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Generalized Channelmodel for Mimo Transceivers Multiplexing Gain

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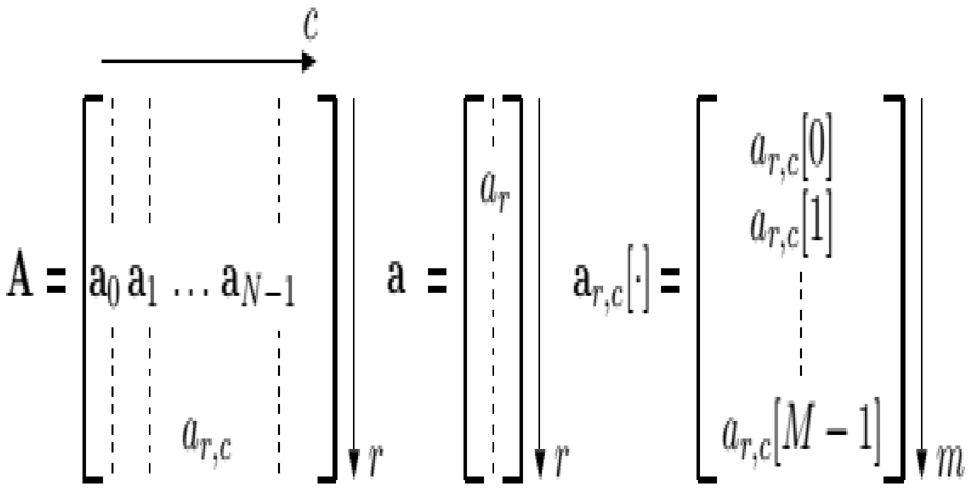
Abstract:*The capability of perfect MIMO channels has a high SNR grade that equals the minimum of the add active to of transmit and receive masts. This is due to the fact that, unlike base stations, transmits are low-cost swells that can be simply deployed and, hence, enhances the network agility. The vast majority of works in the context of relaying grids make the assumption of ideal transceiver hardware. The vast majority of mechanical contributions in the area of relaying assume ideal transceiver hardware. These deficiencies are conventionally overlooked in information theoretic studies, but this letter shows that they have a non-negligible and essential impact on the spectral efficiency in modern deployments with high SNR. Technological advances can condense transceiver impairments, but then again there is currently an opposite trend towards small low-cost low-power transceivers where the inherent dirty RF effects are inevitable and the transmission is instead adapted to them. We prove analytically that such physical MIMO channels have a finite upper capacity limit, for any channel distribution and SNR.*

Keywords: *SNR, RF, MIMO, relaying, Transciever*

I. Introduction

Wireless communication enjoys considerable attention in the research community. Recent advances are mainly market driven by the demand for applications with increased data rates. Especially, wireless local area networks (WLANs), which aim at replacing wired computer network infrastructure with wireless communication technology, seem to raise a strong demand for further research and development.

Different approaches to boost WLAN data rates have been considered in the past, as reflected in the amendments of the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards, First, data rates up to 11 Mbit/s are supported by IEEE 802.11b compliant equipment. The modulation is direct sequence spread spectrum-based, which renders wireless channel equalization a complex task in the receiver. Unlike the conventional point-to-point channels, in a wireless network, the overall throughput of the system is interference limited.



That is, boosting up the transmitted power of a user cannot efficiently increase the spectrum efficiency of the network, since strong signals transmitted by one user acts as strong interference on other users. Therefore, it is of interest to develop approaches to increase the spectrum efficiency without increasing the transmitted power. With the introduction of orthogonal frequency-division multiplexing (OFDM) [1] techniques in the popular IEEE 802.11a and IEEE 802.11g standards, data rates up to 54 Mbits/s in a bandwidth of 20 MHz can be realized with low complexity channel equalization. Channel bonding, i.e., expanding the bandwidth from 20 MHz to 40 MHz, doubles the data throughput in some systems.

OFDM has been employed in other standards as well due to its suitability for transmission over wireless links that exhibit frequency selectivity. These include standards for metropolitan area networks such as the IEEE 802.16 (WiMAX) standard. Even for broadcast systems, OFDM is becoming increasingly important. This manifests itself through the introduction of digital radio mondiale and digital audio broadcast in the short-wave bands and high-frequency bands, respectively. For video broadcasting, OFDM with advanced data compression techniques is also set to replace legacy analog transmission schemes.

