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REVIEW ARTICLE

A REVIEW OF DIVERSITY COMBINING TECHNIQUES WITH KALMAN FILTERING IN MIMO-OFDM

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Abstract: OFDM is the latest technology of wireless communication which works upon multiple carrier frequency. OFDM is most suitable for the utilization of the frequency spectrum due to overlapping of sub-carriers. MIMO technology used multiple antennas to exploits various domains for spatial multiplexing and spatial diversity. The transmission strengths of OFDM and superior antenna capabilities of MIMO gives better speed and utilization of frequency. Noise and other interferences are responsible to increase bit error rate during communication. In this paper, various techniques for bit error rate reduction are presented.

Keywords: OFDM, MIMO, MRC, SNR, ISI, MSE, ZF.

1. Introduction

Orthogonal Frequency division multiplexing is a format of modulation which plays an indispensable role in wireless communication. It is the most up-to-date technology which is widely used now-a-days. OFDM has been preferred by a variety of international standards of wireless networks like 802.11c, 802.11ac. Moreover it has been accepted by the cellular telecommunication standards and Wi-FI, Wi-max also. OFDM comes under the category of multicarrier modulation [1]. An OFDM signals are the combination of multiple closely spaced modulated carriers. By applying modulation in the form of data or voice, the sidebands of the modulation are spread out on either side. During the receiving of the signal, it is necessary for the receiver to demodulate the whole data for the successful receiving of the data. Simply during transmission of signals which are close to each other they must be spaced. There is a guard between present them. Moreover during receiving, receiver has to use some filter to demodulate them. In the case of OFDM, side bands are orthogonal to each others. During transmission they might overlap with each other without any interference and receiver can easily demodulate them. This is because carrier frequency is the reciprocal of symbol periods. It simply means that there is zero interference. OFDM is the latest

technology of wireless communication which works upon multiple carrier frequency. OFDM is most suitable for the most utilization of the frequency spectrum due to overlapping of sub-carriers. There is huge disparity between band limited and OFDM channels [1]. OFDM is a method for digital data encoding on multiple frequencies. This technique has been developed to be used in television, digital systems, copper wires, DSL broadband and 4G communications.

1.1 MIMO: MIMO is multiple in multiple out in which multiple antennas are used at both the sides i.e. at transmitter side and receiver side to improve communication performance. MIMO technology give best results in the wireless communication field by increasing data throughput and linkage without any additional band and transmit power. Furthermore it spreads total transmit over the antennas to improve spectral frequency [2]. MIMO technology used multiple antennas to exploits various domains for spatial multiplexing and spatial diversity. In spatial multiplexing it sends independent data streams with same time slot and frequency band simultaneously to increase link capacity of the MIMO. Moreover MIMO has advantage of multiple antennas as compared to the conventional systems. MIMO used to put and receive multiple signals at the same time with same frequency band and time slot due to multiple antennas. The main purpose of using MIMO is to increase link capacity with reliability. Diversity can also use two or more antennas as receiver end as well as transmitter end. In the basic form of diversity two antennas are place at some distance from each other. Each receiver receive slightly different signal due to the variation of location. The receiver combined them in better way to calculate signal strength as compared to the single antenna receiver [3].

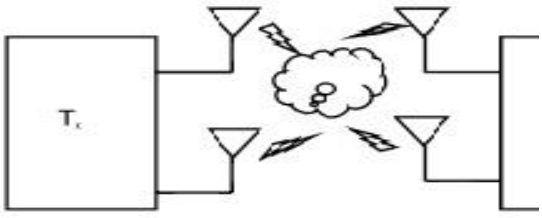

Fig.1.1 Basic Structure of MIMO

1.2 MIMO-OFDM: There are mainly three problems faced by all the wireless networks. These problems are range, reliability and speed. These three problems form voracious cycle. These are totally depended upon each other. Range could be increase with the extension of range as well as reliability. Speed could be increase only by give up reliability and speed. Same way reliability will be improves only when we control speed as well as range also. In MIMO-ODFM technology, with OFDM one spectrum band can be divided into multiple sub signals which are capable of transfer signals without any interferences [11]. As we know MIMO technology is capable to link many small antennas into one and helps to increase frequency bandwidth as required by the users. OFDM technology is best suited to overcome the problem of multipath propagation where as MIMO is used to optimum used for spectral bandwidth. Thus by combing these techniques in wireless system which provides best spectral coverage, more reliable transmission and higher data rate i.e. megabits.

