Location-based Image Acquisition and Management for SABO Facility Inspection

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Recent Natural Disasters (Landslide) in Japan

20th, August, 2014
Landslide in Hiroshima

Hillsides and slopes rapidly swept away in torrents of rock, mud and debris in at least five valleys in Hiroshima city suburbs.

16th, April, 2016
Earthquake in Kumamoto

- Image acquisition: Asia Air Survey
- 3D modeling: Nakagawa Lab.

Require to protect a city against natural disasters, based on SABO

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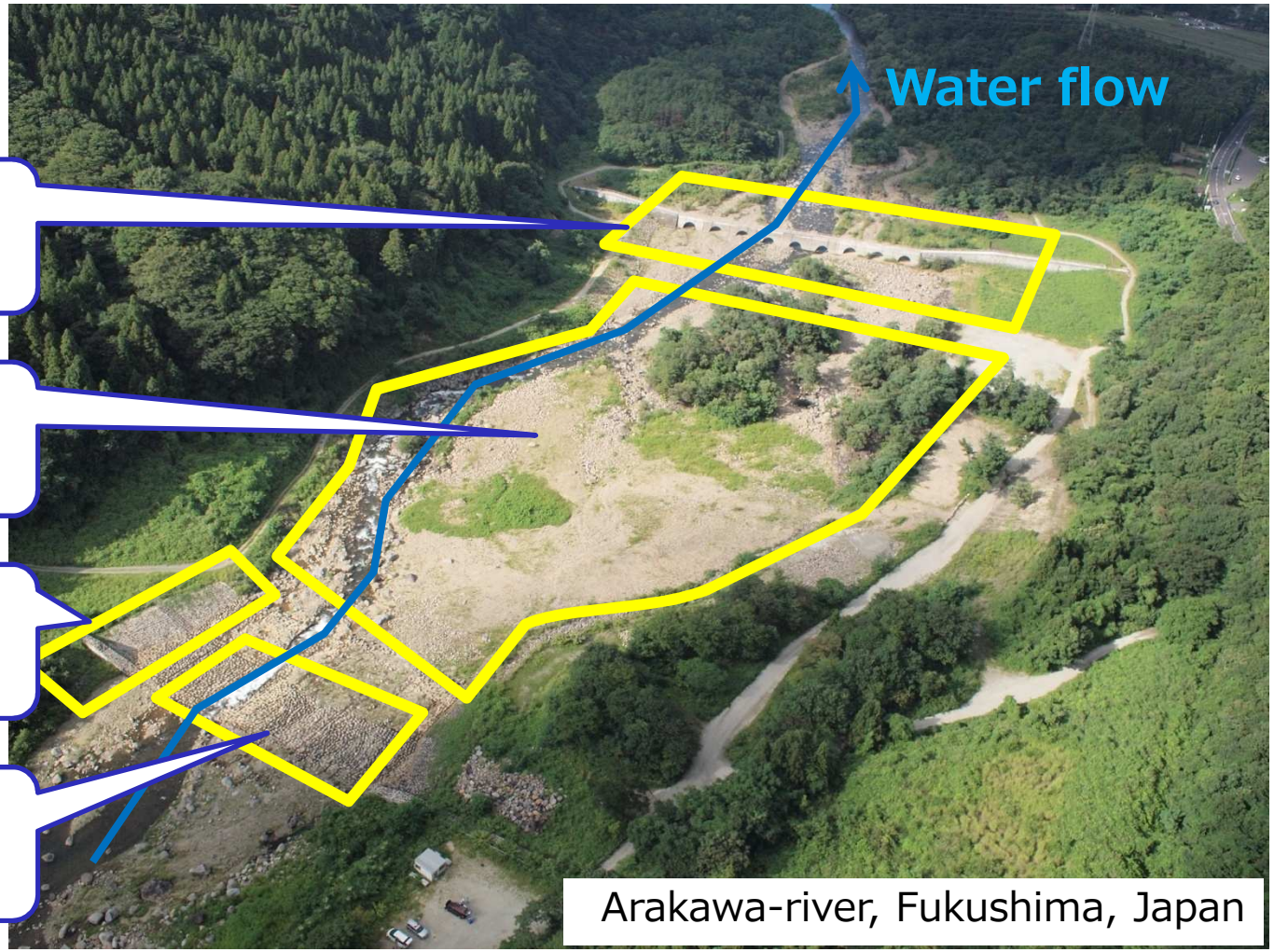
SABO

Plans and Facilities to protect a city against debris-avalanches

“SABO facilities”

- **Debris barrier (dam)**
- **Sediment-retarding basin**
- **Revetment**
- **Protected riverbed**



Require data acquisition for “Maintenance” of SABO facilities

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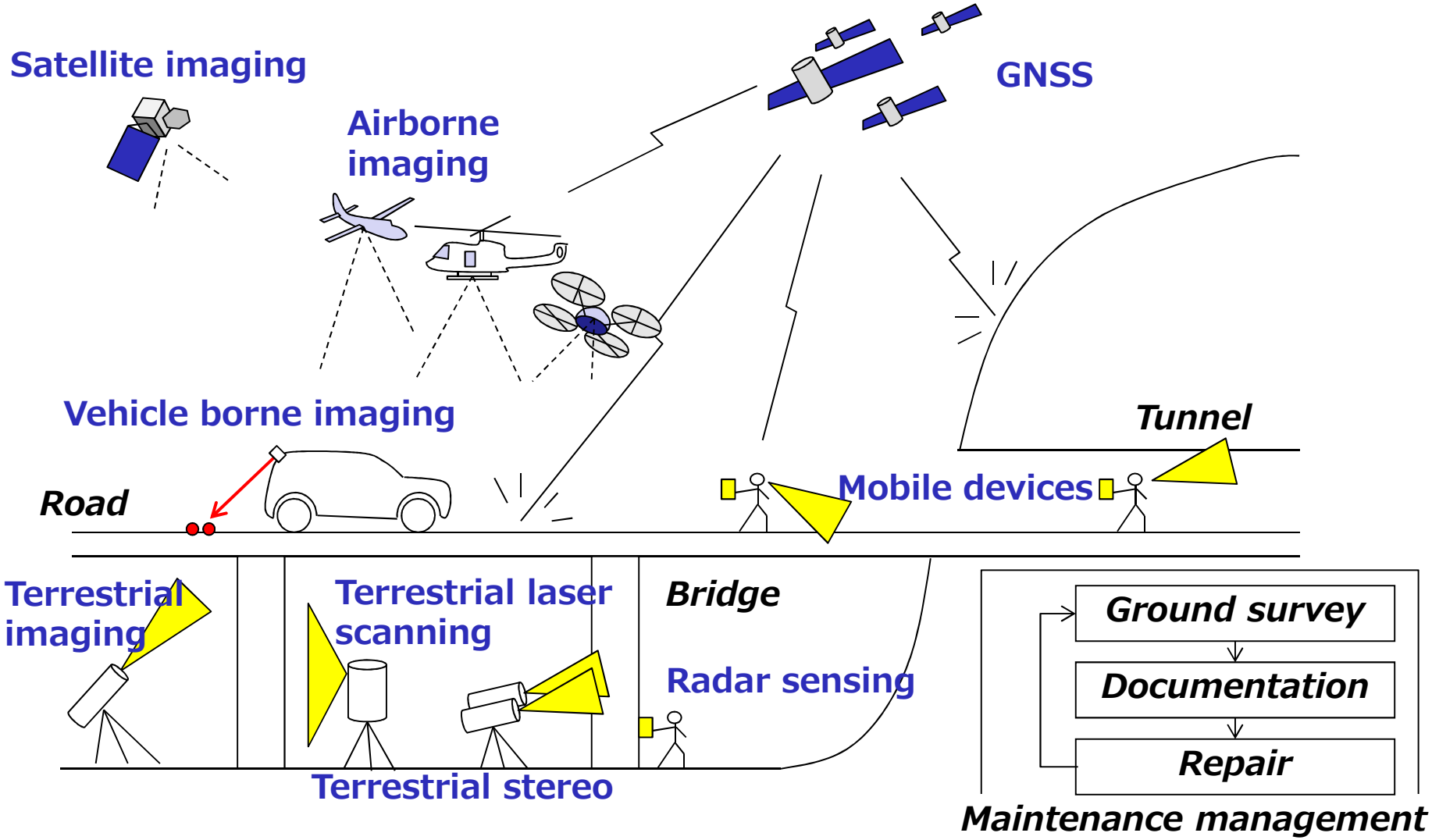
“Maintenance” requires “Geo-referenced monitoring”

