Spatial Information
Quality Management Service

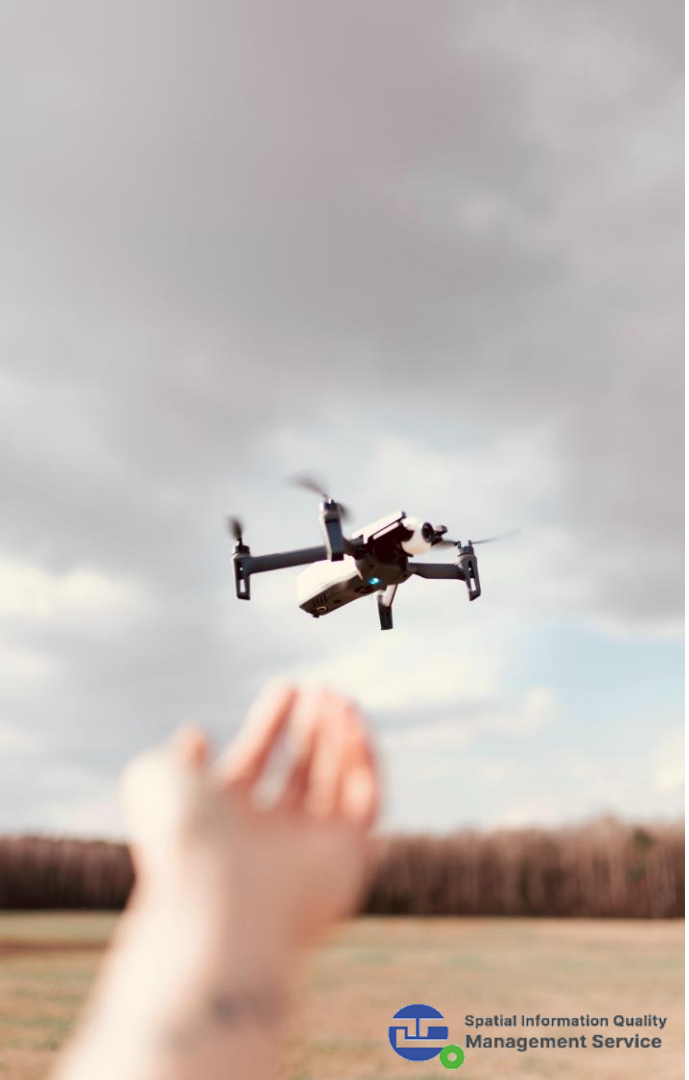
Data collection & Utilization using DSIT

(Drone Spatial Information Technology)

SIQMS **Kim Tae-hoon**

Director, Quality Research Division

Contents



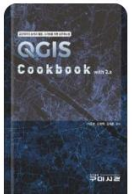
Introduction

[Kim Tae-hoon]

Title/Position: **Director, Quality Research Division**

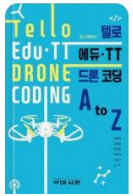
Organization: **Spatial Information Quality Management Institute**

- Author of 5 books on GIS & Drone
- Met and collaborate with Pix4D CEO
- Operated the Spatial Information Alliance at the 2023~2024 Busan Drone Show.



QGIS Cookbook..
2023.03.07

Understanding Maps
2022.04.30



Tello Edu TT Drone Coding...
2022.01.15

Drone Pix4Dmapper
2021.11.01

Drones and Anti-Drones...
2020.04.29

How To?

- (1955) 60$ → (2022) 35400$
- With Spatial Information

Spatial Information

- Manually represents geographic locations and features visually
- Used for military objectives, national land management, and administrative boundary settings

- Emergence of aerial and satellite imagery, digitization
- simple topographic maps to environmental monitoring

- Comprehensive data beyond location and topography
- Expansion of information scope
- Supports data-driven decision-making in real-time


USA
UNITED KINGDOM
DENMARK
NETHERLANDS
GERMANY
SWITZERLAND
CANADA
SINGAPORE
IRELAND
FRANCE
AUSTRALIA
CHINA
SWEDEN
25위
SOUTH KOREA
PORTUGAL
AUSTRIA
ITALY
NEW ZEALAND
ESTONIA
POLAND
BELGIUM
JAPAN
SPAIN
NORWAY
FINLAND
RUSSIA
INDIA
HUNGARY
SOUTH AFRICA
GREECE
BULGARIA
SAUDI ARABIA
INDONESIA
PHILIPPINES
MALAYSIA
UAE
MEXICO
ISRAEL
KAZAKHSTAN
KENYA
BRUNEI
QATAR
IRAN
COLOMBIA
UKRAINE
BAHRAIN
CHILE
THAILAND
ARGENTINA
BRAZIL

Spatial Information History

~ 1900s

Goguryeo Tomb Murals(4th ~ 7th C.)

Goryeo Map (9th ~ 12th C.)

Paldo Map (1434 ~ 1436)

Daedongyeojido (1861)

Ancient Map Production

1400 1500 1800

1200 1900

1402 1435 1530 1861

Gov

Market

Int

Honil Gangni Yeokdae Gukdo Ji Do (1402)

Dongguk Map (1530)

1910 ~ 1980

1910

1945

1980

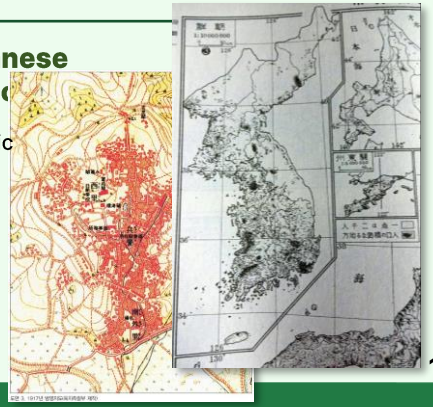
Government

Market

International

Adoption of Japanese Surveying Techno

- Creation of topographic maps at high altitude
- Maps for civilian communication and resource exploitation purposes



