.

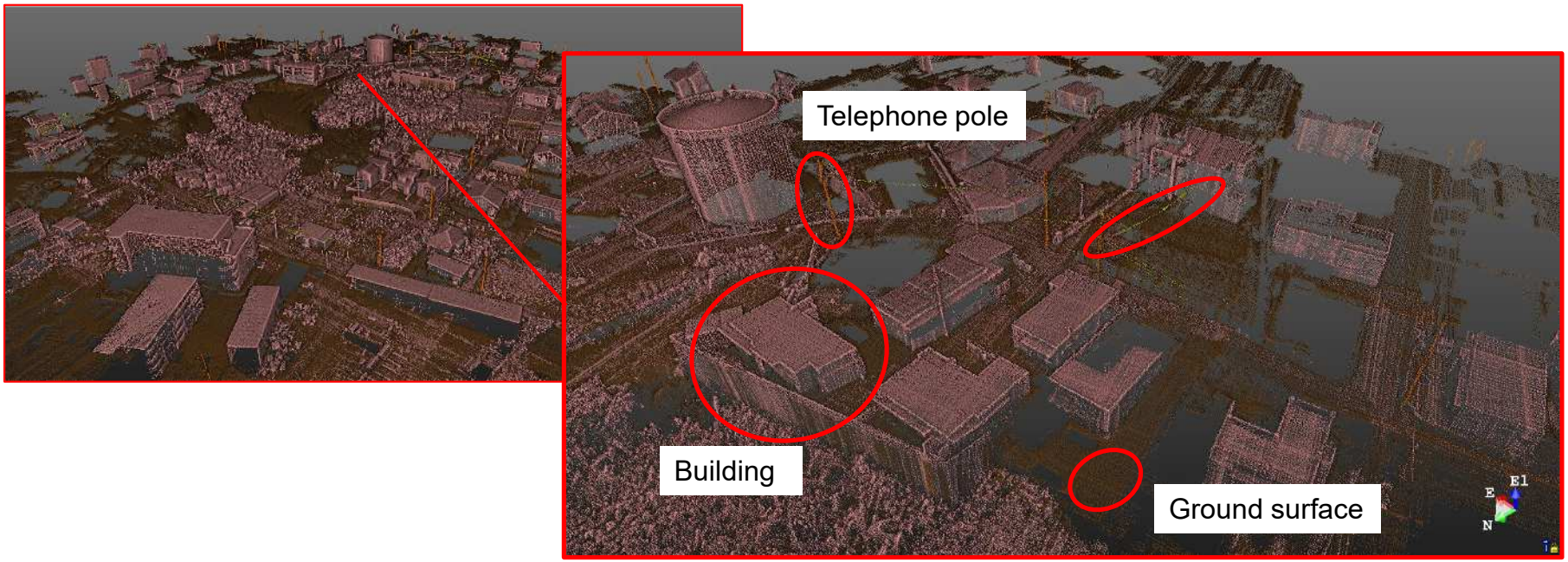
Drone Laser Surveying Method

8. Point cloud coloring

The point cloud data is colored using the photographic data taken at the time of measurement.