Geoinformatics techniques support Infrastructure investigation



Conduct Geo-referenced monitoring based on BIM

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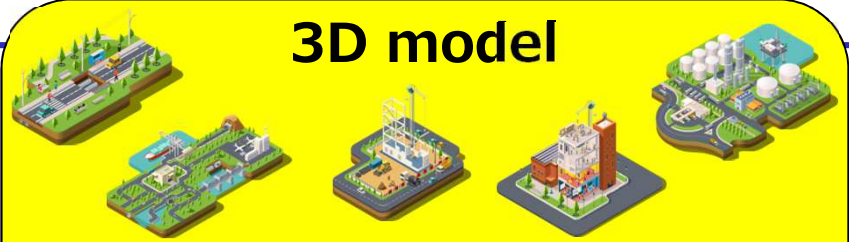
Building Information Modeling (BIM)

Improve project delivery and better manage design information across the entire project lifecycle

Survey/Design
"PLAN"

Construction
"DO"

3D model



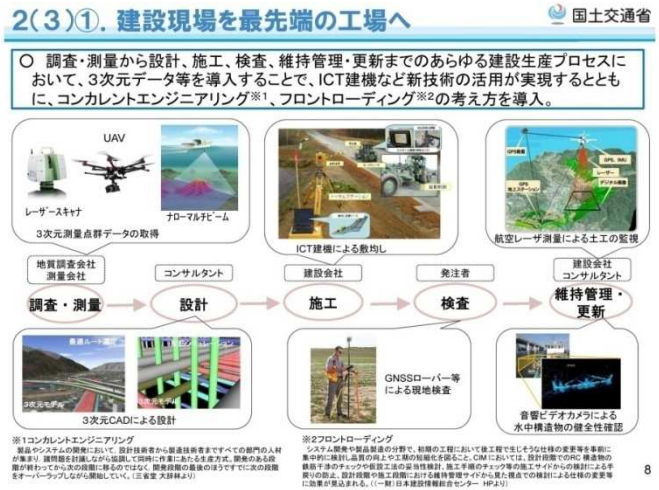
Building, water, refuse, electricity, gas, communication utilities, roads, bridges, ports, tunnels, etc.

Maintenance
"ACT"

Inspection
"CHECK"

in Japan

i-Construction（MILT）



- **Improve construction planning**
- **Produce results faster**
- **Finish projects on budget**

How to get 3D geometry and attributes?

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International WS on BIM (May, 2015 in Tokyo)

Thursday, 21st	Friday, 22nd
TS A : BIM - 1	TS D : BIM - 2
TS B : Indoor LBS	TS E : Wearable Sensors
TS C : Image-Based Modelling-1	TS F : Image-Based Modelling-2
	TS G : Point Cloud Processing

- 82 participants from 12 countries
- 42 articles (18 posters)

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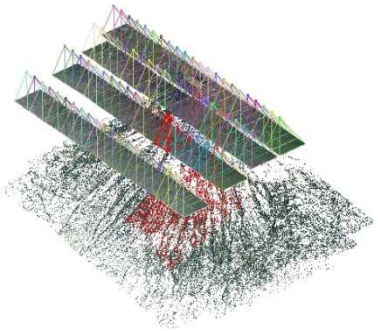
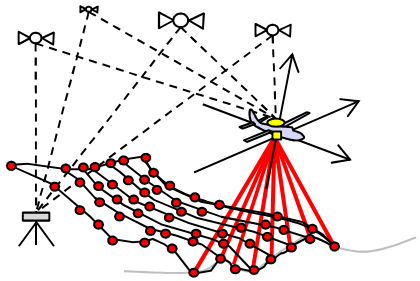
Big company's approaches

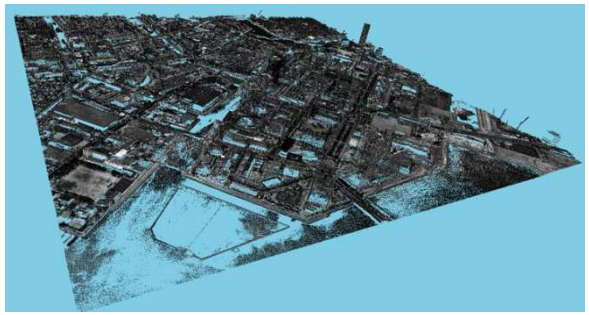
Combination of (RTK-)GNSS, IMU, and 3D sensors

Aerial Photogrammerty



Airborne Laser Scanner





Terrestrial Laser Scanner

but, Expensive !!

Objective

Aim to assist investigators in infrastructure asset monitoring

- Expensive approaches? (Laser scanning, RTK-GNSS, etc.)

- 3D basemap generation using Drone and standalone GNSS
  - Low-cost 3D modeling
  - Rapid modeling
  - High resolution data

3D mapping using GNSS without GCP installation

- Attribute data acquisition using mobile/wearable devices
  - Field-based inspection requires some location-based applications
  - Mobile devices have the potential to assist inspectors in infrastructure asset monitoring because of their built-in sensors and components

POI management using GNSS

3D basemap generation using Drone and standalone GNSS

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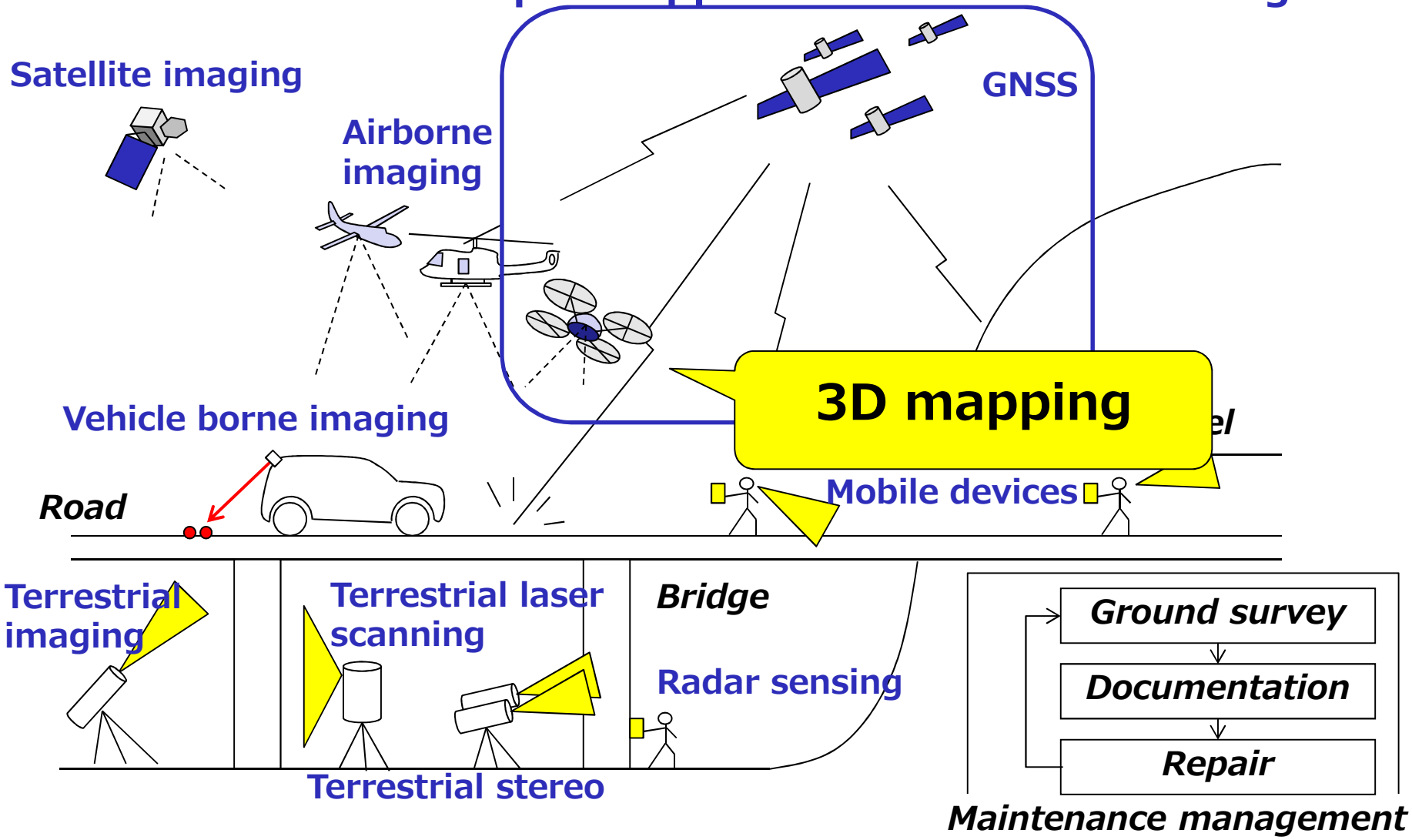
Geoinformatics techniques support Infrastructure investigation



