**Problem Formulation**

**Challenge Summary**

False detections on non-target waveforms are more frequent than on target waveforms.

Non-target detections occur when partially coherent waveforms have sufficient projection onto the template signal to exceed the threshold for event declaration.

The null hypothesis do not predict presence of dissimilar waveforms.

**Solutions Requirements**

False detections are statistically predictable with prescribed false alarm rates.

Non-target waveforms should produce a sub-threshold statistic.

Revised detector should require minimal modification to current detection to accomplish objective.

Detection performance must be quantitatively verifiable.

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**Solution Development: A Representative Hypothesis Test**

**Hypothesis Testing with a Representative, Implicit Signal Model**

We use an implicit signal model that includes target and non-target waveforms. Each signal channel corresponds to a sensor. The sensor is a set and defined by the correlation of it's member with the stochastic template waveform. The performance of the false alarm detector is generally illustrated by considering projections, $|P_w|^2$, onto the signal set and the target.

$$ P_w = \frac{\| \mathbf{w}^* \|}{\| \mathbf{w} \|} $$

**False Alarm Rates with the Cone Detector**

The implicit cone model of the detector is based on generating a large number of cone distributions. Each cone distribution is set to generate a new signal at random. The false alarm rate can then be calculated by the number of signal distributions that exceed a given threshold divided by the number of all possible signals.

$$ P_f = \frac{\| \mathbf{w}^* \|}{\| \mathbf{w} \|} $$

**Solution Synthesis: Screening Non-Target Waveforms**

The simplest solution combines the signal geometries.

$$ H_0: \mathbf{x} = \mathbf{n} + \mathbf{w} \sim N(\mathbf{0}, \sigma_w^2 I) \quad \mathbf{C} $$

$$ H_1: \mathbf{x} = \mathbf{n} + \mathbf{w} \sim N(\mathbf{n}, \sigma_t^2 I) $$

**The Convex Detector Outperforms the Correlation Detector With Real Data**

The convex detector combines the implicit signal model and the template data. The convex detector is defined by the convex set $\mathbf{C}$, which is the set of all vectors $\mathbf{x}$ such that $\mathbf{x} \in \mathbf{C}$.

$$ \mathbf{C} \subset \mathbf{R}^n $$

**Concluding Remarks and Continuing Work in Multichannel Detection**

The results demonstrate that a representative hypothesis test is necessary to reduce the rate of detection on non-target waveforms. We have implemented an implicit, convex cone model that is based on the template data. These results are verified by using both the convex cone hypothesis and the traditional correlation hypothesis. The convex cone detector has reduced the detection of non-target data while maintaining acceptable performance on target data.

**References and Support**