U.S. Technology Support

- Support for technology and education
- Arial photogrammetry

Support Equipment (EDM, Theodolite)

1974

1973

Modern Map Standardization

- Standardization of geographic information
- Reference points, coordinate systems
- Creation of 1:50,000; 1:25,000 scale topographic maps

Saudi Arabia Technology Support

- NGII dispatched technical support
- Request from the Saudi government
  (Purpose: Surveying and mapping)
- Support for surveying and mapping technology

Establishment of NGII

Ministry of Land, Infrastructure and Transport
National Geographic Information Institute

- National Geographic Information Institute
- Centralization of precision map production

1980 ~ 2000

Gov Market Intl

1980

Digital Map Production and Digitization

- Digitization of spatial Information
- The ultimate goal is to build a spatial information database

✓ **Digitization of existing paper maps**

✓ **Spatialization of additional data like population**

✓ **Nationwide map digitization using aerial photograph**

✓ **Construction of basic spatial information DB**

1990

Yahyeon-dong City Gas Explosion Accident

- Gas pipeline burst
- UG facility management failure
- Key turning point for GIS market activation

1994

1995

Adoption of GIS, Overseas Training Programs

- Adoption of GIS programs
- NGII staff participation in overseas GIS training programs
- Used for national land development and urban planning
- ArcGIS, ERDAS Imagine

ESRI ArcGIS

ERDAS IMAGINE®

National Spatial Information Construction 5-Year Plan

- Reference to overseas cases and infrastructure construction
- Reference to standardization from Japan and the U.S., Set the national spatial information standard

National Spatial Information DB Construction

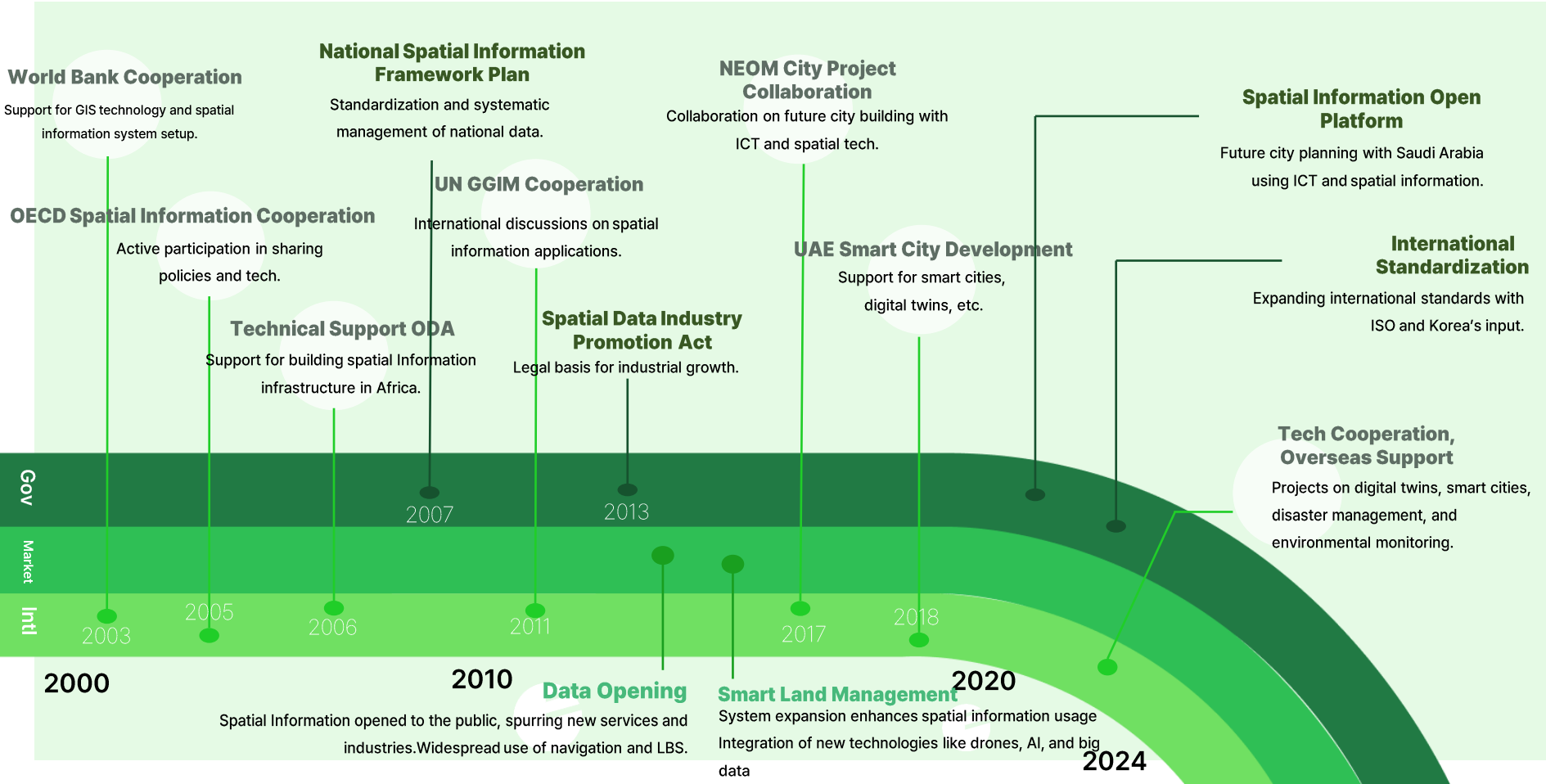
Standardization and Data Sharing System Established

