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Effect of BPSK & QPSK on MU-MIMO Signal Detection Techniques

Shraddha Kharat[1], Seema Hanchate[2]

PG Student, Dept. of Electronics and Communication, Usha Mittal Institute of Technology, SNDT Women's University, Mumbai, India[1]

Assistant Professor, Dept. of Electronics and Communication, Usha Mittal Institute of Technology, SNDT Women's University, Mumbai, India[2]

ABSTRACT:Fourth generation representative MU-MIMO is served by IEEE 802.11ac standard, which has already proved many tremendous merits over SU-MIMO. One of the ways to determine performance of MU-MIMO by the detection method used at the receiver. Suboptimal & optimal detection techniques such as ZF, MMSE & ML with low complexities are commonly used. Most of the previous precoding & signal detection work is done for the SU-MIMO to test their realizations. The trait of signal detection in MU-MIMO also rely upon the modulation technique used for its communication. The aim of this paper is to analyse the performance of different signal detection methods for BPSK & QPSK modulation techniques & determine the most sophisticated one. The performance is also done for the different antenna configurations of MU-MIMO.

KEYWORDS:MIMO, ZF, MMSE, ML, BPSK, QPSK, Signal Detection, Modulation Techniques

I. INTRODUCTION

In MIMO communication, rather than SU-MIMO, MU-MIMO is favoured due to merits as SU-MIMO doesn't acquire spatial multiplexing & spatial diversity like MU-MIMO. MU-MIMO shows hike in capacity of the system, diminished latency & comprehensive throughput by allowing independent numerous spatial data streams [1][2]. Also MU-MIMO possesses spatial beamforming & spectral reuse which utilizes almost complete bandwidth through dedicated paths. MU-MIMO extends the channel frequency binding & shows modulation upto 256-QAM, where SU-MIMO exhibits till 64-QAM [4]. Hence, modulation rate is high for MU-MIMO. With growing digital communication activity, the need of modulation is also increasing. For practicability of an antenna, for narrow-banding of a signal, for encryption & to transmit data to long distance modulation is required. Every modulation scheme shows different characteristics while concerting with signals. Out of exiting modulation techniques, PSK or QAM shows better performance against error than FSK [4]. As PSK shows more efficiency, it is commonly used digital modulation scheme. Signal detection is a technique in which, collection of transmitted information bits takes place at the receiver end over estimated channel state information. As signal detection is an important & critical matter, many researches have already been done on this topic [4]-[6];; but all for SU-MIMO. In this paper, linear ZF, MMSE & non-linear detection method ML are implemented for MU-MIMO communication system & they are tested for BPSK & QPSK modulation techniques for comparative analysis.

The lining up of paper is as follows : Section 2 explains the system model used for the signal detection in MUMIMO. Section 3 gives short comparison between BPSK & QPSK modulation techniques, where section 4 discusses executions & simulations done for detection methods & compares modulation techniques used. Last section concludes the proposed work.

II.SYSTEM MODEL AND ASSUMPTIONS

Figure 2 proposes the system model used for simulation andanalysis of multiuser MIMO signal detection. This proposed technique uses spatial multiplexing scheme, where transmitted data signal stream is split into different and

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independent parted streams for every present transmit end. Due to spatial multiplexing, this model results into merits like spectral diversity, efficiency and spatial gain. Powerful encoding at the receiver terminal is one of the requirement of spatial multiplexing. For this technique, we are considering three separate kind of receivers that are ZF, MMSE and ML. Projected detection model is moderately matching to the Vertical-Bell Laboratories Layered Space Time (VBLAST) [9] technique. For explanatory benefits, the system model considers distinctive receiverswith numerousmultiuserMIMO antenna configurations. Transmitter-receiver antennapairs used for execution are 2x2, 4x4 and 8x8; so that it will be easy for comparative analysis on the basis of characteristics. Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK) modulation methods are used for this model and constellation size is taken as of order 1 and 2 respectively. Flat Rayleigh fading is taken into account for employment on spatially multiplexed separate antenna links. For improved realization, we have anticipated that receivers has knowledge about channel state information and it is not giving feedback. Hence, itis an open loop system approach. Channel is assumed to be error-free and receive array gain is ignored in the system. The proposed system model is essentially split into two modules. First module is initiation part, where we generate and set up all vital system parameters and another module describes actual system operation. In generation and set up part, any number of transceiver antennas of fixed SNR span and constellation size for modulation is arranged. For BPSK modulation scheme constellation size is 2, where for QPSK, it is 4.