Geo-referenced monitoring is based on BIM

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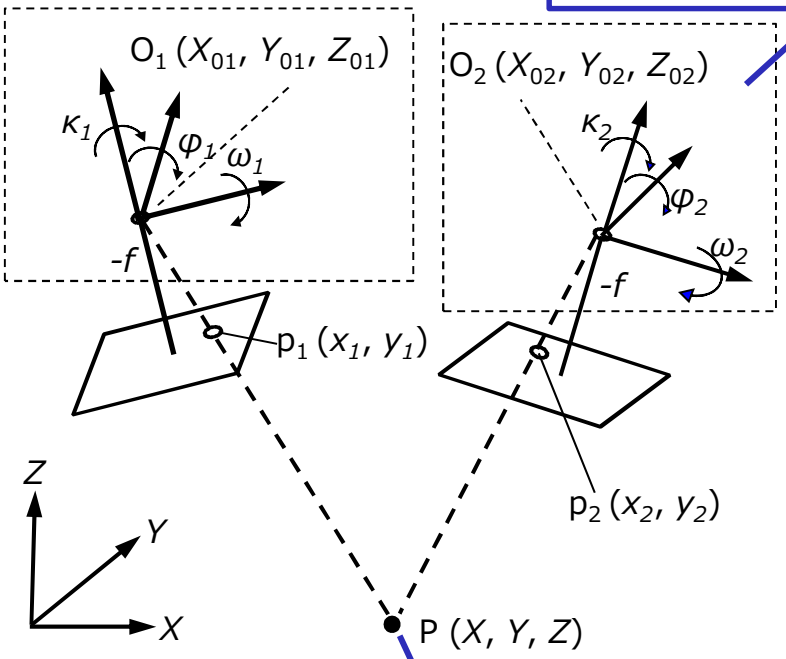
Aerial Photogrammetry using Drone

3D modeling using geo-tagged images without GCPs

①Prepare two images

②Estimate interior and exterior parameters

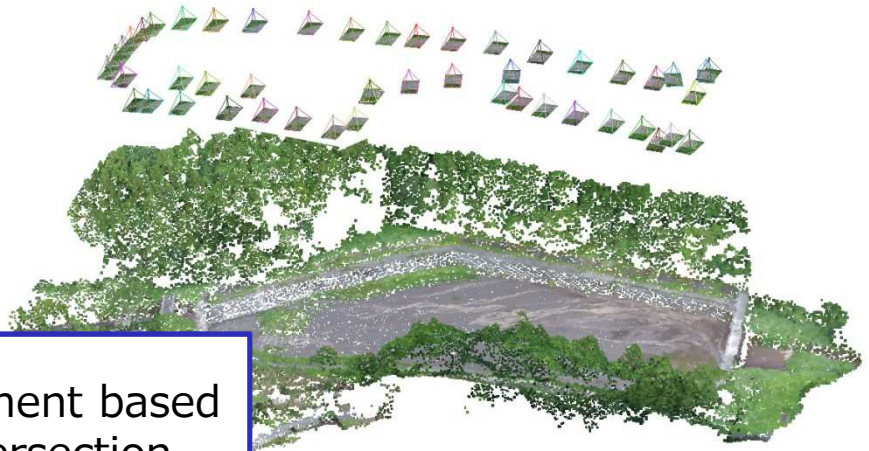


③3D measurement based on Forward intersection

Geo-tagged image

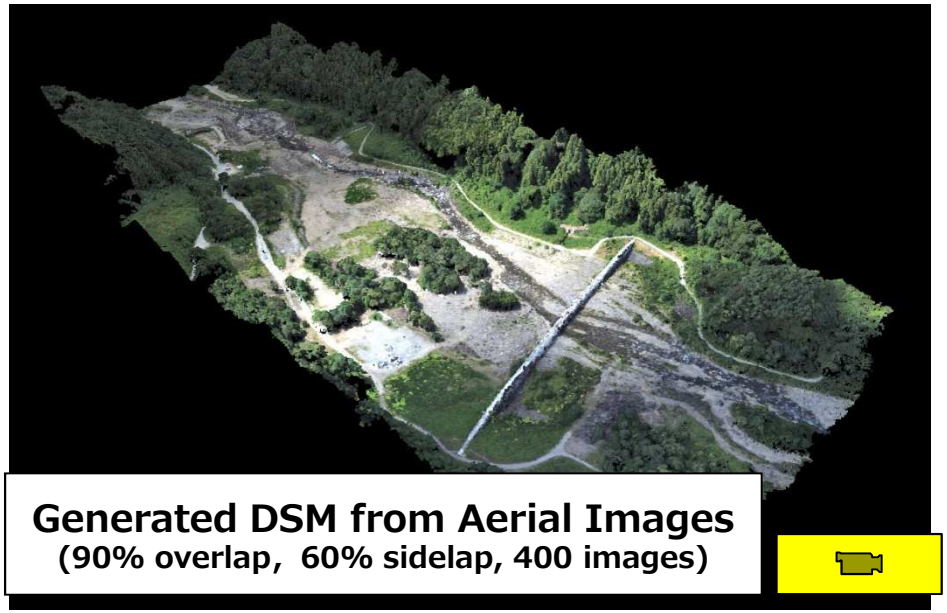
+

GNSS data
= "Scale factor" and "Geo-reference"

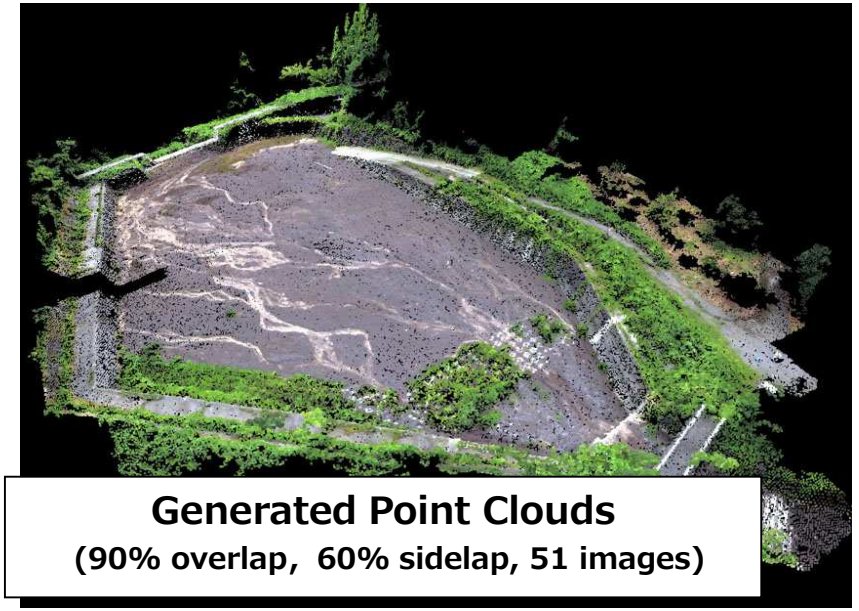


Point Cloud Generation using Aerial Images

Mapping for SABO Infrastructure Inspection



Generated DSM from Aerial Images
(90% overlap, 60% sidelap, 400 images)