Efficiency Improvement in Land Development and Urban Planning

Support for GIS Budget and Manpower

2000

2000 ~ 2020


World Bank Cooperation
Support for GIS technology and spatial information system setup.
National Spatial Information Framework Plan
Standardization and systematic management of national data.
NEOM City Project Collaboration
Collaboration on future city building with ICT and spatial tech.
Spatial Information Open Platform
Future city planning with Saudi Arabia using ICT and spatial information.
OECD Spatial Information Cooperation
Active participation in sharing policies and tech.
UN GGIM Cooperation
International discussions on spatial information applications.
UAE Smart City Development
Support for smart cities, digital twins, etc.
International Standardization
Expanding international standards with ISO and Korea's input.
Technical Support ODA
Support for building spatial Information infrastructure in Africa.
Spatial Data Industry Promotion Act
Legal basis for industrial growth.
Tech Cooperation, Overseas Support
Projects on digital twins, smart cities, disaster management, and environmental monitoring.
Gov
Market
Intl
2003
2005
2006
2007
2011
2013
2017
2018
2000
2010
2020
2024
Data Opening
Spatial Information opened to the public, spurring new services and industries.Widespread use of navigation and LBS.
Smart Land Management
System expansion enhances spatial information usage
Integration of new technologies like drones, AI, and big data

Expansion of Using Areas

▶ 2024 Check Point

✓ Sensors, Statistical·GIS Data

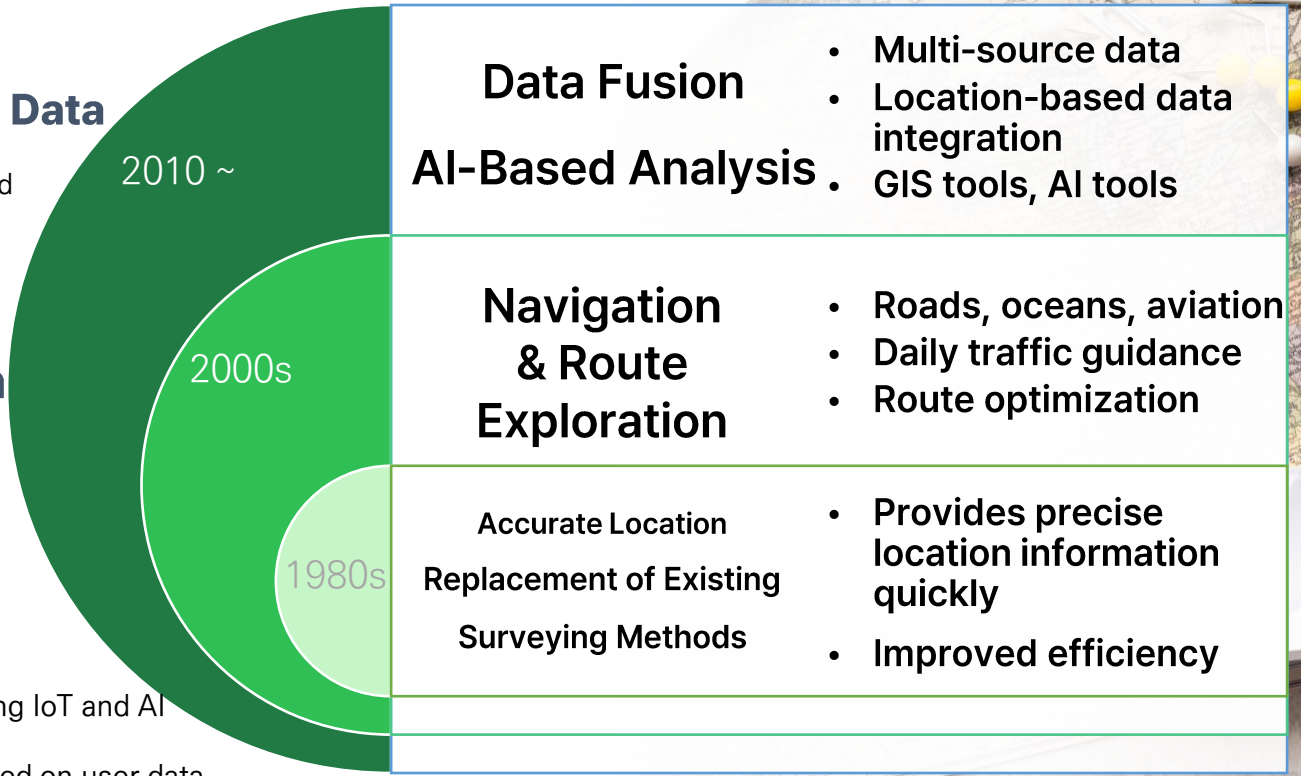
- Data layering and integration based on location
- Multi-source analysis capability

✓ AI-Based Automation

- Replaces data processing
- Strong in big data processing

✓ Real-Time, Personalized Services

- Provides real-time interaction using IoT and AI
- Delivers personalized analysis based on user data



Drone Surveying

Compared to Traditional Surveying,

Advantages of Drone Surveying

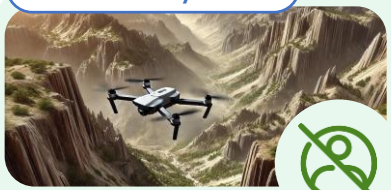
Economic Efficiency

Can cover a wide area with a single drone

Time Efficiency

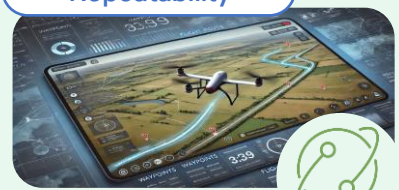
Survey operation time is short, and data can be processed in real time

Safety



Easily flies over terrain that is difficult for people to access

Repeatability



Data can be consistently collected by following the same planned flight route

Drone Surveying

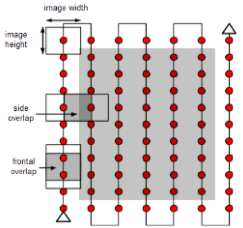
- Capturing images using sensors mounted on drones
- Perform photogrammetry and remote sensing using drone image processing SW
- Six factors influence the drone market (DRI index): applicability, workforce, administrative infrastructure, operational limits, airspace integration, and social acceptance.

