Special Issue on Coding and Signal Processing for MIMO System

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Projections indicate that by the year 2005 the number of wireless subscribers will exceed that of wireline subscribers, a fact that promises both an explosive growth in wireless services as well as a rapid convergence with the Internet. The wireless challenges are varied and many: multimedia traffic requiring high data rates, networking requiring seamless connectivity, mobility causing the physical channel to change rapidly, portability contrasting with the need of a long battery life, etc. In addition, fading, limited bandwidth and power, and interferences impair the wireless channel to an extent that makes it very difficult to meet the requirements for high-quality transmission.

It is now accepted that the introduction of multiple antennas in the wireless link, and consequently of signal processing in the space and time domains, is not only a useful addition to existing systems, but is needed to provide the necessary transmission quality. The papers presented in this Issue document the widespread interest in multiple-antenna systems, and provide the readers with a cross-section of recent research results in this area.

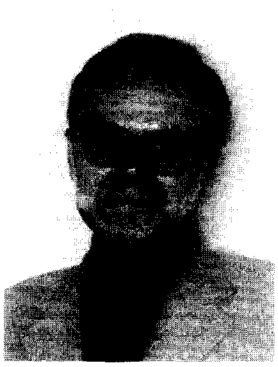
The paper by Biglieri and Taricco describes some analytical tools that can be used to predict the performance of multiple-antenna systems: They are based on asymptotic formulas (obtained for a large number of antennas) which yield results that are surprisingly tight even when the number of antennas is very small. Giorgetti *et al.* examine how MIMO capacities are influenced by temporal and spatial correlations among antennas.

The contribution by Sellathurai, Guinand, and Lodge documents a pragmatic solution to the design of multirate codes for transmission over MIMO channels and reception by receivers of the successive-decoding and interference-cancellation type. As is typical in similar problems, the assumption is made that the receiver has complete knowledge of the fading state of the channel; however, the transmitter does not have access to this information. It is shown that such code designs, that make of use punctured turbo codes for a horizontal coded MIMO system, achieve performances within 1 to 2 dB of channel capacity.

The paper by Simon and Wang investigates the pairwise error probability performance of noncoherently detected orthogonal FSK modulation combined with Alamouti space-time block coding for scenarios where the assumption that channel state information is available at the receiver is questionable. Exact, compact closed-form expressions for the pairwise error probability (PEP) in the presence of an arbitrary number of receive antennas are obtained. The PEP results show that noncoherent FSK combined with STBC achieves full spatial diversity. Also derived is an approximate expression for the average bit error probability (BEP) for M-ary orthogonal signaling that allows one to assess the tradeoff between increased rate and performance degradation.

In the paper "Error Performance of Serially Concatenated Space-Time Coding," Altunbas and Yongaçoglu consider a serially concatenated system of a nonrecursive convolutional code as the outer code and a recursive space-time code as the inner code. The authors evaluate the error performance of a serially concatenated coding scheme for MIMO hannels for a number of cases. The paper by Park and Lee considers space-frequency bit-interleaved coded modulation, which integrates space-time codes, interleavers and OFDM into one system. The authors compute the pairwise error probability (PEP) bound for two given codewords and formulate design criteria based on the PEP. In the paper, "Performance of multicarrier-CDMA with antenna arrays and Multiuser detection," Sigdel and Ahmed consider uplink MC-CDMA system using multiuser detection and smart antenna. Asynchronous and synchronous users are evaluated. Asynchronism and channel correlation are found to affect the system performance. Finally, the paper of Daneshgaran *et al.* proposes new initialization techniques for VQ for blind channel identification. The convergence and distortion performances of their proposed system are compared with the Pruning Method.

The Guest Editors wish to thank the authors of (successful or unsuccessful) submissions to this Special Issue for their interest in JCN, as well as the Reviewers who devoted their time and their competence to enhance the quality of this Issue. The Editors-in-Chief provided constant stimulus and encouragement.



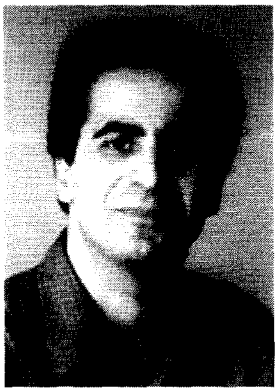
Ezio Biglieri was born in Aosta (Italy). He studied Electrical Engineering at Politecnico di Torino (Italy), where he received his Dr. Engr. degree in 1967. From 1968 to 1975 he was with the Istituto di Elettronica e Telecomunicazioni, Politecnico di Torino, first as a Research Engineer, then as an Associate Professor (jointly with Istituto Matematico). In 1975 he was made a Professor of Electrical Engineering at the University of Napoli (Italy). In 1977 he returned to Politecnico di Torino as a Professor in the Department of Electrical Engineering. From 1987 to 1989 he was a Professor of Electrical Engineering at the University of California, Los Angeles. Since 1990 he has been again a Professor with Politecnico di Torino.