The capacity of ideal MIMO channels has a high SNR slope that equals the minimum of the number of transmit and receive antennas. This letter analyzes if this result holds when there are distortions from physical transceiver impairments. We prove analytically that such physical MIMO channels have a finite upper capacity limit, for any channel distribution and SNR. The high-SNR slope thus collapses to zero. This appears discouraging, but we prove the encouraging result that the relative capacity gain of employing MIMO is at least as large as with ideal transceivers.

This work analyzes the generalized MIMO channel with transceiver impairments. We show that the capacity has a finite high-SNR limit for any channel distribution. The multiplexing gain is thus zero, which is fundamentally different from the ideal case in (detailed above). Similar single antenna results are give. The practical MIMO gain— the relative capacity increase over single-antenna channels—is however shown to be at least as large as with ideal transceivers.

II. Methodology

This section outlines the notation used in this thesis. An exhaustive list of all operators and variables is given in Appendix A. A matrix is denoted by a bold uppercase letter. The entry of matrix A in the r_{th} row and c_{th} column is denoted by a_r , c. The c_{th} column of matrix A is denoted by a_c. Lowercase bold letters denote vectors. Therth entry of vector a is denoted by a_r.

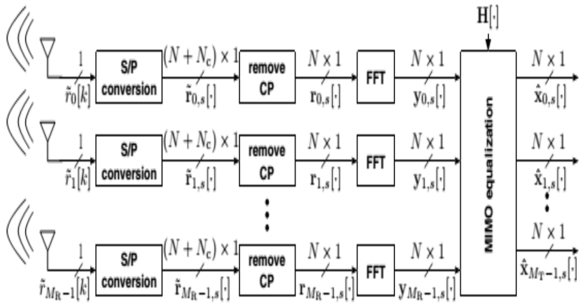
To describe MIMO-OFDM systems in vector notation, three dimensions are required. This can be introduced making use of brackets[·]. Therefore, A[m] denotes the m_{th} matrix of a collection of M matrices. The c, r_{th} element of the m_{th} matrix is denoted by a_r, c[m]. This extra dimension describes usually the time or frequency index. a_r, c[·] denotes aM×1column vector containing all entries a_r, c[m] wherem=0,1,...,M−1. See Figure 2.1 for an illustration of the notation.

Brackets may also be used to access individual entries of a vector; thus, the r_{th} entry of a vector a is denoted as a[r]=ar. Occasionally, the index exceeds the defined length of a vector. We assume all vectors to be virtually expanded with zeros, thus returning() in these cases. The symbols w and k denote indices in the frequency domain and time domain, respectively. Constants, operators, and identifiers of variables are always written in upright font, for example, A_{hs} denotes the Hermitian transposition of a matrix A with label s.

In this section, a frame-based MIMO-OFDM system model is introduced. The structure of this MIMO Model is organized in order to be compatible with the IEEE 802.11 system description. Spatialmultiplexing is employed, where multiple, independent streams are transmitted in parallel in the same frequency band at the same time. The data is transmitted in frames. This allows multiple users to access the same physical resources easily by means of time division multiple access (TDMA). The MIMO system under consideration employs MT antennas at the transmit terminal andMRantennas at the receive terminal as outlined in Figure 2.2 and Figure 2.1, respectively. For a spatial multiplexing system to function efficiently, we impose that the number of receive antennasMRalways exceeds or equals the number of transmit antennas MT.

III. Channel Capacity

The Shannon capacity of a time-invariant channel is defined as the maximum mutual information between the channel input and output. This is the maximum data rate that can be transmitted over the channel with arbitrarily small error probability. When the CSI is perfectly known at both the transmitter and the receiver, the transmitter can adapt its transmission strategy relative to the instantaneous channel state. If the channel is time variant, the ergodic capacity is the maximum mutual information averaged over all channel states. The ergodic capacity is typically achieved using an adaptive transmission policy where the power and data rate vary relative to the channel state variations. In a multiple user scenario, MU MIMO allows the reuse of time and frequency resources. Due to the scattering in different scenarios, the users' wavefronts may have large angle spreads and random signatures. Therefore, even users that are well separated in angle may have potentially overlapping subspaces spanned by left singular vectors of their channel matrices. Separability of their subspaces is much more difficult to achieve.



