Near-Capacity Multi-Functional MIMO Systems:

Sphere-Packing, Iterative Detection and Cooperation

by

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We dedicate this monograph to the numerous contributors of this field, many of whom are listed in the Author Index

The classic Shannon-Hartley law suggests that the achievable channel capacity increases logarithmically with the transmit power. By contrast, the MIMO capacity increases linearly with the number of transmit antennas, provided that the number of receive antennas is equal to the number of transmit antennas. With the further proviso that the total transmit power is increased proportionately to the number of transmit antennas, a linear capacity increase is achieved upon increasing the transmit power, which justifies the spectacular success of MIMOs...

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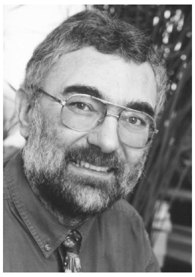

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- L. Hanzo, J.S. Blogh, S. Ni: *3G, HSDPA, HSUPA and FDD Versus TDD Networking: Smart Antennas and Adaptive Modulation* John Wiley and IEEE Press, 2008, 564 pages

[1] For detailed contents and sample chapters please refer to http://www-mobile.ecs.soton.ac.uk

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Preface

The family of recent wireless standards included the optional employment of MIMO tyechniques. This was motivated by the observation according to the classic Shannon-Hartley law the achievable channel capacity increases logarithmically with the transmit power. By contrast, the MIMO capacity increases linearly with the number of transmit antennas, provided that the number of receive antennas is equal to the number of transmit antennas. With the further proviso that the total transmit power is increased proportionately to the number of transmit antennas, a linear capacity increase is achieved upon increasing the transmit power, which justifies the spectacular success of MIMOs...

Hence this volume explores recent research advances in MIMO techniques as well as their limitations. The basic types of multiple antenna-aided wireless systems are classified and their benefits are characterised. We also argue that under realistic propagation conditions, when for example the signals associated with the MIMO elements become correlated owing to shadow fading, the predicted performance gains may substantially erode. Furthermore, owing to the limited dimensions of shirt-pocket-sized handsets the employment of multiple antenna elements at the mobile station is impractical. In this scenario only the family of distributed MIMO elements relying on the cooperation of potentially single-element mobile stations is capable of eliminating the correlation of the signals impinging on the MIMO elements, as it will be discussed in the book. The book also reports on a variety of avantgarde hybrid MIMO designs to set out promising future research directions.

Our intention with the book is:

1. First, to pay tribute to all researchers, colleagues and valued friends, who contributed to the field. Hence this book is dedicated to them, since without their quest for better MIMO solutions for wireless communications this monograph could not have been conceived. They are too numerous to name here, hence they appear in the author index of the book. Our hope is that the conception of this monograph on the topic will provide an adequate portrayal of the community's research and will further fuel this innovation process.

2. We expect to stimulate further research by exposing open research problems and by collating a range of practical problems and design issues for the practitioners. The coherent further efforts of the wireless research community is expected to lead to the solution of the range of outstanding problems, ultimately providing us with flexible MIMO-aided wireless transceivers exhibiting a performance close to information theoretical limits.

Glossary

16-QAM	16-level Quadrature Amplitude Modulation
3G	Third generation
8-PSK	8-level Phase Shift Keying
AGM	Anti-Gray Mapping
APP	A Posteriori Probability
AWGN	Additive White Gaussian Noise
BEC	Binary Erasure Channel
BER	Bit error ratio, the number of the bits received incorrectly
BICM	Bit-Interleaved Coded Modulation
BICM-ID	Bit-Interleaved Coded Modulation with Iterative decoding
BPS	Bits per modulated symbol
BPSK	Binary Phase Shift Keying
BSA	Binary Switching Algorithm
CCMC	Continuous-input Continuous-output Memoryless Channel
CCSDS	Consultative Committee for Space Data Systems
CDMA	Code-Division Multiple-Access
CSI	Channel State Information
DCMC	Discrete-input Continuous-output Memoryless Channel
DMC	Discrete Memoryless Channel
DSTBC	Differential Space-Time Block Coding
D_4	The lattice corresponding to the sphere packing having the best minimum Euclidean distance in the four-dimensional real-valued Euclidean space R^4
EXIT	EXtrinsic Information Transfer

E_b/N_0	Ratio of bit energy to noise power spectral density
FFT	Fast Fourier Transform
GF	Galois Field
GM	Gray Mapping
i.i.d.	Independent and Identically Distributed
IRCC	Irregular Convolutional Code
ISI	Intersymbol Interference
LDPC	Low Density Parity Check
LLR	Log-Likelihood Ratio
MAP	Maximum A Posteriori
MED	Minimum Euclidean Distance
MI	Mutual Information
MIMO	Multiple-Input Multiple-Output
ML	Maximum Likelihood
PDF	Probability Density Function
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QAP	Quadratic Assignment Problem
QPSK	Quadrature Phase Shift Keying
RA	Repeat-Accumulate
RSC	Recursive Systematic Convolutional
RTS	Reactive Tabu Search
SISO	Soft-Input Soft-Output
SNR	Signal to Noise Ratio, noise energy compared to the signal energy
SP	Sphere Packing
SP-SER	Sphere Packing Symbol Error Ratio
SPSI	Sphere Packing Symbol Invariant
ST	Space-Time
ST-SER	Space-Time Symbol Error Rate
STBC	Space-Time Block Coding
STBC-SP	Space-Time Block Coding using Sphere Packing modulation
STC	Space-Time Coding
STP	Space-Time Processing

STTC	Space-Time Trellis Coding
TCM	Trellis Coded Modulation
V-BLAST	Vertical Bell Laboratories Layered Space-Time
WLAN	Wireless Local Area Network
ZF	Zero Forcing

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