The DAS experiment using MIT telecommunication dark fibers

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The DAS experiment using MIT telecommunication dark fibers

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Telecom cable as seismic antenna

• With Distributed Acoustic Sensing (DAS): Measuring strain rate.

• Applications
  • Traffic monitoring
  • Shallow/deep structure
  • Subsurface properties changes monitoring

Stanford (Lindsey et al., 2020)                   Goldstone (Yu et al., 2019)
Content

• The DAS experiment overview
• What is in the data?
• Bonus:
  • Collocated active geophone survey
• Analysis in progress
The dark-fiber underlying the MIT campus

Cable length ~ 2 km (1.2 mile)
The dark-fiber underlying the MIT campus

- Buried at 2—5 ft depth underground
- Bundled in layers of polyethylene and plastic tubing.
- Suspended when passing main buildings.
On-campus DAS demonstration with Silixa

1. Tutorial in the classroom.

2. Setting up in the telecommunication cable hub at Building 24.
Real-time monitoring

https://drive.google.com/file/d/1L8ZcDbf9SHfFfHENttMm_K92NNT7gVhZ/view
Locate the DAS channels on the map

- Using tap test during quite time
What is in the data?

• 5 days of continuous data

Corresponding locations identified by tap test
What is in the data?

- 5 days of continuous data

Weekend

Construction operations

Trains?
Dominant frequency band 0.1–30 Hz

• Evolution of spectra (strain rate)

The Briggs Field

The Kresge construction site

Mass Ave
Construction operations

The Kresge construction site

1000 m/s
Traffic and train tracks

Vassar Street

Vehicles along Vassar street

Small train passing
Target teleseismic earthquakes in the 5 days.

NE.BCX seismic station

M7.3 in Japan

M5.0 in Mid-Atlantic

NE.BCX: 6 km away from MIT

BCX seismic station recordings
Earthquake arrived at busy time is buried behind local noises.

• M 7.3 in Japan

BCX station
Particle Velocity

DAS strain
Stacked along Vassar street (~300 channels)

Lunch time of nearby construction site
Earthquake arrived at quite time have better chance to be identified.

- M5.0 Mid-Atlantic

**BCX station**

Particle Velocity

**DAS strain**

Stacked all NE-SW oriented cable sections (~1400 channels)

Phase-weighted stacking

\[ s(t) = \frac{1}{N} \sum_{j=1}^{N} x(t)_j c(t)_j \]
Potential for subsurface monitoring

• Using interferometry to extract signals.

230 m/s
At 2—4 Hz

Vassar st
Briggs field
Dorm 3
Collect co-located active geophone data

• Hammer source
Geophone data can be used as constraints

Geophone

Surface wave
200 m/s

Shear wave?
900 m/s

Agree with previous DAS observations.

DAS

Vibration due to poor coupling.
Analysis in progress

• Receiver functions
  • Explore different processing strategy to enhance teleseismic signal.

• Subsurface properties analyzing/monitoring
  • Using local sources (source distributions?).
  • Compare with geophone data.

• Traffic monitoring.
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