IEEE ComSoc & SPS Distinguished Lectures

Taipei Chapter

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IEEE Communications Society (ComSoc) and Signal Processing Society (SPS), Taipei Chapter, invite you to attend IEEE Distinguished Lectures by Prof. Kon Max Wong from McMaster University, Canada.
IEEE通訊學會與訊號處理學會之台北分會很榮幸地邀請到加拿大麥克馬斯特大學 Prof. Kon Max Wong 前來進行三場IEEE傑出講座，我們誠摯地邀請您蒞臨這場知識交流的盛會。

- **Dec. 11, 14:20-15:30, 資工系 R103, NTU (台灣大學)**

Optimum Space-Time Block Code Design for MIMO Communications: A Case for Linear MMSE Receivers

- **Dec. 13, 13:30-15:20,工程四館 R219, NCTU (交通大學)**

Optimum Space-Time Block Code Design for MIMO Communications: A Case for Linear MMSE Receivers

- **Dec. 15, 14:10-16:10, 物理館地下室002室, NTHU (清華大學)**

The QRS Decomposition and Block Data Transmission Systems with Decision Feedback Detectors

主辦單位:
清華大學通訊工程研究所/交通大學電信工程研究所/台灣大學電信工程研究所
IEEE Communications Society Taipei Chapter/IEEE Signal Processing Society Taipei Chapter

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Optimum Space-Time Block Code Design for MIMO Communications: A Case for Linear MMSE Receivers

Abstract :

The explosive expansion in wireless communications in recent years encounters severe technical challenges including the demand of transmitting signals at high rates under strict limitations of power and bandwidth in an environment rich of scattering. Multi-input multi-output (MIMO) wireless links are important recent developments in wireless communication systems due to their enormous potential in meeting these challenges. Existing MIMO communications employ M transmitter antennas and N receiver antennas and design space-time codes to enable the exploitation of both the high performance provided by the space diversity and the high data rate afforded by the capacity available in the MIMO channels. Recent research on space-time code design to exploit these factors has been mainly targeted for the MIMO system equipped with a maximum likelihood (ML) receiver since an ML receiver is able to achieve the full diversity gain provided by the multiple antenna system. However, ML receivers are non-linear receivers well-known to have very high complexity often prohibiting practical implementation. Thus, there is a need to study space-time code designs for MIMO systems employing linear receivers.

In this lecture, we examine the design of optimum space-time block codes (STBC) for MIMO systems equipped with a linear MMSE receiver. From the analysis of the probability of detection error of the system, we show the necessary and sufficient structures of a STBC for achieving minimum bit-error rate (BER) from which the diversity gain of such a system is then derived. Indeed, the diversity gain of such a system, even when employing optimum STBC, is shown to be inferior to that of a MIMO system equipped with an ML detector. We then propose that the optimum STBC design principle be extended to cover the transmission of multiple blocks of data. Examination of the BER for the multi-block transmission system shows us that the extended optimum STBC design has necessary and sufficient structures parallel to those of the optimum single-block design. Analyses reveal that increasing the number of blocks covered by the optimum code design increases the diversity gain, yet the order of the normalized detection complexity remains virtually constant. Theoretical predictions confirmed by computer simulations showed that the number of blocks covered by the optimum STBC design does not have to be very large for the system performance to catch up with and surpass that for an ML receiver. Utilizing this optimum code design extended to multi-block transmission, for applications permitting latency of signal reception, the MIMO wireless system can be brought to practical implementation without losing any of its advantages.

The QRS Decomposition and Block Data Transmission Systems with Decision Feedback Detectors

Abstract :

In this talk, we first introduce the QRS decomposition of a matrix and its geometric interpretation. We then digress and examine a block-by-block communication system that employs (intra-block) decision feedback detection. We develop a method for jointly designing the transmitter-receiver (transceiver) pair in such systems. We provide closed-form expressions for transmitter-receiver pairs that simultaneously minimize the arithmetic mean squared error (MSE) at the decision point (assuming perfect feedback), the geometric MSE, and the bit error rate of a uniformly bit-loaded system at moderate-to-high signal-to-noise ratios. Separate expressions apply for the “zero-forcing” (ZF) and “minimum MSE” (MMSE) decision feedback structures. We then examine the optimum designs of the transceivers for the two cases in terms of the algebraic QRS decomposition and explains the functions of the optimum structures in the light of the component matrices. Finally we present simulation studies which indicate that the proposed transceivers perform significantly better than standard transceivers, and that they retain their performance advantages in the presence of error propagation.

About the speaker :

Kon Max Wong received his BSc(Eng), DIC, PhD, and DSc(Eng) degrees, all in electrical engineering, from the University of London, England, in 1969, 1972, 1974 and 1995, respectively. He started working at the Transmission Division of Plessey Telecommunications Research Ltd., England, in 1969. In October 1970 he was on leave from Plessey pursuing postgraduate studies and research at Imperial College of Science and Technology, London. In 1972, he rejoined Plessey as a research engineer and worked on digital signal processing and signal transmission. In 1976, he joined the Department of Electrical Engineering at the Technical University of Nova Scotia, Canada, and in 1981, moved to McMaster University, Hamilton, Canada, where he has been a Professor since 1985 and served as Chairman of the Department of Electrical and Computer Engineering in 1986-87 and 1988-94. Professor Wong was on leave as Visiting Professor at the Department of Electronic Engineering of the Chinese University of Hong Kong from 1997 to 1999. At present, he is the holder of the Canada Research Chair in Signal Processing and is the Director of the Communication Technology Research Centre at McMaster University. He is also serving as Chair of the Department of Electrical and Computer Engineering from 2003-08.

Professor Wong's research interests are in signal processing and communication theory and has published over 200 papers in the area. He was Keynote Speaker in various international conferences including the ICSP'93, ICNNSP'95, and IEEE Asia-Pacific CCAS'98, and has given invited lectures world-wide. He was Distinguished Lecturer at the Chinese University, Hong Kong in 2000, at CITO, Ottawa, Canada in 2001, at the Gerhard-Mercator University, Duisberg, Germany, in 2002 and 2003, at the University of Waterloo, Canada in 2004, and at the Technical University of Vienna, Austria, and the Technical University of Darmstadt, Germany, 2005. He was the recipient of the IEE Overseas Premium for the best paper in 1989, and is a co-author of the paper that received both the 2003 Best Paper Award of the Information Technology Society (ITG) of the German Institute of Electrical Engineering, Electronics and Information Technology (VDE), and the IEEE SP Soc Young Author Award, 2006. He also served as an Associate Editor of the IEEE Transaction on Signal Processing, 1996-98 and has been a member and chair of the IEEE Sensor Array and Multichannel Technical Committee of the Signal Processing Society. Professor Wong is a Fellow of IEEE, a Fellow of the Institution of Electrical Engineers, a Fellow of the Royal Statistical Society, and a Fellow of the Institute of Physics. He was the recipient of a medal presented by the International Biographical Centre, Cambridge, England, for his "outstanding contributions to the research and education in signal processing" in May 2000, and was honoured with the inclusion of his biography in the two books: Outstanding People of the 20th Century and 2000 Outstanding Intellectuals of the 20th Century published by IBC to celebrate the arrival of the new millennium.