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Review on MIMO Detection under Imperfect CSI

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Abstract: Multilateral input systems (MIMO) have set very high standards in recent decades, including IEEE 802.11n (Wi-Fi) and long-term evolution (LTE). In addition, MIMO techniques will be used for 5G by increasing the number of antennas at the end of the channel. MIMO systems enable multiplexing spatial, capable of increasing the capacity of the communication channel in proportion to the minimum number of antennas installed on both sides without sacrificing any additional bandwidth or power. To handle space-division multiplexing (SDM), recipients must use new algorithms to exploit location data to separate streams of data transferred. This chapter offers an overview of all the most popular and promising MIMO machines, as well as some unusual-yet-interesting ones. We focus on the definition of different paradigms to highlight the different ways studied.

1. Introduction:

Multiple-input multiple-output (MIMO) communications currently represent one of the most dynamic areas of research. Over the past ten years, there has been a surge of research activities in this field. This is mainly due to an explosive demand for internet access, driven by wireless data applications on user equipment. Also, the significant progress in very-large-scale integration (VLSI) technology enabled the implementation of complex signal processing algorithms and resulted in a small area and low power consumption. This led to the development of various communications techniques and mathematical tools in the past decade and the research is still very vibrant in this field. There are two fundamental issues of wireless MIMO communications that make the problem challenging. The first one is the effect of channel fading. Fading has a small scale effect which is multipath propagation with time-varying channel strengths and large scale effects such as path loss and shadowing due to obstacles. The second issue is that the existence of a large amount of users in cellular networks has driven communication channels from being noise-limited to interference-limited. Each transmitter receiver pair cannot be viewed as an isolated point-to-point link, but wireless users communicate over the air and there is significant interference between them. The interference can be between transmitters communicating with a common receiver, between signals from a single transmitter to multiple receivers or between different transmitter receiver pairs. How to deal with channel fading and with interference is central to the design of wireless communication systems. In particular, we focus on these issues for the single-user MIMO and the inter-cell interference network. The single-user MIMO is the simplest MIMO channel model, where one pair of transmitter and receiver nodes are equipped with multiple antennas and communicate with each other. In doing so, they have to deal with the wireless channel uncertainty. Variations of the channel strength over time, frequency, and space makes the issue more challenging. This system model consisting of multiple dimensions (time, frequency, and space) also implies a possible solution to improve network performance after the correlation in each dimension is modeled properly and well exploited.

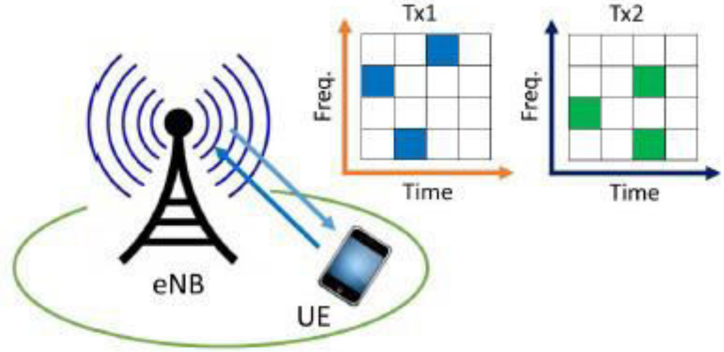

Figure 1: The single-user MIMO system

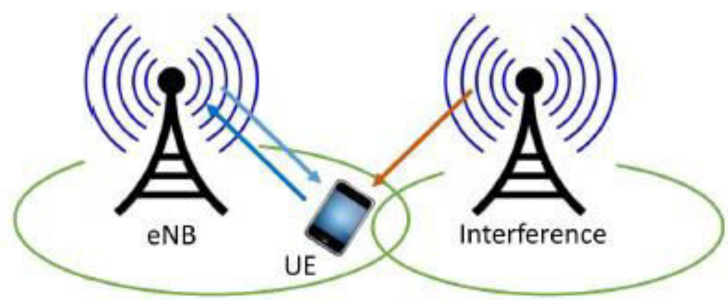

Figure 2: The inter-cell interference network

2. Research Scope and Objectives:

The traditional design of MIMO systems has focused on increasing the reliability of wireless transmission. In this context, channel fading and interference need to be properly handled. By using some signal processing techniques like channel equalization and interference suppression, advanced receivers in the network can boost the overall system performance. Recently the MIMO research has shifted more towards achieving an attractive compromise between area spectral efficiency and energy efficiency. Spectral efficiency and throughput versus energy efficiency and low complexity are rapidly changing the topology of operational cellular networks. This shift provides a new point of view that fading can be viewed as an opportunity to be exploited.

