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Analysis of Bit Error Reduction Technique of MIMO-OFDM

Madan Pal Singh, Er.Satnam Singh Dub
Sri Sai College of Engineering and Technology, Pathankot, Punjab, India

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ABSTRACT: Multiple-input and multiple-output (MIMO) is defined as the technology in which the transmitter and receiver ends have multiple antennas. The performance of communications that are being held within the network is enhanced using this technology. The data throughput as well as link range is increased within MIMO systems. Thus, within several wireless communication applications, MIMO technology is utilized. For providing any extra throughput or link range, any additional bandwidth or huge transmission power is not required. For achieving the objective, similar total transmission power is spread out over the antennas. In this paper, various Bit error reduction techniques are reviewed for the MIMO-OFDM
Keywords: MIMO, OFDM, Bit Error

I. INTRODUCTION

The high-data-rate wireless access at high QoS should be offered is one of the fundamental issues occurred before the future wireless communication systems. This requirement integrated with the facts that the spectrum is an inadequate resource and propagation conditions are intimidating because of fading which occurred due to destructive addition of multipath components and intervention of other users has needed for maximizing the spectral efficiency and for enhancing the link reliability [1]. The wireless technology named MIMO is capable for dealing with these demands and provides enhanced spectral efficacy by spatial multiplexing gain and maximized the link reliability with the antenna diversity gain. Although numerous issues of open research still occurs under the area of Multiple-input multiple-output wireless from a theoretical as well as a hardware execution perspective, the technology attained a stage in which it is considered ready to be utilized in practical systems. In fact, the MIMO technology based first products are available easily. The pre-IEEE 802.11n WLAN system is an example of it. The recent industry trends intend that the large-scale of Multiple-input multiple-output wireless systems will be executed at first in WLANs and in WMANs.

Conversely, the OFDM is one of the communication methods in which multiple carriers are modulated at a time [2]. Although, their spectra overlap, the demodulation of transmitted carriers is done in orthogonal manner providing that correct time windowing is carried out at the receiver. Because the OFDM-based system has included high spectral efficacy and robustness against ISI and frequency selective fading channels, this system is commonly implemented for European digital audio or video broadcasting and wireless WLAN and WMAN standards. At present, this system is carried out in most broadband wireless communication systems. Furthermore, the traditional pre-coded Orthogonal Frequency-division multiplexing systems includes the limitation of a high PAPR. Now-a-days, OFDM has attained a lot of attention in wireless communications. The complication of equalizers is mitigated and a higher immunity is provided to multi-path fading using system based on OFDM for wireless applications [3]. At present, the IEEE 802.11n wireless local area networks and IEEE 802.16 wireless metropolitan area network standards are involved in the corresponding standards currently under MIMO-OFDM definition. The air interfaces are described on the basis of MIMO-OFDM by both the standards. The wireless technology, MIMOOFDM is one of the attractive air-interface solutions for next-generation WLANs, WMANs, and 4-G mobile cellular wireless systems. A high channel capability and high data rate is obtained from Multiple-input multiple-output having or not additional bandwidth and high transmit power in comparison with the SISO systems. But, received signal is a combination form of the various distorted transmit signals undergoing of the fading channel [4]. At the receiver, optimal error performance is contained in ML detection. The SED amid the received signals and all of the reference signals is computed in the constellation using maximum likelihood. But, the

