Tracking Multipath Structures in Shallow Water Acoustic Channels using Nonlinear Feature Representations

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• **Research Question:** Given an estimated Delay vs. time channel, can we track and adapt to dynamic dominant parts of estimated channel?

• **Purpose:** Interpret multipath events as it evolves in delay and time. Moreover, tracking these events can help us improve channel estimation time by localizing estimating to dominant channel activity.

Description

Method

- Braiding utilizes the complex nature of channel
- Plot real and imaginary point: $D_0 = (t_0, \tau_0)$
- Examine set $N = \{(t_0 + 1, \tau_0 \pm r \geq i)\}$
- Closest angle to $D_0$ is best path

Example Braid
Results

1. Varying Thresholding

\( t \ll \text{Half Max Height} \)

\( t \sim \text{Half Max Height} \)

\( t \gg \text{Half Max Height} \)
Results

2. Varying Range

Braided Estimated Channel

\[ r = 1 \]

Braided Estimated Channel

\[ r = 4 \]
Results

<table>
<thead>
<tr>
<th>BELLHOP Simulation Parameters</th>
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<tbody>
<tr>
<td>Range</td>
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<tr>
<td>200 m</td>
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</table>

(1) Estimated Channel
5 db added AWGN SNR

(2) Initialized Braid choices

(3) Thresholding at 0.10

(4) Braided Estimated Channel
Discussion

• Varying Thresholding- increasing thresholding constraint includes more taps for consideration in the braid path including non-dominant taps.

• Varying Range- when the range is large, braiding fluctuates in the delay more covering the spread of activity in the channel.
Future Work & Conclusion

• Braids form a feature representation of the channel to track and adapt to multipath activity
• Can be utilized for improved and localized channel estimation
• Use braids as feature extraction for machine learning