International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Hybrid Multiple-Input Multiple-Output OFDM Index Modulation for 5G Wireless System

Dr. K. O. Joesph[1], G. Valarmathy[2], A. Rajeshwari[3]

[1]Professor, Department of electronics and Communication Engineering, GKM college of engineering and technology, Chennai

[2]Assistant Professor, Department of electronics and Communication Engineering, GKM college of engineering and technology, Chennai

[3]P. G. Scholar, Department of electronics and Communication Engineering, GKM college of engineering and technology, Chennai

Abstract: ***Multiple-input multiple-output (MIMO) based index modulation has the advantage of high data rate and low complexity transmission and has great attention now a days. At the same time due to invention of digital video broadcasting 16-QAM and 64-QAM schemes are widely used in wireless systems. In this paper we introduce a novel low-complexity signal detector enabled multiple-input multiple-output (MIMO) detector with IM systems, suitable for efficient low complexity system with tolerable error rate. The actual IM methods has no diversity gain which causes a significant reduction in the system performance. In this paper to eliminate the bad effects of the channel assignment of the IM, novel ML based MIMO systems with index modulation technique (ML-MIMO-IM) is proposed. Here the efficient hybrid ML sub detector system is used to achieve superior performance compared to the conventional MIMO detectors. The performance of the proposed design is close to the existing MIMO scheme, while resulting in a significantly lower complexity. The efficiency of MIMO over high order constellations are verified through MATLAB BER simulation and complexity reduction is also proved to be an efficient one.***

Keywords: MIMO, spatial modulation, index modulation, bit error rate , ML detector etc

1. Introduction

Telecommunications, 4G is the fourth generation of cellular wireless standards. It is a successor to 3GIn and 2G families of standards. Speed requirements for 4G on peak download speed at 100 Mbit/s for good mobility communication at trains and cars 1 Gbit/s for low mobility communication Pre-4G technologies such as mobile WiMAX and first-release 3G

Long term evolution (LTE) respectively, and are often branded as 4G. IMT-Advanced compliant versions of the two standards are under development and called “LTE Advanced” and “Wireless MAN” respectively. ITU announced that current versions of LTE, WiMax and other evolved 3G technologies that do not fulfill "IMT-Advanced" requirements could be considered "4G", provided they represent forerunners to IMT-Advanced and "a substantial level of improvement in performance and capabilities with respect to the initial third generation systems now deployed”

In all suggestions for 4G, the CDMA spread spectrum radio technology used in 3G systems and IS-95 is abandoned and replaced by OFDM and other frequency-domain equalization schemes.

MIMO

In point-to-point multiple-input multiple-output (MIMO) systems, a transmitter equipped with many antennas that communicates with a receiver. Most classic precoding results assume narrowband, slowly fading channels, that the channel for a certain period of time can be

A single channel matrix which does not change faster. Such channels can be achieved through OFDM.

2. System Description

The block diagram of a MIMO-LTE system is shown in Fig1. Basically, the MIMO transmitter has NT parallel transmission paths compare to single antenna system, each branch performing serial-to-parallel conversion, pilot insertion, N-point IFFT and cyclic extension before the final TX signals are up-converted to RF and transmitted. The receiver estimate and correct the possible symbol timing error and frequency offsets, e.g., by using some training symbols in the preamble as standardized one. Subsequently, the CP is removed and N-point FFT is performed per receiver branch. In this thesis, the channel estimation algorithm we proposed is based on single carrier processing that implies MIMO detection has to be done per subcarrier. Therefore, the received signals of subcarrier k are routed to the kth MIMO detector to recover all the NT data signals transmitted on that subcarrier. Next, the transmitted symbol per TX antenna is combined and outputted for the subsequent operations like digital demodulation and decoding. Finally all the input binary data are recovered with certain BER.

SM Coding For MIMO

A **spatial modulation** (SM) is a method employed to improve the reliability of data transmission in wireless communication systems using multiple transmit antennas. Time codes may be split into two main types:

Space time trellis codes (STTCs) distribute a “trellis code over multiple antennas and multiple time-slots and provide both coding gain and diversity gain”

Space time block code (STBC) act on a block of data at once (similarly to block codes) and provide only diversity gain, but are much less complex in implementation terms than STTCs.

