Applications of Compressive Sensing to Communication Systems

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Project Goal

To investigate novel applications of *compressive sensing* and *sparse signal recovery* techniques to communication systems.
Compressive Sensing

The basic problem: recover $x$ from the linear measurement

$$y = A \cdot x + e$$

Where $A$ is a known $M \times N$ matrix, and $M << N$

In general, no unique solution exists (under-determined)

But when $x$ is sparse, can hope to find a solution

Sparse: when many entries of the vector are zeros
Problems Studied

- Multiple transmitter localization and footprint identification
  - Joint work with Venugopalakrishna YR, DN Dutt, SnehaLatha K

- OFDM channel estimation and data detection using sparse Bayesian learning
  - Joint work with Ranjitha Prasad
Multiple Tx Localization & Footprint Identification

- Multiple transmitter localization and footprint identification
- Use a small number of sensors to localize
- Want to minimize the number of transmissions from sensors to quickly construct the spectral usage map

![Diagram of footprint and alarming sensors](image)
Key Contributions

- Proposed 2 novel CS-based algorithms that reduce number of transmissions from sensors
- Proposed algs for est. num. tx, localize tx. compute comm. radius, etc.
- Determined num. sensors + num. tx required
Sparse OFDM Channel Estimation & Data Detection

- Typical OFDM channel: sparse in time domain
- SBL techniques are adapted to obtain sparse vector estimates for the OFDM channel
  - The algorithm is enhanced to obtain the EM-SBL algo.
- Proposed a pruning technique to further improve on the EM-SBL algorithm
- Simulations results demonstrates the improved performance in MSE, SER and the support recovery of sparse vectors
Simulation Result: MSE in channel estimate vs. SNR
Publications


Summary

Compressive sensing is a hot new area of research.

Offers potential benefits in a variety of applications:
- Image/video processing
- Communication systems
- Biomedical signal processing
- Etc.

The project has successfully studied two separate communication systems – related applications of compressive sensing.
Near-Future Plans

- Study of the fundamental limits of estimation via the Cramer-Rao Bounds on the estimation error of SBL
- Explore more advanced techniques for joint sparse OFDM channel estimation and data detection, e.g., in a MIMO setting
- Extension of the multiple transmitter localization and communication footprint identification to handle multiple-bit quantization at the individual sensors
- Study of the performance loss due to quantization, e.g., in terms of the Fisher information obtained from the alarming/non-alarming sensors