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Multiple snapshot compressive matched field processing

Kay L. Gemba, William S. Hodgkiss, and Peter Gerstoft

Marine Physical Laboratory Scripps Institution of Oceanography University of California, San Diego gemba@ucsd.edu

CS approach to geophysical data analysis



Presentation Objectives

- 1. Compressive sensing (CS) is equivalent in tracking performance to the Bartlett processor for a single-source scenario using single and multiple snapshots.
- 2. CS behaves equivalently to an adaptive processor. The output of CS is compared to the white noise constraint (WNC) processor in a two-source scenario. The scenario includes geo-acoustic parameter mismatch, requiring each processor to discriminate against false source locations.
- Results are demonstrated using data (SwellEx-96)

Single Snapshot compressed sensing

Single snapshot minimization problem using ℓ_1 - norm.





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Multiple Snapshot compressed sensing

Multiple snapshots (L is the # of snapshots)

$$\hat{\mathbf{X}} = \underset{\mathbf{X} \in C^{MxL}}{\operatorname{argmin}} \| B - SX \|_{2}^{2} + \lambda \| X \|_{21}$$

→ a new solution for every snapshot
 Thus complex amplitude of X can
 vary across snapshots

Conventional MFP:

$$\mathbf{x}(d,r) = \frac{1}{L} w^H (BB^H) w$$

Single magnitude for all snapshots



- S is $n \times m$ measurement/Dictionary matrix, m >> n
- x is $m \times L$ desired matrix which is sparse with r nonzero
- ε is the measurement noise



Bartlett processor

Compressive sensing



Tracking 2 sources – Processor comparison



Data source location (Interferer with SNR = 9)



- Injected source location (quiet source)
- CS computes 9 solutions
- WNC is constant at -2.5 dB
- Parameters:
 - Frequency: 166 Hz
 - Resolution:
 50 m range, 10 m depth
 - 28 snapshots (50% overlap, using 40 seconds of data for each event)



Tracking 2 sources



CS has adaptive capabilities





Conclusions



- CS and the Bartlett processor yield identical localization results for a single source using single and multiple snapshots.
- CS is comparable to the performance of the WNC processor. It behaves similar to an adaptive processor and can discriminate against false source locations.
- The connection between WNC and CS requires further investigation.

- End of presentation -