Licensed Under Creative Commons Attribution CC BY

Index Modulation – MIMO

This is the variant antenna technology that enhances the communication capabilities of the individual radio terminal used by radios in the network by introducing multiple independent radio terminals. This allows transmission and reception to and from multiple users using the same band. In this section, it will be attempted to illustrate how SM works. It will facilitate the illustration of the MIMO in throughput rate. We have all the possible cases of 4 bits transmission. When one antenna is employed then a 16-Quadrature Amplitude Modulation (16-QAM) constellation signal will be used so as to map bits into symbols. In the case now that 2 antennas are deployed each antenna will be designated to transmit a lower constellation signal namely an 8-QAM.

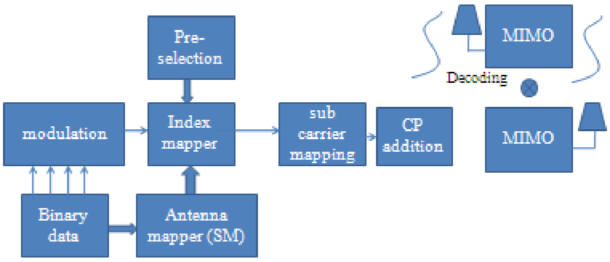


Figure 1: MIMOI M Block Diagram

When the number of antennas increases, the constellation order decreases. Thus, there is a trade-off between the number of antennas and the constellation signal used. Apparently, any number of antennas can be used with any constellation signal. By taking advantage of the properties of SM each user enciphers K source bits using a concatenation co operation is accomplished by initially sending the first frame of N1 bits and the proposed users detect and decode what has been sent.

3. Performance Results

From Figure 2 with MIMO BER is reduced considerably. When number of antennas increased BER will be reduced considerably. Diversity gain can be increased by increasing antennas. When number of antennas increased BER will be reduced considerably. If we use high end mapping weneed to use maximum antennas then only BER will be reduced considerably**.**

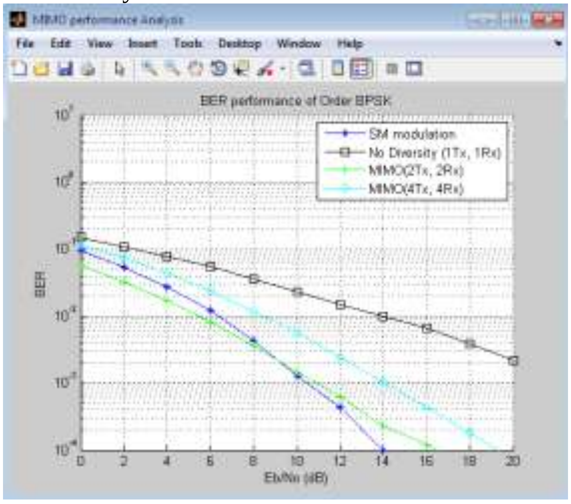
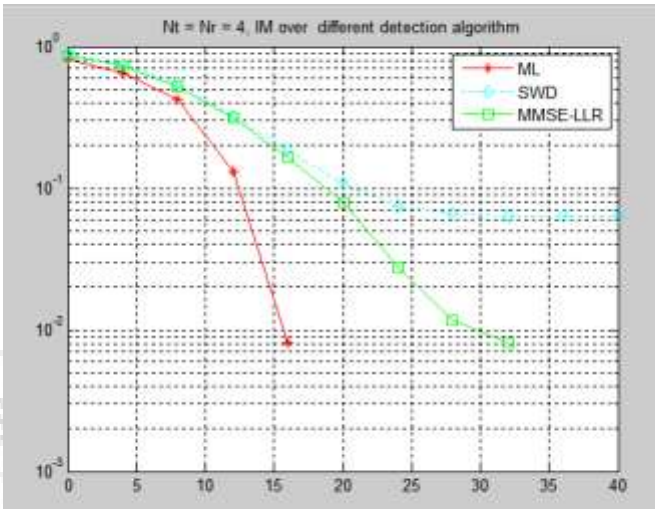


Figure 2: MIMO vs IM modulation

Among all the three detectors ML plays a better role in improving QoS, because ML is consistent.

