

Interference Alignment: A new look at Signal Dimensions in Interference Networks

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Tutorial

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Abstract:

The Shannon capacity of wireless networks is the holy grail of network information theory. Recently, this area has seen a burst of activity leading to remarkable progress on a variety of problems including the capacity of interference networks, X networks, cellular networks, multicast and compound broadcast networks, tactical communication networks with secrecy and jamming issues, cooperative communication networks, cognitive radio networks, and network coding for multiple unicast networks and distributed data storage networks. While each communication scenario has its own peculiarities, a common thread running through a vast number these recent developments is the new idea of interference alignment. This tutorial is intended as a survey of these recent advances, following the connecting thread of interference alignment and highlighting the new insights and intuition that emerge out of the recent results. The tutorial will place special emphasis on the signal processing aspects of Interference Alignment. Topics covered will include – the non-trivial nature of bandwidth and degrees of freedom metrics in a multiuser setting; the tradeoffs between accessible signaling dimensions – time, frequency, space and signal levels in a wireless network with multiple antenna nodes; interference alignment as a means to recover desired information when the number of equations is much smaller than the number of unknown variables; conceptual examples to illustrate the principles behind interference alignment; feasibility conditions for interference alignment through linear beamforming schemes and connections to algebraic geometry; lattice alignment and connections to diophantine

approximation theory; asymptotic interference alignment; opportunistic and ergodic interference alignment; distributed interference alignment; blind interference alignment; retrospective interference alignment; and the combination of interference alignment and network coding for applications like multiple unicasts and distributed data storage repair.

Bio:

Syed Ali Jafar received the B. Tech. degree in Electrical Engineering from the Indian Institute of Technology (IIT), Delhi, India in 1997, the M.S. degree in Electrical Engineering from California Institute of Technology (Caltech) , Pasadena USA in 1999, and the Ph.D. degree in Electrical Engineering from Stanford University, Stanford, CA USA in 2003. His industry experience includes positions at Lucent Bell Labs, Qualcomm Inc. and Hughes Software Systems. He is currently an Associate Professor in the Department of Electrical Engineering and Computer Science at the University of California Irvine, Irvine, CA USA. His research interests include multiuser information theory and wireless communications.

Dr. Jafar received the NSF CAREER award in 2006, the ONR Young Investigator Award in 2008, the IEEE Information Theory Society paper award in 2009 and the Engineering School Fariborz Maseeh Outstanding Research Award in 2010. He received the UC Irvine Engineering Faculty of the Year award in 2006 and the UC Irvine EECS Professor of the Year Award twice, in 2009 and 2011, for excellence in teaching. Dr. Jafar was the inaugural instructor for the First Canadian School of Information Theory in 2011, a plenary speaker for the IEEE Communication Theory Workshop 2010 and SPCOM 2010, and a Visiting Erskine Fellow to the University of Canterbury New Zealand. He served as Associate Editor for IEEE Transactions on Communications 2004-2009, for IEEE Communications Letters 2008-2009 and is currently serving as Associate Editor for IEEE Transactions on Information Theory.

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