Primal and Dual Perspectives of Rank-Constrained Semidefinite Programming with Applications to Optimal Beamforming

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Abstract

Consider a downlink communication system where multi-antenna base stations transmit independent data streams to decentralized single-antenna users over a common frequency band. The goal of the base stations is to jointly adjust the beamforming vectors to minimize the transmission powers while ensuring the signal-to-interference-noise ratio (SINR) requirement of each user within the system. At the same time, it may be necessary to keep the interference generated on other coexisting systems under a certain tolerable level. In addition, one may want to include general individual shaping constraints on the beamforming vectors. This beamforming problem is a separable homogeneous quadratically constrained quadratic program (QCQP), which is difficult to solve in general. In this talk, we will give conditions under which strong duality holds, and propose efficient algorithms for the optimal beamforming problem from primal and dual perspectives. First, we study rank-constrained solutions of general separable semidefinite programs (SDPs) and propose rank reduction procedures to achieve a lower rank solution. Then we show that the SDP relaxation of three classes of optimal beamforming problem always has a rank-one solution, which can be obtained by invoking the rank reduction procedures.

Biography

Daniel P. Palomar (S'99-M'03-SM'08) received the Electrical Engineering and Ph.D. degrees (both with honors) from the Technical University of Catalonia (UPC), Barcelona, Spain, in 1998 and 2003, respectively. Since 2006, he has been an Assistant Professor in the Department of Electronic and Computer Engineering at the Hong Kong University of Science and Technology (HKUST), Hong Kong. He has held several research appointments, namely, at King's College London (KCL), London, UK; Technical University of Catalonia (UPC), Barcelona; Stanford University, Stanford, CA; Telecommunications Technological Center of Catalonia (CTTC), Barcelona; Royal Institute of Technology (KTH), Stockholm, Sweden; University of Rome "La Sapienza", Rome, Italy; and Princeton University, Princeton, NJ. His current research interests include applications of convex optimization theory, game theory, and variational inequality theory to signal processing and communications.

Dr. Palomar is an Associate Editor of IEEE Transactions on Signal Processing, a Guest Editor of the IEEE Signal Processing Magazine 2010 special issue on "Convex Optimization for Signal Processing," was a Guest Editor of the IEEE Journal on Selected Areas in Communications 2008 special issue on "Game Theory in Communication Systems," as well as the Lead Guest Editor of the IEEE Journal on Selected Areas in Communications 2007 special issue on "Optimization of MIMO Transceivers for Realistic Communication Networks." He serves on the IEEE Signal Processing Society Technical Committee on Signal Processing for Communications (SPCOM).

He is a recipient of a 2004/06 Fulbright Research Fellowship; the 2004 Young Author Best Paper Award by the IEEE Signal Processing Society; the 2002/03 best Ph.D. prize in Information Technologies and Communications by the Technical University of Catalonia (UPC); the 2002/03 Rosina Ribalta first prize for the Best Doctoral Thesis in Information Technologies and Communications by the Epson Foundation; and the 2004 prize for the best Doctoral Thesis in Advanced Mobile Communications by the Vodafone Foundation and COIT.