



22 Creation of Monitoring System using Equipment with Robotic Camera and etc. for Bridge Inspection



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R&D Objectives and Subjects

Objectives

This research aims to develop a regular monitoring system to determine the information of a bridge deteriorated due to aging at locations that cannot be inspected at close range, such as girder ends and bearings.

Conventional system

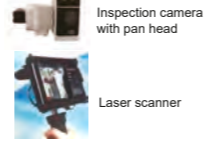
General regular inspection



- Difficult to inspect locations which cannot be approached
- Difficult to ensure a place for equipment installation
- Difficult to refer to past data on site

Regular monitoring using equipment with robotic camera, etc.

- Locations at close range can be inspected.
- The same location as with the previous inspection can be inspected by linking with GPS.
- The data on site can be accessed by connecting with the Internet



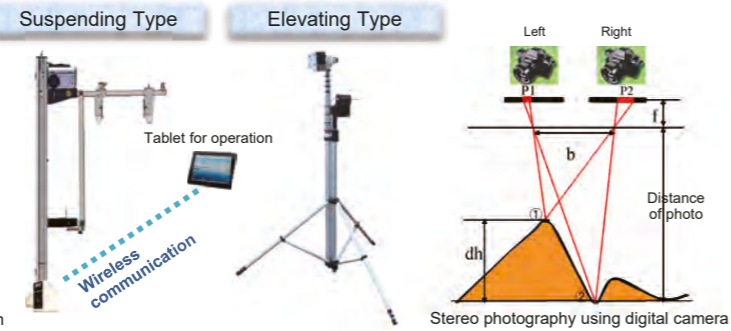
Suspending Type

Subjects (2014-2018)

- The inspection equipment includes a robotic camera, digital camera, and laser scanner.
- Development of the linkage and practical use of each device by considering the advantages of each.
- Verification of the system on an actual bridge.

➔ A monitoring system which uses the advantages of each device can be realized.

※Robotic camera with laser range finder and light for bridge inspection



Current Accomplishments (1/2)

(2014-2018)

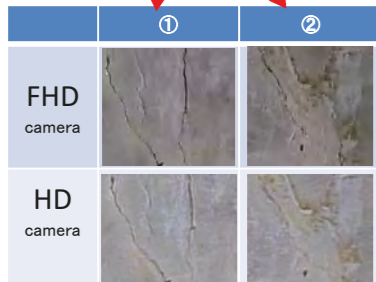
1. Resolution improvement

To improve the image resolution, the prototype model, which uses a Full High-Definition (FHD) camera, was modified from the original model, which had a High-Definition (HD) camera.

HD camera: 1280 x 720 pixels
FHD camera: 1920 x 1080 pixels



Zoomed-up (image comparison)



- The modification from HD camera to FHD camera:
- Improves the damage detection performance.
 - Improves the clarity of cracks.

2. GPS capability

By linking the camera with GPS, it is possible to inspect the same location of the bridge at any time.



Linkage of the camera with GPS



Camera position shown on the display

- With GPS capability:
- Linkage of camera with GPS can be realized.
 - The position of the camera can be determined, enabling inspection the same location.

3. Color tone correction

The damage due to aging deterioration from the image is difficult to detect when affected by environmental influences such as changes in weather and brightness of the day. Two correction techniques were investigated to remove the environmental influences.

- (1) Using standard color palette technique
The color tone correction of the image can be carried out by taking an image of the structure with the standard color palette.



- (2) Using laser pointer beam technique
In case the palette is not available for use, a laser pointer can be used to correct the color tone of the image.



- The use of standard color palette and laser pointer beam:
- Can exclude the environmental influences.
 - Can correct the color tone image of a location that cannot be inspected at a close range.

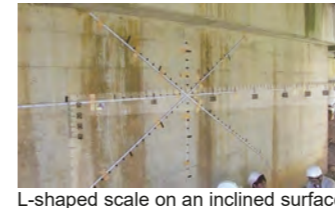
Current Accomplishments (2/2)

(2014-2018)

4. Capture reference distance using stereo photography

3D configuration of the structures can be recognized by using stereo photography of 2 digital cameras. However, a reference distance on the structure's surface is required.