The transmission strengths of OFDM and an superior antenna capabilities of MIMO consent to number of users at higher speed than 10 times faster than current commercially to be packed into available spectrum deployed UMTS networks and four to five times faster than HSDPA.OFDM and MIMO are the fundamental elements for future wireless standards.

LDFC filters are widely used in MIMO-OFDM technology to reduce bit error rate using Shannon's capacity limit. The experimental results show that BER value is 30-40% decrease with MRC in terms of bit error analysis. It is also viable to reduce more bit error rate using Kalman filtering.

2. Review

In paper [1] a spread spectrum based on 3G technology has been mentioned. In this paper spark gap transmitter has used in RF bandwidth which is wider than information band. Latest technology in cellular communication has explained and defined uses of map locator. Experimental results show spread spectrum with DSSS and FHSS techniques.

In paper [2] a spread spectrum defined which is based upon ultra wide time hopping for multiple access communication. In this paper feature of time hopping for multiple communications has been defines. It is also defined about emerging issues of OFDM. At the end, performance evaluation of the digital as well as analog system has been discussed for multiple channel access. At the end performance analysis has been done on the basis of multi-access channel conditions in terms of transmission rate and capability for analog and digital systems both.

In paper [3] represented results of the SNR threshold of the regular as well as the irregular LDPC codes. After that best degree distribution of LDPC code has been discussed for SIMO system according to various diversities. Threshold of regular LDPC and irregular LDPC has been derived in this paper. At the end comparing of optimal distribution with regular LPDC has been shown.

In paper [4] different types of diversities techniques has been applied. Moreover quantitative measures of selection diversity, maximal ratio combining and equal gain combining system has discussed. Rayleigh fading has been used for diversities techniques. It is accomplished that equal gain combine system gives optimum results. Results with RADAR and navigator system is also discussed.

In this paper [5] performance analysis of the hybrid system has been discussed. Selective combing/Maximal Ratio combing and Nakagami m-fading has been compared with multipath intensity. SC and MRC techniques are compared. Results show that by merging two techniques bit error rate has reduced as compared to independent technique. Performance analysis shows comparison between n_R and L and defined values of differential binary shifting key with non-coherent shifting key. Experimental results show that by implementing proposed techniques efficiency has been removed 45-50%.

In paper [6] analytical performance has been evaluated using iterative receiver to find out signal to interference and noise ratio. Later on a based upon SINR mapping system a prediction method has been proposed. Simulation results show that it is independent from channel realization and MIMO scheme. It is dependent upon coding and modulation scheme. Once the SINR is computed, we have proposed an adaptation of the EESM technique to predict the BER at the output of the channel decoder.

In paper [7] Bit error rate analysis has presented based upon Long Term Evaluation system in 3GPP. An expression is derived using two MIMO schemes based upon flat Rayleigh fading channels. To prove the accuracy of the LTE system result, Monte Carlo simulations results are also provided at the end which shows that these results are closely related to mathematical formulas.

In paper [8] Bit error rate with channel estimation errors and carrier frequency offset of OFDM-MIMO system is examined in this paper. First of all Due to residual frequency intercarrier interference and interantenna interference is analyzed later on SINR is also derived. At the end to find out accuracy of BER equal gain combing and maximal ratio combing with OFDM-MIMO is also derived to improve accuracy of 60%..

In Paper [9], main aim is to provide high data rate capacity related to mobility and location. MMSE is used to achieve highly strong equalization technique. BER performance is correlated with MIMO-MMSE over flat Rayleigh fading which is better than zero force equalizer. ZFE helps to remove all the ISI only when channel is noise free. MIMO equalization has been used in this paper and it depicts that BER has reduced by increasing number of antennas.