To actualize the desirable QoS, with low complexity we are into SWD. As shown in Figure 3 ML is always better when interference increases but in MMSE-LLR and SWD the complexity will be high



Maximum Likelihood (ML) Detector

The resultant DeF-SM is capable of striking a flexible tradeoff in terms of the achievable BER, complexity and unequal error protection .Moreover, by exploiting the benefits of our low-complexity relaying protocols and inter-element interference (IEI) model, the destination node (DN) is capable of jointly detecting the signal received from the SD and RD links using the proposed low-complexity maximum-likelihood (ML) detector. In this DeF-SM, the DN should jointly detected both the SD signals of (2) and the RD signals of (9) for achieving a beneficial cooperative diversity gain.

In many cases an optimal single-stream ML detector was proposed for conventional SM systems. Here, we extend it to the cooperative DeFSM receiver by exploiting our low-complexity relaying protocol and the IEI system model at the SN. With the added benefit of relaying, typically a good BER performance is expected.

The ML Detector is the optimum detector once the probability of error is minimized. The noise terms at the receiving antennas are statistically independent, identically distributed, zero mean Gaussian and therefore, joint conditional probability density function P y s (/) is Gaussian. Hence, the detector opts for the symbol vector that minimizes the Euclidean distance metric.

$$\mu(s) = \sum_{m=1}^{N_r} | y_m - \sum_{n=1}^{N_t} h_{nm} s_n |^2$$

Licensed Under Creative Commons Attribution CC BY

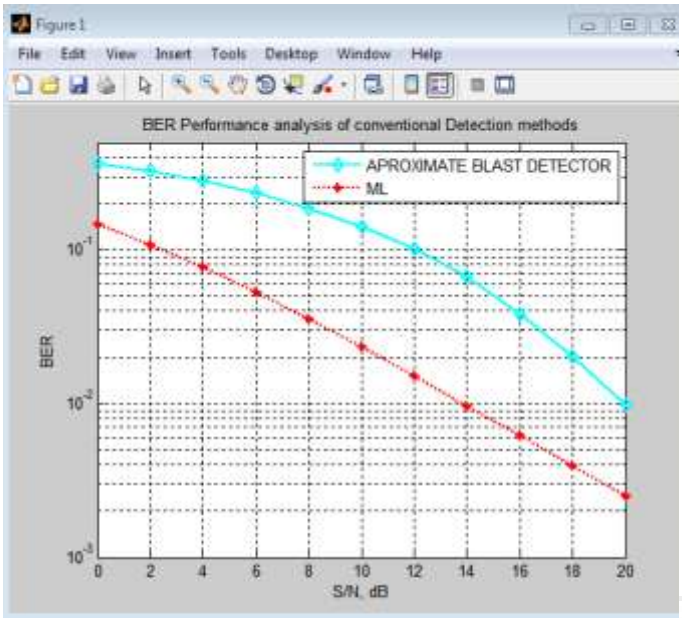


Figure 3: Performance of ML over conventional detectors

Here compared to conventional signal detector ML based approach will give better BER rate. Error rate is linearly reduced when signal energy increased. But ML will give better results in moderate SNR rate.

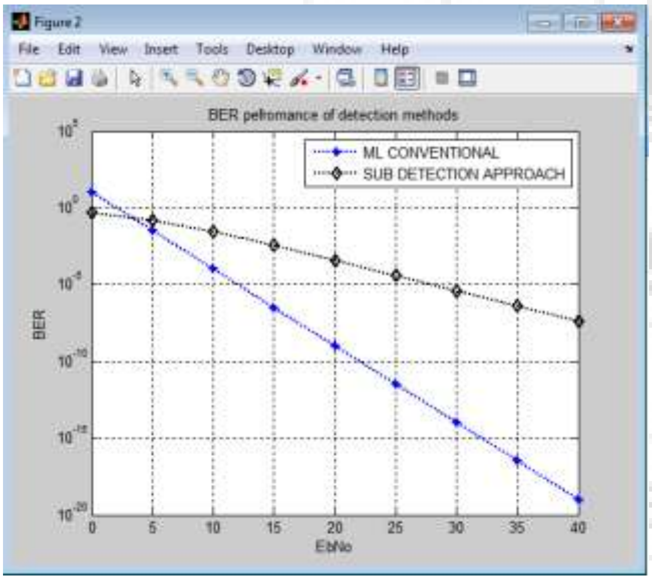
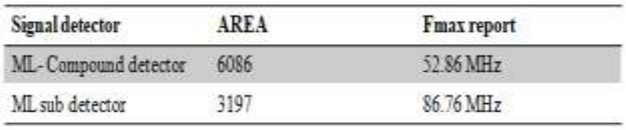


Figure 4: Performance comparison of sub detector ML MIMO

4. Experimental Results

Here we compare the performance of the proposed ML sub detector over using single compound MLas a benchmark schemes which explored in table 1 with improved hardware efficiency. We extended this analyzes using FPGA implementation schemes and implemented using verilog HDL. The hardware FPGA synthesis was carried without using any degree of EDA driven optimization since the objective of this work is to prove the performance of the aforementioned designs, using architectural level modifications to analyze the highest achievable complexity reduction and frequency.