Drone Laser Surveying Method

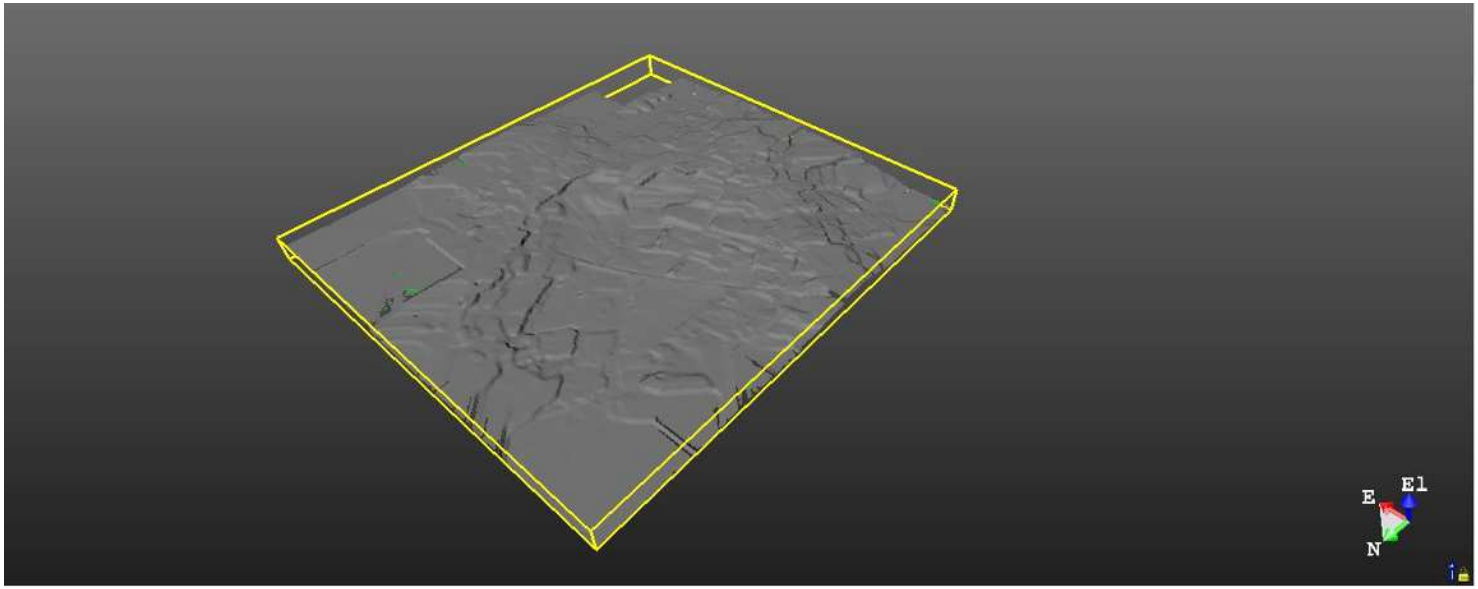
9. Extraction of features



Extract terrain features and object characteristics from laser data. These include the height of the ground surface, the shape of buildings, the location of trees, etc.

Drone Laser Surveying Method

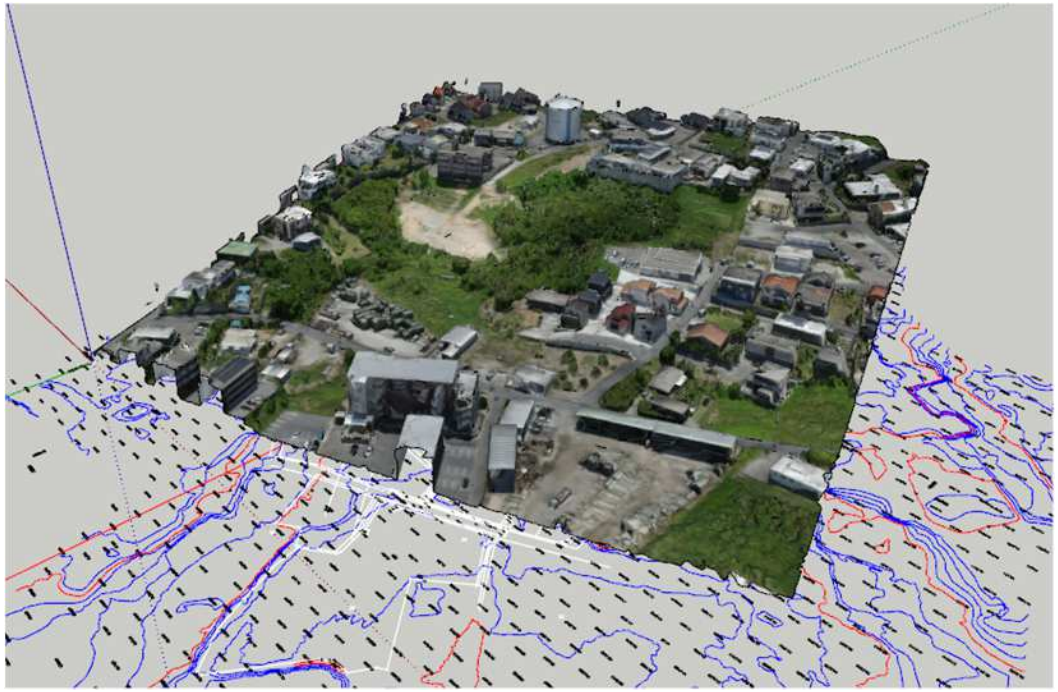
10. Terrain modeling



Terrain modeling reconstructs the shape of the land surface.
This model is used in geographic information systems (GIS) and urban planning to show the elevation and slope of the terrain.