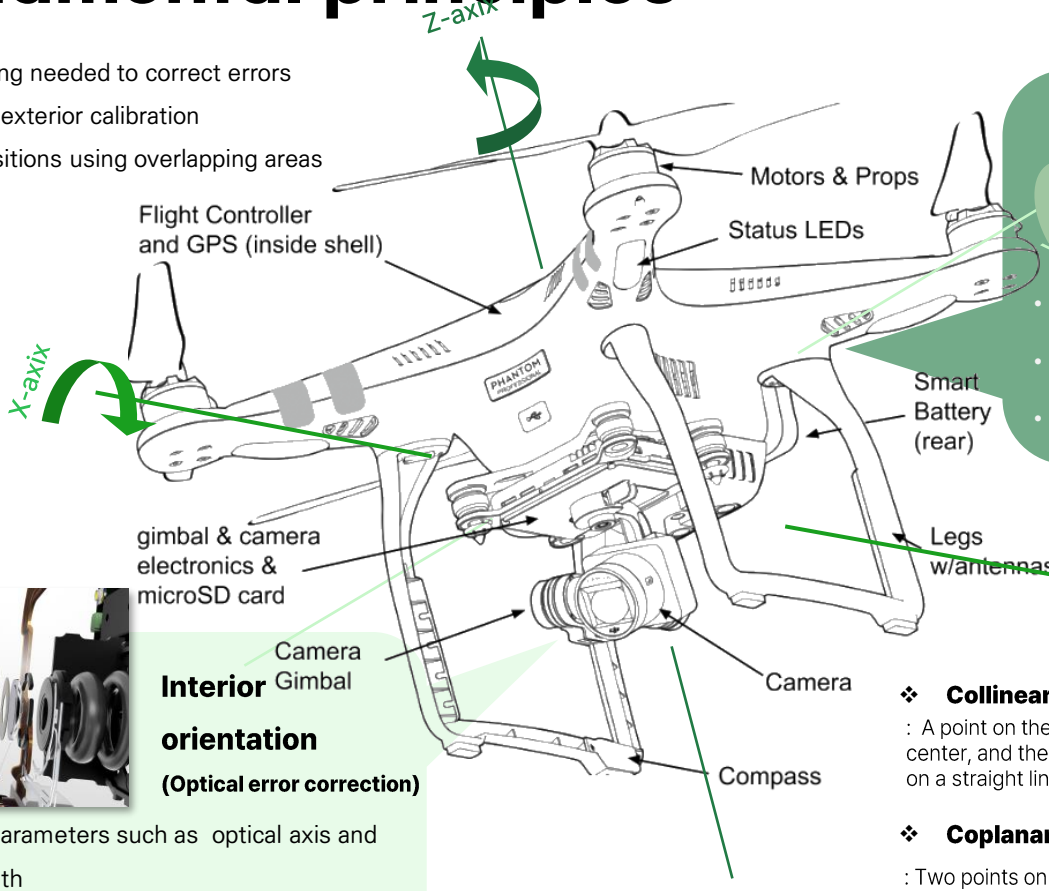
Top 24 Countries in the DRI Ranking

1	Australia	7	Germany	13	Malaysia	19	Swiss
2	Belgium	8	India	14	Netherlands	20	Taiwan
3	Brazil	9	Indonesia	15	Norway	21	UAE
4	Canada	10	Israel	16	Poland	22	UK
5	China	11	Italy	17	REPUBLIC OF KOREA	23	USA
6	France	12	Japan	18	Spain	**DRONEII, 2024**	

Fundamental principles

- ✓ Additional processing needed to correct errors
- ✓ Interior calibration, exterior calibration
- ✓ Estimate actual positions using overlapping areas





Exterior orientation (Camera Position correction)

- Axis-specific Rotation angles for spatial position
- Roll(X-axix), Pitch(Y-axix), Yaw(Z-axix)
- parameters: omega (ω), phi (φ), kappa (κ)

Interior orientation (Optical error correction)

- Defines parameters such as optical axis and focal length
- Corrects lens distortion and rolling shutter issues

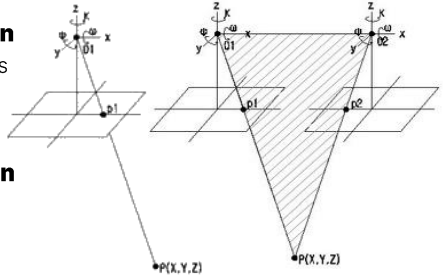
Basic Photogrammetry Model

❖ **Collinearity Condition**

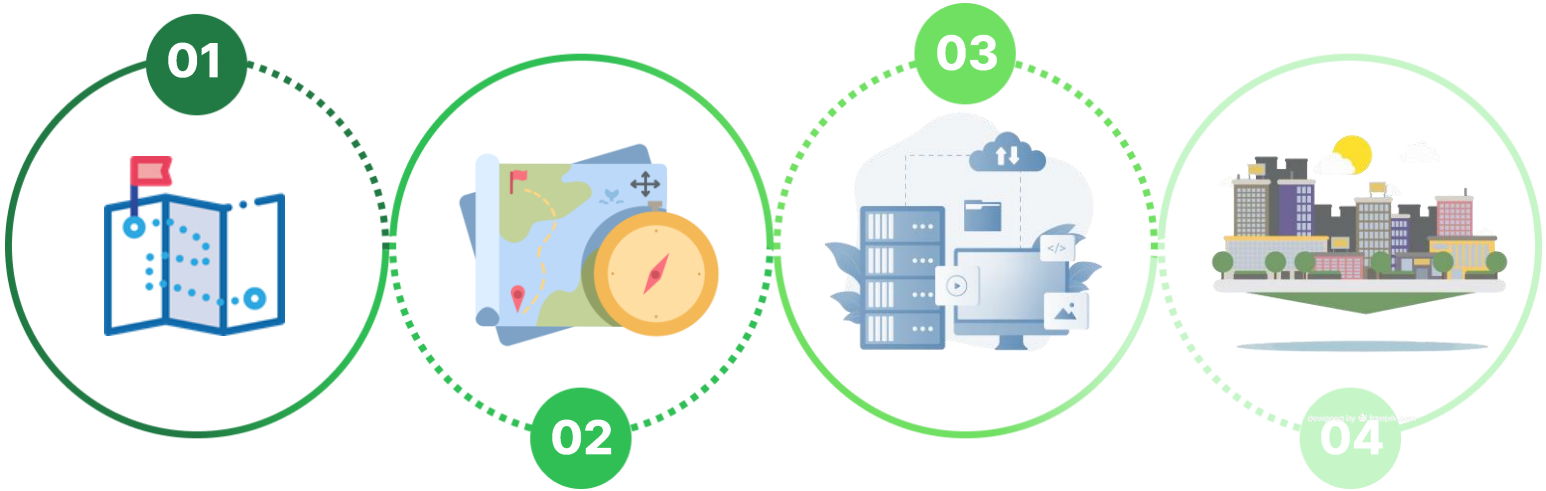
: A point on the photo, the lens center, and the target point lie on a straight line..