In a single-user MIMO system the link is point-to-point with a defined capacity. In a multi-user MIMO system, the link is a multiple access channel on the uplink and broadcast channel on the downlink. The achievable rates are characterized in this case in terms of a sum rate region. SU MIMO suffers only a small penalty in information rate without CSI at the transmitter. MU MIMO has a much larger penalty on the downlink. In a SU MIMO system, precoding at the transmitter and decoding at the receiver can be done with full cooperation between the collocated antennas. In a MU MIMO system, the antennas can cooperate at the base station for precoding on the downlink and for decoding on the uplink. However, the users cannot cooperate in decoding on the downlink or during the precoding on the uplink. In a MU MIMO system, cooperation between the users may be possible in terms of power rates assigned to the users. In a SU MIMO system, the information rate is identical on the uplink and downlink for the same transmit power if the channel is known at the transmitter and the receiver.

IV. Tx-Rx Impairments

MIMO wireless communication systems have attracted considerable attention over the past decades due to their ability to enhance the channel capacity and transmission reliability. Telatar and Foschini have respectively and that there is a linear growth in channel capacity by increasing the number of transmit and receive antennas, without requiring additional transmit power or bandwidth. Although numerous publications have appeared in this field, the vast majority assumes ideal RF hardware.

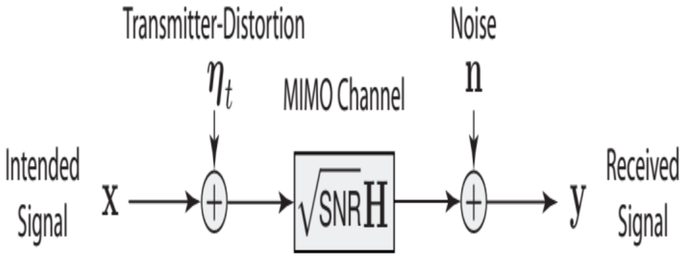


Fig 1.0.: Block diagram of the generalized MIMO channel considered in this letter. Unlike the classical channel model, the transmitter distortion generated by physical transceiver implementations is included in the model.

Physical radio-frequency (RF) transceivers suffer from amplifier non-linearities, IQ-imbalance, phase noise, quantization noise, carrier-frequency and sampling-rate jitter/offsets, etc. These impairments are conventionally overlooked in information theoretic studies, but this letter shows that they have a non-negligible and fundamental impact on the spectral efficiency in modern deployments with high SNR. This letter analyzes the generalized MIMO channel with transceiver impairments from [7]. We show that the capacity has a finite high-SNR limit for any channel distribution. The multiplexing gain is thus zero, which is fundamentally different from the ideal case in [1] (detailed above). Similar single antenna results are given in [5]. The practical MIMO gain— the relative capacity increase over single-antenna channels—is however shown to be at least as large as with ideal transceivers.

However, this assumption is quite unrealistic in practice. More specifically, RF impairments, such as I/Q imbalance HPA nonlinearities and oscillator PN are known to have a deleterious impact on the performance of practical MIMO systems. Even though one can resort to calibration schemes at the transmitter, or compensation algorithms at the receiver to partially mitigate these impairments [9], there still remains certain amount of distortion unaccounted for. The reasons for such residual transceiver impairments are, for example, inaccurate models which are used to characterize the impairments' behavior, imperfect parameters estimation errors due to thermal noise, and unsophisticated compensation algorithms with limited capabilities.

In this context, very few publications have studied the impact of residual transceiver impairments. For example provided experimental results to model the statistical behavior of residual hardware impairments. Moreover, they also investigated the impact of transmitter impairments on several existing MIMO detection algorithms (e.g., zero-forcing detection, maximum-likelihood detection, and max-log a posteriori probability detection).

In real-world systems, signals are affected by non-idealities and imperfections. In the case of the test bed, the RF-chain in the transmit and receive-path is especially vulnerable to impairments. In this chapter, the main impairments in the transmit-path of the test bed are identified and measured. The EVM is used to determine the overall performance of the transmit chain. Then, the system model introduced is changed such that impairments in the transmit-path are also considered. The impact of impairments in the transmit-path on different MIMO detection algorithms is illustrated by simulations and measurements carried out on the offline-test bed. And last but not least, performance measurements of the real-time test bed are shown.

V. Outputs

Technological advances can reduce transceiver impairments,but there is currently an opposite trend towards small low-costlow-power transceivers where the inherent dirty RF effects areinevitable and the transmission is instead adapted to them.