Drone Laser Surveying Method

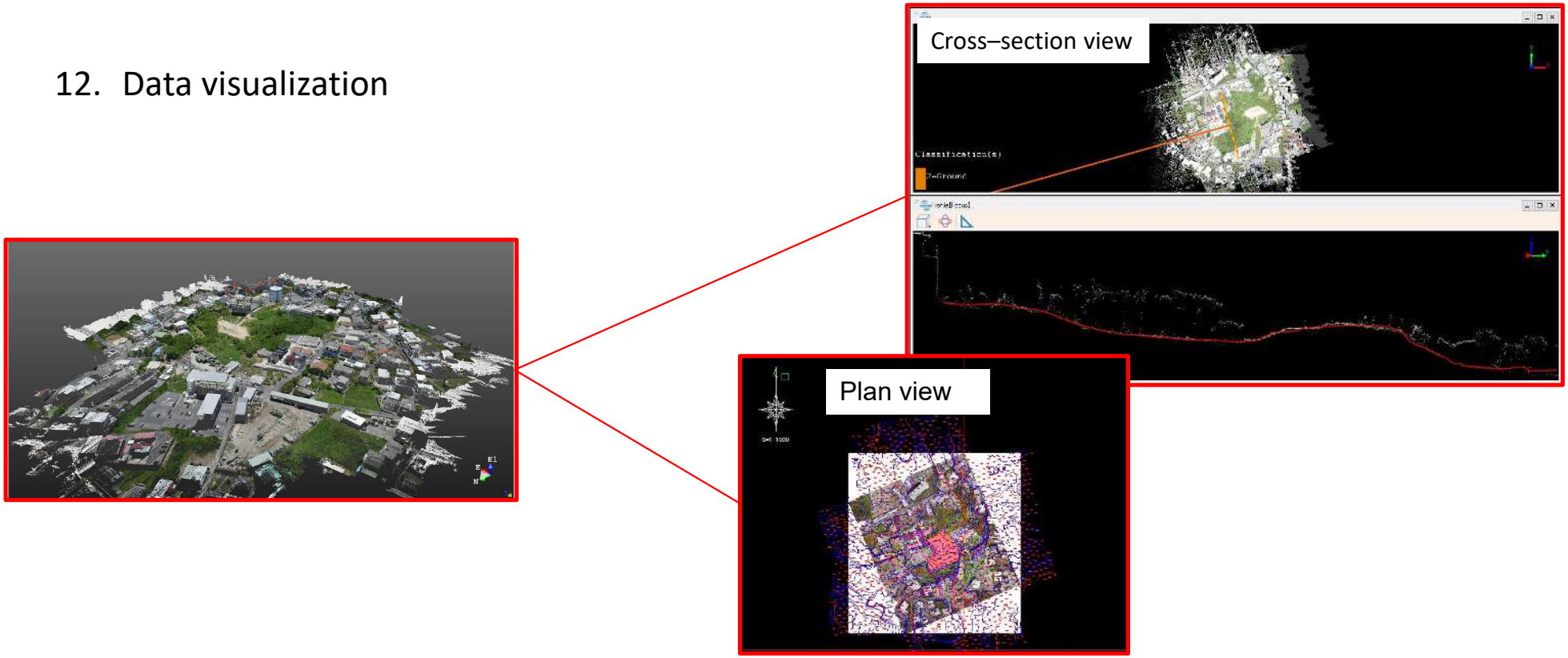
11. 3D model generation



It generates 3D models of specific objects and regions. This allows for building design, urban extension planning, and environmental monitoring.