❖ **Coplanarity Condition**

: Two points on the photo, two lens centers, and the target point lie on the same plane.



Process



PLAN

- Work plan development
- Capture design
- Flight path planning

CAPTURE

- Aerial marker setup
- GCP surveying
- Automated flight capture

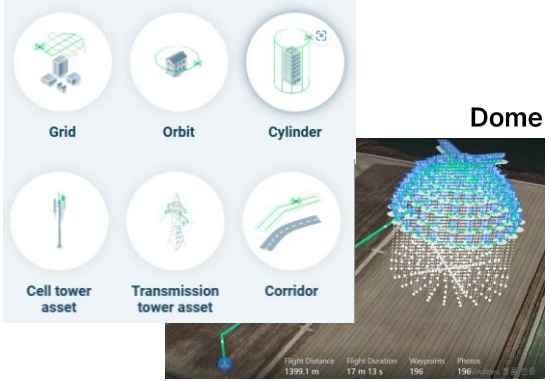
PROCESSING

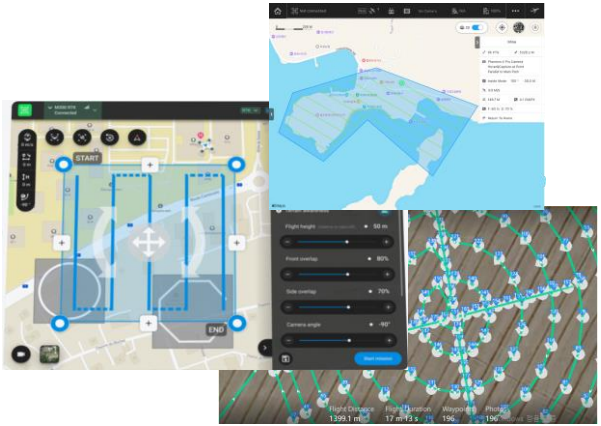
- Image alignment
- Exterior calibration
- Interior calibration

RESULT

- Performance summary
- Quality report review

01 Pre-survey tasks





Work plan

Planning the entire survey operation

- Check Task order
- Get flight approval and shooting permit
- Site survey
- Equipment selection and inspection

Capture design

Plan shots to match survey goals

- Design the model to match the target
- Set parameters like area, altitude, speed, hovering, interval, and gimbal angle.
- Keep in mind drone flight time limitations

Flight route planning

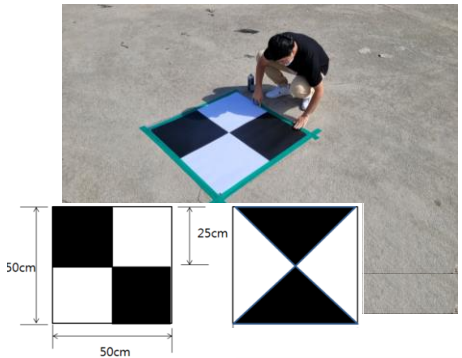
Use drone control SW for path planning

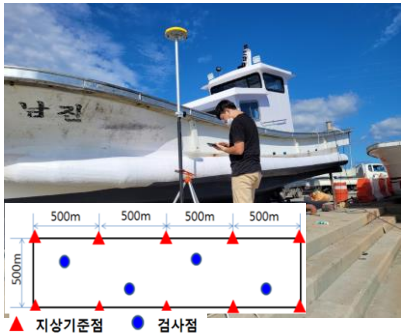
- Automatically set the path by inputting parameters like overlap
- Manual waypoint-based path setting is also available.

02

Survey execution

Aerial marker setup & GCP surveying

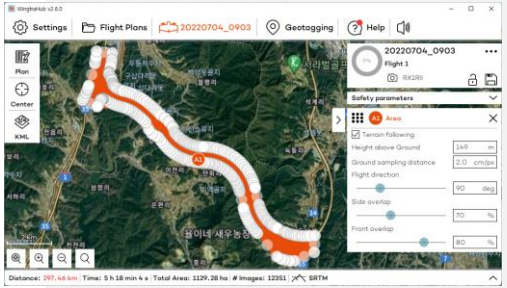




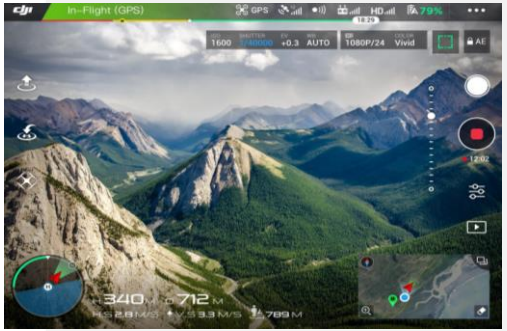
- ❖ Ensure at least 2 GCPs are visible in all drone photos
- ❖ Install aerial markers at GCPs for easy identification

  (If can't, use distinct features like road edges, coastlines, or building corners.)
- ❖ Accurately survey the position of the GCPs