He has held visiting positions with the Department of System Science, UCLA, the Mathematical Research Center, Bell Laboratories, Murray Hill, NJ, the Bell Laboratories, Holmdel, NJ, the Department of Electrical Engineering, UCLA, the Telecommunication Department of The Ecole Nationale Superieure des Telecommunications, Paris, France, the University of Sydney, Australia, the Yokohama National University, Japan, and the Electrical Engineering Department of Princeton University.

He was elected three times to the Board of Governors of the IEEE Information Theory Society, and he served as its President in 1999. He is a Distinguished Lecturer of the IEEE Information Theory Society and the IEEE Communications Society.

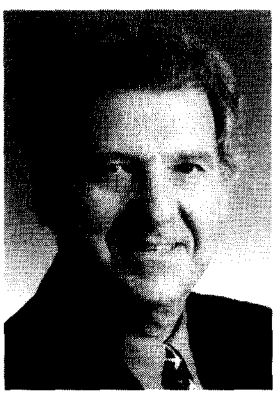
He was an Editor of the *IEEE Transactions on Communications*, the *IEEE Transactions on Information Theory*, and the *IEEE Communications Letters*, and the Editor in Chief of the *European Transactions on Telecommunications*. Since 1998 he has been a Division Editor of the *Journal on Communications and Networks*. He has edited three books and co-authored five, among which the recent *Principles of Digital Transmission with Wireless Applications* (New York: Kluwer/Plenum, 1999).

Among other honors, in 2000 he received the IEEE Third-Millennium Medal and the IEEE Donald G. Fink Prize Paper Award, and in 2001 the IEEE Communications Society Edwin Howard Armstrong Achievement Award.



Vahid Tarokh received the Ph.D. degree in Electrical Engineering from the University of Waterloo, in 1995. He joined the AT&T Labs-Research in 1996, where he was a ``Senior and Principal Technical Staff Member", and later on the "Head of the Department of Wireless Communications and Signal Processing". He then joined Dept of EECS of MIT in 2000 as an Associate Professor. He is now a "Gordon Mckay Professor of Electrical Engineering" at the "Division of Engineering and Applied Sciences" of Harvard University, where he is also a holder of "Vinton Hayes Senior Research Fellowship".

His contributions include "his pioneering invention of space-time coding techniques" (jointly with Seshadri and Calderbank) and the invention of "complementary beamforming" techniques (jointly with Alamouti and Choi). His awards include the "1995 Governor General of Canada's Academic Gold Medal", the "1999 IEEE Information Theory Society Prize Paper Award", and the "2001 Alan T. Waterman Award". In 2002, he was also selected as one of the 100 young inventors of the year by the Technology Review Magazine. His honorary degrees include those from Harvard and Windsor.



Marvin K. Simon is currently a Principal Scientist at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California where for the last 35 years he has performed research as applied to the design of NASA's deep-space and near-earth missions resulting in the issuance of 9 patents and 23 NASA Tech Briefs. Dr. Simon is known as an internationally acclaimed authority on the subject of digital communications with particular emphasis in the disciplines of modulation and demodulation, synchronization techniques for space, satellite and radio communications, trellis-coded modulation, spread spectrum and multiple access communications, and communication over fading channels. In the past, Dr. Simon also held a joint appointment with the Electrical Engineering Department at Caltech where for 6 years he was responsible for teaching the first year graduate level three-quarter sequence of courses on random processes and digital communications.

He has published over 180 papers on the above subjects and is co-author of 10 textbooks including, *Telecommunication Systems Engineering* (Prentice-Hall, 1973 and Dover Press, 1991), *Phase-Locked Loops and Their Application* (IEEE Press, 1978), *Spread Spectrum Communications, Vols. I, II, and III* (Computer Science Press, 1984 and McGraw-Hill, 1994), *An Introduction to Trellis Coded Modulation with Applications* (MacMillan, 1991), *Digital Communication Techniques: Vol. I* (Prentice-Hall, 1994) and *Digital Communication Over Fading Channels: A Unified Approach to Performance Analysis* (John Wiley & Sons, 2000), *Probability Distributions Involving Gaussian Random Variables - A Handbook for Engineers and Scientists* (Kluwer, 2002) and *Bandwidth-Efficient Digital Modulation with Application to Deep-Space Communication* (John Wiley & Sons, 2003). His work has also appeared in the textbook *Deep Space Telecommunication Systems Engineering* (Plenum Press, 1984) and he is co-author of a chapter entitled *Spread Spectrum Communications* in the *Mobile Communications Handbook* (CRC Press, 1995), *Communications Handbook* (CRC Press, 1997) and the *Electrical Engineering Handbook* (CRC Press, 1997). He is the co-recipient of the 1988 Prize Paper Award in Communications of the IEEE Transactions on Vehicular Technology for his work on trellis coded differential detection systems and also the 1999 Prize Paper of the IEEE Vehicular Technology Conference for his work on switched diversity. He is a Fellow of the IEEE and a Fellow of the IAE. Among his awards are the NASA Exceptional Service Medal, NASA Exceptional Engineering Achievement Medal, IEEE Edwin H. Armstrong Achievement Award and most recently the IEEE Millennium Medal all in recognition of outstanding contributions to the field of digital communications and leadership in advancing this discipline.