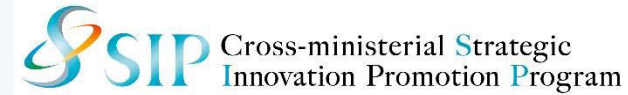


- R&D Topics : Inspection, Monitoring, and Diagnostics Technologies
- R&D Theme : R&D of quantitative evaluation system of cracks on distant slabs by digital image analysis technology
- Principal Investigator : Kenichi Horiguchi (Taisei Corporation)



R&D Objectives and Subjects



Objectives

- Development of a system that can quantitatively evaluate the deterioration stage of road bridge slabs by image analysis

Conventional inspection of slabs



- Creating crack drawings by freehand
- Difficulty in quantitative evaluation of cracks
- Difficulty in inspecting distant and narrow spaces

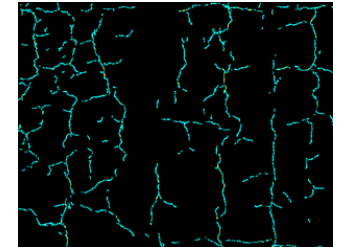


Inspection of slabs by image analysis

- Automatic creation of accurate crack drawings
- Quantify the length for each crack width
- More efficient inspection of distant and narrow spaces



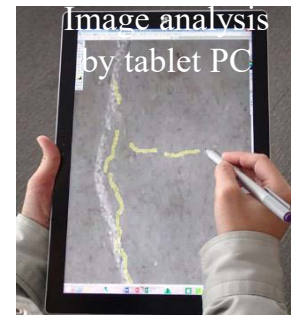
Photographing by UAV



Result of crack image analysis

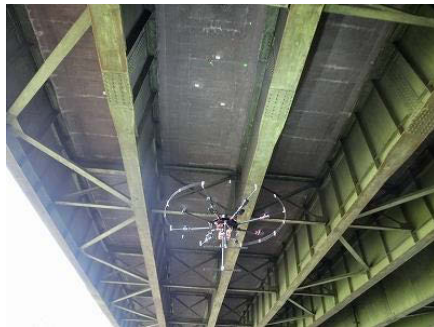
Subjects (2014 – 2018)

- Development of digital imaging technology by UAV and pole
 - **Realization of high-definition image shooting eliminating the influence of vibration**
- Development of image analysis technology capable of extracting and quantitatively evaluating planar damage
 - **Estimation of area of free lime and hidden crack width**
- Image technology that can obtain analysis results quickly on site
 - **Realization of faster processing using tablet PC**

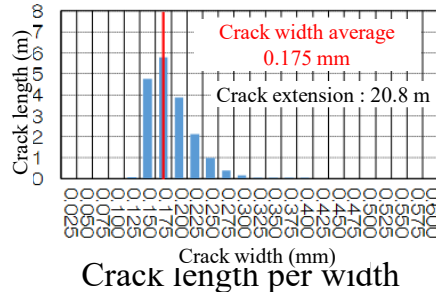


1. Shooting technique of distant and narrow spaces

Conventional inspection of bridge slabs is implemented by visual inspection and freehand drawing by inspectors. In this developed technology, it is possible to quantitatively calculate the width and length of cracks by creating a crack drawing from images taken with a digital camera mounted on a UAV or a pole.



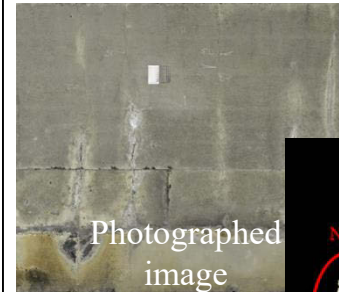
Photographing by UAV



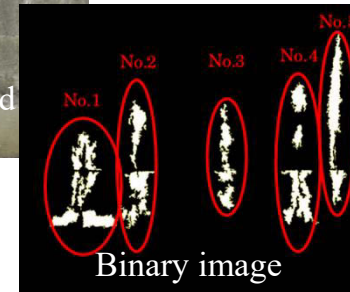
- Possible to shoot distant and narrow spaces of slabs
- Accurate drawing of cracks from digital images
- Accurate calculation of crack width, length, and density
- Eliminate errors by inspector

2. Quantitative evaluation technique of planar damage

When free lime is generated in bridge slabs and covers cracks, cracks inside the free lime cannot be quantitatively evaluated. In this developed technology, the area of free lime can be quantitatively calculated from image analysis and the width of hidden cracks can be estimated.