Drone Laser Surveying Method

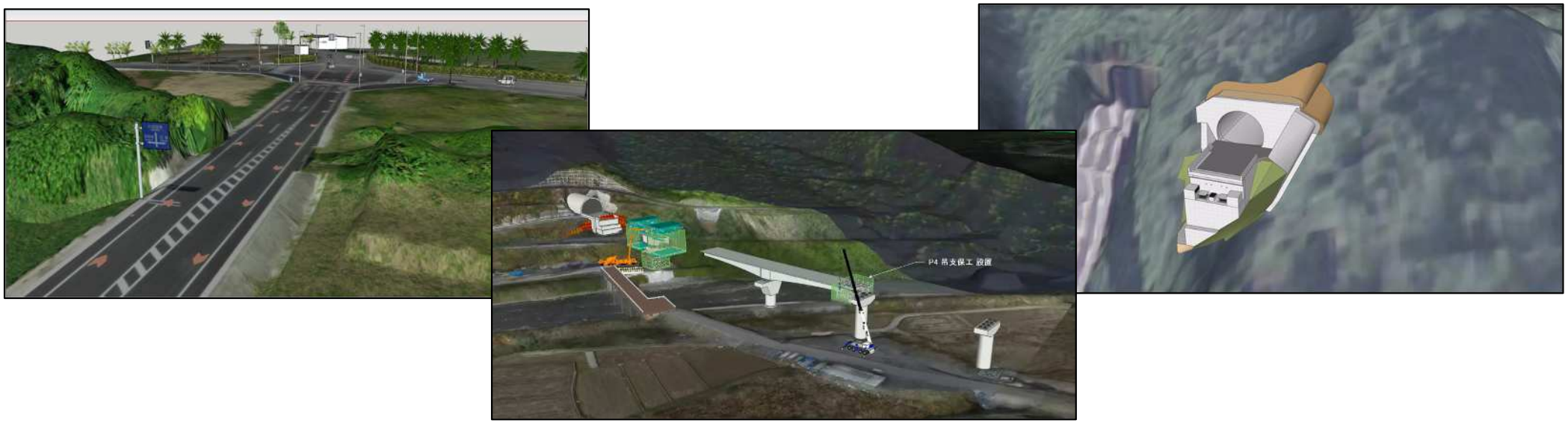
12. Data visualization



Visualize the results of the analysis and display them as a vertical map of the terrain or as a 3D model. Visualizations help you understand and share data.

Drone Laser Surveying Method

13. Application of data

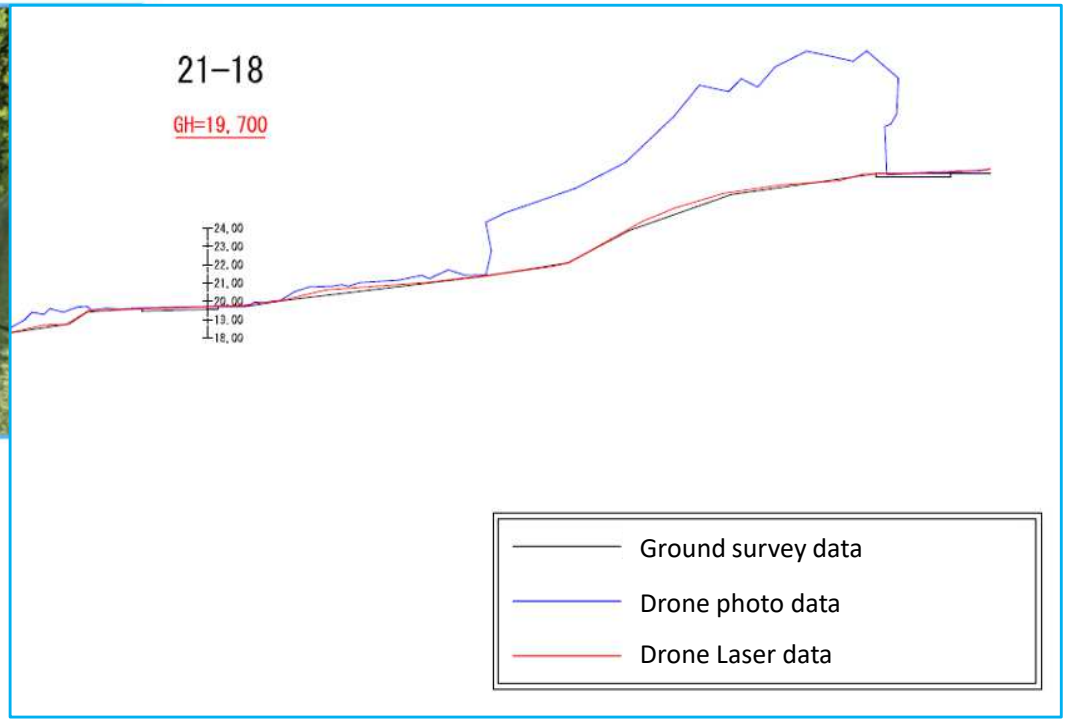


Ultimately, the analyzed data is used for specific projects and application areas.
This includes urban planning, environmental monitoring, traffic management, real estate valuation, agricultural management, etc.
This is the general process up to this point, but more advanced analysis steps and customization may be performed depending on the specific project and requirements.

