Exploiting Interference Diversity for Event-Based Spectrum Sensing

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Motivation: recovering spectrum holes
Motivation: existence-based detection
Motivation: change of perspective
Outline

- Motivation
- Fundamental limits of existence-based detection
- Event-based detection
- When the local-global assumption fails
Noise uncertainty

![Diagram showing noise uncertainty with overlapped regions and reduced signal energy.]
Max-Min eigenvalue detector and noise uncertainty

\[ H_0 : \text{Covariance Matrix} \rightarrow \sigma_w^2 I \]

\[ H_1 : \text{Covariance Matrix} \rightarrow \sigma_w^2 I \]
Importance of interference on noise uncertainty
Outline

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## Description

<table>
<thead>
<tr>
<th><strong>Detector:</strong></th>
<th><strong>Traditional Existence-based</strong></th>
<th><strong>Event-based</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypotheses:</strong></td>
<td>High-power vs low-power</td>
<td>Increased vs decreased vs unchanged power</td>
</tr>
<tr>
<td></td>
<td>( H_0[n] ): primary on at time ( n ); ( H_1[n] ): primary off at time ( n );</td>
<td>( H_-[n] ): negative edge at time ( n ); ( H_+[n] ): positive edge at time ( n ); ( H_I[n] ): otherwise.</td>
</tr>
<tr>
<td><strong>Detector statistic:</strong></td>
<td>Received power-level</td>
<td>Change in received power-level</td>
</tr>
<tr>
<td><strong>False alarms:</strong></td>
<td>Noise higher than expected</td>
<td>&quot;Noise&quot; increases suddenly</td>
</tr>
<tr>
<td><strong>Missed detections:</strong></td>
<td>Noise lower than expected</td>
<td>&quot;Noise&quot; drops suddenly</td>
</tr>
<tr>
<td><strong>Dom. uncertainty:</strong></td>
<td>Number of active interferers</td>
<td>Activity pattern of interferers</td>
</tr>
</tbody>
</table>

\[
H_0 \quad \text{primary on at time } n; \\
H_1 \quad \text{primary off at time } n;
\]

\[
H_- \quad \text{negative edge at time } n; \\
H_+ \quad \text{positive edge at time } n; \\
H_I \quad \text{otherwise.}
\]
Insensitive to uncertainty in the level of energy
Edge-detection: a simple approach to sensing events
Distinguishing primaries and interferers
Signal Strength = 0.6
Distinguishing primaries and interferers: cooperation
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- Event-based detection
- **When the local-global assumption fails**
Revisiting interference diversity
Revisiting interference diversity

Signal Strength = 0.6
Revisiting interference diversity

Signal Strength = 0.3
Revisiting interference diversity

Signal Strength = 0.15
Gradual invalidation of local-global assumption
Gradual invalidation of local-global assumption
Mobility and interference diversity
Mobility and interference diversity