Computer Science > Information Theory

Measurement Design for Detecting Sparse Signals

Ramin Zahedi, Ali Pezeshki, Edwin K. P. Chong

(Submitted on 9 Jul 2011)

We consider the problem of testing for the presence (or detection) of an unknown sparse signal in additive white noise. Given a fixed measurement budget, much smaller than the dimension of the signal, we consider the general problem of designing compressive measurements to maximize the measurement signal-to-noise ratio (SNR), as increasing SNR improves the detection performance in a large class of detectors. We use a lexicographic optimization approach, where the optimal measurement design for sparsity level k is sought only among the set of measurement matrices that satisfy the optimality conditions for sparsity level k-1. We consider optimizing two different SNR criteria, namely a worst-case SNR measure, over all possible realizations of a k-sparse signal, and an average SNR measure with respect to a uniform distribution on the locations of the up to k nonzero entries in the signal. We establish connections between these two criteria and certain classes of tight frames. We constrain our measurement matrices to the class of tight frames to avoid coloring the noise covariance matrix. For the worst-case problem, we show that the optimal measurement matrix is a Grassmannian line packing for most---and a uniform tight frame for all---sparse signals. For the average SNR problem, we prove that the optimal measurement matrix is a uniform tight frame with minimum sum-coherence for most---and a tight frame for all---sparse signals.

Subjects: **Information Theory (cs.IT)**
Cite as: **arXiv:1107.1824 [cs.IT]**
(or **arXiv:1107.1824v1 [cs.IT]** for this version)

Submission history

From: Ali Pezeshki [view email]
[v1] Sat, 9 Jul 2011 22:46:19 GMT (1091kb,D)

Which authors of this paper are endorsers?