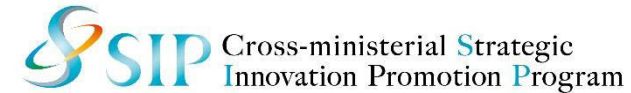


- R&D Topics : Inspection, Monitoring and Diagnostic Technology
- R&D Theme : Monitoring system for a round of airport paved road inspection, utilizing a technique for detecting cracks automatically from high-resolution images.
- Principal Investigator : Toru Hara (Alpha Product Co., Ltd.)
- Collaborative Research Groups : Alpha Product Co., Ltd. and the Osaka Institute of Technology



R&D Objectives and Subjects



Objectives

- The objective of this research was to develop a system that could record the length and width of cracks on the surfaces of the runway of an airport and transcribe the obtained crack data on existing CAD plane views of the roads, to supplement the rounds of visual road inspections performed by an airport worker.

Subjects

• <Automatic Extraction of Cracks>

Images taken with two digital video cameras are processed automatically with dedicated software. Cracks extracted automatically from the images are displayed in different colors by width (in 0.5 mm increments). The length of the cracks is aggregated by width.

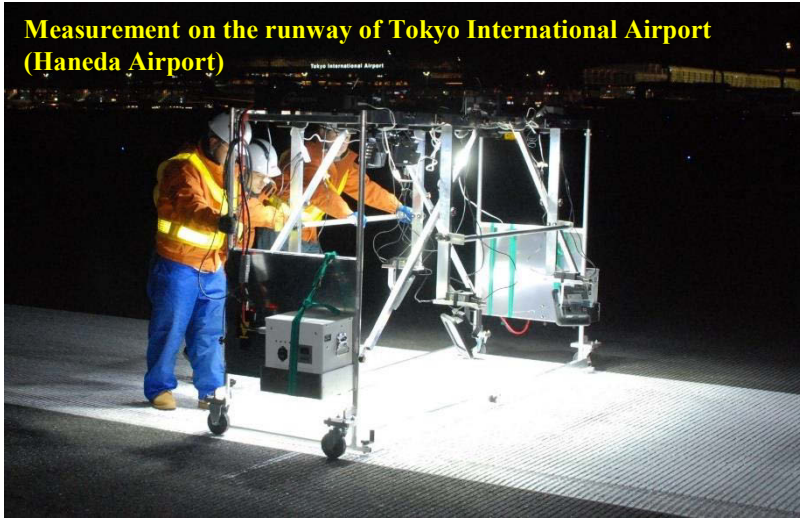
• <Conversion and Transcription to CAD Data>

The obtained data is converted into DXF format and transcribed correctly onto the existing plane views (CAD drawings) of the airport based on GPS coordinates and azimuth orientations measured at the start of shooting the video.

• <Shooting System>

- The video is recorded by two persons using a handcart. Combined use of a laser pointer allows the operators to maintain linearity. The shooting system is capable of taking images of an area approximately 12 m × 3,000 m in 5 hours. The system can also be moved with a tug vehicle.
- The shooting system can be disassembled to load on the work vehicle. The system is assembled by two persons. Assembly and disassembly time for the system is approximately 30 min and 15 min, respectively.
- All devices of the system use a rechargeable battery as power source. The estimated operating time of the system is approximately about 4 hours at a temperature of 0 °C.
- Use of a Doppler laser range finder allows correct measurements of moved distances.

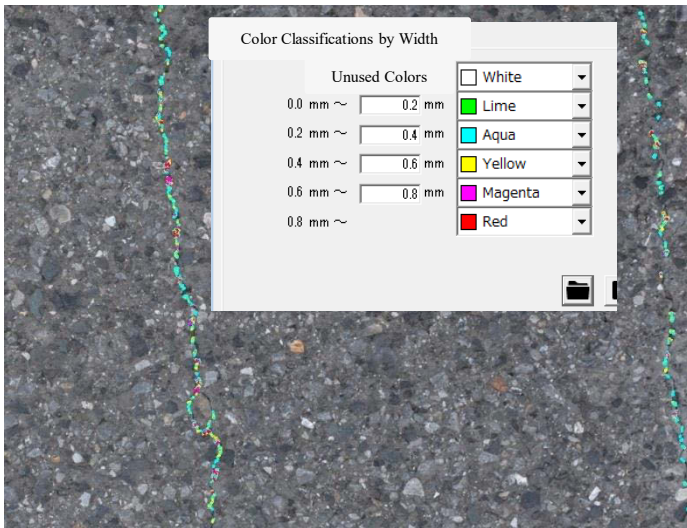
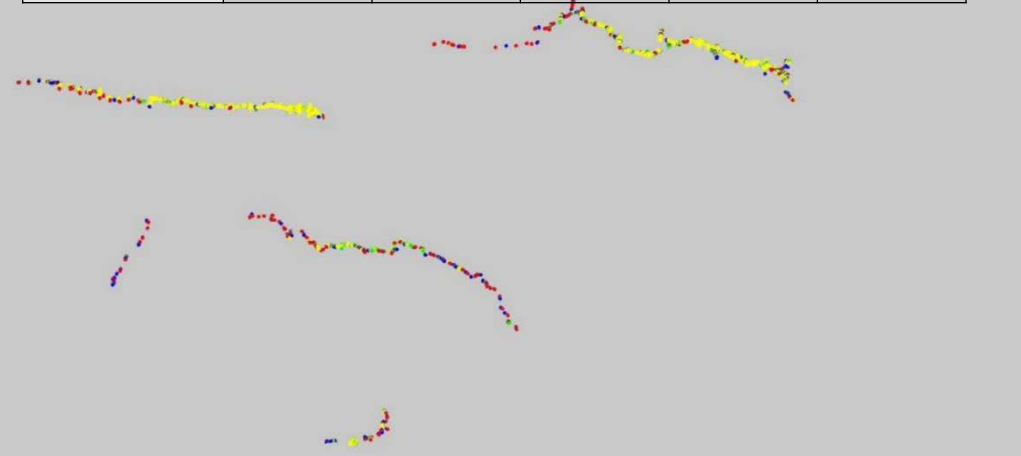
Measurement on the runway of Tokyo International Airport (Haneda Airport)