3. Literature Review:

The literature review outlines previous work by other researchers, which forms the foundation of this paper. Orthogonal Frequency Division Multiplexing (OFDM) has been distinguished between other types of data transmission and reception schemes, for its excellent tolerance towards multipath fading and for supporting even higher data rates. OFDM has been a primary part of interest in many scientific researches and it has been included and implemented in various standards and application fields. Digital Audio Broadcasting (DAB), Terrestrial Digital Video Broadcasting (DVB-T), Wireless Local Area Network (WLAN { IEEE 802.11), High-Performance LAN type 2 (HIPERLAN/2), Broadband Wire- less Access (BWA IEEE 802.16), Mobile Broadband Wireless Access (802.20), wimax, Broadcast Radio Access Network (BRAN), Digital Subscriber Lines (DSL) and Multimedia Mobile Access Communication (MMAC) have all adopted OFDM [1]. Many schemes for reducing Imperfect CSI have been proposed and are worth mentioning not only for their innovations but also due to hard work that appears to have been done by all authors. Clipping is very simple and has a quick implementation [2]. Unfortunately it causes out- of-band radiation. Even if digital filtering is used for reducing radiation [3] which is very proper to do, BER deteriorates. Constellation shaping using SLM method in conjunction with Hadamard code [4] offers good results but complexity of this method is relatively high compared to others, like Low Complexity Technique which utilizes simple algorithm [5]. The latest still requires magnifier in receiver. Also in-depth BER performance is not mentioned. But, we must not omit the fact that its Imperfect CSI performance is fine. Another scheme is Imperfect CSI reduction with Huffman Coding [6] but it introduces the necessity of transmitting the encoding table to receiver. Even if bandwidth will not be affected, a serious drawback remains. System complexity is high. Another excellent idea is about recovering the clipped part of the OFDM signal [7], but it has restrictions, like trading-off between low CR and increasing the amount of the copied signal which in turn introduces redundancy in the transmitted data. Using a root commanding transform technique still requires expander in the receiver and exhibits good trade-off between imperfect CSI and SER. SER Performance appears to be good but not innovative. Other technique using combined interleaving and commanding [6][7] exhibits good CCDF performance but introduces the necessity of k interleaves in transmitter's part. Also side information must be sent to receiver containing identities of corresponding interleaves. This deteriorates simplicity of system design. In practice, wireless communications channels are time varying or frequency selective especially for broadband and mobile applications. To address these challenges, a promising combination has been exploited, namely, MIMO with Orthogonal Frequency Division Multiplexing (OFDM), which has already been adopted for present and future broadband communication standards such as LTE or WiMax [12-14]. OFDM can reduce the effect of frequency selective channel. This is because in OFDM, the data stream that is to be transmitted is divided into multiple parallel streams and the wideband channel is divided into a number of parallel narrowband sub channels and thus each sub channel has a lower rate data stream. OFDM is also used for its simplicity of implementation in the digital domain by the use of DFT. Moreover, OFDM is bandwidth efficient since the parallel subcarriers are orthogonal to each other and as a result overlaps each other without causing interference. With the use of cyclic prefix, OFDM has also been proven as a robust modulation technique under multipath frequency selective fading environment [3, 15].

4. Conclusion:

A Bayesian model selection (BMS) based MIMO detector has been proposed. In order to deal with the uncertainty of channel estimation errors, we consider the optimum receiver based on the Bayesian inference and derive an efficient detection algorithm to achieve it. The main results will show that: instead of a worst-case (or min-max) design, the proposed algorithm not only guarantees robustness in the worst scenario but also provides an improvement in other scenarios.

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