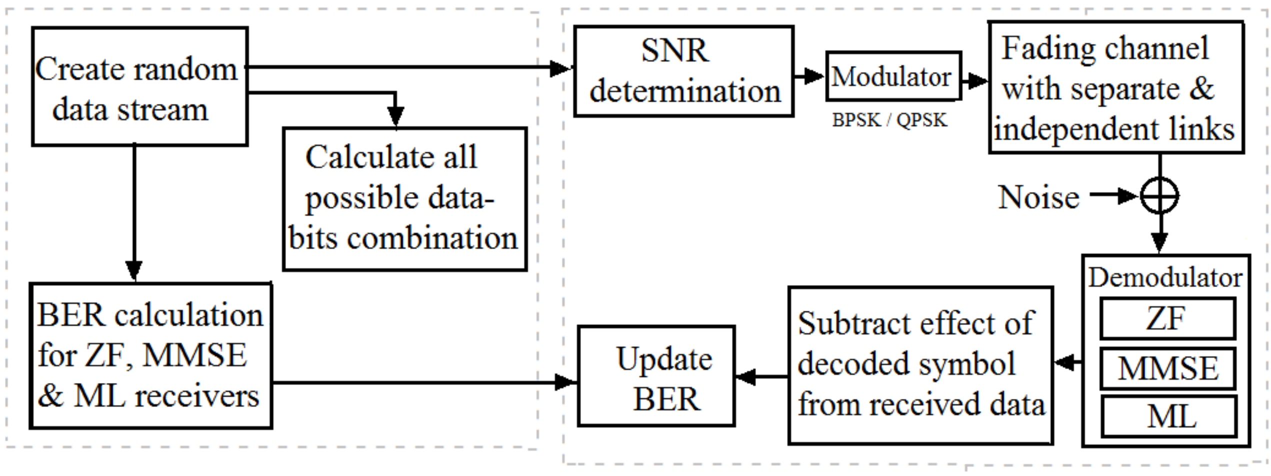

Figure 1. Signal detection model in MU-MIMO

A generated random data stream is given to a decoder. At same instant, all probable combinations of created data symbols are calculated for ML receiver. BER values are calculated and restored for used receivers, which are ZF, MMSE and ML receivers. Bit error rate is modified and for each independent spatial links, SNR is calculated from the Eb/No. After multiplexing all data bit vectors, noise addition is there into the faded data. Decoding process takes place at receiver terminal and demultiplexer unit consists of linear and non-linear receivers as plotted in system model. At this phase, channel matrix gets fade out to eliminate impact of previously decoded bit. At the end, the impact of decoded bits, subtracted from conceded data bits with new symbols. Alike to V-BLAST scheme, this will precedes to the next uttermost signal estimation, which also cancel out the BER over a given channel. Nothing like STBC model (Space-Time Block Coding), this scheme does not required explicit orthogonalization [5]. Executions are completed using this proposed scheme by usingboth BPSK and QPSK modulation techniques for ZF, MMSE and ML detection schemes and simulated for 2x2, 4x4 and 8x8 antenna configurations. Thorough analysis of this is discussed in section IV.

III.BPSK & QPSK COMPARISON

Though both BPSK & QPSK has phase as a carrier variable characteristic, but BPSK shows two level (0 & 1) modulation, where QPSK shows four level (00, 01, 10, 11) modulation. Therefore, in BPSK a binary bit symbolize by single phase state & in QPSK same done by an aggregation of two binary bits[3]. BPSK modulation shows 0˚ or 180˚

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phase shift, where QPSK modulation scheme rotates the output reference to 45˚ phase shift. In result, bit rate is double in QPSK than that of BPSK but generation & detection of QPSK is more complex as compared to BPSK [3]. Next section represents the comparative performance analysis of signal detection techniques for BPSK & QPSK.

IV. PERFORMANCE ANALYSIS

This section provides a concise interpretation of simulations done for the comparative analysis of signal detection techniques for BPSK & QPSK modulation schemes in MU-MIMO communication system. These executions are done in MATLAB environment. Simulations are accomplished for different antenna configurations such as 2X2, 4X4 & 8X8 considering each linear & non-linear signal detection technology. Here, we are considering ZF, MMSE & ML techniques for both modulation cases, that are BPSK & QPSK & finally the comparative graphs are plotted for 2X2 configuration of MU-MIMO. For implementation, Rayleigh flat fading MIMO channel is considered. The SNR range taken for span 0-10 dBs & characteristics are observed for BER.