Generated Point Clouds
(90% overlap, 60% sidelap, 51 images)

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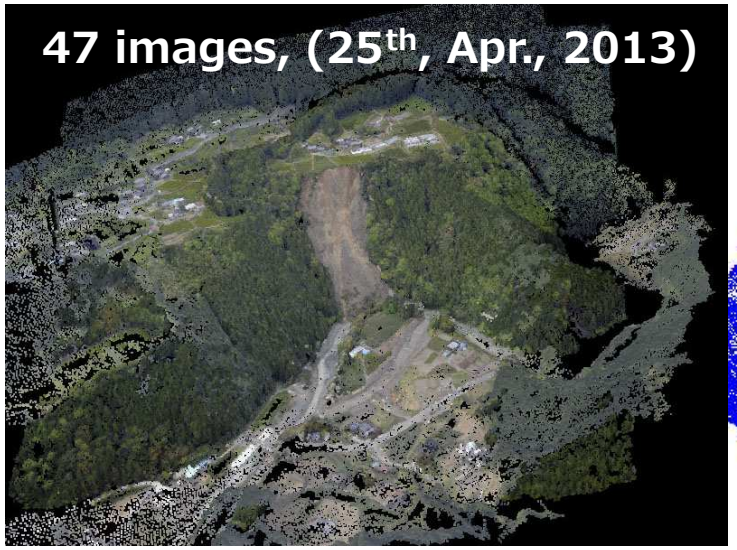
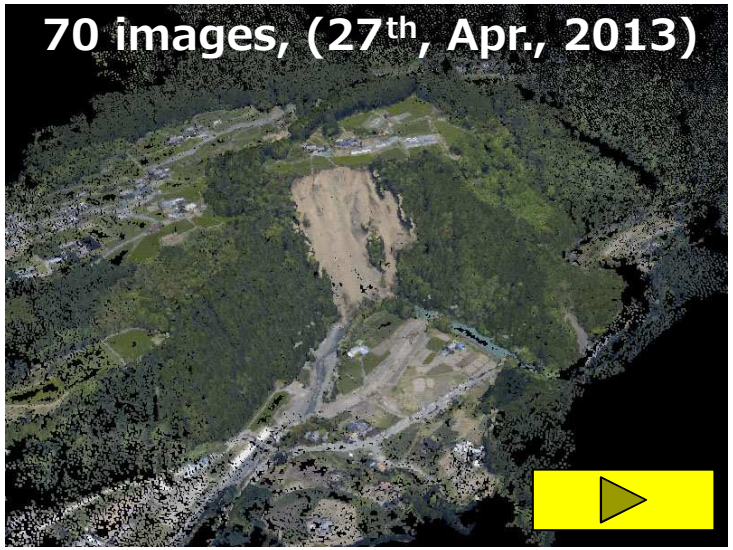
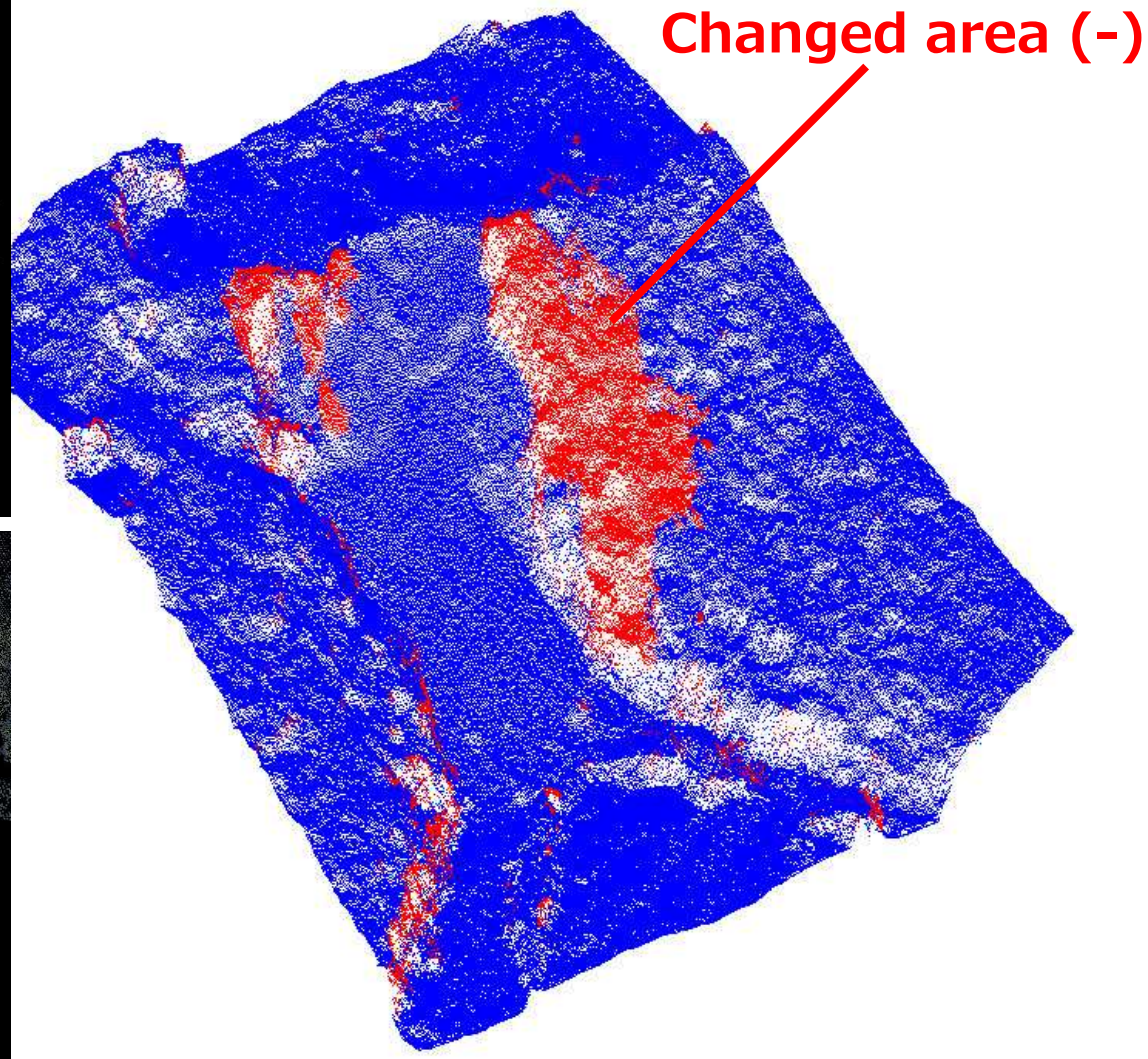
Change detection

Can achieve “Volumetric change detection” using 3D data







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Attribute data acquisition using mobile/wearable devices

