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Sensing with Optimal Matrices

Hema Kumari Achanta, Soura Dasgupta, Weiyu Xu

(Submitted on 1 Jun 2012)

We consider the problem of designing optimal \$M \times N\$ (\$M \leq N\$) sensing matrices which minimize the maximum condition number of all the submatrices of \$K\$ columns. Such matrices minimize the worst-case estimation errors when only \$K\$ sensors out of \$N\$ sensors are available for sensing at a given time. For M=2 and matrices with unit-normed columns, this problem is equivalent to the problem of maximizing the minimum singular value among all the submatrices of \$K\$ columns. For M=2, we are able to give a closed form formula for the condition number of the submatrices. When M=2 and K=3, for an arbitrary \$N\geq3\$, we derive the optimal matrices which minimize the maximum condition number of all the submatrices of \$K\$ columns. Surprisingly, a uniformly distributed design is often \emph{not} the optimal design minimizing the maximum condition number.

Comments:Authors temporarily listed in alphabetical orderSubjects:Information Theory (cs.IT); Discrete Mathematics (cs.DM)MSC classes:05Cite as:arXiv:1206.0277 [cs.IT](or arXiv:1206.0277v1 [cs.IT] for this version)

Submission history

From: Weiyu Xu [view email] [v1] Fri, 1 Jun 2012 19:13:22 GMT (13kb)

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