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MIMO Detection Aided by Lattice Reduction:
Introduction and Recent Advances*

Prof. Wai Ho Mow
Visiting Scholar
Hong Kong University of Science and Technology

Abstract:

The lattice formulation of signal detection problems has led to some of the most efficient MIMO detectors known. In fast Rayleigh fading channels, it is known that full diversity order can be achieved by use of the so-called LLL-reduction-aided successive interference cancellation (SIC) detector, which has a worst-case complexity being quartic in the MIMO dimension. This is a very attractive alternative to the optimal maximum likelihood detector which has an exponential complexity. However, it doesn't mean that there is no room for further improvement. The LLL (Lenstra-Lenstra-Lovasz) lattice reduction algorithm, which is a famous tool in the computational number theory, has been one of the most widely used algorithm in the area of cryptography. In this presentation, we show how the idea of sorting can be integrated into the classical LLL algorithm enabling the complexity to be halved, approximately. The resultant algorithm is called the joint sorting and reduction (JSAR) algorithm. Moreover, when the LLL reduction algorithm is seriously truncated or early terminated, the novel JSAR based LLL-SIC significantly outperform and appears to achieve possibly higher (but still suboptimal) diversity order than the conventional counterpart at low-to-moderate bit-error-rates. This suggests that it can be applied advantageously to MIMO systems with a strict delay constraint. Inspired by the JSAR result, we further propose the so-called partial reduction algorithm that only performs lattice reduction for the last several, weak MIMO substreams and sorting for the remaining streams. By tuning the block size of the partial reduction (hence the complexity), it can achieve a variable diversity order, hence offering a graceful tradeoff between performance and complexity for SIC-based MIMO detection. Among other consequences, our result leads to the first cubic worst-case complexity MIMO detector with a diversity order greater than 1, to the best of our knowledge. The previous known best cubic complexity MIMO detector is the famous VBLAST detector.

Bio:

Wai Ho MOW received his PhD degree in Information Engineering from the Chinese University of Hong Kong. He was a visiting research fellow at the University of Waterloo in Canada, the Munich University of Technology (TUM) in Germany, and the Kyoto University in Japan in 1995, 1996 and early 2000, respectively. From 1997 to 1999 , he was an assistant professor at the Nanyang Technological University, Singapore. He joined the Hong Kong University of Science and Technology since 2000 and is currently spending his sabbatical at the Center for Magnetic Recording Research, UC San Diego. He was the recipient of the Croucher Research Fellowship (HK), the Humboldt Research Fellowship (Germany), the Telecommunications Advancement Research Fellowship (Japan), the Tan Chin Tuan Academic Exchange Fellowship (Singapore), the Wong Kuan Cheng Education Foundation Academic Exchange Award (China), the Foreign Expert Bureau Fellowship (China) and the Royal Academy of Engineering Award for Short Research Exchanges with China and India (UK). His research interests are in the areas of wireless communications, coding and information theory. He pioneered the lattice approach to signal detection problems and unified all known constructions of perfect roots-of-unity sequences (widely used as CAZAC preambles and radar signals). Since Jun 2002, he has been the principal investigator of over 10 funded research projects. He has published 1 book, and co-authored over 20 filed patent applications and over 100 technical publications, among which he is the sole author of over 40. He co-authored a paper that received the ISITA2002 Paper Award for Young Researchers and supervised one student who won the first prize in the IEEE HK Section Postgraduate Paper Contest. He was the chair of the Hong Kong Chapter of the IEEE Information Theory Society in 2005. He was a technical program co-chair of 5 conferences and served the technical program committees of many conferences such as Globecom, ICC, ISITA, ITW, VTC and WCNC. He was the guest (associate) editor for 3 special issues of the IEICE Transactions on Fundamentals. He was a member of the Radio Spectrum Advisory Committee, Office of the Telecommunications Authority, the Hong Kong S.A.R. Government from 2003 to 2008.

*Joint work with Ling Cong (Imperial College)

If you have any questions or, time permitting, would like to meet with the speaker,
contact him at eewhmow@ust.hk / Phone 858-534-6214).

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