FEE K13137 Digital Radio Communications (DiRaC) group introduces

Have you ever asked yourself whether physical layer modulation, coding and signal processing research is attractive enough for your future carrier?

Professor Tad Matsumoto will show how challenging and exciting the research in this field can be.

professor Tad Matsumoto

5 May 2009, CTU in Prague, FEE, Czech Republic

Are Weak Codes Always Too Bad? Very Simple BICM-ID Techniques Achieving Near-Capacity Performance

Tad Matsumoto, Professor (matumoto@jaist.ac.jp)

- Japan Advanced Institute of Science and Technology, Japan
- Finland Distinguished Professor, Center for Wireless Communication at University of Oulu, Finland
- IEEE VTS Board of Governor member
- Research Specialties
  Wireless Communications, Coding Theory, Iterative (Turbo) Algorithm, Network Information Theory

Short Bio

Tad MATSUMOTO received his M.S., and Ph.D. degrees from Keio University, Yokohama, Japan, in 1978, 1980, and 1991, respectively, all in electrical engineering. He joined Nippon Telegraph and Telephone Corporation (NTT) in April 1980. Since he engaged in NTT, he was involved in a lot of research and development projects, all for mobile wireless communications systems. In July 1992, he transferred to NTT DoCoMo, where he researched Code-Division Multiple-Access techniques for Mobile Communication Systems. In April 1994, he transferred to NTT America, where he served as a Senior Technical Advisor of a joint project between NTT and NEXTEL Communications. In March 1996, he returned to NTT DoCoMo, where he served as a Head of the Radio Signal Processing Laboratory until August of 2001; He worked on adaptive signal processing, multiple-input multiple-output turbo signal detection, interference cancellation, and space-time coding techniques for broadband mobile communications. In March 2002, he moved to University of Oulu, Finland, where he served as a Professor at Centre for Wireless Communications. In 2006, he served as a Visiting Professor at Ilmenau University of Technology, Ilmenau, Germany, funded by the German MERCATOR Visiting Professorship Program. Since April 2007, he has been serving as a Professor at Japan Advanced Institute of Science and Technology (JAIST), Japan, while also keeping a part-time professorship at University of Oulu. Prof. Matsumoto has been appointed as a Finnish Distinguished Professor for a period from January 2008 to December 2012, funded by the Finnish National Technology Agency (Tekes) and Finnish Academy, under which he preserves the rights to participate in and apply to European and Finnish national projects. Prof. Matsumoto is a recipient of IEEE VTS Outstanding Service Award (2001), Nokia Foundation Visiting Fellow Scholarship Award (2002), IEEE Japan Council Award for Distinguished Service to the Society (2006), IEEE Vehicular Technology Society James R. Evans Avant Garde Award (2006), and Thuringen State Research Award for Advanced Applied Science (2006), and 2007 Best Paper Award of Institute of Electrical, Communication, and Information Engineers of Japan. The project led by Prof. Matsumoto under the FiDiPro appointment is "Distributed Decision making for future wireless communication Systems (DIDES). The major goal of the project is to create technological bases of distributed cooperative wireless networks using Slepian-Wolf compression techniques. Algorithm developments for cooperative communications, and evaluations of efficiency, reliability, convergence properties of the proposed techniques, theoretical analysis, and establishment of optimal design methods are within the scope of the project. The major applications of the project outcomes include wireless multi-hop and ad-hoc networks, sensor networks, monitoring systems, and network coding aided code-on-graph.

Location & Time

Tuesday 5 May 2009, 14:00 – 15:30, room T2:C3-434
The lecture is open for all academics and students.

Lecture abstract

This talk is comprised of two major sections. The first part covers historical review of "turbo equalization", which the lecturer has mainly worked on in the last 10 years, including the time he spent in Center for Wireless Communications, University of Oulu. The Technological fundamentals of turbo equalization for broadband single carrier signaling, exemplifying the turbo principle, are provided in this talk with an intensified focus on the technique, frequency domain soft cancellation and minimum mean squared error filtering (FD SC-MMSE) equalization, as a practical and flexible platform. FD SC-MMSE is then applied to the multi-user multiple input multiple output (MU-MIMO) cases as a reasonable extension of the technique. The talk will then change the focus to more information theoretic issues, covering convergence property analysis of turbo equalization using the extrinsic information transfer (EXIT) chart as a tool for evaluating the efficiency of mutual information exchange. Asymptotic and convergence properties of the FD SC-MMSE turbo equalization are analyzed. The latest results of the research work, (1) repetition coded Bit Interleaved Coded Modulation with Iterative Detection (BICM-ID) with extended mapping and irregular degree allocations, and (2) Probabilistic Data Association based convergence analysis of equalization systems having internal and global turbo loops are briefly introduced. This talk then presents future prospects and technological direction of turbo equalization is presented, with a special emphasis on the relationship between network information theory and the lecturer's responsible project under the FiDiPro project, Distributed Decision making for wireless communications Systems (DIDES). The second part of this seminar covers an up-to-date technical issue related to the turbo detection technique, bit-interleaved coded modulation with iterative detection (BICM-ID). Performances of BICM-ID systems strongly depend on the matching between mapping rule and code structure. This talk proposes a combined use of extended mapping (EM) and simple repetition code. It is shown that such extremely simple structure can achieve turbo cliff happens at a value range of signal-to-noise power ratio (SNR) at around 1 dB to the Shannon limit. This talk then introduces check node as well as irregular node degree allocation to the proposed structure described above, so that we can flexibly change the shape of the decoder EXIT curve, thereby achieving near-capacity performance. Even with such simple structure, near-capacity performance can still be achieved, and furthermore, since there is no loop in the decoder, unlike LDPC codes, BER floor is determined only by the EXIT intersection point with the proposed structure. It is shown that EXIT analysis and BER performance obtained by chain simulation exactly match each other.

About DiRaC (Digital Radio Communications) group

DiRaC group is the research group at the department of Radio Engineering K13137 at FEE/CTU. The group is headed by prof. Jan Sykora. General areas of activity are: Digital communication theory - modulation, coding, physical layer signal processing algorithms, Information theory, Parameter estimation and detection theory, Stochastic signal processing. In our current effort, we concentrate on: Mobile radio communication systems with distributed, cooperative and MIMO coding and processing, Spatial diversity technique, particularly MIMO systems, Nonlinear Space-time modulation and coding, Iterative Factor Graph based technique in detection, channel state estimation and equalization, Adaptive modulation under specific constraints.

More information at...

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