Compressive Domain Interference Cancellation

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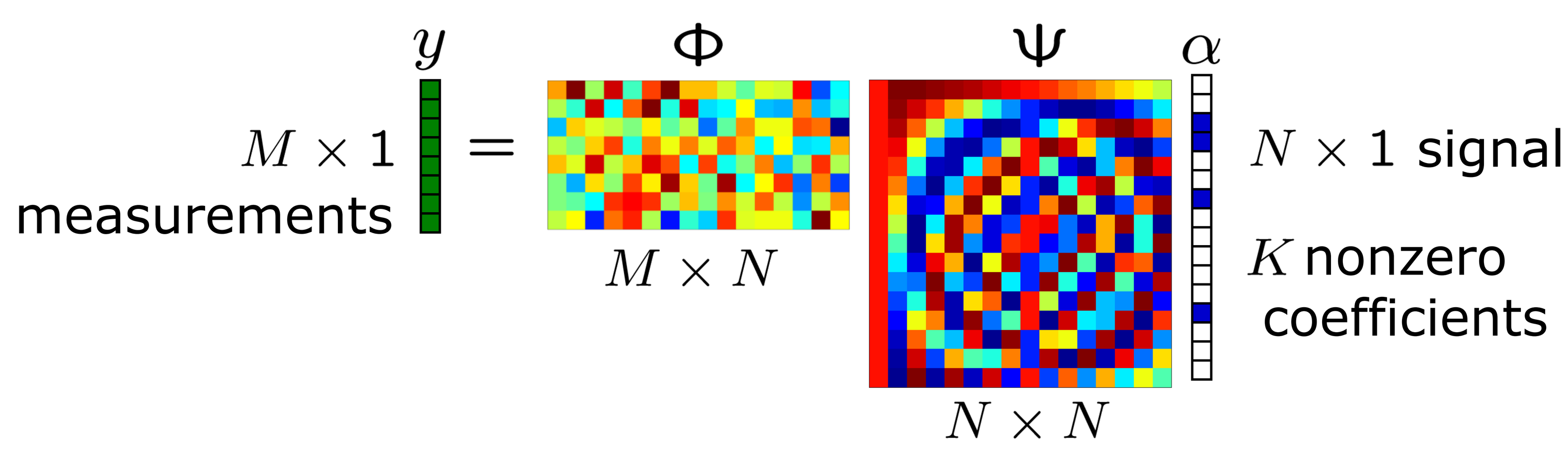
Compressive Sensing