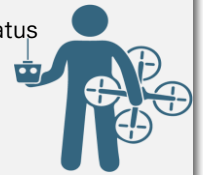
Automated flight capture



- Perform automated flight along a planned route
- Ensure quality by considering sun, light, and atmosphere
- Check the drone before flight



- Manual control possible during automated flight
- Monitor progress and drone status

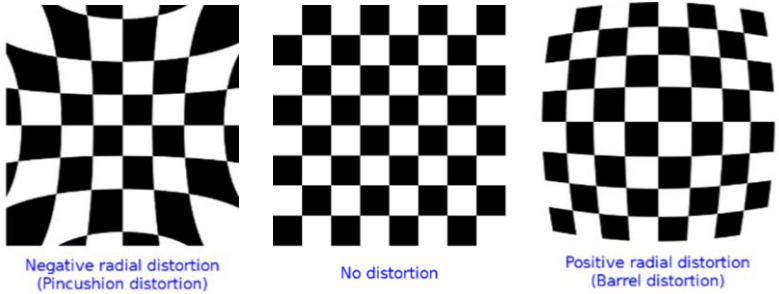


03

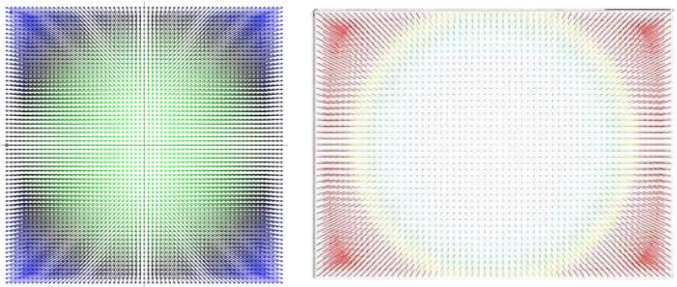
Image Processing and Correction

Lens Distortion

Lens Distortion: Radial Distortion

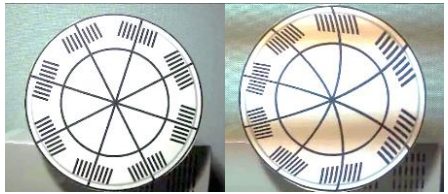


Distortion Plot



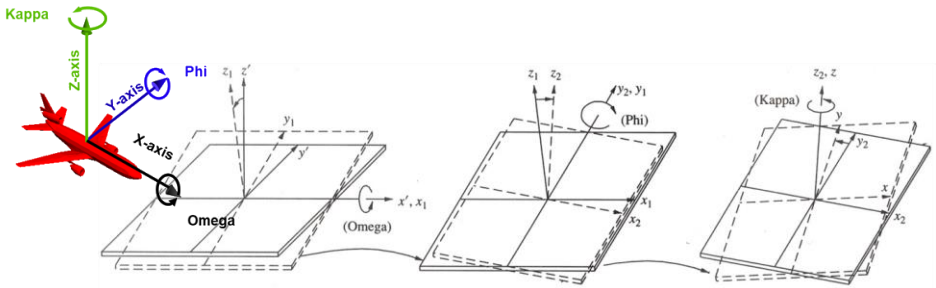
- Lens-specific distortion
- Standard lens – Barrel distortion,Wide-angle lens – Pincushion distortion.

Rolling Shuttter



- Captures one line at a time
- Distortion occurs with fast-moving objects
- especially at high drone speeds

Exterior Orientation



- Quantifies the tilt and orientation of the image sensor based on the drone's position.

03

Image Processing and Correction

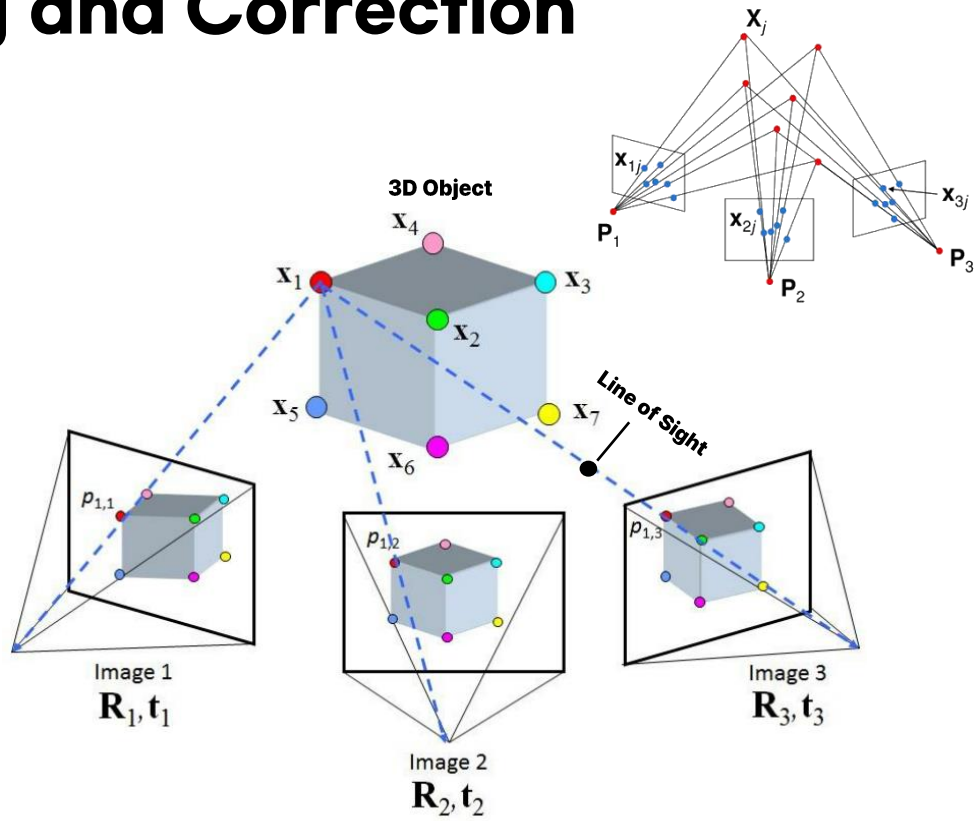
SFM Technique

(Structure from Motion)

(Photogrammetry Technique)

From 2D images taken from multiple viewpoints, estimates the camera's position and orientation to reconstruct the 3D structure of objects or scenes.