Table 1: Performance measures of ML detector.



Signal detector	AREA	Fmax report
ML- Compound detector	6086	52.86 MHz
ML sub detector	3197	86.76 MHz

5. Conclusion

The proposed method is based on IM modulation (IM) at the transmission side for improved system data rate and the information bit stream is divided into different antenna index sets: the antenna index-bits (AI-bits) as well as the amplitude (QAM-modulation) and phase modulation (PSK-modulation)-bits. First, we derive analytical expressions of the elementary Raleigh channel with different assumptions. Then, we apply the obtained expressions to calculate the achievable BER rates and compare them with the values of a simulated transmission. The ML approximations is used the end-to-end SM coded bit error rate (BER) of a general MIMO IM scheme with multiple antenna index. Simulation results demonstrate the accuracy of our derivations for different detector configurations and achievable hardware efficiency around 50% with improved system performance is also proved through FPGA hardware synthesis.

References

[1] CHAO-WANG HUANG, PANG-AN TING, AND CHIA-CHI HUANG "A Novel Message Passing Based MIMO-OFDM Data Detector with a Progressive Parallel ICI Canceller." IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 10, NO. 4, APRIL 2011.

[2] V. Tarokh, H. Jafarkhani, and A. R. Calderbank, "Space-time block codes from orthogonal designs," *IEEE Trans. Inf. Theory*, vol. 45, pp. 1456-1467, July 1999.

[3] H. Jafarkhani, "A quasi-orthogonal space-time block code," *IEEE Trans. Commun.*, vol 49, no. 1, pp. 1-4, Jan. 2001.

[4] V. Tarokh, A. Naguib, N. Seshadri, and A. R. Calderbank, "Combined array processing and space-time coding," *IEEE Trans. Inf. Theory*, vol. 45. pp. 1121-1128, May 1999.

[5] A. F. Naguib, N. Seshadri, and A. R. Calderbank, "Applications of space-time block codes and interference suppression for high capacity and high data rate wireless systems," in *Proc. 32nd Asilomar Conf.Signals, Syst. Comput.*, pp. 1803-1810, 1998

[6] A. Stamoulis, N. Al-Dhahir and A. R. Calderbank, "Further results on interference cancellation and space-time block codes," in *Proc. 35thAsilomar Conf. Signals, Syst. Comput.*, pp. 257-262, Oct. 2001.

[7] J. Kazemitabar and H. Jafarkhani, "Multiuser interference cancellation and detection for users with more than two transmit antennas," *IEEETrans. Commun.*, vol. 56, no. 4, pp. 574-583, Apr. 2008.

[8] J. Kazemitabar and H. Jafarkhani, "Performance analysis of multiple antenna multi-user detection," in *Proc. 2009 Workshop Inf. TheoryApplications*, Feb. 2009.

Licensed Under Creative Commons Attribution CC BY

[9] A. Scaglione, P. Stoica, S. Barbarossa, G. Giannakis, and H. Sampath, “Optimal designs for space-time linear precoders and decoders," *IEEETrans. Signal Process.*, vol. 50, no. 5, pp. 1051-1064, 2002.

[10] D. Love and R. J. Heath, “Limited feedback unitary precoding for orthogonal space-time block codes," *IEEE Trans. Signal Process.*, vol. 53, no. 1, pp. 64-73, 2005.

[11] A. Ghaderipoor and C. Tellambura, “Optimal precoder for rate less than one space-time block codes," in *Proc. IEEE International Conf.Commun.*, Glasgow, Scotland, June 2007.

[12] H. Sampath and A. Paulraj, “Linear precoding for space-time coded systems with known fading correlations," *IEEE Commun. Lett.*, vol. 6, no. 6, pp. 239-241, June 2002.

www.ijsr.net
IJSR
ISSN (Online): 2319-7064

Licensed Under Creative Commons Attribution CC BY