Ground-Based LiDAR

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The Reconnaissance Problem:

We want to collect and archive highly detailed, accurate spatial measurements of damaged ground and structures, and do this rapidly, with limited budget?

Solution: Tripod-mounted LiDAR
Ground-Based LiDAR

- LiDAR (Light Detection And Ranging)
- Portable & light tripod-mounted systems
- Fixed or Rotating laser-line scanner systems
- Produces 3-D target positions at up to 500k positions/minute
- Range: Up To 1 kilometer around Tripod under optimal atmospheric conditions

Distance = (Speed of Light x Time of Flight) / 2
LiDAR & GEER: Bringing damage ground and structural morphologies back to the lab for analysis, and as a permanent record of event effects.

- Rapid data collection of damaged terrain.
- Ultra-high accuracy terrain models for deformation calculations and change detection.
- Archive-quality spatial models of damage.
- 3-D spatial visuals and fly-through videos for engineering analysis and public outreach.
LiDAR Systems at the USGS

Riegl z210i
General Purpose Mapper:
• 700m+ Range
• Max. X,Y,Z Accuracy 0.9 cm
• Targets: 5.6M in 11 minutes
• Scan window: 80° by 336°

OpTech ILRIS-3D
Narrow window High-Res Mapper
• 300m+ Range
• Max. X,Y,Z Accuracy 0.3-0.4 cm
• Targets: 1.8M in 15 minutes
• Fixed window: 40° by 40°

USGS-Geologic Division System
USGS-Water Resources Division System
Denali Fault offset at
Trans Alaska Pipeline, 7/2004:
Single Riegl z210i Scan range 580m
LiDAR Systems at the USGS

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USGS-GD System

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USGS-WRD System
Point Resolution
Spacing: ~2mm
near tripod
with 9mm 3-D resolution

Parkfield 10/4/04

Traditional post-slip survey marks

~30 cm

Fissure
Sub-cm 3-D spatial deformation measurements of minor or significant damage at distances up to 700-1000m

Minor Fissures
LiDAR Data Processing

**Riegl z210i**
- Single or Multiple scans.
- Merge point cloud data with I-Site3D
- Triangulated surface (TIN) for measurement and change detection using I-Site3D

**OpTech ILRIS-3D**
- Multiple scans to expand scan window & eliminate shadow zones.
- Merge point cloud data, produce triangulated surface (TIN) with PolyWorks.

**USGS-GD System**

**USGS-WRD System**
Merging scans to eliminate shadow zones

Example: single scan of 50-60 cm Denali Fault scarp.

Merging scans to eliminate shadow zones
Denali Fault: Merge of 2 scans to produce fewer shadow (no data) zones in surface model. High quality DGPS geo-referencing needed for merge.
Denali Fault: Merging of 8 scans to produce a largely shadow free surface model of rupture
Digital Terrain Model Generation

TIN surfaces ready for change detection analysis

Height of Bluff ~60 feet

Blue=Oct 2002
Orange=Jan 2003
Purple=March 2003
Green=May 2003

Summary

- GEER-EERI-USGS can utilize ground-based LiDAR to collect damage morphology data at speeds, accuracies, and range that was previously unimaginable in earthquake reconnaissance.
- These permanently archived terrain models will vastly improve controls on empirical deformation studies and allow researchers decades later to virtually-revisit damage sites.
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