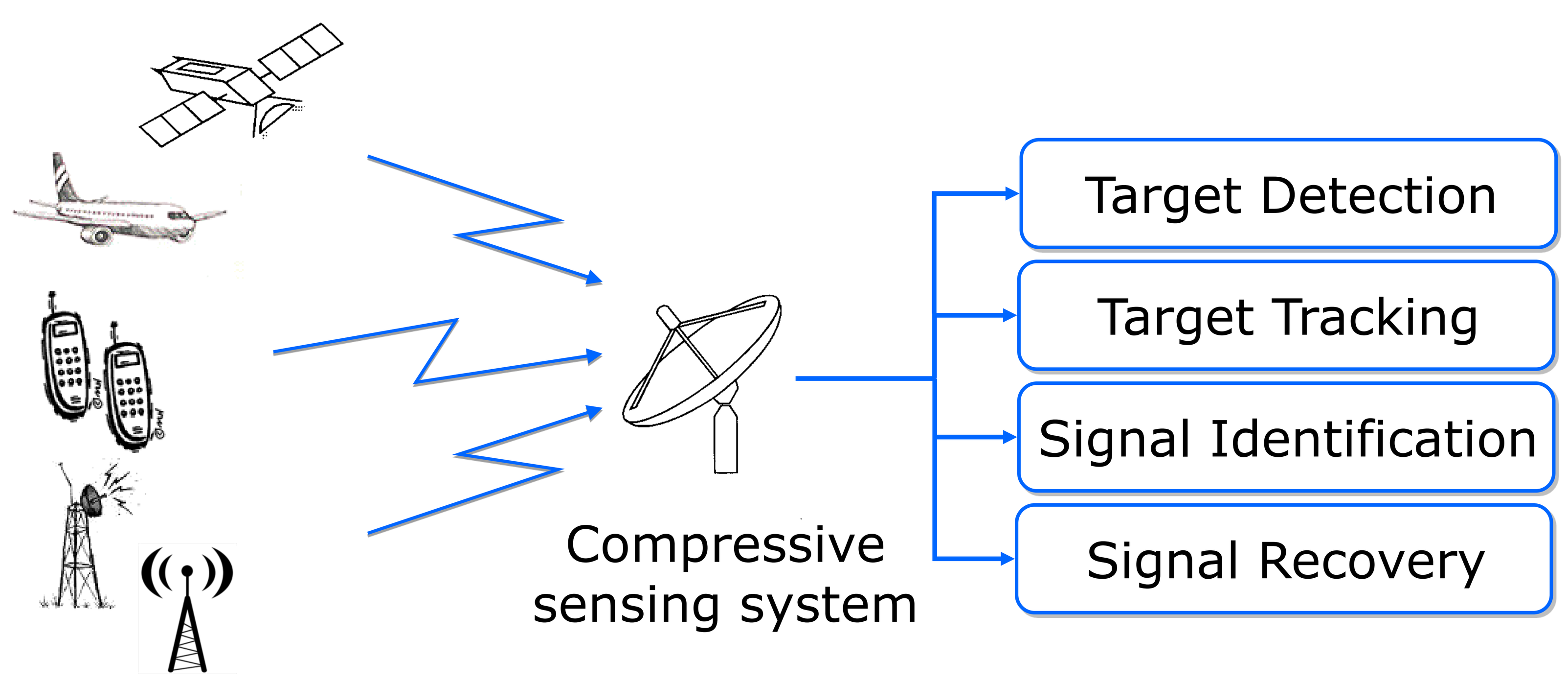
Directly acquire a reduced set of low-dimensional ***compressive measurements***



The ***restricted isometry property*** (RIP) ensures that Φ captures the information in the signal

$$a\|\alpha\|_2^2 \leq \|\Phi\Psi\alpha\|_2^2 \leq b\|\alpha\|_2^2 \quad \forall\alpha \quad \|\alpha\|_0 \leq K$$

Random Φ satisfy the RIP provided that $M = O(K \log(N/K))$, and provide ***information scalability***



Interference Cancellation

Measurements are often contaminated with ***interference***

$$y = \Phi x_S + \Phi x_I$$

Seek to remove contribution of x_I to y without necessarily reconstructing $x = x_S + x_I$

x_I might represent actual interference, or signals we wish to ignore for some intermediate processing

General Technique

Assume $x_S \in \mathcal{X}_S$ and $x_I \in \mathcal{X}_I$, where $\langle x_I, x_S \rangle = 0$ for all $x_S \in \mathcal{X}_S$, $x_I \in \mathcal{X}_I$

Design $\widetilde{M} \times M$ matrix P such that

$$\|P(\Phi x_I)\|_2 \approx 0 \text{ and } \|P(\Phi x_S)\|_2 \approx \|\Phi x_S\|_2$$