- ❖ Quickly processes numerous photos taken by drones
  (Automatically processed using image processing software powered by computer vision)
- ❖ No special equipment needed, but large datasets may increase computation and processing time.



- Matches overlapping areas from photos taken at different angles
- To ensure accuracy, drone surveys typically set an image overlap rate of at least 75%.

04

Result Output

Performance

Quality Report

Tie Point

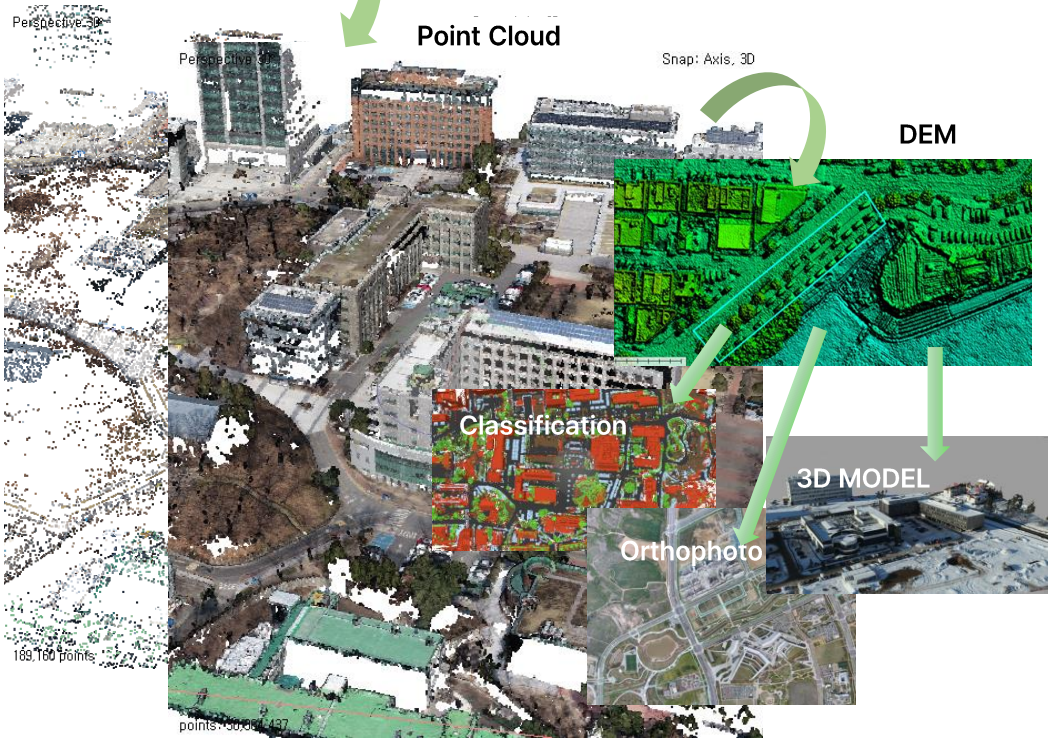
Point Cloud

DEM

Classification

3D MODEL

Orthophoto



Camera Locations

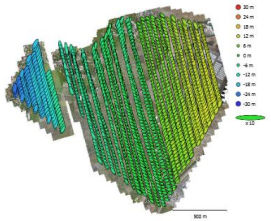


Fig. 3. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
1.72641	4.39576	8.17558	4.72263	9.44157

Table 3. Average camera location error.
X - Easting, Y - Northing, Z - Altitude.

Camera Calibration

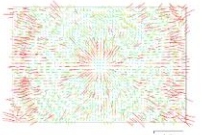


Fig. 2. Image residuals for FC6310S (8.8mm).

FC6310S (8.8mm)
1510 images

Type	Resolution	Focal Length	Pixel Size
Frame	5472 x 3648	8.8 mm	2.41 x 2.41 µm

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	4286.09	0.93	1.00	0.01	-0.01	-0.88	0.87	0.40	-0.76	-0.01
Cx	0.4821039	0.13		1.00	0.06	0.03	-0.04	0.00	-0.03	-0.10
Cy	-14.5285	0.14			1.00	0.02	-0.03	0.03	-0.03	-0.59
K1	-0.0197154	1.2e-003				1.00	-0.73	0.23	0.31	0.24
K2	0.0032266?	3.6e-003					1.00	-0.82	-0.03	-0.02
K3	0.01054	9e-003						1.00	-0.00	0.27
P1	-0.0002643	1e-006							1.00	0.40
P2	-0.0003283?	8e-007								1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

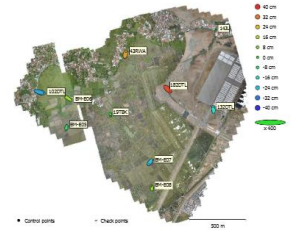


Fig. 5. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
10	7.39587	7.3387	20.0213	10.419	22.5701

Table 5. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

Processing Parameters

General	
Cameras	1510
Aligned cameras	1510
Markers	10
Coordinate system	WGS 84 / UTM zone 48S (EPSG::32748)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	2,521,953 of 3,414,674
RMS reprojection error	0.140279 (0.654042 px)
Max reprojection error	0.655237 (44.7918 px)
Mean key point size	4.00564 px
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	3.5768
Depth Maps	
Count	1510
Dense Point Cloud	
Points	152,269,947
Point colors	3 bands, uint8
DEM	
Size	19,781 x 19,445
Coordinate system	WGS 84 / UTM zone 48S (EPSG::32748)
Software	
Version	1.5.1 build 7618
Platform	Windows 64

Applications of Drone Surveying

With Advanced Drone Application, We Elevate to New Heights!