execution of ML is not possible in the large MIMO-OFDM system because of very high complication. Different from the ML, the ZF, well known for linear detection is easily executed in the large MIMO-OFDM system. In digital transmission, the number of bit errors is the number of receiving bits of a signal data on a communication channel which is already changed due to the noise, distortion and interference. The BER is referred to the rate at which errors are occurred in a transmission system under a studied time interval. It is a unit less quantity usually expressed as a percentage or 10 to the negative power. The evaluation of performance of any communication system is often recognized as BER that can be expressed as BER= Errors/Total Number of Bits With a strong signal and an unperturbed signal path [5]. This number is very small and irrelevant. This number becomes important while handling an adequate signal-to-noise ratio in the availability of insufficient transmission using electronic circuitry and the medium to perform the propagation. Noise is one of the major opponents of BER performance. BER performance is alleviated by unclear reconstruction of the digital waveform. due to the quantization errors. The quantization errors are also affected due to the accuracy of the analog modulation/ demodulation process and the effects of filtering on signal and noise bandwidth.Some popular techniques have been presented for the reduction of BER in MIMO ODDM. Filtering is a desirable factor in radio communication systems. The noise present in the commination channel setting degrades the quality of information data signal in these systems. At this time, a filtering technique is needed for eradicating noise from the EM environment signals during the retrieval of valuable data information [6]. The use of Kalman filtering approach technique is quite common to filter out noise present in the received data information signal at the receiver end. In this way, this filtering approachsuccessfully reduces bit error rate. DPSS technique is an channel estimation based technique which is used to give optimum BER performance of the OFDM System. DPSS (Discrete Prolate Spherpoidal Sequences channel estimation) is a commonly used DPSS filtering approach. This approachhas two time of orthogonal ability over the finite and the infinite sequence set at the same time. This filtering based technique shows good performance when applies with the window technique. Moreover, this filtering based DPSS scheme has the ability to overcome the shortcomings of the window method [7]. The combination of DPSS filtering approach and window method enhances the Bit error performance of the OFDM System over the communication channel settings. Adaptive modulation approach can deliver the best BER and increases spectral efficiency in the noisy communication channel setting. This modulation scheme shows good performance in the slow fading environment and reduces the bit error rate of an OFDM System. Also, higher SNR (Signal to noise ratio)helps in the reduction of bit error with the slow fading environment in the radio communication systems.

II. LITERATURE REVIEW

TomoyaKageyama, et.al (2019) suggested an analytical technique for computing attainable Bit error rate performance of downlink OFDM with the peak cancellation in mMIMO systems [8]. To achieve this, arbitrary numbers of transmit antennas and served users had employed. The BER was generated on the basis of the supposition that in-band distortion was approximated as random variable because of the peak cancellation in this technique. Subsequently, the variance of the Gaussian distribution was offered in two user case through the Gaussian distribution. The outcomes demonstrated that the theoretical Bit Error Rate expressions for arbitrary numbers of transmitting the antennas and served users provided agreements in its simulation results. Furthermore, the affect of the increasing number of transmit antennas on achievable mitigated BER and PAPR potential in MRC pre-coded suggested system with the peak cancellation.

Vishal Sharma, et.al (2016) analyzed that MIMO was considered as the well known and competitive technique for obtaining high data rates and maximizing the potential range together with reliability in recent wireless communication system at same time [9]. Multiple antennas were utilized to transfer and receive the information at the same time and the probability of detected information was generated precisely higher under the massive multi-input-multi output. This revealed the analysis of bit error rate of MIMO-OFDM, a method in which OFDM was combined with MIMO system for enhancing spectral efficiency together with ISI reduction and combination of several modulation methods. In addition, the comparison of outcomes was done with the performance obtained from C-OFDM system and an enhancement in BER was reported with presented system.

Rajashree A. Patil, et.al (2018) focused on implementing the LTE improved system in which MIMO and OFDM techniques for obtaining a high data rate for transmissions [10]. The utmost

spectral effectiveness was obtained and transmitted the maximum data regarding throughput and capacity using this system. The execution relied on release 10 of the 3GPP standard was discovered and the performance of Turbo coded suggested system was analyzed within LTE-A networks for which 64-QAM modulation technique and 256 subcarriers were carried out. The MATLAB was utilized to conduct the simulation for computing the BER and downlink throughput with respect to SNR along with16 X 16 MIMO configurations in downlink.

Javed Akhtar, et.al (2016) intended a robust pre-coder design for the MIMO-OFDM systems using insufficient CP. Interference alignment was carried out for the formulation of the pre-coder design problem as a BER minimization issue which was depending on a total power constraint [11]. Finally, the robustness of pre-coder was planned to the errors in the available channel estimates for which the worst-case BER was taken in account to perform the optimization. The existence of channel estimates at transmitter and receiver was facilitated in error. The simulations were conducted for the comparison of the performance of several MIMO-OFDM systems having or not robust pre-coders.