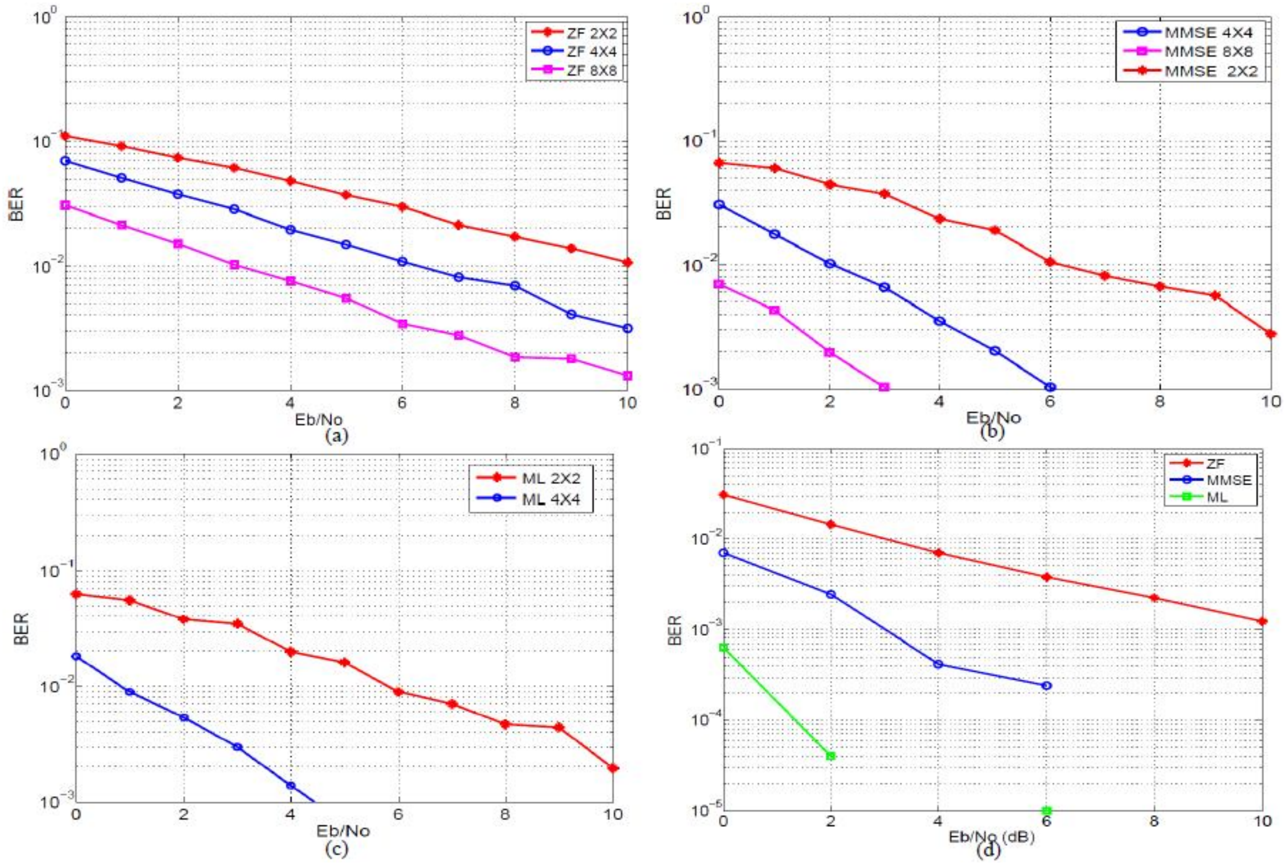

Figure 2. (a) ZF, (b) MMSE, (c) ML shows detection for different MIMO configurations using BPSK & (d) Comparative analysis of BPSK detection of ZF, MMSE & ML for 2X2 configuration

Figure 2 deals with BPSK simulations, in which figure 2(a), (b) & (c) represents the performance analysis for ZF, MMSE & ML signal detection techniques respectively & each technique is observed for 2X2, 4X4 & 8X8 antenna configurations. Among ZF, MMSE & ML, ML shows best performance with lowest BER followed by MMSE & ZF. ZF is poor with performance, recording high bit error rate. Figure 2(d) is plotted for 2X2 configuration of MU-MIMO in BPSK case. All three receivers shows linear characteristics. ML is nearly ideal showing approximately zero BER after 2 dB Eb/No.