Photographed image



Binary image

Free lime area

Group	Area (mm ²)
1	46579
2	34542
3	21731
4	36671
5	37659

- Free lime areas can be calculated by image analysis
- The width of cracks hidden by free lime can be estimated
- From the image analysis results of cracks, accurately evaluate the degradation stage of slabs

Utilization examples

- Investigation of places using areas under the high bridges as stores
- Investigation of places where installation of scaffolds is extremely difficult with remote island bridges



Urban Road (Store)

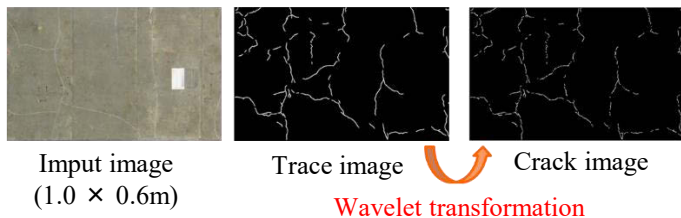
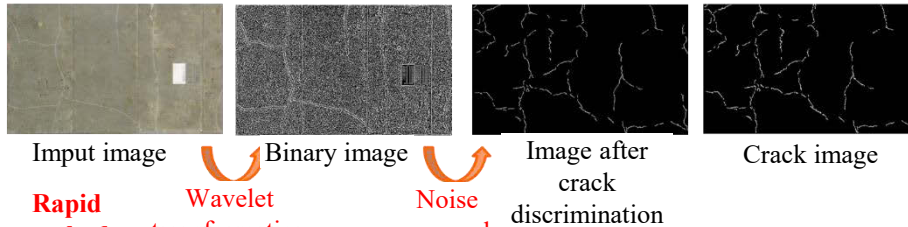


- Possible to free up investigation site in a short time
- Enables efficient shooting at sea

3. Rapid technology for image analysis processing

In the conventional inspection conducted by an inspector, it takes time to collect inspection data and draw freehand, and it was difficult to immediately obtain inspection results at the site. This developed technology can simplify image processing and can also be processed on a tablet PC, so that results can be obtained quickly on site.

Conventional method



	Conventional	Rapid
Noise removal	52:20	06:30
Trace		
Analysis time	02:46	01:37
Total	55:06	08:07

- Significantly improved speed of image analysis processing
- Possible to show inspection results at the site

Flow of utilization

1. Shooting of distant and narrow spaces

2. Quantitative evaluation of cracks

3. Quantitative evaluation of free lime

4. Summarize quantitative evaluation results

5. Evaluation of relationship with damage level of slabs

Realization of quantitative evaluation of damage level of bridge slabs

Numerical target

Among inspections of 500,000 small and medium-sized bridges, realize more than 1% share

Users

Inspection company of structure, local government, especially municipalities

How to use/Places of use

- 1) Selling system packages to inspection companies
- 2) Analysis agency businesses utilizing cloud function

Sales method

System change to an easy-to-use interface

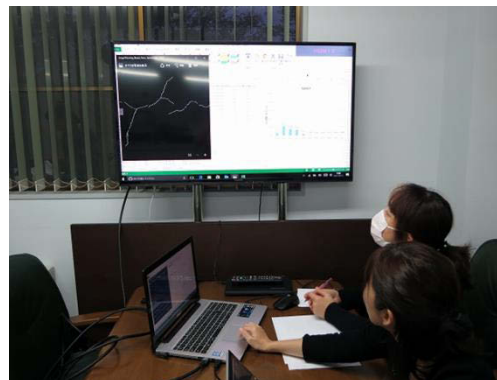
Services to Offer

Provide data that quantitatively evaluate damage stage of road bridge slabs



Choose the appropriate shooting method

【Efforts toward practical application】



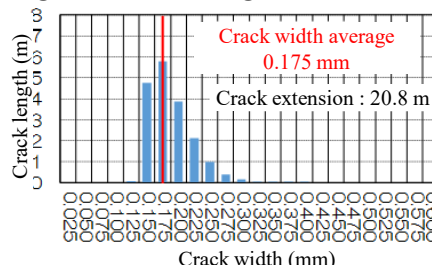
Usability evaluation by structure inspection company



A trial example of detection of cracks in video provided by University of the Ryukyus

Technical support to inspectors, analysis agency businesses utilizing cloud function

Management of inspection data agency business



Quantitatively grasp the cracked quantity

Damage Level	Criteria of crack width	Image analysis result
a	0.05mm	<ul style="list-style-type: none"> • Crack width, length, density • Calculation of crack width from free lime area
b	0.10mm	
c	0.20mm	

Accurately grasp the damage level of the bridge slab

Possible to quantitatively evaluate the degree of damage of bridge slabs which was difficult in the past

→ Provide information for checking and prioritizing countermeasures and maintenance