A sparsity-based adaptive filtering approach to Shear Wave Splitting

H. Mohammadigheymasi[1] MR. Ebrahimi G. Silveira[2,3]
D. Schlaphorst[2]

[1]University of Beira Interior, Computer sciences, Portugal

[2]Instituto Dom Luiz, Faculty of Science, University of Lisbon, Portugal

[3]Instituto Superior de Engenharia de Lisboa, Portugal

26 April 2021

Shear Wave Splitting

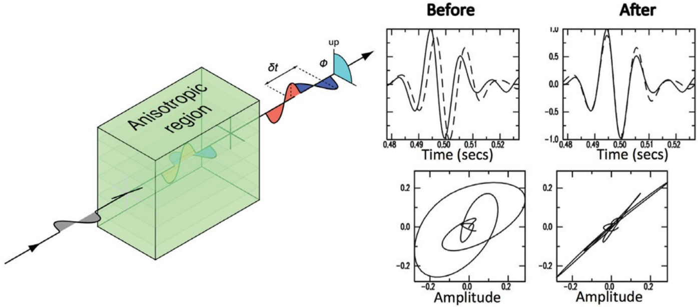

Figure: Processing of split shear waves. Fig from Kendall et al.(2014).

Challenges to process the data

- **Contaminated noise**
- **Interfering phases,**
- **Length of the analyzed waveform**
- **Stability and reliability of results,**

Theory: Sparsity-based adaptively filtering

- The work is an extension to [Jurkevics(1988)].
- Time-frequency decomposition as an optimization problem with a sparsity constraint [Gholami(2012)]:

$$\boldsymbol{\alpha} = \arg\min_{\boldsymbol{\alpha}} \frac{1}{2}\|\mathrm{G}\boldsymbol{\alpha} - \mathrm{x}\|_2^2 + \mu\|\boldsymbol{\alpha}\|_1 \qquad (1)$$

- Semi-minor and semi-minor axis of the polarized motion in TF-domain is obtained by solving eigen-problem

$$\begin{aligned} \mathrm{SM}(\mathrm{k},\mathrm{l}) &= ||\mathrm{SM}(\mathrm{k},\mathrm{l})||_2 = \tfrac{\sqrt{2}\lambda_1}{\mathrm{L}}||\mathrm{u}_1(\mathrm{k},\mathrm{l})||_2, \\ \mathrm{Sm}(\mathrm{k},\mathrm{l}) &= ||\mathrm{Sm}(\mathrm{k},\mathrm{l})||_2 = \tfrac{\sqrt{2}\lambda_2}{\mathrm{L}}||\mathrm{u}_2(\mathrm{k},\mathrm{l})||_2, \end{aligned} \qquad (2)$$

- The information of semi-minor axis is utilized to design an adaptive filter to amplify the elliptically polarized signals and suppress the noise and interfering phases.

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Evaluation of the method:

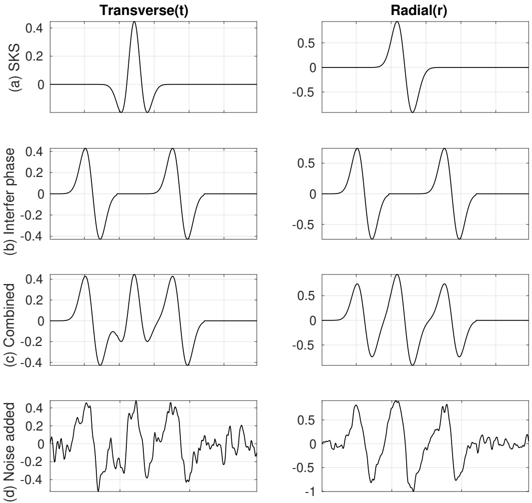

Figure: Panels (a): Transverse and Radial components of clean data, (b): interfering non-polarized events, (c): adding (a) and (b), and (d): noise added.

Evaluation of the method:

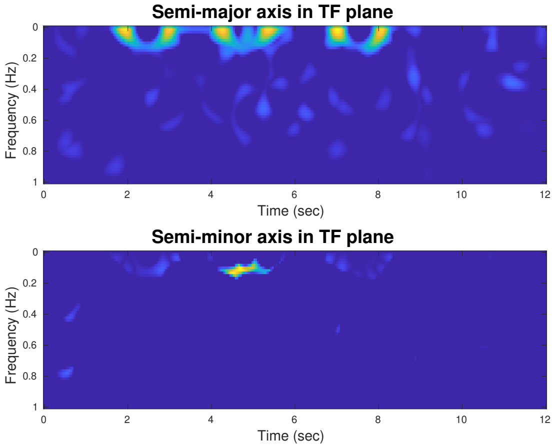

Figure: Top: TF-domain semi-major and bottom: semi-minor axis of the signal.

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Evaluation of the method:

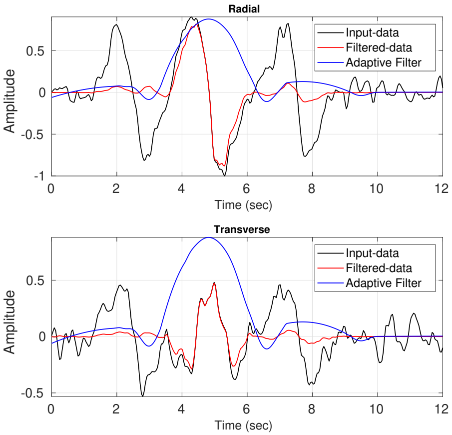

Figure: Adaptive filtering of the data.

Numerical example

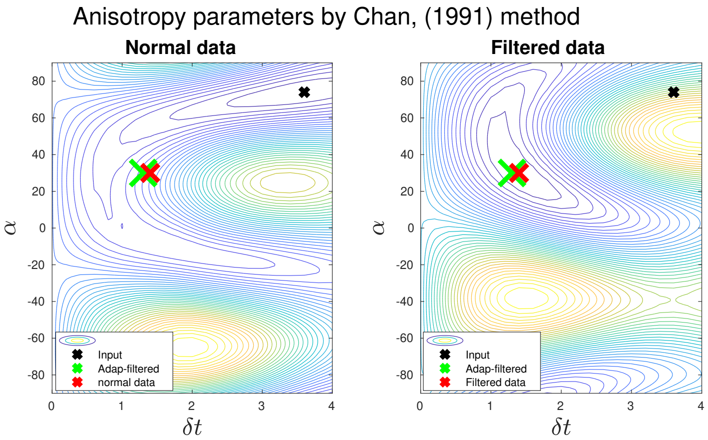

Figure: Anisotropy parameters obtained from the raw data and filtered data.

Future work:

Future work involves implementing the processing algorithm on real data recorded in São Tomé and Príncipe, Madeira, and Canary islands.

Acknowledgement

This research contributes to the FCT-funded

- SHAZAM (Ref. PTDC/CTA-GEO/31475/2017), and
- SIGHT (Ref. PTDC/CTA-GEF/30264/2017)

projects.

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THANKS FOR YOUR ATTENTION