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Similarly, graphs for QPSK are plotted in figure 3. At 0 dB SNR, for ML technique, BPSK scheme showing BER of 0.06227 & 0.9960 for QPSK. Hence, it is observed that, at 0 dB SNR, BER of 2X2 ML at BPSK scheme is 93.74%

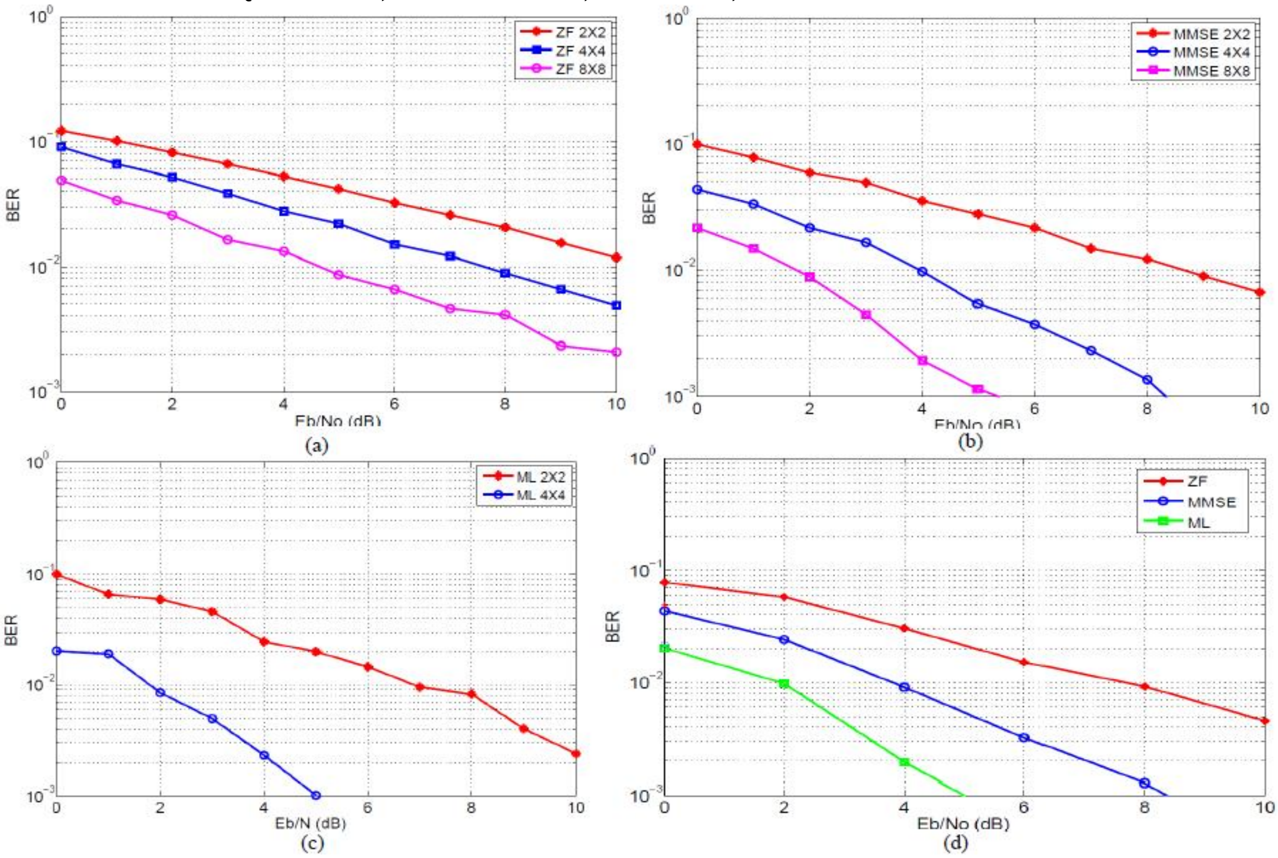

Figure 3. (a) ZF, (b) MMSE, (c) ML shows detection for different MIMO configurations using QPSK & (d) Comparative analysis of QPSK detection of ZF, MMSE & ML for 2X2 configuration