Comparison of UAV laser surveying with ground surveying

This data compares drone laser surveying with conventional ground surveying.

Photo of middle wood vegetation area taken by drone



The data is comparable to that of conventional ground surveys.

Introduction of past project

Topographic surveying using UAV-mounted laser scanner

Introduction of past project

Inspection of structures using drones

What is drone inspection?

Drone inspection is the process of using drones to visually survey and evaluate structures, equipment, infrastructure, and the natural environment.
This is an efficient and accurate method of inspection that does not require humans to enter hazardous areas and can be performed in situations where access to high ground or difficult terrain is difficult.

Drone Inspection Flow

Our company mainly uses drones to inspect cracks in structures.
The following is a rough outline of the drone inspection process.

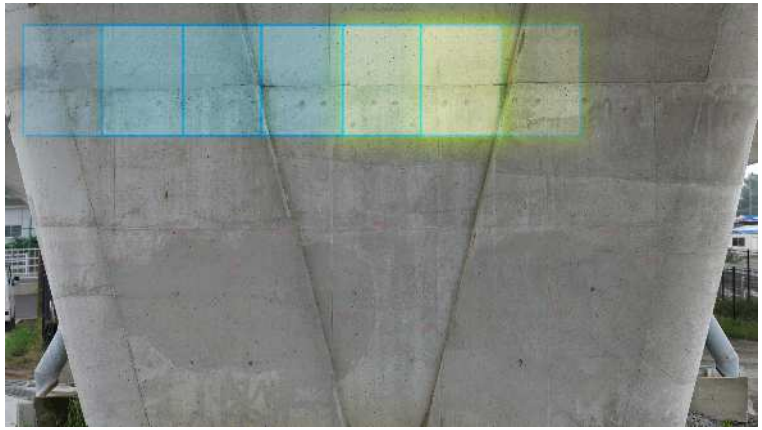
- Shooting with a high-resolution camera mounted on a drone
- Crack analysis using analysis software from the captured data
- Drawing damage diagrams from the analysis data

Drone inspection (shooting)

When conducting a drone inspection, the following points should be considered before determining the subject distance to be photographed.

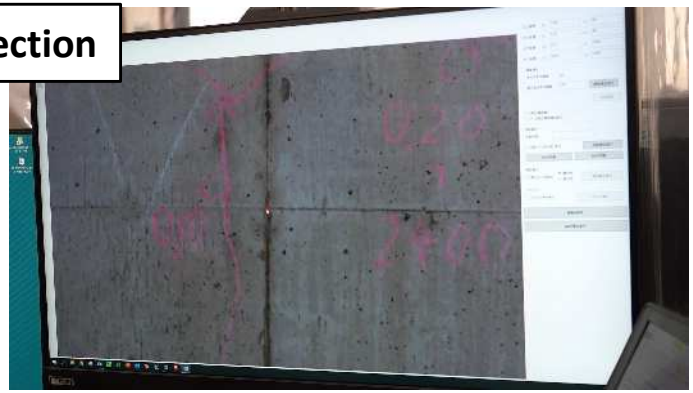
- How wide do you want to see the crack?
- What are the specs of the camera and lens to use?
- What are the specifications of the analysis software to use?

Once the subject distance is determined, maintain that subject distance and shoot while lapping.