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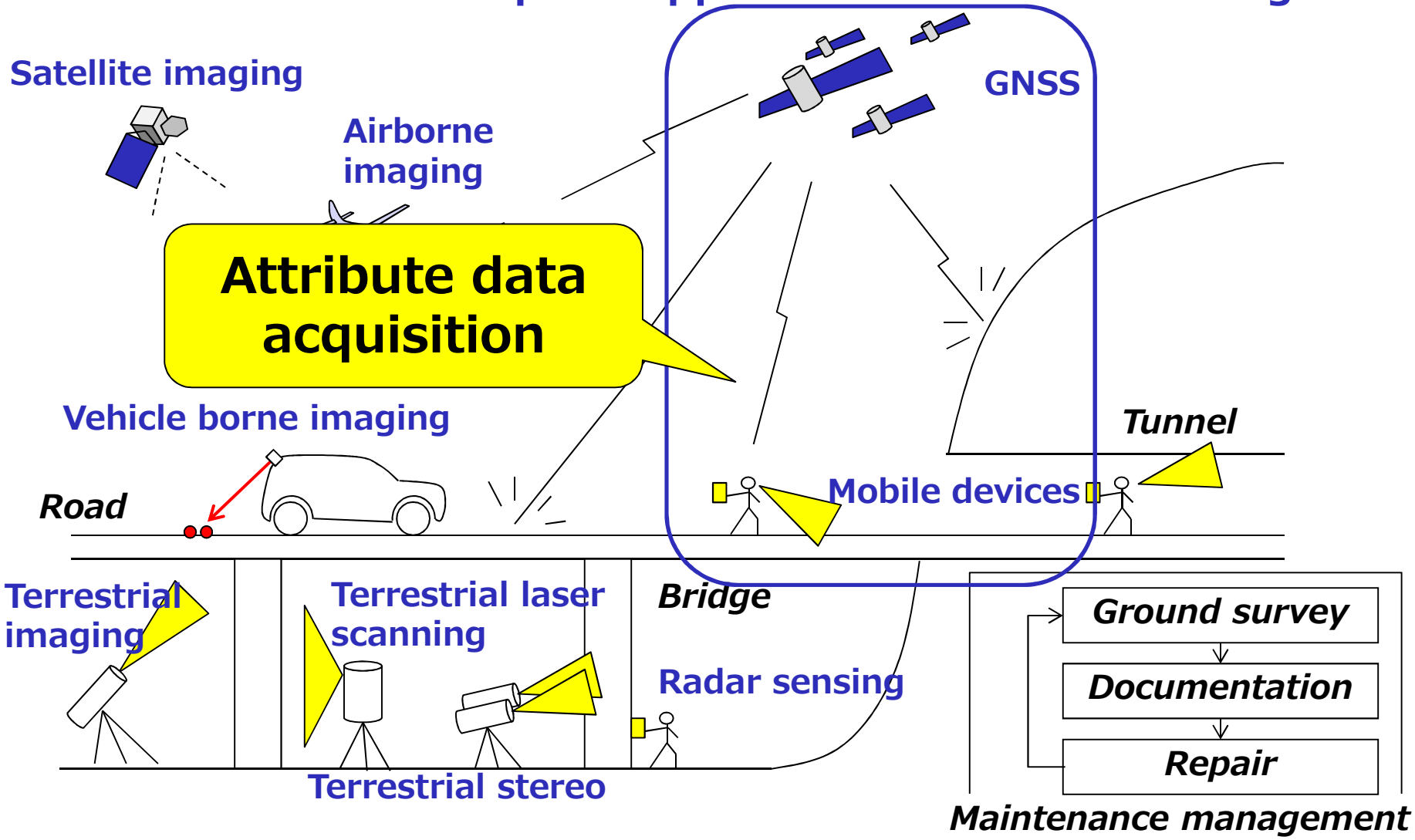

Geo-referenced monitoring is based on BIM

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What is observed in Structure's inspection?

Observe "deformations" of (concrete) structures

A large increase of damaged infrastructures

Reference by Nihon Keizai Shimbun 2012/5/9

Deformation

Initial defects
… Occurs during construction

Deterioration
… Proceed with time
(Alkali-silica reaction, Damage by salt attack)

Instantaneous damages
… Earthquake, Traffic accident

Cracks	Cross-sectional loss	Damage to the ancillary facilities
Free lime	Peeling	Failure of the expansion joint
Gel	Spalling	Abnormal deflection and vibration
Rust leachate	Floating	Environmental condition
Steel corrosion	Scaling	Use conditions
Discoloration	Appearance	Loading condition

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Mobile Devices for Infrastructure Inspection

Handheld + Wearable devices with GNSS devices

Omni-directional camera
THETA S, RICOH

Wearable camera
HX-A500, Panasonic

GPS logger
N-241, HOLUX

Camera controller, Image Logger

AHRS
Xsens Mti-G

GNSS data
= "for POI data management"

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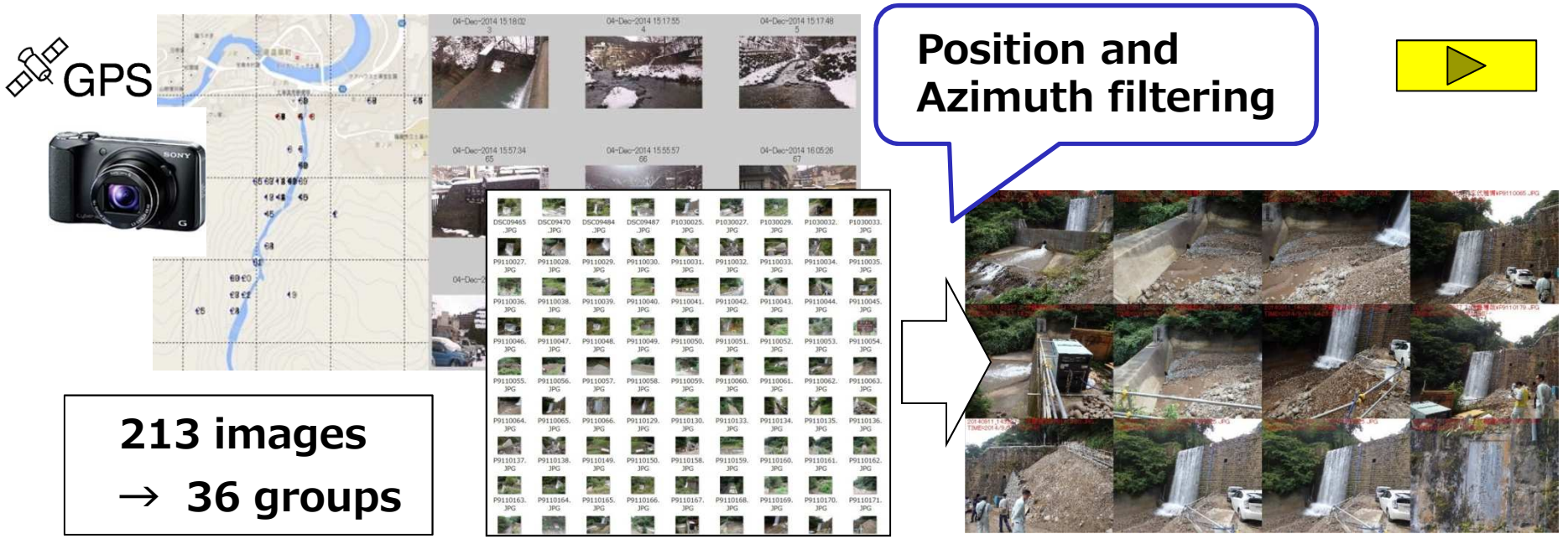
Camera orientation-based Geospatial photo retrieval

