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Antenna Selection Techniques for Channel Capacities for MIMO OFDM Systems

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***Abstract*—In this article channel state information (CSI) using various antenna selection (AS) techniques is exploited for multiple input multiple output (MIMO) system. Exploitation of CSI allows the improvement in channel capacity and performance of error rate. The communication system performance can be enhanced by reducing hardware complexity by choosing AS technique. The improvement in channel capacities is relative to the number of antennas selected. The AS techniques employed are optimal and suboptimal techniques which can be compared on the basis of system complexity level. The performance of the system can be enhanced on the basis of improved complexity in most favorable AS technique whereas suboptimal AS technique enhances the system behavior at the price of reduced complexity. In this paper various capacity expressions have been demonstrated and comparative analysis for various parameters like quantity of antennas and *SNR* values have been performed for system improvement. Simulation outcomes reveal that the channel capacities can be enhanced by varying the selected antennas and *SNR* of the system.**

Keywords—MIMO; AS; CSI; SVD; STC; channel capacity; SNR; BER.

I. Introduction

The wireless systems equipped with MIMO antenna systems can deliver superior performance without using extra bandwidth and transmit power. Antenna spatial diversity and orthogonal frequency division multiplexing (OFDM) are the major advantages of MIMO systems which can overcome major challenges in delivering more data rate at better value of service. The spectrum scarcity and random varying channel conditions are the issues to be addressed to overcome fading and interference. The MIMO antenna systems can extensively overcome the rising demand for enhanced capacity through antenna diversity and spatial multiplexing gain without additional bandwidth and transmit power [1, 2]. The MIMO system equipped with more than one antenna at transmitter and receiver end incorporate additional high cost radio frequency modules including low noise amplifiers (LNA), frequency down converters and A/D converters [3, 4]. The cost related with several RF modules can be significantly reduced by precoding and AS technique where smaller number of RF modules as compared to number of transmit antennas are employed. The MIMO systems equipped with spatial diversity followed by AS techniques can be suitably used to optimize the behavior of point to point MIMO, cooperative MIMO and large scale MIMO systems. The objective of AS is to select the most excellent performing antenna(s) as an alternative of all the accessible antennas. This reduces the decoded RF modules at the receiver side. The AS is relevant at the transmitter and/or receiver side [5]. This paper consider AS at transmitter side. With AS at the transmitter the antenna with best performance is chosen. The antenna with maximum SNR is selected. The signals at the receiver side can be collected using various combining procedures, like, maximal-ratio-combining (MRC), equal-gain-combining (EGC) and selection combing (SC). MRC is found the best performing and will be used during the analysis of the transmit antenna selective MIMO system. This article presents and evaluates the capacity analysis of MIMO systems with reference to optimal and sub-optimal AS techniques over Rayleigh fading channel. The SNR performance mathematical model with increase in number of antennas with MRC combining technique have been studied for various antenna configurations and different *SNR* values. One can obtain the results to validate the enhancement in channel capacities.

The paper is prepared as follows. System model for channel capacity for optimal selection of antennas for all possible combinations is detailed in section-II. The channel capacity can be maximized by selecting the antenna with highest capacity. In Section-III various illustrative simulation results are presented for various antenna combinations. The parameters considered are the number of selected antennas and *SNR* values with optimal antenna selected method and sub-optimal method. The paper is finally concluded in section IV with references.

II. MIMO System Model

A. System Model

One can consider a MIMO communication system using N_t transmit antennas and N_r receive antennas with H, complex MIMO channel matrix of dimension $N_r \times N_t$ as shown in Figure 1[5,6].

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Analysis of Channel Capacities for MIMO OFDM Systems

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Abstract—**In this article channel capacities of multiple input multiple output-orthogonal frequency division multiple access (MIMO-OFDM) systems under various scenarios are investigated. The investigations are based on the improvement in the channel capacity which affects the overall performance of the system for more reliable communications. A MIMO communication system pooled with the OFDM can achieve high data rate over wireless channels. An important tool singular value decomposition (SVD) is also analyzed for characterizing MIMO-OFDM channel. It has been demonstrated that the SVD performs a vital role in analyzing the performance of MIMO-OFDM channel. One important algorithm termed as Water pouring is demonstrated to achieve the capacity or maximum sum rate of MIMO-system. The investigations have been done on capacity expressions for deterministic and random channels and comparative analysis for various parameters like antenna configuration and signal to noise ratio (*SNR*) values have been performed. Simulation outcomes reveal that the channel capacities can be enhanced by varying the configuration and correlation of MIMO antennas.**

Keywords—MIMO; OFDM; CSI; SVD; STC; channel capacity; SNR; BER.

I. Introduction

The forthcoming wireless systems are facing major challenges in delivering more data rate at better value of service. The scarcity of the spectrum and varying propagation conditions are to be addressed to overcome fading and interference issues. The optimal solution is to fundamentally increase bandwidth and channel reliability. The development of MIMO antenna systems can significantly overcome the rising demand for enhanced capacity through antenna diversity and spatial multiplexing gain without additional bandwidth and transmit power [1, 2]. The MIMO system equipped with multiple antennas at transmitter and receiver end can improve the channel capacity of wireless communication systems [3, 4]. The property of MIMO systems which allows transmitting multiple information streams in parallel is termed as Spatial Multiplexing. In this case space is used to simultaneously transmit information in parallel streams. Effective approaches for improving the data rate over wireless channel through multiple transmit and receive antennas have been applied termed as Space-time coding (STC)[5, 6]. 4G and 5G wireless systems can deliver the data rate as high as 1Gbps. STC coding techniques results in increase in channel capacity due to the "smoother" fading to effectively control and reduce the power transmitted [5]. Coding gain can be gracefully combined with spatial diversity gain [6]. At the transmitter it does not demand channel state information (CSI) and can be operated in open-loop mode, thus avoiding the demand for a costly reverse link with frequent fading. A robust performance is delivered against correlation between antennas, errors in channel estimation and effects due to Doppler shift [7, 8]. The higher data rates can be achieved by combining STC techniques with the multi-carrier code division multiple access (MC-CDMA) system [9]. Space-time trellis coded (STTC) OFDM [10] and space-time block coded (STBC) OFDM [11-16] are developed to tender transmit diversity and coding gains in frequency selective fading channels. The combination of orthogonal space time block codes (OSTBCs) and OFDM, offers the maximum transmit diversity with a simple maximum-likelihood (ML) receiver structure [12-16]. OFDM combined with MIMO can comprehend and persuade the challenges of audio-video services with digital audio broadcasting (DAB), digital video broadcasting-terrestrial video (DVB-T), and wireless local area networks (WLANs) application standards [17]. This paper presents and evaluate the mathematical models of deterministic and ergodic MIMO channel capacity with and without correlation for various antenna configurations and different *SNR* values. Simulation results are obtained to validate the improvement in channel capacities.

This paper is structured as follows. Section-II involves discussion on MIMO-OFDM system model with application of SVD in analyzing the behavior of channel. This section also investigates the mathematical models for deterministic and ergodic channel capacities under different antenna configurations and *SNR* values. It has been demonstrated that how a MIMO-channel utilizes Spatial Multiplexing to improve the gain and capacity of the system. In Section-III various illustrative simulation results are presented for various MIMO channels. The parameters considered are the types of channels considered for various antenna configurations and *SNR* values with and without the availability and unavailability of CSI. The paper is finally concluded with list of references.