Munshi Mahbubur Rahman, et.al (2018) recommended a 3x3 MIMO-OFDM power line communication scheme for quantifying the BER performance after considering the total accumulated effect of noise, influence of adjacent conductors and mutual correlation among the conductors of a 3-phase line in an analytical approach [12]. The analysis BER was demonstrated in numerical way. The outcome of performance revealed that the crosstalk had impact on the3x3 multi-input-multi output PLC scheme. MATLAB simulation was utilized to perform the analysis. The penalty generated because of the combined effect mentioned above was evaluated approximately 5dB at a BER of 10^{-6} during the consideration of the line length as 100m in which the contribution of impulsive noise was observed considerable. The performance of Bit Error Rate was enhanced when the fading variance factor σg and Rician k-factor of fading parameter had enhanced.

TridebaPadhi, et.al (2015) discussed that the performance of adaptive channel equalizer based on FRLS was analyzed for the MIMO-OFDM mechanisms which had carried out in signal transmission by the means of BPSK modulation [13]. Its comparison was done with the well known ZF and MMSE equalizer. There were two transmission and two receiving antennae utilized to analyze the robustness of channel equalizers. Various SNRs were employed to conduct the simulations and to determine the BER. The future work would be focused onfor discovering the utilization of even complex adaptive filters within channel equalization in MIMO-OFDM systems having robustness in Rician and Nagakami-m channels and obtained superior performance in comparison with the existing algorithms in terms of low computational complexity.

Comparison Table

Author	Year	Description	Outcome
TomoyaKageyama, Osamu Muta	2019	Suggested an analytical technique for computing attainable Bit error rate performance of downlink OFDM with the peak cancellation in mMIMO systems.	The outcomes demonstrated that the theoretical Bit Error Rate expressions for arbitrary numbers of transmitting the antennas and served users provided agreements in its simulation results.
Vishal Sharma, Harleen Kaur	2016	Analyzed that MIMO was considered as the well known and competitive technique for obtaining high data rates and maximizing the potential range together with reliability in recent wireless communication system at same time.	Multiple antennas were utilized to transfer and receive the information at the same time and the probability of detected information was generated precisely higher under the massive multi-input-multi output

Rajashree A. Patil, P. Kavipriya, B. P. Patil	2018	Focused on implementing the LTE improved system in which MIMO and OFDM techniques for obtaining a high data rate for transmission.	The MATLAB was utilized to conduct the simulation for computing the BER and downlink throughput with respect to SNR along with16 X 16 MIMO configurations in downlink.
Javed Akhtar, Amrit S. Bedi, Ketan Rajawat, Aditya K. Jagannatham	2016	Intended a robust pre-coder design for the MIMO-OFDM systems using insufficient CP. Interference alignment was carried out for the formulation of the pre-coder design problem as a BER minimization issue which was depending on a total power constraint.	The simulations were conducted for the comparison of the performance of several MIMO-OFDM systems having or not robust pre-coders.
Munshi Mahbubur Rahman, Abdullah Al Masud	2018	Recommended a 3x3 MIMO-OFDM power line communication scheme for quantifying the BER performance after considering the total accumulated effect of noise, influence of adjacent conductors and mutual correlation among the conductors.	The performance of Bit Error Rate was enhanced when the fading variance factor σg and Rician k-factor of fading parameter had enhanced.
TridebaPadhi, Mahesh Chandra, Asutosh Kar	2015	Discussed that the performance of adaptive channel equalizer based on FRLS was analysed for the MIMO-OFDM mechanisms which had carried out in signal transmission by the means of BPSK modulation.	There were two transmission and two receiving antennae utilized to analysed the robustness of channel equalizers. Various SNRs were employed to conduct the simulations and to determine the BER

III. CONCLUSION

In this paper, it is concluded that MIMO When multipath signals travel in network using several paths, an independent affect results in the channel. The affects of multipath channel are caused on several signal parameters such as the frequency offset, time delay, phase shift, independent path gain or loss etc. In order to eliminate the ISI from signals, there are several types of equalizers used. By using various techniques, the changes made within the channel can be managed. The filtering techniques for the most efficient techniques for the bit error reduction

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