Bayesian Narrowband Interference Mitigation in SC-FDMA

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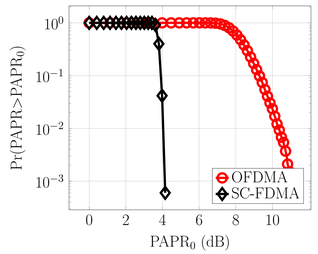
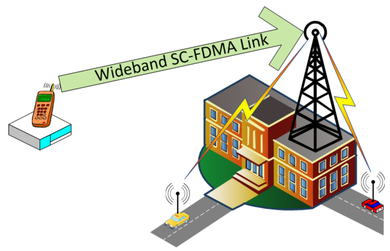
Why SC-FDMA?

- Low PAPR in comparison with OFDMA
- Used in the uplink of LTE [1]



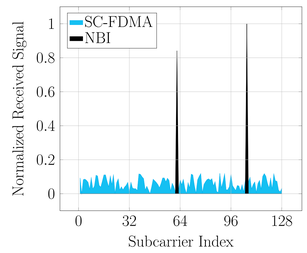
NBI Sources

- Cordless phones
- Garage door openers, etc.



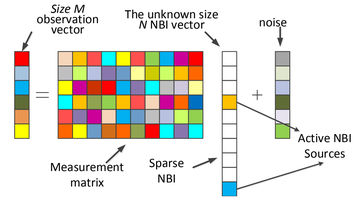
NBI Impact on SC-FDMA

- In low SIR regimes, even a single NBI source can completely destroy the data in SC-FDMA



Bayesian Sparse NBI Recovery

- Few active NBI source $\longrightarrow$ **Compressed Sensing** based recovery is possible
- Randomly chosen data points are kept data free to sense NBI at the receiver



Use **Bayesian** schemes for sparse recovery [2]

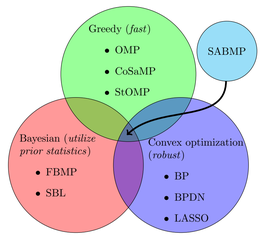
- Low computational complexity
- Good reconstruction accuracy
- Acknowledge Gaussianity of noise

Challenges

- **Unknown Prior**
  - Contemporary Bayesian schemes assume known distribution of the active elements e.g., Gaussian
  - The NBI distribution is generally not known
  - Even if the distribution is known, its parameter (i.e., mean and variance) estimation is difficult
- **Grid Offset**
  - The NBI sources could have a grid offset with the victim SC-FDMA system
  - This destroys the sparsity of the unknown NBI
  - Sprase recovery becomes difficult

Unknown Prior

- The NBI distribution may not be known
- Use support agnostic Bayesian matching pursuit **(SABMP)** [3]
- SABMP works by eliminating the non-Gaussian component of the measurements $\mathbf{y}$
- Low complexity and good reconstruction accuracy
- Successfully utilized in several applications

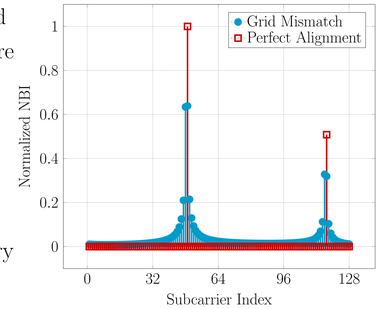


Sparsifying NBI

- If there is grid offset, sparsity need to be restored
- Conventionally *Windowing* is utilized to restore sparsity [4]
- We propose to use **Haar transform** as a sparsifying transform, i.e.,

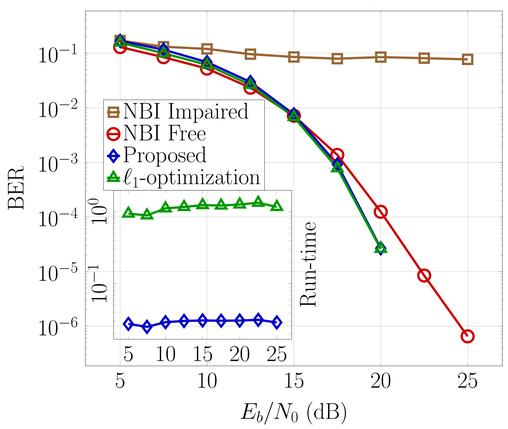
$$\mathbf{y} = \mathbf{A}\mathbf{x} + \mathbf{n} = \mathbf{A}\mathbf{H}^{\mathsf{H}}\mathbf{H}\mathbf{x} + \mathbf{n}$$

- Reconstruct $\mathbf{Hx}$ i.e., a sparse version of $\mathbf{x}$
- Unlike windowing, Haar transform is a unitary transform

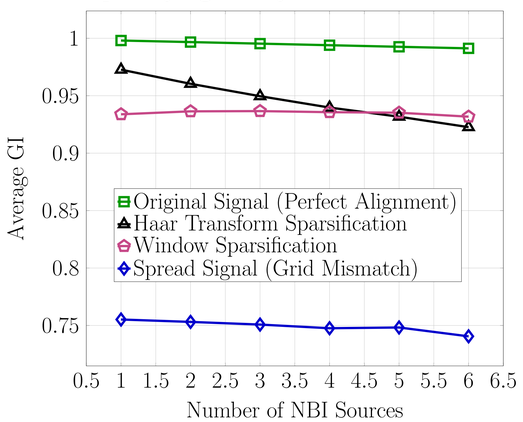


Results

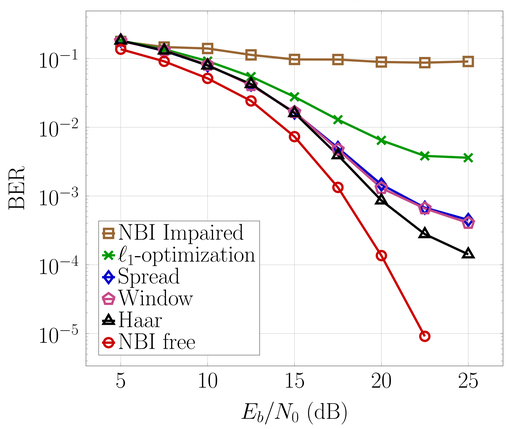
NBI recovery with no grid offset



Sparsifying ability of Haar transform



NBI recovery with grid offset



References

[1] H. G. Myung, J. Lim, and D. Goodman, "Single carrier FDMA for uplink wireless transmission," *IEEE Veh. Technol. Mag.*, vol. 1, no. 3, pp. 30-38, 2006.

[2] S. D. Babacan, R. Molina, and A. K. Katsaggelos, "Bayesian compressive sensing using Laplace priors," *IEEE Trans. Image Process.*, vol. 19, no. 1, pp. 53-63, Jan. 2010.

[3] M. Masood and T. Y. Al-Naffouri, "Sparse Reconstruction Using Distribution Agnostic Bayesian Matching Pursuit," *IEEE Trans. Signal Process.*, vol. 61, no. 21, pp. 5298-5309, 2013.

[4] A. Gomaa and N. Al-Dhahir, "A sparsity-aware approach for NBI estimation in MIMO-OFDM," *IEEE Trans. Wireless Commun.*, vol. 10, no. 6, pp. 1854-1862, Jun. 2011.

[5] A. Ali, M. Masood, M. S. Sohail, S. Al-Ghadhban, and T. Y. Al-Naffouri, "Narrowband Interference Mitigation in SC-FDMA Using Bayesian Sparse Recovery," *arXiv*:1412.6137, 2014.