AN EYE IN THE SKY TO OFFER EARLY WARNING OF LANDSLIDES

AN AI-DRIVEN, HIGH-RESOLUTION SATELLITE MONITORING service provides unprecedented coverage and precision for detecting landslides across Japan.

In July 2021, a sudden landslide struck Atami city in Shizuoka prefecture, killing 27 people. Landslides are a perennial risk in Japan, because it is subject to high annual rainfalls, and mountains make up about 75% of its landmass. And the risk is likely to increase under a climate-change scenario of more frequent and intense rainfall events.

Monitoring of ground movements can help provide early warning of impending landslides, but the scope of ground- or air-based observations is limited. Satellite monitoring is promising for large-scale, high-frequency coverage, but the data generated requires a lot of processing.

Now, by using artificial intelligence (AI) to process data collected by various low-Earth-orbit satellites, the Japanese satellite communications company SKY Perfect JSAT, based in Tokyo, is able to monitor for ground deformation across the entire country, including both cities and regional areas. Accessible via an explorable web portal, the service allows users, such as municipal governments and civil-engineering firms, to keep careful tabs on gradual and sudden ground movements.

MICROWAVES FROM SPACE
This system is based on a microwave imaging technique known as synthetic aperture radar (SAR), which uses reflected microwaves to track
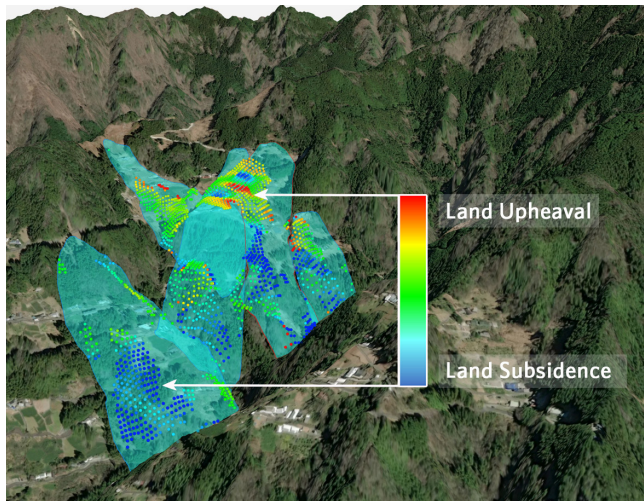
▲ Data based on satellite observations as displayed in SKY Perfect JSAT's InSAR. It reveals areas in mountainous regions that are at high-risk of landslides (red). This information can be used to provide early warning of landslides and inform evacuation efforts.

points on the ground. It can capture a high level of detail without being affected by weather or a lack of daylight. By using many SAR-enabled satellites, SKY Perfect JSAT provides daily imaging of various places in Japan. Ground movements can be detected by comparing images taken at different times.

However, this Interferometric SAR (InSAR) analysis requires extensive processing of the data to remove noise and other errors. "SAR is a very promising technology for ground observation, but it has many limitations that made it difficult to access and use," explains Daisuke Hirata, who heads SKY Perfect JSAT's Space Intelligence Business Team.

"Raw InSAR data includes observation error, topographic

location error, atmospheric delay and other components that require many steps to correct," adds Takuma Anahara, chief researcher of SKY Perfect JSAT's Space Intelligence Business Team. "This normally requires expert analysis and lots of computation, and so has typically been performed only for urban areas, which are easier to process."

SKY Perfect JSAT has turned to AI to overcome this limitation. "We've developed an AI-driven statistical analysis and low-computation algorithm that can complete this process and validate the outputs quickly and accurately with minimal expert input," says Anahara "This allows us to offer the capability at much lower cost across all areas of Japan, not just cities."

TURNING TO AI
SKY Perfect JSAT's InSAR service has been calibrated for urban, rural, and wilderness environments, allowing it to be used for remote landslide monitoring and early warning. The system is already in use by municipal governments, construction companies, airports, etc. The team is now developing the capability further to allow point-by-point monitoring of infrastructure such as bridges and towers, where resolving differential vertical movement is critical.

"Our InSAR service is a unique and powerful capability that can replace laborious ground-based surveys and extend monitoring to inaccessible areas such as the mountainous regions of Japan," says Hirata. "At present, we can achieve measurement of changes with accuracy under 10 millimetres, and we're continually improving our statistical processing to improve this resolution in different environments."

"This service demonstrates the valuable potential of space observations," says Hirata. "And it will help reduce uncertainty and increase safety related to landslides and subsidence in Japan." ∎

SKY Perfect JSAT Corporation

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