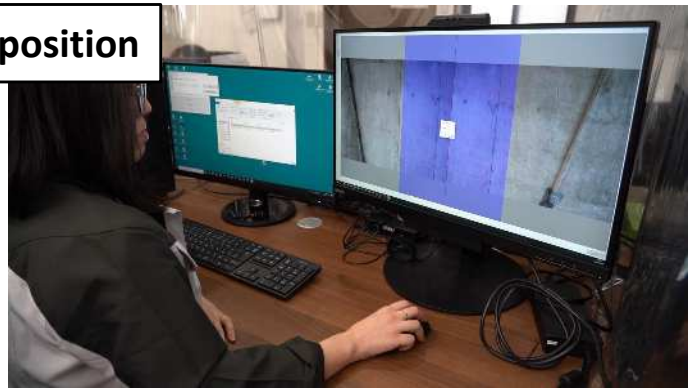


Drone inspection (analysis)

Correction



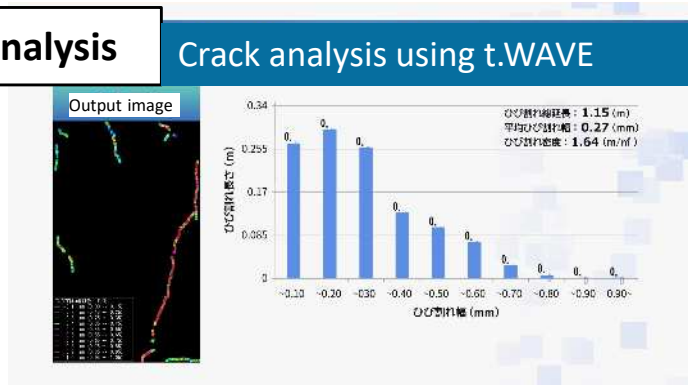
Composition



Tracing

Analysis

Crack analysis using t.WAVE

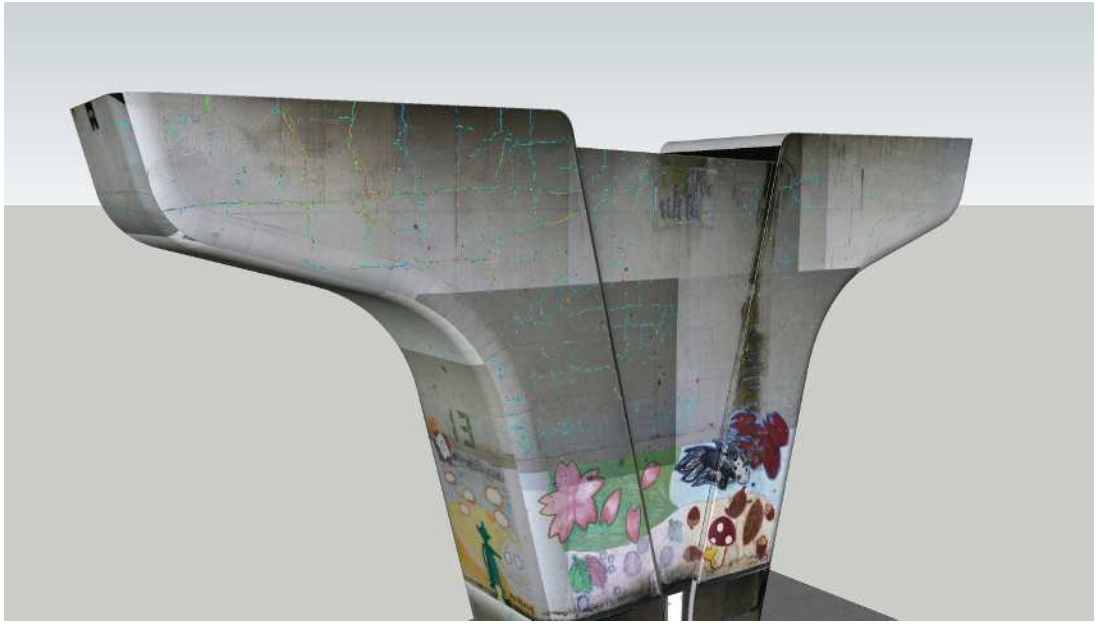


The captured image is processed through the image "correction," "composition," "tracing," and "analysis" procedures as shown in the figure above to extract crack width and length information from the image.

Drone inspection (damage mapping)

The analyzed data are shown in the following figures.

2D drawing



3D drawing

Finally

So far, I have explained the techniques and procedures for surveying and inspection using drones. While it is convenient and work efficiency can be improved, there is a possibility that accidents such as dropping the drone may occur due to the lack of knowledge and technical skills of the operator who handles the drone.

It is important to acquire surveying and inspection skills using drones, but it is more important not to cause accidents before that, so I hope that you will hone your piloting skills and take on the challenge.