25 R&D of the technology which monitors the displacement rate of a manmade structure with high accuracy and efficiency

Principal Investigator: Minoru Murata (NEC Corporation)

Collaborative Research Groups: Obayashi Corporation

R&D Objectives and Subjects

Objectives

・Development of technology which monitors the displacement rate of infrastructures in a wide area (manmade structures such as bridges) with high accuracy and efficiency

Conventional Infrastructure Inspection

- Grasp the degradation by close visual inspection.
- Grasp the degradation by hammering test.
- Measure the distortion by sensors.

Requires a lot of time and costs (problem).

Infrastructure Monitoring by Satellite SAR

- Can extract a point for inspecting infrastructures in a wide area.
- Higher density measurement than the point leveling.
- High accuracy measurement (mm/year).
- Can measure ground deformation around the area.

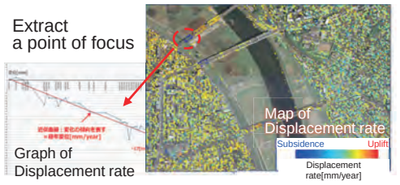
Synthetic Aperture Radar (SAR)

Can identify an inspection object with high priority (screening).

Subjects (2014-2015)

・Analyze satellite image data of target bridge.
→ Check the displacement rate (mm/year) at multiple points on a bridge.
→ Check the ground displacement (subsidence/uplift) around a bridge.

・Confirm measurement accuracy by verification experiments.
→ Measure and verify the displacement by placing a reflector at a test site (error: Approx. 0.5 - 1 mm).



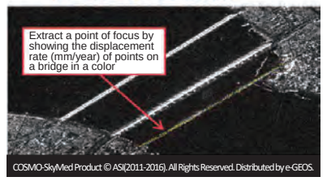
Current Accomplishments (1/2)

(2014-2015)

1. Displacement rate of Bridge

Analyze SAR image of a wide area to measure the displacement rate of a bridge within the area at once.

Overlay analysis results to show the displacement rate in a color.

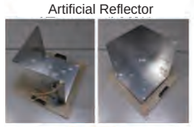


Wide Area/High Density Monitoring
・Extract an abnormal part of manmade structures such as bridges.
・Extract a point of focus for close visual inspection.

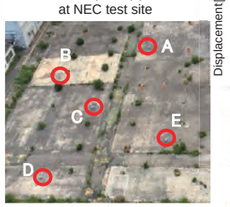
2. Accuracy Verification

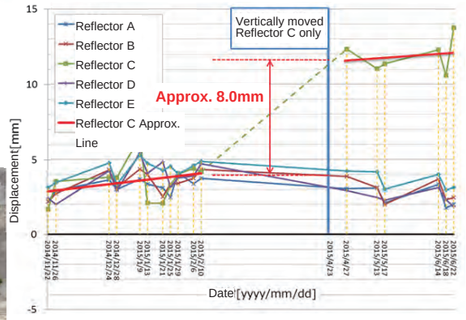
Conducted accuracy verification of this method at NEC test site.
・According to the calculation result of Reflector C movement (approx. 8.0 mm), the accuracy of this method is 0.5 to 1.0 mm.

Artificial Reflector



Reflectors (A – E) placed at NEC test site





High Accuracy Monitoring
・Measure artificial structures such as a bridge to an accuracy of millimeters.

Utilization Example

Earthquake-resistant land promotion project
(Large-scale filled development land screening)

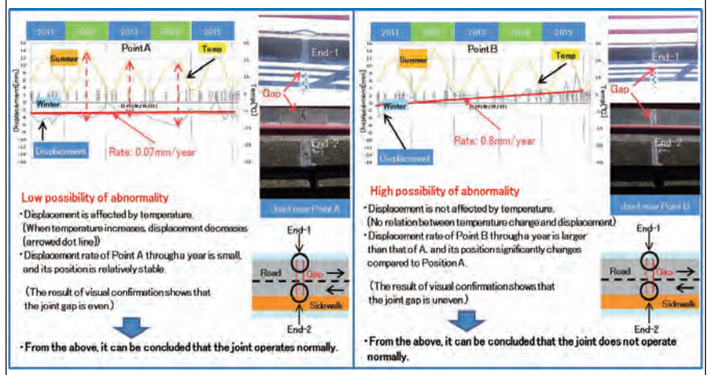
Provide a quantitative criteria for specifying a dangerous location (secondary screening). (Substantially reduce the burden at a site.)

Current Accomplishments (2/2)

(2014-2015)

3. Detailed Analysis of Measurement Point on Bridge

Analyzed the relation between displacement and temperature of a measurement point on a bridge. (Period: April 2011 to February 2016)



Monitoring which reduces the burden at a site

・NEC's own image analysis technology allows the detection of possible defect on a bridge. (Since it is unnecessary to set up a measuring device at a site, approval for use of road and traffic control are not required.)

・Measure the surrounding area of a target structure at one time at high density (including private land).

Flow of utilization

(Periodic inspection of bridge)

Inspection Plan

Utilize this achievement

Screening (Achievement 1, 2, 3)
(Minimize life cycle cost by prioritization)

Close Visual Inspection

Grasp damage situation

Record periodic inspection result

Maintenance and Repair Plan
(Minimize a life cycle cost)

Achieve screening of multiple bridges in a wide area, prioritization, and selecting of point of focus.

Goals

Numeric Target

Achieve 30% of application rate to subsidence screening.

Users

Local governments, Highway companies, Railway companies, General contractors, etc.

How to use/Places of use

Analyze SAR images of an area which contains various infrastructures specified by a user and provide information of the displacement rate of the infrastructure.

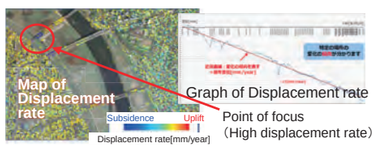
No	Scene	Application
1	Bridge Inspection	Screening (priority of close visual inspection)
		Displacement with age monitoring (fixed point monitoring, forecast)
2	Large-scale filled developed land monitoring	Screening of filled developed land (Specify dangerous area)
3	Slope monitoring	Security for highway, etc.
4	Subsidence monitoring	Effect of tunnel construction (shield work)
		Uneven settling of buildings
		Uneven settling of airport/port
		Subsidence of commercial facilities (filled ground)
		Uneven settling of plant/outdoor tank
5	Monitoring of facilities, buildings, houses	Select facilities, etc. which are in danger of collapsing at the time of disaster. –> Preventive maintenance
6	Deterrence to improper construction	Monitor the health of construction (pilling, etc.).
7	Monitoring of effect of strengthening work	Monitor the health after construction.

Sales Method

A target user specifies infrastructures to be measured and measurement period. ▶ Analyze SAR images which contain the infrastructure and measure the displacement rate. ▶ Provide a report or GIS data to the user.

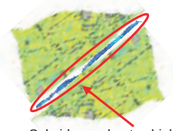
Services to Offer

Provide data of displacement rate of infrastructures (bridge, large-scale filled development land, ground over shield work, etc.)



Bridge inspection service

Overlay displacement rate data on a map.
Large-scale filled development land monitoring service



Subsidence monitoring service

Can provide highly accurate and efficient infrastructure monitoring which has not been obtained by various sensors, close visual inspection, or leveling.
→ Achieve advanced preventive maintenance of infrastructure.