Reverse geocoding for Geo-tagged photos



213 images
→ 36 groups

Conventional method (manual)	3120 sec（52min）
Proposed method	4 sec

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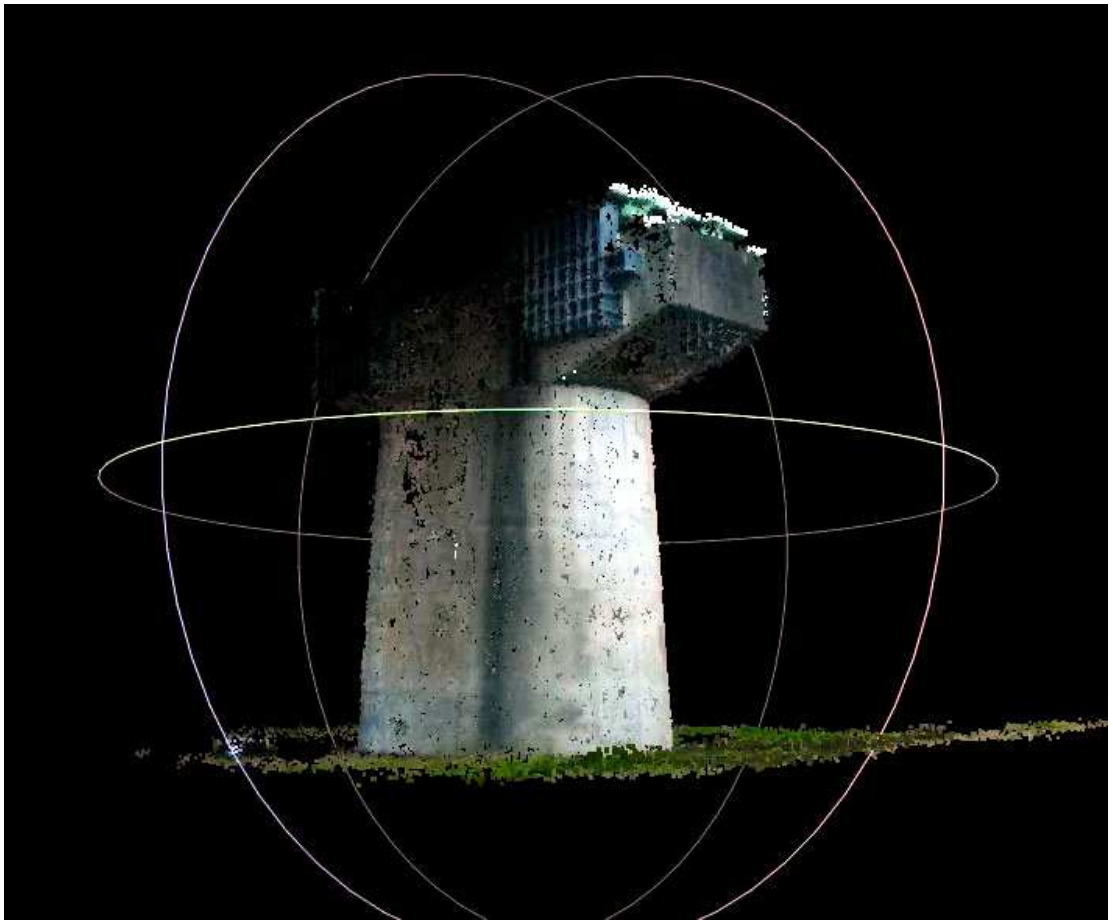
Point Cloud Generation using Digital Camera

