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PREDICTING LANDSLIDES IN REAL TIME

A project explores the use of 3-D laser scanning to detect landslides before they happen, improving highway maintenance.

The Issue

The Oregon Department of Transportation, or ODOT, has an ongoing struggle to maintain public highways against earth movements such as erosion, earthquakes and landslides. An earthquake or landslide can close down a road for days, while highway workers fight to keep supply lines open and repair the damage. Particularly along Oregon's coastal roads with high sea cliffs, these natural processes are a constant threat to transportation infrastructure. The damage caused by gradual erosion is typically not detectable until there is a landslide or other disaster, costing the state considerable time and money to repair. New technology has the potential to change this. Many landslides, in fact, show some form of movement prior to catastrophic failure, and this project introduces a way to proactively detect that slight change.

The Research

LiDAR, Light Detection And Ranging, is a "line-of-sight" remote sensing method in which laser beams are aimed at terrestrial formations. After taking multiple scans from different vantage points of an area, researchers merge the scans together to form a complete 3-D model of the site. The technique is sensitive enough to represent fine details, even down to the texture of the leaves on the vegetation when a high-definition scan is used. When scans of a cliff or embankment, even in lower definition, are compared with past scans of the same area, it becomes possible to determine the rate of erosion and to predict the location of a landslide. Highway construction workers can then do preventive maintenance to shore up structural weak points, rather than have to perform emergency missions to clear a destroyed road.

In the past, ODOT has used an airborne application of LiDAR, in which a laser scanner mounted on an airplane does a broad sweep of a several-hundred-kilometer area. Airborne LiDAR could help determine where erosion was happening when scans were analyzed later. There are drawbacks to this method, however, including the fact that in Oregon,

THE ISSUE

In Oregon, landslides and soil erosion have cost the Department of Transportation heavily in the past, by interrupting traffic and damaging roads.

THE RESEARCH

This project focuses on using LiDAR (Light Detection and Ranging) technology to predict landslides before they occur. The researchers:

- Developed a method for using ground-based LiDAR to scan field sites where landslides are prone to occur;
- Created and tested an algorithm to compare data in the field;
- Achieved real-time change detection on site.

THE IMPLICATIONS

Real-time landslide detection, in the field, can prevent road damage before it occurs. This stands to be a potential cost- and time-saving measure for state departments of transpotation and other transportation agencies.

Photo: Erosion is a constant threat

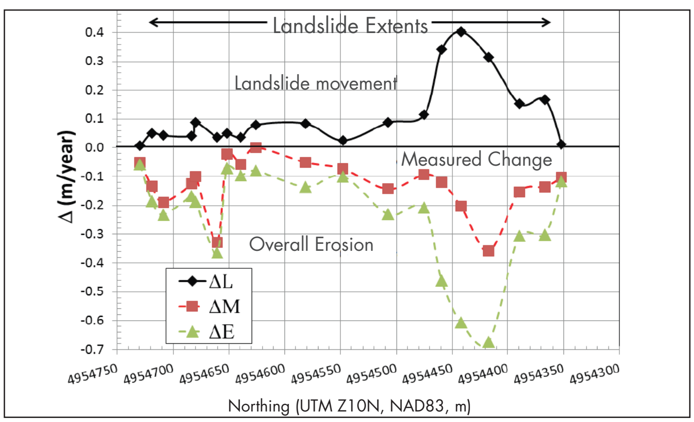
some of the most problematic areas for highway maintenance are the landslide-prone sea and riverside cliffs. An airborne laser scanner looks down from above, and doesn't "see" the vertical sides of cliffs.

Researcher Michael Olsen and his team used TLS, or terrestrial laser scanning, with a scanner mounted on a tripod. As a supplement to the aerial views, the ground-based scans fill in missing information about vertical cliffsides. The team also developed an algorithm that allows landscape changes, even minute alterations, to be detected immediately in the field rather than through analysis later. The program they created, called LISCAN, combines the fast-working algorithm with a simple-to-use interface that works with the TLS units.

In developing the process, Olsen and his team worked on two test sites along Oregon's coastal route, Highway 101: the Spencer Creek Bridge site and the Johnson Creek landslide. The Johnson Creek landslide site, they found, does show active movement. The team collected baseline information for these sites, then took new scans. By comparing newly acquired scans to their baseline information, they were immediately able to see what change had happened in the interim. The algorithm works quickly, executing its comparisons within less than a minute. This allows research teams to analyze data while still in the field so that they can make additional observations and better understand the geologic processes of the site.

Implications

ODOT stands to be able to use these methods to significantly decrease the amount of money and staff time they spend repairing road damage from landslides. LISCAN, the open-source program that was developed by researchers on this project, will be provided to ODOT for use in monitoring hazardous sections of highways. Real-time change detection in the field has the potential to help stop highway damage before it occurs.



Rates of movement for the Johnson Creek landslide from 2007 to 2011.

Landslide movement, change, and erosion rates for the Johnson Creek landslide site. Positive values indicate movement towards the ocean; negative values represent movement away from the ocean.

With a tripod-mounted TLS unit and a computer that can run the program (LISCAN is able to function on a range of hardware, from workstation units to mobile laptops), field workers will be able to visit sites that are known from past scans to be areas of high soil movement, and routinely monitor the change that has happened since the last time the area was scanned.

Additionally, improvements are planned for future versions of LISCAN, to increase the usability, performance, and functionality of the program based on developer and user feedback.

PROJECT INFORMATION

TITLE: Real-Time Change and Damage Detection of Landslides and Other Earth Movements Threatening Public Infrastructure

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MORE INFORMATION
http://otrec.us/project/398

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