3D GIS Cultural Heritage Management

Swarm Drone Networks

Drone Show

CCTV Drones

Military Reconnaissance

3D Road Mapping Rapid Precision Mapping

Air Quality Analysis Pollutant Emission Monitoring

Building-Level Precision Digital Twin
(Real-time Data Integration)

Large Industrial Complex Monitoring

Agricultural Drones

Cultural Heritage Management

Future Generations Platform

Artistic Experience

Public Safety and Military

By Purpose,
Utilizing Various Types of
Drone Equipment or Footage

Digital Twin Territory

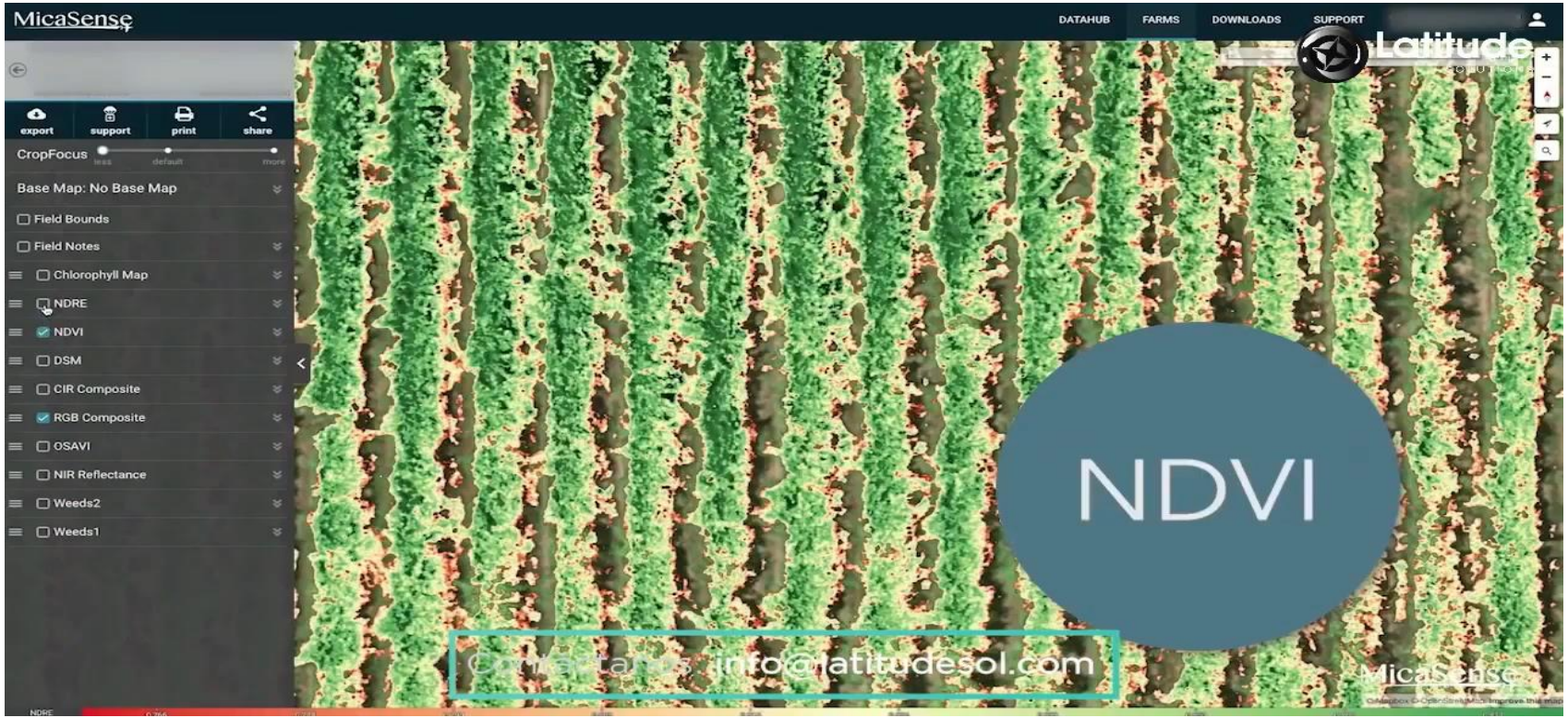
Industrial Sites

Mobility

Environment Monitoring

Drone Use - Agriculture

Agricultural Vegetation Management Methods Using Multispectral Cameras



Drone Use - Industrial Applications

Precision Inspection of Pipelines Using Drones Equipped with Shock Protection Guards

Drone Use- Air Quality Monitoring

Drone System Equipped with an Air Pollution Monitoring

Drone Show Korea Highlight Photos

Milestones of Progress

- Held annually at BEXCO, sharing information about drone and related technologies.
- Exchange and sharing Information between drone-centric businesses and with other industries.
- SIQMS sets & operates the Spatial Information Convergence Alliance exhibition booth during the event and also hosts seminars on new technologies.

Drone Show 2024 On-site Photos

Ministry of Land, Infrastructure and Transport
National Geographic Information Institute

Spatial Information Quality Management Service

Daeyoung M&S	Mobile Tech Co., Ltd.
KOSECO Co., Ltd.	Dabeeo Co., Ltd
Saehan Survey Instruments Co., Ltd.	Our Land System Co., Ltd.
WIFCO Co., Ltd.	IGIS Co., Ltd.
Wayz One Co., Ltd..	Leica Geosystems Korea
WAVERS Co., Ltd.	Drone Division Co., Ltd.
All4Land Co., Ltd.	GeoStory Co., Ltd.
Spatial Information Co., Ltd.	MAYSA Co., Ltd.
UOCanie Co., Ltd.	SAMA Aero Co., Ltd.

Companies of the Spatial Information Alliance

Moving Forward

Drone Show 2025

BEXCO / BUSAN / KOREA
26th ~ 28th FEB 2025

Drone | Robotics | Mobility | Security | 5th Industrial Revolution | Aerospace

1. Boost your industry insights by engaging with top developers and technologies
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