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Evolution of MIMO Systems

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Abstract
MIMO system uses multiple transmitting and multiple receiving antennas. MIMO System produces omnidirectional beam pattern due to uncorrelated beam patterns of its individual antenna. In this paper we present a brief review of evolution of MIMO SYSTEMS. Specifically transmit diversity techniques, decoding algorithms, their advantages and advancement in technology. The method and advantages of channel estimation techniques are described. Massive MIMO system is used in 5G telecommunication network. The other applications of MIMO system are also described in this paper.
Keywords: MIMO, STBC, WCDMA, STS, QOSTBC, STTC, PSK, DSTBC.

Introduction
MIMO system uses transmit diversity technique. This technique using two transmit antennas has key advantage of employment of low complexity use of multiple symbols. The decoding algorithm proposed in this can be generalized to an arbitrary number of receive antennas using MRC, equal gain combining (EGC) or successive combining (SC). The new scheme does not require any bandwidth expansion any feedback from the receiver to the transmitter and its computation complexity is similar to MRRC (Alamouti 1998). It has been reported on recent findings in quasi- orthogonal space-time block codes (QOSTBC) and show how these codes can be modified to offer high flexibility for many transmission schemes, support antenna selection, water filling and beam-forming, approach maximal diversity, provide high capacity and still work with low complexity well suited for implementation (Badic Billjana et al. 2004).The transmit diversity concept known as space-time spreading (STS) for the downlink of wideband code division multiple access (WCDMA) that is capable of achieving the highest possible transmit diversity gain. The STBC and STS designs of contrived for more than two transmit antennas result in a reduction of the achievable throughput per channel use (Hochwald et al. 2001). In detection algorithm for the Alamouti's scheme dispensing with channel estimation the channel encountered at time instant t was estimated using the pair of symbols detected at time instant t-1. The algorithm, nonetheless, has to estimate the channel during the very first time instant using training symbols and hence is not truly differential (Tarokh, V. et al. 1998). It has been considered the capacity analysis of multiple-input multiple-output (MIMO) systems. Space-time coding schemes are the signal design techniques to realize the information theoretic capacity limits of MIMO systems. The orthogonal space-time block codes were considered for the capacity and error probability analysis of MIMO systems (Hiwale and Ghatol, 2007). Linear dispersion codes (LDC) which is a high-rate space-time code that is linear both in space and time .It provides a flexible trade-off between emulating space-time coding and/or spatial multiplexing. In contrast to this, the STBC and STS designs offer-at best - the same data rate as an uncoded single-antenna system, but they provide an improved bit error rate (BER) performance compared to the family of single-antenna aided systems by providing diversity gains (Hassibi and Hochwald, 2002). A novel method for channel estimation in a single-carrier multiple- input multiple output (MIMO) system with frequency-domain equalization/detection has been purposed to construct novel short MIMO training sequences that have constant envelope in the time domain to preclude the peak-to-average power ratio problem encountered in many systems that utilize the frequency domain for data recovery (Hassibi and Hochwald, 2002). A differential modulation scheme based on quasi-orthogonal STBCs, which were compared to that of other schemes resulted in a reduced BER as a benefit of providing full diversity (Zhu et al. 2005). A complete study of design criteria for maximum diversity and coding gains in addition to the design of space-time trellis codes purposed the family of STBCs that is capable of attaining the same diversity gain as space-time trellis codes (STTC) at a lower decoding complexity, when employing the same number of transmits antennas. However, a disadvantage of STBCs when compared to STTCs is that they employ unsophisticated repetition-coding and hence provide no coding gain **(**Tarokh et al. 1998). The alternative idea invoked for constructing full-rate STBCs for complex-valued modulation schemes and more than two antennas. Quasi-orthogonal STBCs was constructed which was relaxed in favour of achieving higher data rates (Jafarkhani, H., 2001). DSTBC scheme that supports non-constant modulus constellations combined with four transmit antennas was developed. This extension, however, requires the knowledge of the received power in order to appropriately normalize the received signal. The received power was estimated blindly using the received differentially encoded signals without invoking any channel estimation techniques or transmitting any pilot symbol (Nam et al. 2004). The ability of transmit diversity to provide diversity benefit to a receiver in a Rayleigh fading environment has been reported previously. With transmit diversity; multiple antennas transmit delayed versions of a signal to create frequency-selective fading at a single antenna at the receiver, which uses equalization to obtain diversity

gain against fading. Simulation shows to study transmit diversity for the case of independent Rayleigh fading from each transmit antenna to the receive antenna and maximum likelihood sequence estimation for equalization at the receiver (Winters 1994). Transmit diversity schemes to more than two transmit antennas, contriving the generalized concept of space-time block codes (STBC) (Tarokh et al. 1999).A differential encoding/decoding of Alamouti's scheme with phase shift keying (PSK) constellations using real valued phase constellations has been purposed and hence the transmitted signal can be demodulated either with or without channel state information (CSI) at the receiver. The resultant differential decoding aided non-coherent receiver performs within 3 dB from the coherent receiver assuming perfect channel knowledge at the receiver. The differential scheme was restricted to complex-valued PSK modulation (Tarokh and Jafarkhani (1999). STBC (space-time block coding) transmission technique is used in order to evaluate the link availability and transmission quality of multi antenna systems that operate under various channel conditions. The propagation channel follows the IEEE 802.11n specifications. The influence of the diversity order and the spatial correlation is investigated in terms of error performance and throughput. The efficient use of the space and the power resources leads to significant improvement in the link reliability, if channel state is available at the transmission. The throughput enhancement of a 2×2 MIMO system relatively to the basic SISO (Single Input Single Output) mode is evaluated considering a fix antennas separation and different channel models (Vermes□an, et al. 2010). The channel encoder called 'trellis-coded modulation with unger-boeck-gray mapping' (TCM-UGM) to 'space–time block code' (STBC), in order to study its performance to correct the transmission errors of a JPEG image is associated. The performance of the proposed scheme is evaluated in senses of bit error rate (BER), frame error rate (FER) and peak signal-to-noise ratio (PSNR) of the reconstructed image. Compared to the association TCM/STBC for a throughput of 2 bits/s/Hz, TCM-UGM/STBC permits to obtain a PSNR gain up to 2 dB (Benaissa and Bassou 2012). The space time block codes the with larger the number of transmitting antennas give better performance in terms of BER as throughput increases with more number of transmitting antennas and BER decreases (Kaur et al. 2013). Error ratio and Mean square error decreases as the Signal to noise ratio increases. Different modulation schemes can be used in MIMO systems like BPSK QPSK Error ratio of system implementing BPSK modulation technique decreasing more rapidly than system implementing QPSK. BER of system using QPSK modulation scheme is less than BER using QPSK modulation scheme (Kaur et al. 2013) the diversity technique of MIMO Alamouti STBC is used in slow fading channel. Its performance degrades when used in vehicle to vehicle communication due to vehicle speed, asymmetric channel and distance between vehicles (Barrak and Khalil 2018). In Massive MIMO number of antennas are much larger than number of users. Each of individual antenna can bring down power transmitted in proportion to the number of base station antenna with absolute channel state information. Filter Bank multicarrier is used to improve spectral efficiency (Shreesh, 2018)

Conclusion

To fulfill the need of high data rate and error free communication without increasing bandwidth and power requirements MIMO system is used. It increases spectral efficiency, sends data at more speed, handle more simultaneous users with less signal fading and dead spots. It also provides better resistance to interference and increased range. Massive MIMO is used in realizing 5 G network now a days.

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