3D modeling using acquired images in inspection works

SfM result



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P1350127.JPG


P1350129.JPG


P1350131.JPG

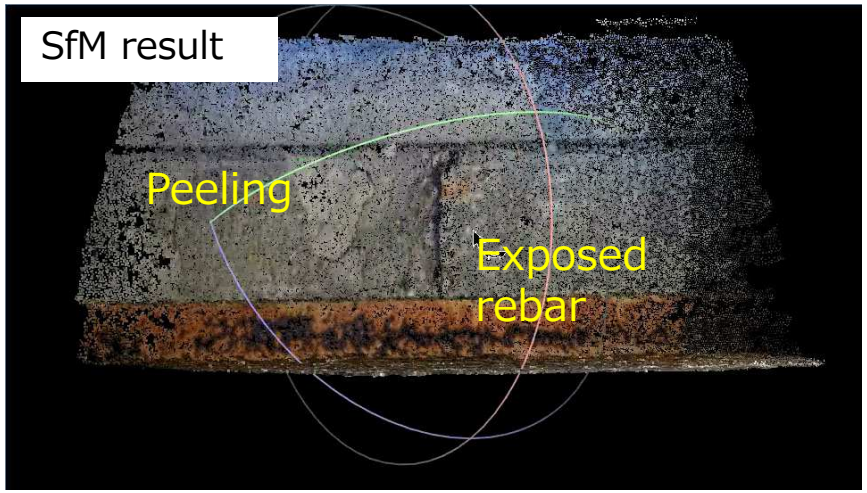

P1350133.JPG

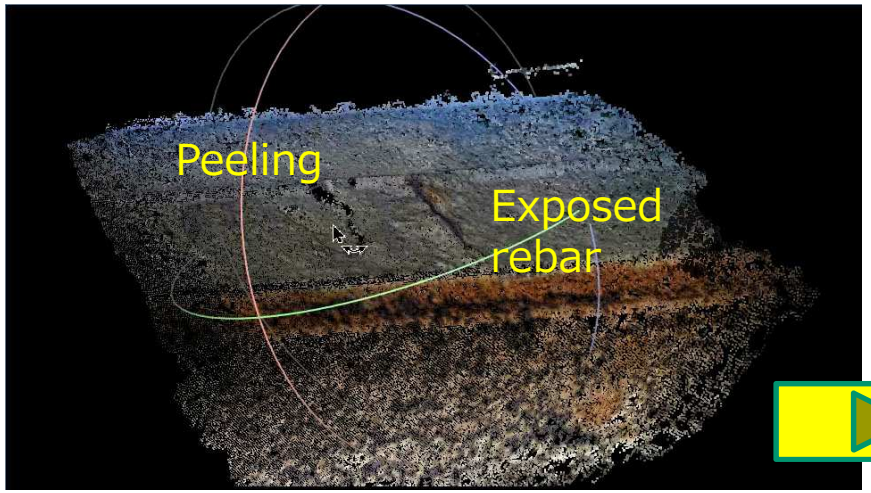

P1350134.JPG


P1350136.JPG


P1350137.JPG


P1350140.JPG

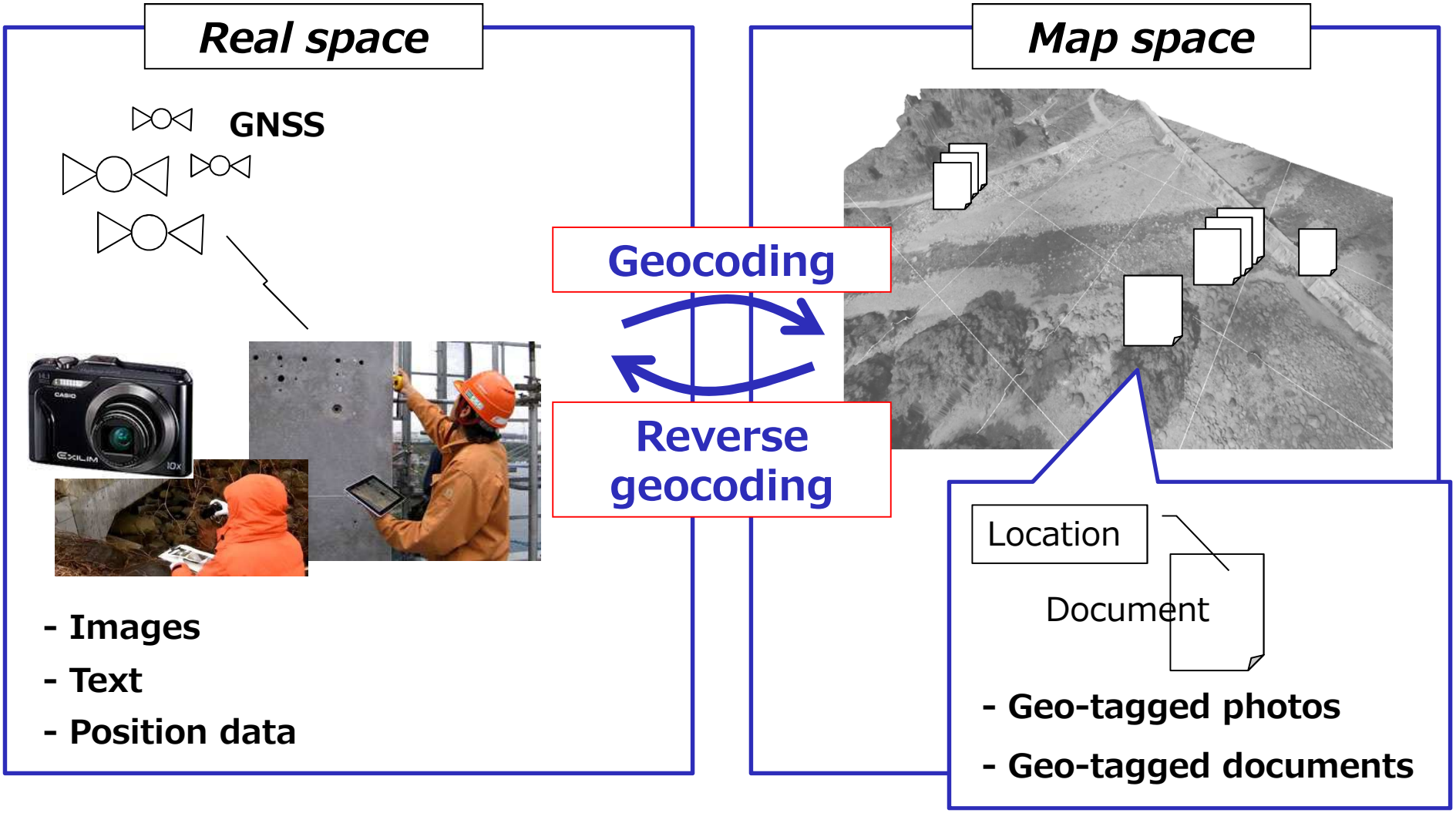




GNSS data are uses for Position data management

Geocoding & Reverse Geocoding

Manage inspection data as geotagged data in Map space



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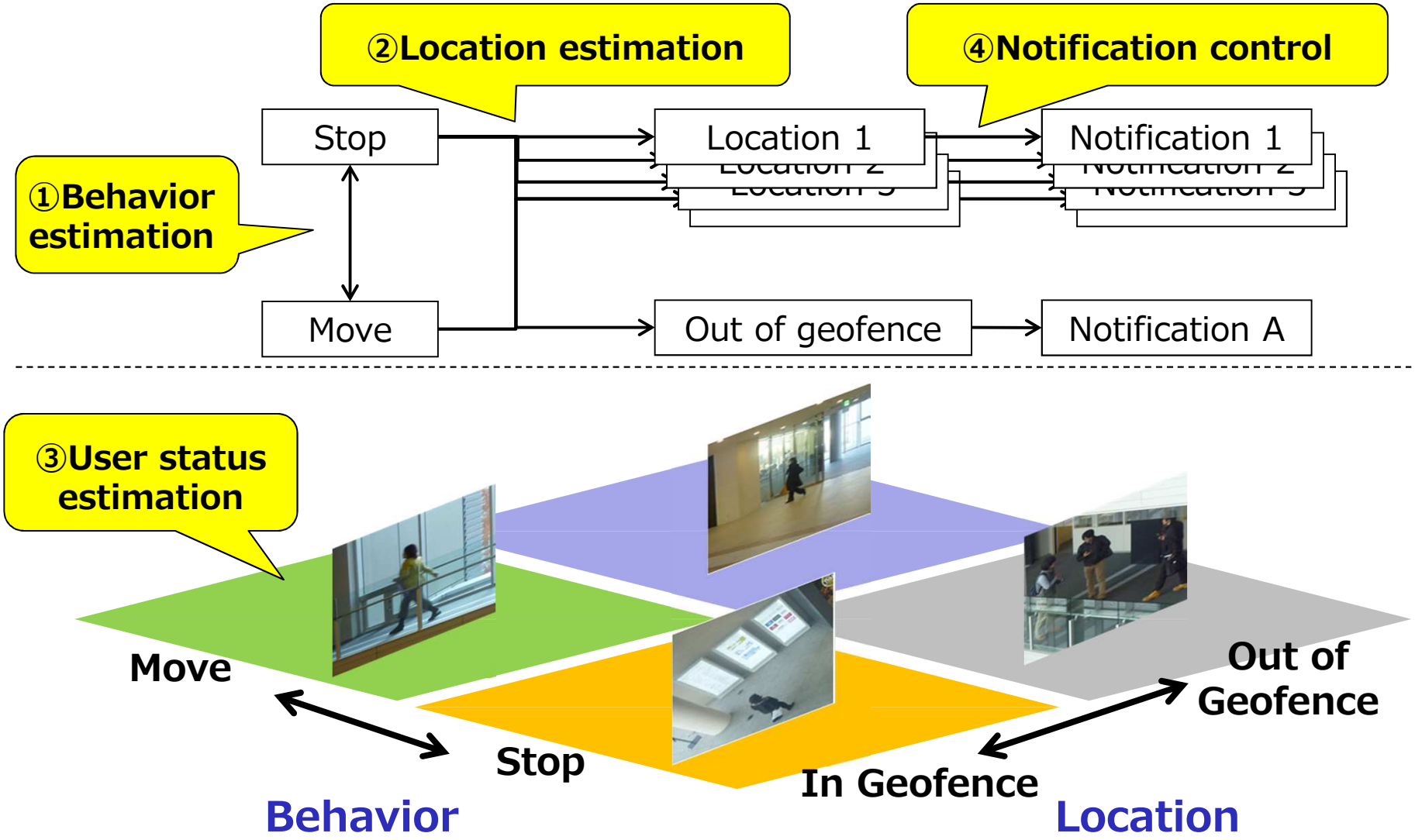
Estimate User Status for Notifications

Location-based user status recognition



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Data Flow after Data Acquisition

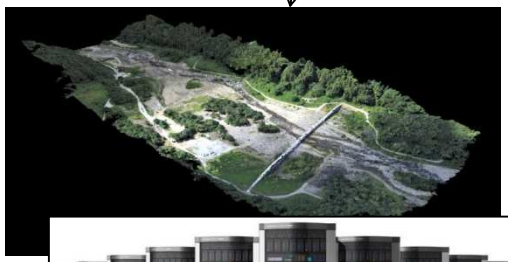
Mobile / wearable devices can be used as “sensor” and “browser”