< Automatically Extracted Crack (No. 10) >

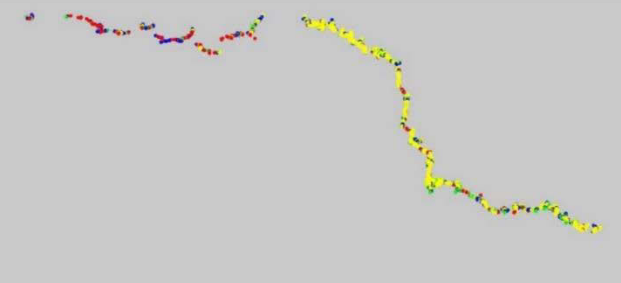
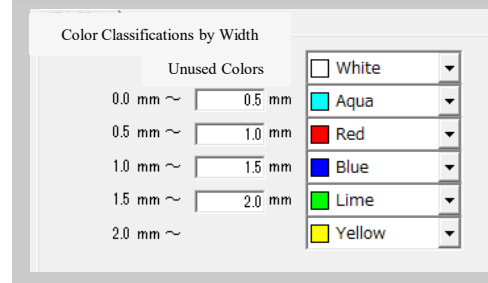
The figures below show Crack No. 10 and the aggregated lengths of the crack by width. The crack is indicated in different colors by width.

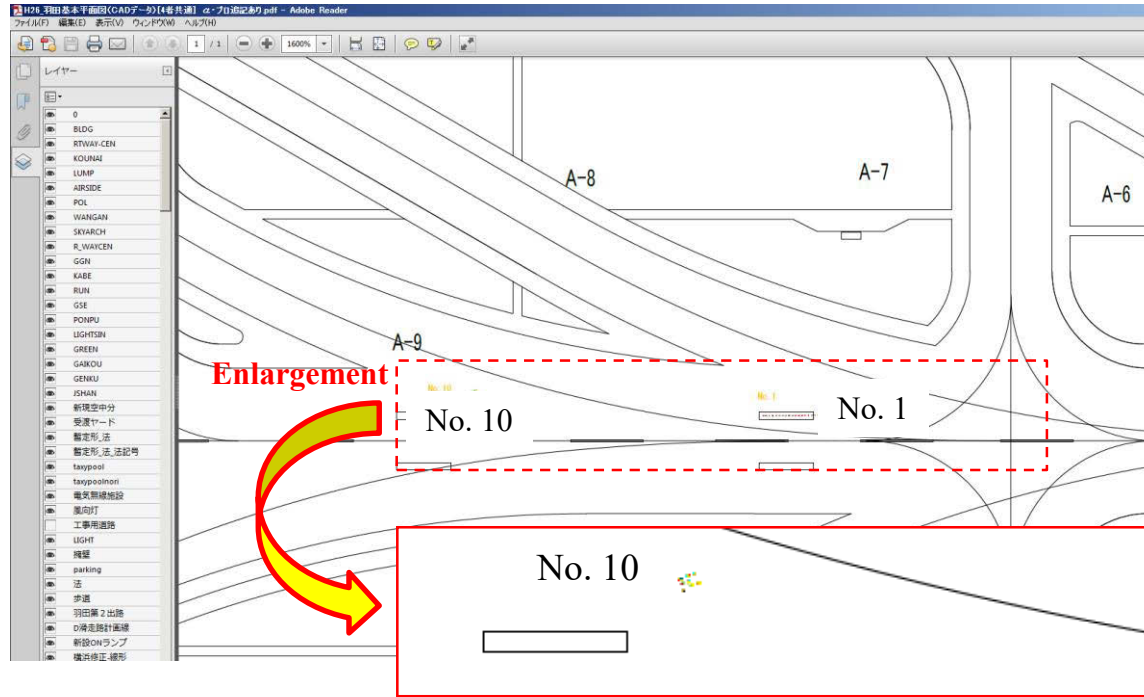
Width of Crack	0 - 0.5	0.5 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0-
Length (mm)	0	702	1169	1039	4746