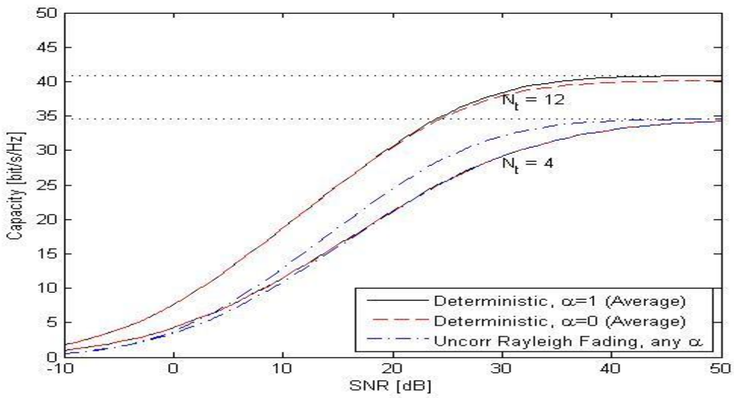


Fig.2.**0** Average capacity of a 4x4 MIMO channel over different deterministic channel realizations, different levels of transceiver impairments, and α = 1.

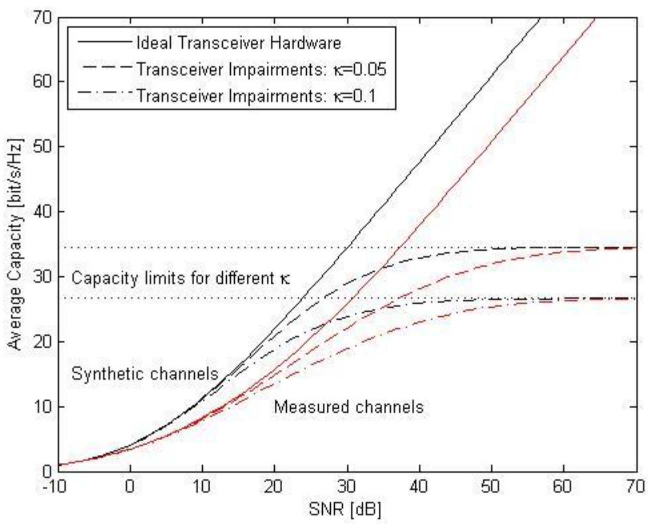


Fig.2.**1** Capacity of a MIMO channel with Nr = 4 and impairments with K= 0.05. We consider different Nt , channel distributions, and α-values

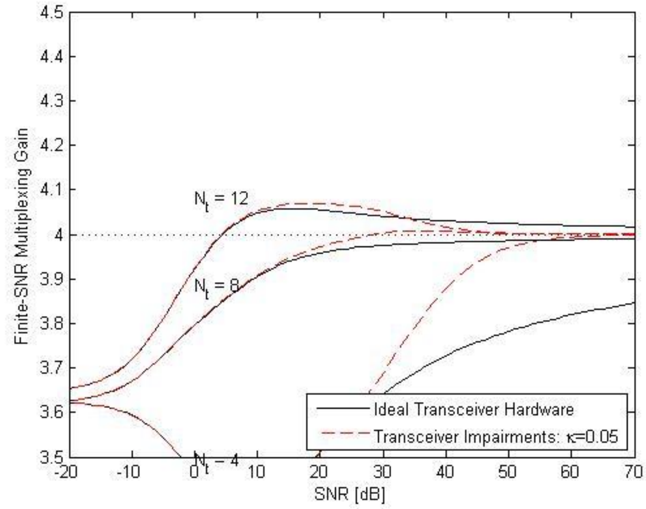


Fig.2.**2** Finite-SNR multiplexing gain for an uncorrelated Rayleigh fading channel with Nr = 4 and Nt ≥ 4.

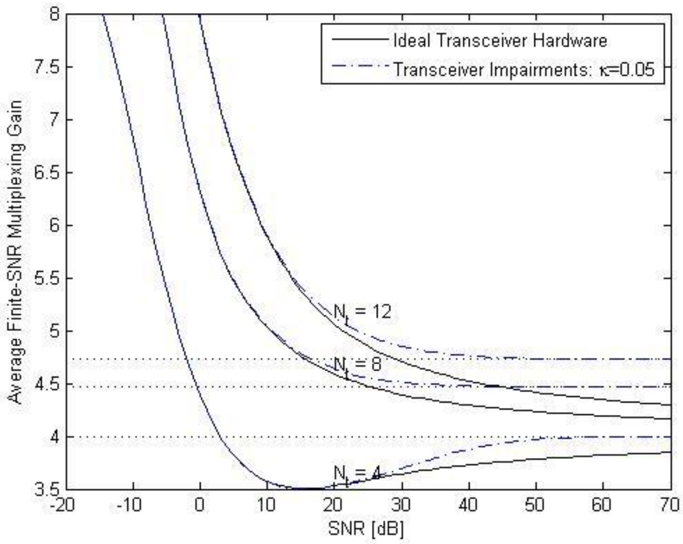


Fig.2.**3**Average finite-SNR multiplexing gain of deterministic channels (generated with independent CN (0, 1)-entries) with Nr = 4 and Nt 4.