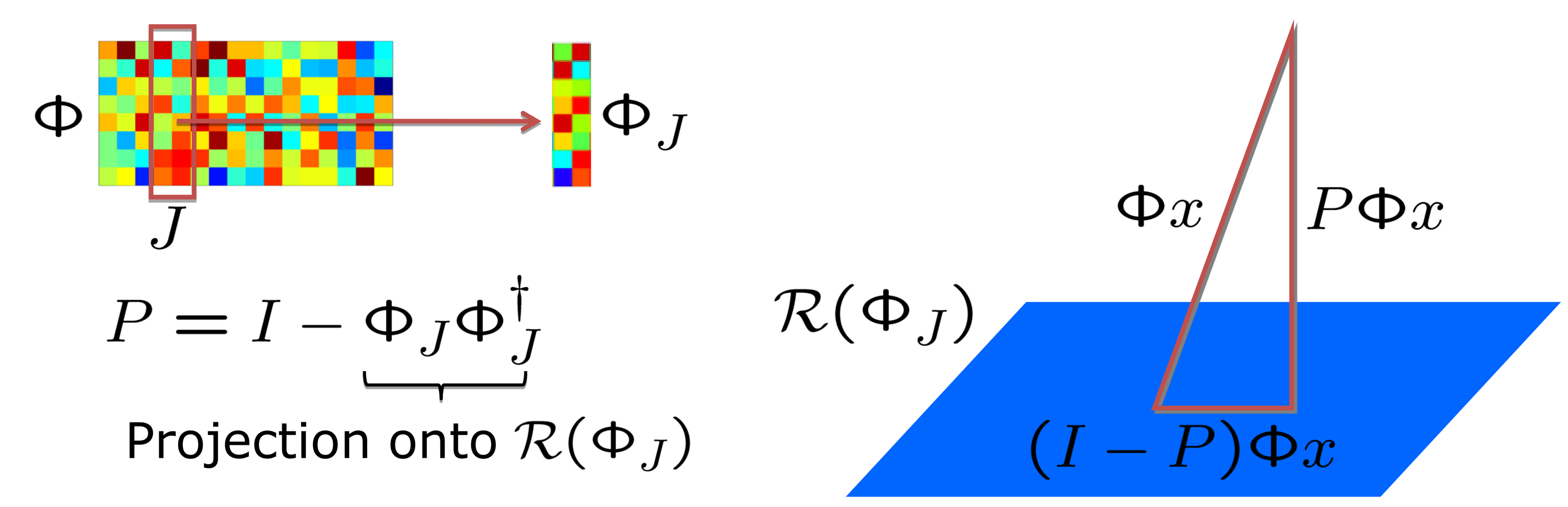
Note: Not always possible

Depends on structure of $\mathcal{X}_S$ and $\mathcal{X}_I$

Subspace Cancellation

Example: x_I has known support set J of size K_I

Seek P such that $\mathcal{R}(\Phi_J) \subseteq \mathcal{N}(P)$



Observe that $Py = P\Phi x_S + \cancel{P\Phi x_I}$
$= P\Phi x_S$

Theorem: If Φ satisfies the RIP of order $2K_S + K_I$, then $P\Phi$ satisfies

$$\left(a - (b-a)^2/4a\right)\|x\|_2^2 \leq \|P\Phi x\|_2^2 \leq b\|x\|_2^2$$

for all x such that $\|x\|_0 \leq 2K_S$ and $\text{supp}(x) \cap J = \emptyset$.

Proof exploits two facts:

