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Paper Authors
Sk Shakira Begam, N Srikanth Prasad

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Precoding and Detection Techniques for massive MIMO Systems

Sk Shakira Begam[1], N Srikanth Prasad[2]
Assistant Professor[1,2]
Department of ECE
MREC

Abstract: This paper outlines the advanced signal processing and coding techniques employed in MIMO systems to deliver high data rates and more robust communications. In MIMO technologies such as Maximum Likelihood Detection (MLD), and Minimum Mean Square Error (MMSE) detection, the signal processing is associated only at the receivers. In these systems, data streams for different users are transmitted directly into the wireless channel and the individual user's data are retrieved by employing MIMO signal processing at the receiver. Singular Value Decomposition (SVD) based MIMO techniques include signal pre-processing or precoding before transmission in addition to MIMO signal processing at the receiver.

It is also possible to have the MIMO system with signal pre-processing or precoding only, so that a simplified mobile station is devised. In this case, though the mobile station requires the basic front-end units, the associated MIMO signal processing at the receivers is greatly reduced. The basic principle of precoding is that if the transmit side knows the channel information, the signal to be transmitted is designed in such a manner to mitigate the adverse effect of the wireless channel. The precoding is used in SU-MIMO system to improve SNR at the receiver and the requirement of precoding is necessary in MU-MIMO system to minimize multi user interference. Precoding is performed with the help of down-link Channel State Information (CSI) which is not essential in SU-MIMO systems but is required for MU-MIMO systems.

Index Terms: MIMO, SVD, MLD, Precoding, Likelihood and Detection.

I Introduction:

Wireless communication is a field that has successfully demonstrated the first radio transmission. Today, wireless communication occupies the most vibrant area in the communication field. The rapid progress in wireless communication technology has been in the air over the past few decades. The very modern wide spread and successful

technology in wireless communication could be witnessed in mobile or cellular communication largely. Many wireless communication techniques such as Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiple Access(OFDMA), Multi Input Multi Output (MIMO), MU-MIMO and Ultra-Wide Band systems (UWB) have been developed during the past two decades to achieve higher data rate, more robust link quality and more user capacity in equally more rigorous channel conditions. Recently, the mobile communication industry is rapidly gliding towards Long Term Evolution (LTE) systems because of the increasing number of smart phone users and ever-increasing demand for high quality multimedia over wireless. LTE aims to provide improved service quality in terms of throughput, spectral efficiency, latency, and peak data rate, and MIMO is one of the key enablers of the LTE system for achieving these diverse goals. There are many features in the LTE Advanced (LTEA) and it supports up to 3Gbps throughput in downlink.

Multi user Multiple Input Multiple Output (MU MIMO) scheme is one of the key features of LTEA for achieving a high spectral efficiency. LTE Advanced MU-MIMO techniques have been evolved from their premature form to the more elaborated version.

II Existing Work or Literature Survey:

This paper includes Design of optimum linear precoders to maximize channel capacity, maximize the minimum distance, minimize the Bit Error Rate (BER), or minimize the Mean Square Error (MSE) etc have been reported in the open literature. Most of the previous researchers in linear precoding design for MU-MIMO systems assumed that perfect Channel State Information (CSI) is available at the transmitter. But in practice, the errors are inevitable in channel estimation process. This erroneous CSI at transmitter degrades the performance, due to difference between the true channel and the erroneous channel used for precoder. Hence, it is necessary to design a precoder to incorporate channel estimation error.

There have been many practical designs that consider imperfect CSIT. Under an independent identically distributed Rayleigh flat fading assumption, an achievable lower bound and cooperative upper bound for sum rate capacity has been derived to arrive at sum rate loss. The imperfect CSI, including channel mean and receive correlation information, is overcomed

by proposed MMSE linear precoder design by considering the imperfect CSI at the (Base Station) BS, in which the channel estimation error variance has been incorporated in the system design for multi user wireless communication system. The authors proved that linear MMSE precoder designed by considering channel estimation error outperformed regularized channel inversion precoder. The linear precoding strategy for distributed MIMO systems with partial CSIT has been proposed due to mobility of the vehicle and the time varying nature of the channel, the CSI available at the BS has to be updated to improve the performance of the system.

In practical downlink systems, the mobile is often surrounded by the local scatterers and channels from different antennas tend to be uncorrelated, whereas the channels from different base station antennas are often correlated due to limited scattering. The spatial diversity gain, one of the MIMO channel parameters, depends upon the antenna correlation. If the antennas are highly correlated, spatial diversity gain is small and vice versa if the antennas are uncorrelated. Though some studies in the literature have addressed the imperfect CSI, they do not consider the impact of above three channel parameters, like feedback delay, spatial correlation and the channel estimation error variance as integral part of the system design.

III Proposed Work:

Based on the problem outlined in the previous section, attempts have been made in our work to enhance the performance of the MIMO system by incorporating the three channel parameters in the system design. The proposed system meets the objectives:

- To find the relation between no. of antennas and Average SE for various precoding and detection techniques like ZF, RZF, S-MMSE. M-MMSE, MR.
- To find the relation between SNR and Average SE for Los and non-Los propagation.
- To find the relation between No of users(UE) and SE
- To find the relation between SNR and SE for various precoding techniques

IV Results:

Massive MIMO is an innovative technology that helps in the achievement

of higher system throughput and reliable transmission for 5G and beyond wireless networks.

In this paper, the major elements of massive MIMO networks, namely precoding, encoding, detection, and beamforming are discussed. We provided a detailed overview of some of the research efforts done in this area.There are many interconnected design issues that need to be properly understood and solved before widespread deployment of the massive MIMO technology. More research is needed to introduce new adaptive beamforming techniques to achieve higher received symbol power and less interference. In addition, introducing efficient beamformers for PTP networks to work under different constraints and with different types of channels, for enabling PTP widespread application in massive MIMO systems.

As detection becomes harder when the number of BS antennas increases, more advanced signal processing methods are required for better detection and are associated with introducing low complexity optimum and nonlinear detectors, and precoders to improve the performance and reduce the computational complexity. Introducing new techniques to reduce the training time, especially when the number of antennas increases is needed, will, in turn, improve the performance of FDD systems in massive MIMO to improve channel gain, capacity, received power, and reduce latency.

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