Therefore, an L-shaped scale of the robotic camera which responds to inclined surfaces was developed to improve the accuracy of this noncontact measurement system.



L-shaped scale on an inclined surface



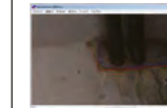
Stereo photography using digital camera

- An L-shaped scale which can be used with the inclined surface was developed.
- The accuracy of stereo photography in the case where the camera is not in front of the structure's surface was improved.

5. Visualize the change in time-series images

Superimposed images captured from different times at the same location can be obtained by extracting some distinguishable features of the image and converting their coordinates to the same direction to match the others.

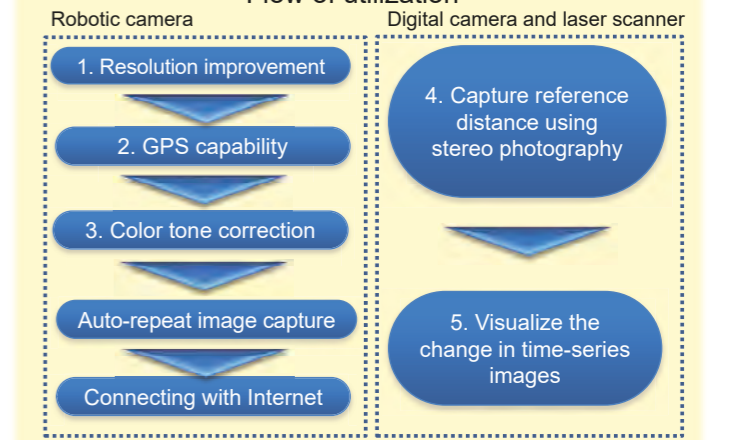
➔ From the superimposed images, the locations where changes are found are displayed in different colors.



- Images which convert to the same direction were used.
- Visualization of the location that changes due to aging damage can be realized.

Display in different color the location with change in time-series

Flow of utilization



A monitoring system with high data access accuracy and ease of usability

Goals

Numerical targets

- Improve the resolution of the robotic camera by 150%
- Decrease the error of the L-shaped scale display of the incline surface to less than 10%

users

Bridge administrators, construction consultants, etc.

How to use/Places of use

Regular monitoring of concrete bridges



Monitoring of girder end using robotic camera (Elevating Type)

Sales method

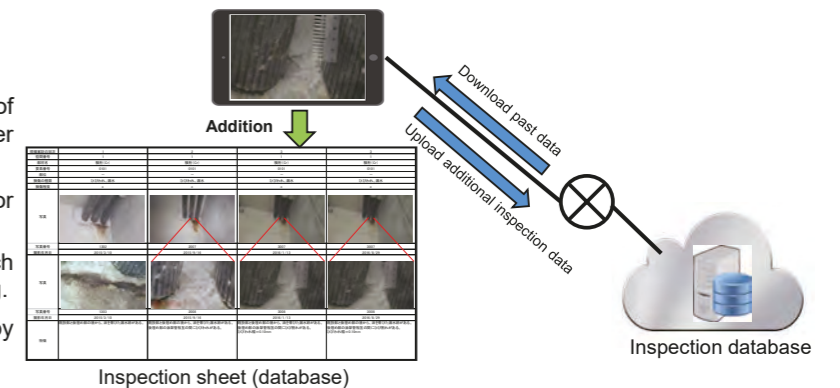
Robotic camera for bridge inspection has been sold by Hiatchi Industry & Control Solutions, Ltd. and SMC Civil Technology, Ltd., and distributed for bridge inspection. Moreover, it is not only for sale but also for rental.

GPS, digital camera, and laser scanner should be prepared by the user by purchasing or renting from the market.

Cloud service for storage system is provided by Hiatchi Industry & Control Solutions, Ltd. and other service companies.

Services to Offer

- The instrument for monitoring, consisting of robotic camera, digital camera, and laser scanner, is provided.
- ➔ A proper inspection technique to monitor girder end and bearing can be selected.
- An Internet database system is set up which can store the deterioration data due to aging.
- ➔ The data can be referenced and edited by login to the system from the inspection site.



Monitoring which is useful for detecting the indication and change of damage becomes possible.

➔ Realize a monitoring system with high data access accuracy and ease of usability