$$\|\Phi x\|_2^2 = \|P\Phi x\|_2^2 + \|(I-P)\Phi x\|_2^2$$

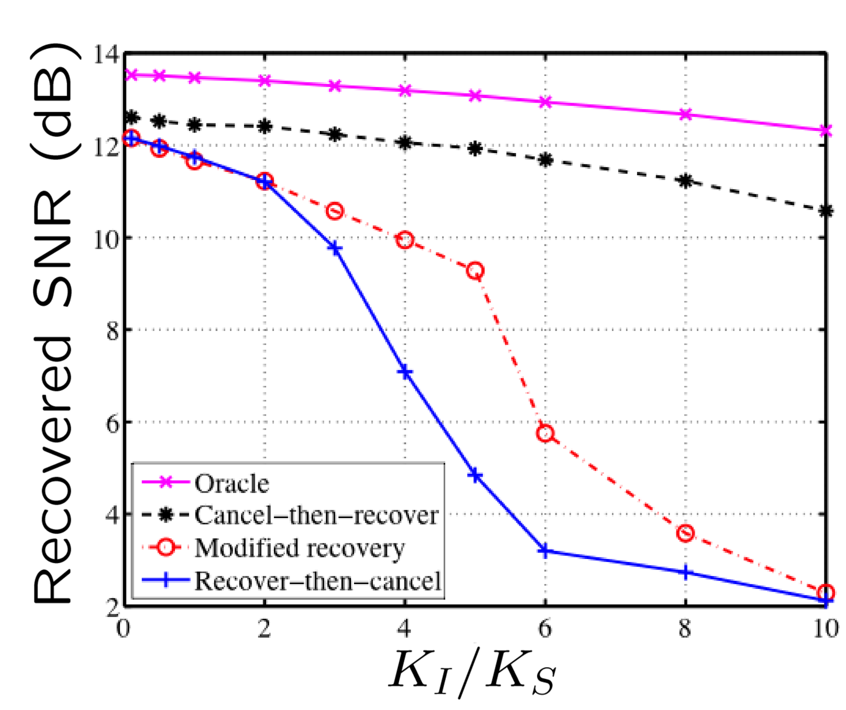
$$\frac{\|(I-P)\Phi x\|_2}{\|\Phi x\|_2} = \frac{\langle (I-P)\Phi x, \Phi x \rangle}{\|(I-P)\Phi x\|_2 \|\Phi x\|_2} \leq \frac{b-a}{2a}$$

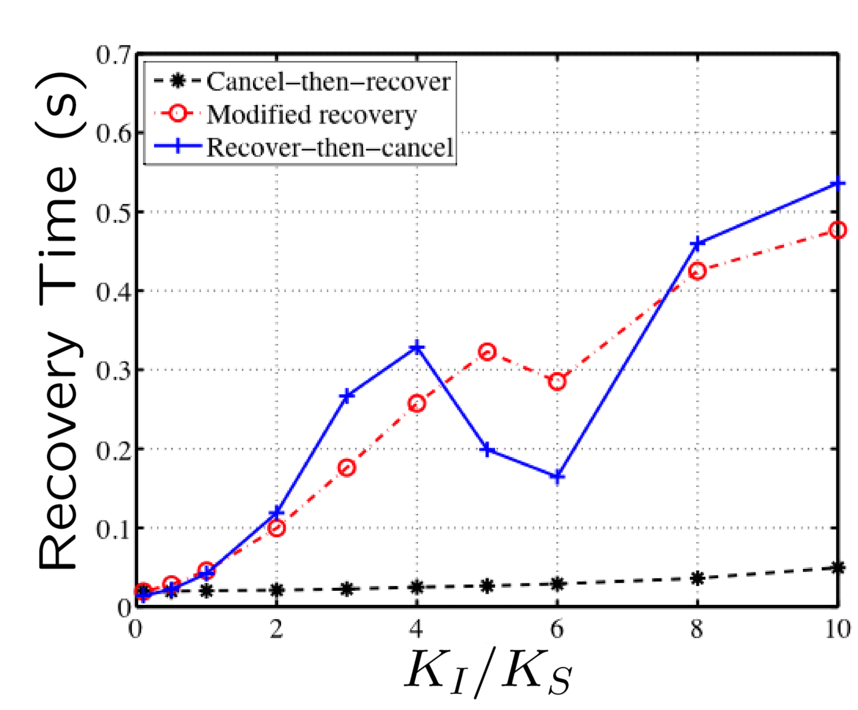
Experiments

Compare four approaches to cancelling interference with known support

1. Cancel-then-recover
2. Modified recovery
3. Recover-then-cancel
4. Oracle-based recover-then-cancel

Compressive domain interference classification is ***faster*** and ***more accurate*** than the recover-then-cancel approaches, and compares favorably to the performance of the oracle





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