Introduction

The acoustic signal from a remote source recorded by an underwater hydrophone array is commonly distorted by multipath propagation.

Blind Deconvolution Technique

Blind deconvolution is the task of determining the source signal and the impulse response from array-recorded sounds when the source signal and the environment’s impulse response are both unknown. Synthetic time reversal (STR) is a passive blind deconvolution technique that relies on generic features (rays or modes) of multipath sound propagation to estimate the original source signal and the source-to-array impulse responses.

\[
P_j(t) = \frac{1}{\sqrt{2\pi}} \int G(r_i, t-t_j) S(t_j) dt_j, \quad \tilde{P}_j(\omega) = \tilde{G}(r_i, \omega) \tilde{S}(\omega)
\]

Develop a correction phase:

\[
\alpha(\omega) = \arg \sum_{i=1}^{N} \Psi_i(\omega) = \phi(\omega) + \frac{R}{c} \omega
\]

Recovering the Green’s function:

\[
\tilde{G}(r_i, \omega) = \frac{\tilde{P}_j(\omega)}{\sqrt{\sum_{i=1}^{N} |\tilde{P}_j(\omega)|^2}} \exp[-i\alpha(\omega)] = \frac{\tilde{G}(r_i, \omega)}{\sqrt{\sum_{i=1}^{N} |\tilde{G}(r_i, \omega)|^2}} \exp[-i\alpha(\omega)]
\]

Recovering the source signal:

\[
\hat{S}(\omega) = \sum_{i=1}^{N} \tilde{G}(r_i, \omega) \tilde{P}_j(\omega) = \frac{1}{N} \sum_{i=1}^{N} \tilde{P}_j(\omega) / \tilde{G}(r_i, \omega)
\]

Results

- Lake Washington (CAPEX09)
- Source signal: 50 ms chirp
- Bandwidth: 1500-4000 Hz
- Source to array range: 100 m
- Number of receivers: 32
- Element distance: 0.22 m
- Bottom of lake: muddy

Whale Localization

- Vertical Array: 12 elements, Spanning the middle 60% of the water column
- DASARs: (Directional Autonomous Seafloor Acoustics Recorders)

Conclusions

The vertical array ranging results are generally within ±10% of the DASAR results. The results suggest that numerous precisely time-synchronized instrument packages across a wide region (several deployments) can be replaced by a vertical array (single deployment).

Current Work

My current research focuses on passive acoustic detection and localization of whale calls in vicinity of seismic survey. This research focuses on the analysis of baleen whale calls recorded before, during, and after periods of active seismic activity to look for any changes in calling patterns or frequencies as well as animal locations where possible.

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References