Distribute

Feedback

Input

Refer

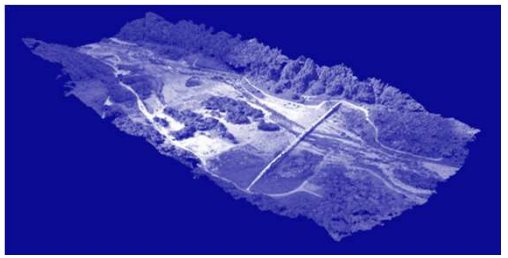


Analyze

Share

Accumulate

Predict



Refer

Inquire

Direct

‘Position’ is ‘Key’ for management data retrieval

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Summary

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POI management using GNSS

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タイトル

Text

Text

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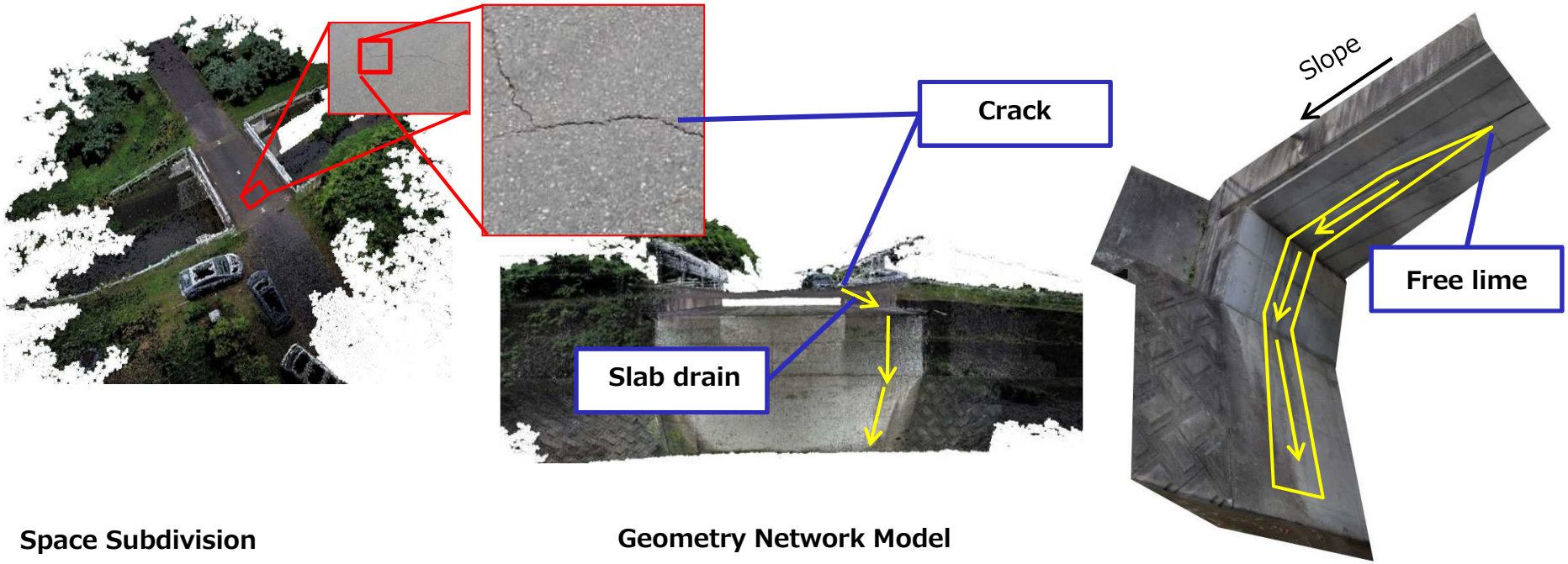
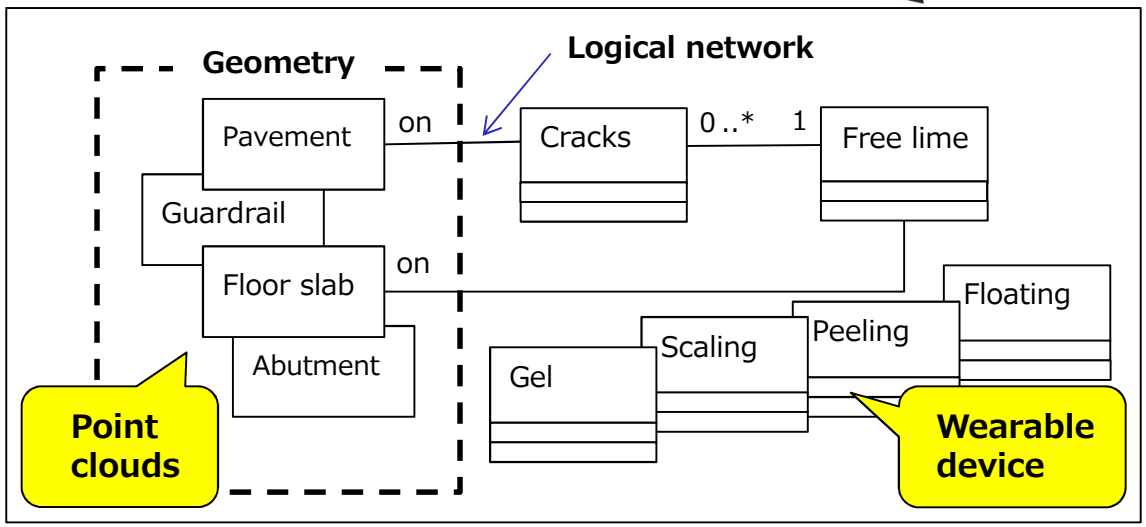
Geometry Network Model for Infrastructure Inspection



Space Subdivision

Agent - Inspector	**Resource** - Deterioration
Activity - Inspection	**Modifier** - Water flow

Geometry Network Model



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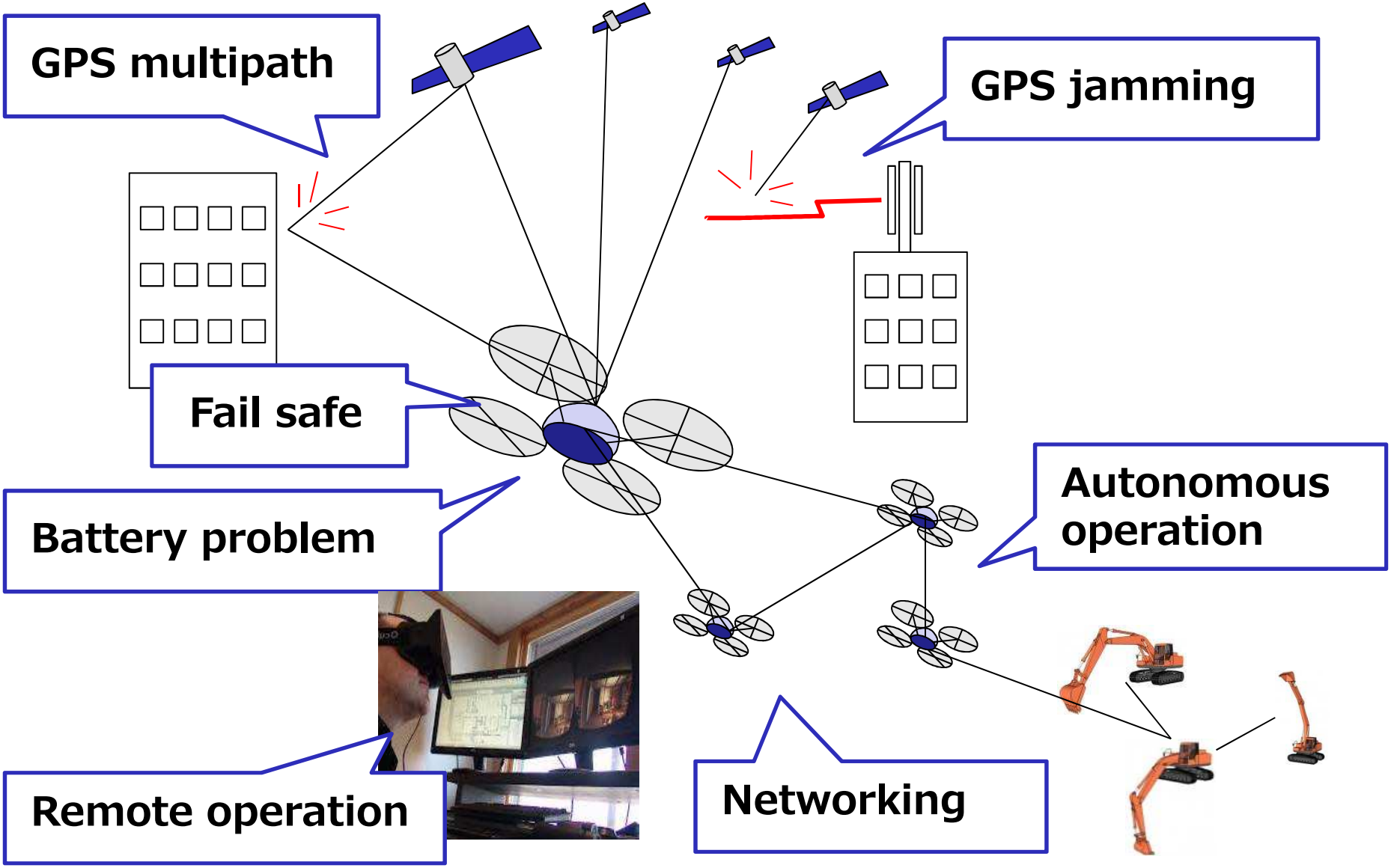
Technical Issues in Drone researches



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