VI. Conclusion

Due to the lack of a fundamental metric of the performance, previous research on multiple antennas channels, especially the design of the coding schemes, is split into two different branches, focusing either on extracting the maximal diversity gain or the maximum spatial multiplexing gain. The purpose of this dissertation is to provide a unified view of the problem, by drawing a picture that connects these two types of gains. The main contribution of this dissertation is summarized as follows. We propose the new point-of-view that given a multiple antenna system both the diversity gain and the multiplexing gain can be simultaneously achieved, but there is a fundamental tradeoff between how much of each type of gain any coding scheme can achieve.

We give a concrete definition of the diversity gain and the spatial multiplexing gain for the multiple antenna channels, and a complete concept of the asymptotic analysis at high SNR. For the coherent channel model, we give a simple closed form solution of the optimal tradeoff curve, as well as a geometric interpretation that helps to understand the typical way to make detection errors in such a channel. The ability of *ideal* MIMO channels has a high-SNR slope that equals the minimum of the number of transceiver antennas.

This work evaluates if this result holds when there are distortions from physical transceiver limitations. We prove analytically that such *physical* MIMO channels have a finite upper capacity limit, for any channel distribution and SNR. The high-SNR slope thus collapses to zero. This appears discouraging, but we prove the encouraging result that the *relative* capacity gain of employing MIMO is at least as large as with ideal transceivers. The entire results will be shown in MATLAB platform effectively.

The approach provides valuable insights to the resource in MIMO systems and understanding of the traditional techniques such as the union bound. We propose to use the tradeoff performance as a comprehensive performance metric. We use this metric to analysis several well-known schemes, to understand their limit and propose improvement.

We computed the high SNR channel capacity of the non-coherent channel, generalized the notion of degrees of freedom. We used a geometric approach that is useful in general problems. We compute the optimal tradeoff curve for the non-coherent channel. We evaluate the performance of a pilot-based scheme, and show that it is optimal both in terms of achieving the maximum number of d.o.f, and achieving the entire optimal tradeoff curve. This result provides theoretical support to apply the results for the coherent channel in the non-coherent case. We also give an intuitive discussion to understand the training schemes and the unitary space-time codes.

References

[1]. J. Winters, “On the capacity of radio communication systems with diversity in arayleigh fading environment,” IEEE JSAC, vol. 5, pp. 871–878, June 1987.

[2]. B. Hassibi and B.M. Hochwald, “High-rate codes that are linear in space and time,”IEEE Trans. on Inf. Theory, vol. 48, no. 7, pp. 1804–1824, July 2002.

[3]. W. Yu, W. Rhee, S. Boyd, and J. Cioffi, “Iterative water-filling for vector multipleaccess channels,” in Proc. IEEE Int. Symp. Inf. Theory, (ISIT), June 2001.

[4]. C. Windpassinger, R. F. H. Fischer, and J. B. Huber, “Lattice-reduction-aided broadcast precoding,” in Proc. 5th International ITG Conference on Source and Channel Coding (SCC), Erlangen, Germany, January 2004, pp. 403–408.

[5]. M. Tomlinson, “New automatic equaliser employing modulo arithmetic,” Electronics Letters, vol. 7, no. 5/6, pp. 138–139, March 1971.

[6]. H. Harashima and H. Miyakawa, “Matched-transmission technique for channels withintersymbol interference,” IEEE Trans on Comn., vol. 20, no. 4, pp. 774–780, August1972.

[7]. R. Bogdan, C. Fernando, and P. T. Balsara, “Event-driven simulation and modeling of phase noise of an RF oscillator,”IEEE Trans. Circuits Syst., vol. 52, pp. 723–733, 2005.

[8]. H. Bölcskei, “Blind estimation of symbol timing and carrier frequency offset in wireless OFDM systems,”IEEE Transactions on Communications, vol. 49, pp. 988–999, 2001.