Extracting subsurface information based on extremely short period of DAS recordings

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Outline

➢ Introduction

➢ Processing workflow
  • PEF interpolation to remove the near-field traffic noise

➢ Interpreting the phase velocity
  • Benchmarking with month-long DAS data
  • Phase velocity changes using 100-second DAS data
  • Average velocity changes using 100-second DAS data

➢ Conclusions
Introduction: challenges in Distributed Acoustic Sensing (DAS)

(1) Real-time processing;
   • Early warnings of the potential hazards in the near-surface.

(2) Huge dataset management;
   • 8Tb/ week (Tribaldos et al., 2019)

One possible way to solve the problems is:

*Using short period of DAS recordings to extract the reliable subsurface information.*
Introduction: Stanford DAS Array

Main road

(1) To prove that reliable information can be extracted using short period of DAS data;
(2) To see if there are any velocity changes before and after the basement construction.
Introduction: problem of using existing DAS data

Bandpass filtering

Median and FK filtering

Correlogram

0.25~10Hz
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Synthetic data example

Gapped data

Interpolated data by Prediction error filter (PEF) interpolation
Synthetic data example

Correlogram

Phase Velocity Spectrum
Synthetic data example

Correlogram

Phase Velocity Spectrum
Processing workflow

**Raw 100-second noise record**

**Ambient – noise interferometry**
1. 0.25~10Hz bandpass filtering;
2. Remove near-field traffic noise using PEF (prediction error filter);
3. remove spikes using median filter;
4. FK filtering.

**Correlograms**

**Dispersion analysis**
1. Use Fourier transform followed by a phase shift and stack along the offset to get the dispersion spectrum.

**Dispersion curve(s)**
Data after processing (without PEF interpolation) and its correlogram
Data after processing (with PEF interpolation) and its correlogram
Phase velocity spectra: without and with PEF interpolation

Without PEF interpolation

With PEF interpolation
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Benchmarking with month-long DAS data

(Martin and Biondi, 2018; Martin, 2018; Spica et al., 2019)
Benchmarking with month-long DAS data

Correlogram and phase velocity spectra using 100s data

Using “\” signal
(traffic noise and signal from the quarry blast)

Using “/” signal
(traffic noise)
Benchmarking with month-long DAS data

Using "\" signal (traffic noise and signal from the quarry blast)

Using "/" signal (traffic noise)

(Martin and Biondi, 2018; Martin, 2018; Spica et al., 2019)
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Phase velocity changes
Correlograms using 100-second DAS data
Phase velocity changes along the basement line

Using “/” signal (traffic noise and signal from the quarry blast)

Using “\” signal (traffic noise)
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Average velocity changes
## Reference velocity

<table>
<thead>
<tr>
<th>Event Time</th>
<th>Velocity (m/s)</th>
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<tbody>
<tr>
<td>2016/09/14</td>
<td>781</td>
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<tr>
<td>2016/09/19</td>
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<td>2016/11/28</td>
<td>836</td>
</tr>
<tr>
<td>2016/12/15</td>
<td>817</td>
</tr>
</tbody>
</table>

Avg. Vel.: 817m/s  
Std/Avg.Vel: 3.2%
Average velocity changes along the basement line

Before construction

After construction
Average velocity changes along the basement line

Red: Before construction
Green: After construction
Average velocity changes along the basement line

Baseline Velocity drop: 12.5%

867m/s
859m/s
824m/s
830m/s
827m/s
721m/s

Before construction

After construction

Velocity drop: 12.5%
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Conclusions

1. Using very short period of DAS data, we can extract the reliable information. It may be a good solution to the existing challenges of DAS.

2. To remove the near-field traffic which is hard to be filtered and occurred at isolated time and space, we first mute it and then interpolate the missing data using PEF.

3. We have observed velocity changes due to the basement construction from both dispersion curves and the average velocity profile.
Acknowledgments

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