	ZF		MMSE		ML	
SNR (dB)	BPSK	QPSK	BPSK	QPSK	BPSK	QPSK
0	0.1102	0.1203	0.06663	0.09960	0.06227	0.9960
1	0.09078	0.10041	0.06029	0.07898	0.05531	0.06527
2	0.07311	0.08172	0.04449	0.05924	0.03771	0.05924
3	0.06057	0.06535	0.03758	0.0492	0.03479	0.04562
4	0.04763	0.05247	0.02329	0.03515	0.01977	0.02465
5	0.03653	0.04148	0.01884	0.02790	0.01596	0.01979
6	0.02955	0.03237	0.01057	0.02159	0.00888	0.01462
7	0.02127	0.02556	0.00816	0.01484	0.00697	0.00963
8	0.01713	0.02041	0.00666	0.01213	0.00469	0.00825
9	0.01373	0.01544	0.00565	0.00895	0.00441	0.00401
10	0.01066	0.01183	0.00277	0.00667	0.00196	0.00240

Table I

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BER comparison of BPSK& QPSK for ZF, MMSE & ML signal detection techniques for 2X2 antenna configuration better than that of QPSK modulation scheme. With increase in SNR value, the bit error rate advancement dropped to 23.99% at 5 dB & 22.44% at 10 dB. The BER values for 0 -10 dB SNR of BPSK & QPSK for detection methods considering 2X2 MU-MIMO antenna configuration (figure 2(d) & 3(d)) are noted in table-I for better comparison.

V. CONCLUSION

For proposed signal detection technique for MU-MIMO channel, ML serves best realization by achieving lowest BER rate succeeded by MMSE & ZF. Monotonic decrement in Eb/No values is observed with increase in SNR. In comparison, though QPSK provides approximately double data rate for transmission, but it is complex to realize & with considerable bit error rate, whereas BPSK shows less BER than QPSK modulation scheme. It is also remarked that performance can be improved by increment in number of antennas in MUMIMO configuration.

REFERENCES

[1] SemihSerbetli, Aylin Yener, "Transceiver Optimization for Multiuser MIMO Systems," IEEE Transaction On Signal Processing, vol. 52, no.1, January 2004.
[2] Ben ZidMaha, RaoofKosai, "Multi User MIMO Communication: Basic Aspects, Benefits & Challenges," available: http://dx.doi.org/10.5772/57133
[3] J. S. Katre, Digital Communication, Tech-Max Publications, Feb 2010.
[4] Madan Lal, HamneetArora,"BER Performance of Different Modulation Schemes for MIMO Systems," IJCSNS International Journal of ComputerScience and Network Security, VOL.11 No.3, March 2011.
[5] R Bhagya, Dr. A G Ananth,"Transmission Characteristics of 2x2 MIMO System Using OSTBC Multiplexing for Different Detector Systems," International Journal of Advanced Research in Electrical, Electronicsand Instrumentation Engineering, Vol. 3, Issue 7, July 2014.
[6] S. Karthikeyan, S. Sasikumar,et al, "Comparison of Linear and Non-Linear Multiuser Detectors with Quantum Constraints," GESJ: ComputerScience and Telecommunications, Vol. 26, No. 3, pp. 40-47, 2010.
[7] Deric W. Waters, "Signal Detection Strategies & Algorithms for Multiple-Input Multiple-Output Channels", Georgia Institute of Technology, December 2005.
[8] Dr.HoumanZarrinkoub, "Overview of the LTE Physical Layer", Underst&ing LTE with MATLAB, John Wiley & Sons Pte Ltd, 2014.
[9] Gerard. J. Foschini,"Layered Space-Time Architecture for Wireless Communication in a Fading Environment When Using Multi- Element Anten nas", Bell Laboratories Technical Journal, pp. 41-59, October 1996.
[10] H.Q. Ngo, et al, "Uplink performance analysis of multiuser MU-SIMO systems with ZF receivers", IEEE Trans. Veh. Technol., vol. 62, pp. 4471-4483, Nov. 2013.
[11] Y.C Liang, G.M.Pan, & Z D.Bai, "Asymptotic performance of MMSE receivers for large systems using r&om matrix theory", IEEE Trans. Inf.Theory, vol. 53, no. 11, pp. 4173-4190, Nov. 2007.

BIOGRAPHY

Shraddha Kharat received her B.Tech. degree in Electronics & Communication Engineering in 2013 from SNDT Women's University, Mumbai, India & currently pursuing M.Tech. degree in Electronics & Communication Engineering from the same university. er research interests include wireless communications, signal detection & synchronization, MIMO technology & wireless security.