* Examples of an actual image and the extracted crack

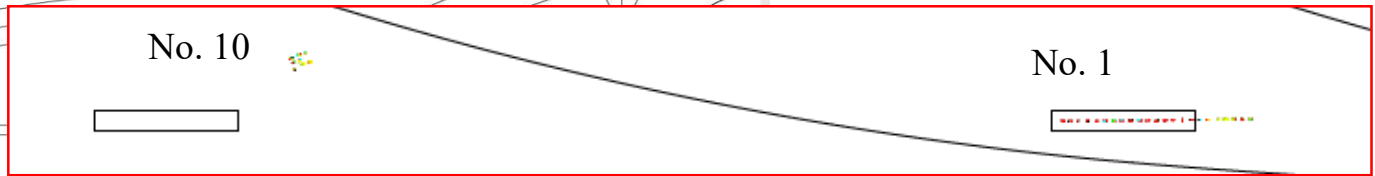
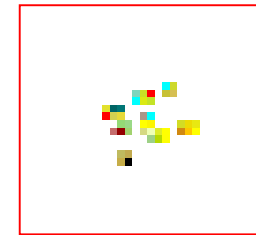
A series of images are pieced together and stored separately. The stored images are available for viewing anytime.



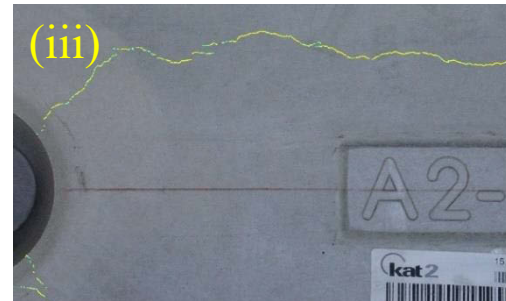


<Cracks No. 1 and No. 10 Transcribed onto CAD Plane View>

Enlarged Image of Crack No. 10



<Confirmation of Changes in a Crack over Time (Data of Tunnel Segment Breaking Test)>



* Data of a tunnel segment pressure breaking test by elapsed time (in one-minute increments) Photos (i)-(iii) show development of the crack over time.

<Real-time Image Display>

Images can be displayed on large monitors (2 pcs) in real time.

Intellectual property rights acquisition and trademark registration

The automatic crack extraction technique has been registered in the New Technology Information System (NETIS) of the Ministry of Land, Infrastructure, Transport and Tourism (registration No.: NETIS KT-130046-V). The shooting system, FOCUS-α, has been registered as a trademark.

The following three business models are under consideration.

1. Sales of the entire system, including the analysis software
Estimated price: Approximately JPY 20 million to JPY 25 million
2. Sales of the shooting system alone. Data analyses will be performed by our company.
Estimated analysis charge (at this time): Approximately JPY 5,600/100 m²*
3. Sales or rental of the automatic extraction software with a fixed extraction accuracy, and the image connection and CAD data conversion software
Estimated price: Approximately JPY 2 million to JPY 3 million

* Image connection (per 100 m) and crack data extraction. CAD data conversion will be charged separately.

As of January 2017

Specifications of Shooting System

Item	Video camera cautious shooting	
Shooting Method	Continuous shooting while moving	
Shooting Area-hours	10,220 m ² /h	
Extraction Accuracy	0.35 mm	
Shot Image	8,800,000 pixels	
Shooting Equipment	4K digital video camera	
Focal Distance	37 mm	
Number of Video Cameras	2 pcs	
Lighting	LED lights (used always)	
Power Source	Rechargeable battery (internal/external)	
Ancillary Devices 1	Aluminum handcart	
Ancillary Devices 2	Laser range finder/Red Laser	
Shooting Operation	Continuous shooting speed: 5 km/h	
Preparation for Shooting	Installation of the laser	
Shooting System Transport Vehicle	1 (carrier)	
Image Processing	Automatic Crack Extraction	Automatic continuous extraction
	Color Classification of Crack by Width	With
	Image Connection (per Shooting Direction)	Automatic connection
	Image Connection (Another Camera)	Automatic connection
Crack Date Conversion into DAD Data	Dedicated software is used	

Data Processing Specification

Item	Automatic crack extraction from images
Extraction Accuracy	For runway: 0.35 mm (0.1 mm max.)
Processing Speed/Image	Approx. 4 seconds
Number of Processing Steps	5 steps
Adjustment of Processing Steps	Automatic adjustment (after making settings)
Applicable PC	Core-i7 3 GHz or more, RAM 32 GB or more