SCAN: Sparse Recovery Transmitter Detection

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Background

-Effective spectrum management is essential for reliable wireless services. This requires sharing of spectrum resources.
-One way to ensure reliable spectrum sharing is accurate detection of transmitters activity in frequency and time.
-Our goal in this work is to develop a platform that would detect all transmitters in a spectrum trace and characterize each transmitter activity in frequency and time.

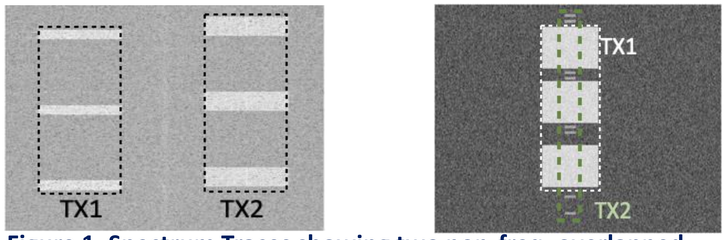
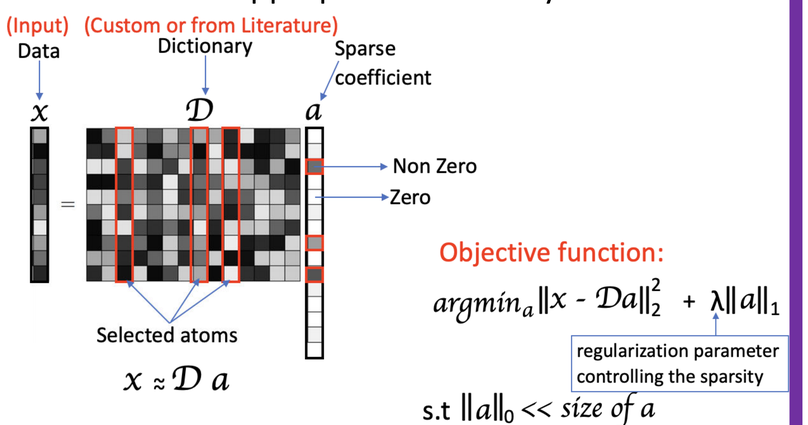


Figure 1. Spectrum Traces showing two non-freq. overlapped transmitters (left) and two narrow and wide band transmitters overlapping in frequency.

Preliminaries

Sparse coding assumes that data can be represented via a linear combination of a few atoms from an appropriate dictionary.



Sparse coding using a single dictionary The optimization problem is solved using: Greedy approach such as OMP Convex relaxation.

Methodology

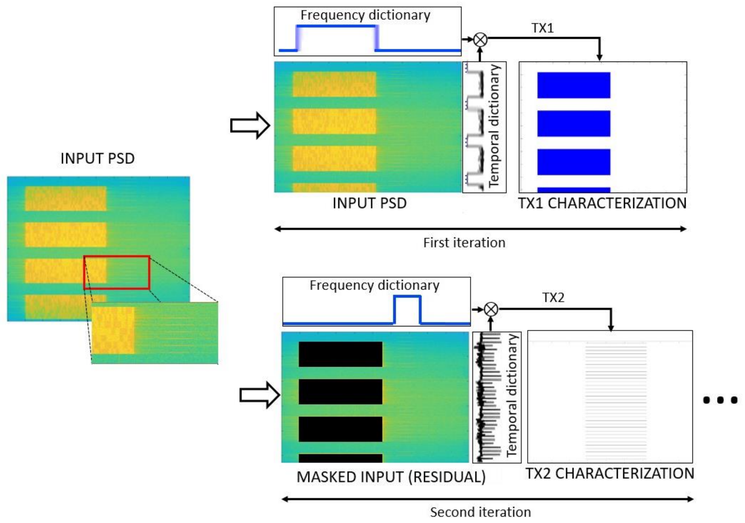
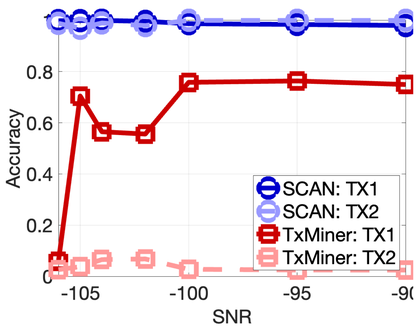


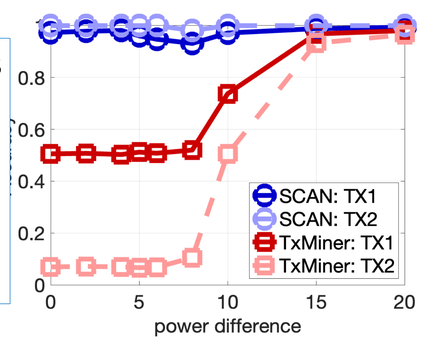
Figure 2. SCAN's general pipeline showing the steps from input to detections.

Synthetic data result



-The two transmitters have the same power profiles.
-SCAN persistently outperforms TxMiner[1] even for noisy regimes.

-Tx1 and Tx2 transmitters at different power levels.
-SCAN outperforms TxMiner[1] even when Tx1 and Tx2 are at the same power levels.

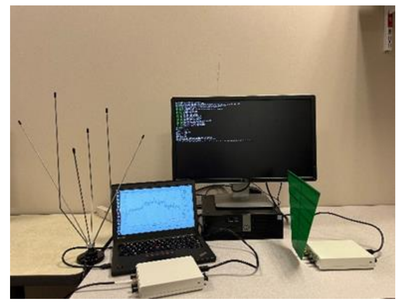


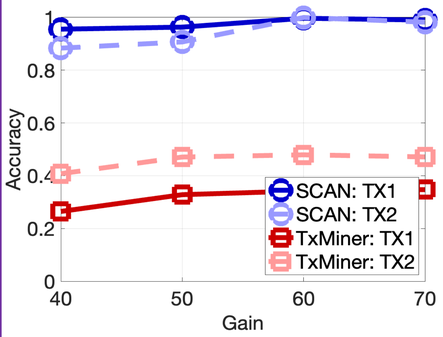
SCAN shows a near perfect detection for these experiments with similar settings as Figure 1.

Real world data result

Setup

-Tx1 and TX2: USRP radios + PC + antenna.
-Sensor: RTL + laptop + antenna.
-Vary sensor gain from 40dB to 70dB.





-SCAN has a near perfect accuracy for all the gain values for the real over-the-air data.
-TxMiner[1] has a significantly low performance with this dataset.

Conclusion

-SCAN is a framework for unsupervised transmitter detection.
-SCAN can accurately detect all the transmitters in a spectrum trace, and then detailed characterization of the time-frequency activity of each transmitter.
-With SCAN policy makers can understand how the spectrum could be better utilized and managed.

Reference

[1] Mariya Zheleva, Aakanksha Chowdhery, Ranveer Chandra, Ashish Kapoor, and Paul Garnett. 2015. TxMiner: Identifying Transmitters in Real-World Spectrum Measurements. In IEEE DySPAN'15. Stockholm, Sweden.