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Monitoring by using Ground-Base Synthetic Aperture Radar and Array-type Ground Penetrating Radar

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R&D Objectives and Subjects

Objectives

- Quick and wide area monitoring of taxiways and runways
- Innovative technology combining Ground-Based Synthetic Aperture Radar (GB-SAR) and Ground Penetrating Radar (GPR)

Subjects

◆ Quick detection of surface anomalies by GB-SAR in large areas

- Repeat monitoring every 5 minutes.
- A 400 m x 400 m area can be observed within 10 seconds.
- Understanding of the surface conditions of pavement



Introduction of new methodologies using electromagnetic waves that replaced conventional sounding tests

◆ Precise inspection by GPR

- Up to 1 m depth in pavement
- 2 cm resolution
- Understanding the condition of the 2 cm thickness layer



Current Accomplishments (1/2)

GB-SAR

◆ GB-SAR Validation at Haneda airport

- Set a GB-SAR on the roof of a building for continuous monitoring of the ground surface of Runways and Taxiways
- Interval measurement (Minimum 1 min.) and displacement detection by Interferometry (Minimum 0.2 mm)
- 17 GHz(Ku band) frequency
- All weather, day and night, 24-hour monitoring
- Automatic early warning

◆ Phenomena observed by GB-SAR

- Deformation of the pavement surface caused by blistering
- Deformation caused by the weight of airplanes
- Debris

◆ Advantages of the use of GB-SAR

- Full automatic measurements
- Automatic detection of anomalous displacement
- Detection of the fast rate change of displacement
- Continuous monitoring
- Five year continuous monitoring was conducted by our group at Miyagi prefecture for land slide monitoring
- Acoustic sounding inspection cannot be used for continuous measurement



GB-SAR system installed at Haneda airport



Interferometric SAR image of the pavement surface obtained at Haneda airport

Current Accomplishments (2/2)

GPR

◆ GPR Validation at Taxiway at Haneda airport

- 8 Ch Multistatic GPR "Yakumo" was used for data acquisition
- 10% water content change can be detected by CMP signal processing in real time
- Validation by comparison with acoustic sounding inspection showed good agreements
- GPR can detect anomalies at a 20-50 cm depth, where the acoustic sounding test detected the anomaly.

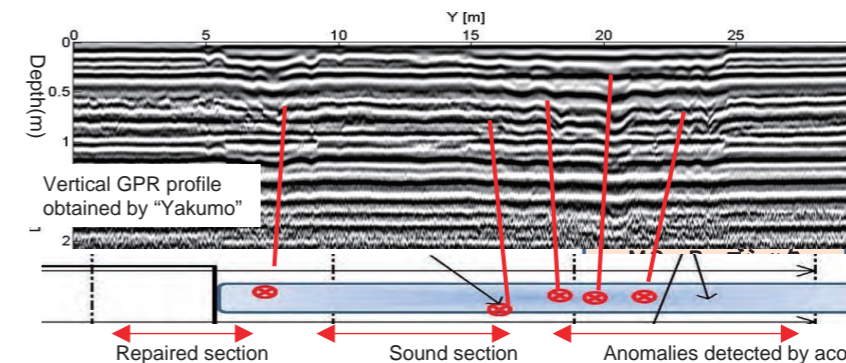


Vehicle mounted GPR system

Hand pull type GPR can acquire data at 4 km/h with a 2 m width.

Vehicle mounted GPR can acquire data at 25 km/h with a 2 m width.

(Five h for a 3500 m runway measurement)



Validation at Haneda airport

Move to the site (15 min)
 Set up system (20 min)
 Data acquisition (3 min)
 4 km/h, 2 m width
 2 m x 20 m area to be inspected
 Analysis (5 min)
 Cost Driver 1, Operator 2 for 4 hours
 【Reference】 Conventional method
 (Observation and Acoustic sounding)
 Operator : 8
 Operation time : 23:30~03:00 (3h30m)
 Inspection area : 2,620 m x 80m

Goals

◆ Final Goals

- ★ Cooperative operation of GB-SAR and GPR
- Wide area monitoring by GB-SAR (Continuous)
400 m x 400 m in 3 minutes, detection resolution 1 mm
- Precise measurement by GPR (Anomaly points detected by GB-SAR)
Measurement resolution 0.5 cm, Up to depth of 50 cm
- ★ Life Time
- GB-SAR 20 years
- GPR 20 years

Expected Deployment

◆ Daily Monitoring

- Continuous monitoring by GB-SAR
- Automatic warning, if a surface anomaly is detected
- Automatic announcements for the operator
- GPR measurement of the spots where GB-SAR has detected an anomaly
- Alternatively, regular inspection by a vehicle mounted GPR is also possible

◆ Regular Inspection

- Regular inspection of planned areas by a vehicle mounted GPR



Measurement area by GB-SAR



GB-SAR arrangements to cover all the area of Haneda airport