In paper [10], estimation for channel filters are based upon kalman filters. The main method is based upon pilot-symbol aided method in which parametric channel estimation is characterized as a propagation path. Kalman filters are used to reduce the problem of optimization. It is proved that kalman is very effective with Doppler frequency as well fading channel to decrease time taken.

3. Bit Error Rate in MIMO-OFDM

Bit error rate is the number of error per unit of time. BER can be calculated analytically. The simulation which is used for the calculation that is Monte Carlo. Bit Error Rate should be minimum. It affects the performance of the system. There are many techniques being used to improve performance of the system.

3.1 Techniques to reduce Bit Error Rate: There are many techniques which are used to decrease bit error rate in a system. These techniques are as follow:

1. LDPC Filters: LDPC codes are generally known as capacity approaching codes. Using these codes system capacity is closer to Shannon‘s capacity limits. LDPC codes are linear error correcting codes in nature. It has sparse parity check matrix. LDPC is a method in which a message is transmitted over the noisy channel. In this method noise threshold is set to the maximum Shannon limit for symmetric channel which is memory less [3]. LDPC can be represented by the tanner graph. It has two types of nodes one is symbol node and other is check nodes. Variable node represents transmitted bits and symbols. Parity check nodes represent each row of parity check matrix.

***2. FFT/IFFT (Fast Fourier and Inverse Fast Fourier Transformation*)**: FFT is used to perform Frequency domain transformation whereas IFFT is

used to translate OFDM sub-channels into time domain. OFDM sub-channels are converted into time domain using IFFT because it generates distinct samples of waveforms with frequency satisfying orthogonality conditions. IFFT modulates each of the sub-channels into a precise orthogonal carrier.

***3. Carrier Frequency Offset*:** OFDM requires high degree of synchronization to maintain sub-channel orthogonality. So level of performance in estimating Carrier Frequency Offset depends upon accuracy [9]. Basically, there is a difference in carrier frequency at transmitter side and the receiver side in CFO estimator. In wireless communication using OFDM due to mobility of the users, more accurate frequency offset control is needed to ensure that subcarriers are orthogonal. There is huge disparity in frequencies of transmitter and receiver so CFO estimation is need. It is used to calculate bit error rate [8].

4. DPSS (Discrete Prolate Spherpoidal Sequences): The channel estimation technique can be applied with the forward propagation to diminish bit error rate in MIMO-OFDM. The technique of DPSS has the double orthogonal property over the finite and infinite channel values. This property reduces the bit error rate in MIMO-OFDM where the windowing techniques had been used for channel estimation. The DPSS is used at the receiver side with back propagation technique. It helps to reduce bit error rate in iterative manner [10].

5**.** ***Kalman Filtering:*** In radio communication systems, filtering is a enviable factor. As radio communication signals are often corrupted with noise, a good filtering algorithm is required to remove noise from electromagnetic signals while retaining the useful information. Kalman Filtering is an effective method to filter impurities in linear systems. The kalman filter basically consists of a set of mathematical equations that provides an efficient computational means to estimate the state of a process that minimizes the mean of the squared error. It operates recursively on streams of noisy input data to produce statistically optimal results. Kalman filter is supportive in number of ways. It can be used to predict past, present and future estimation. Using kalman filter estimation can be possible using unknown precision [10]. It is of two types. One phase kalman filter and other is two phase kalman filter. One phase kalman filter is based upon prediction and update. But it does not remove all the noise from the system. Similarly two phase kalman filter is also based upon prediction and update but it filters two times so possibility of noise in the system is extremely low.

Table for Bit error rate techniques

Techniques	Implementation	Results
LDPC	1.High Complexity due to use of MMSE 2. Long Code Length which is reduced using BPSK modulation	1. Implement parallelizable decoders BPSK modulation to calculate Eb/No. 2. Error rate reduce 10% as compared to existing technique
MRC	1.Require accurate estimates of signal levels using equalizer techniques for reduction	1. Restore signals to original shape using hybrid SC/ZC techniques 2. Optimum Combiner increase efficiency 50%
DPSS	1. Little bit complex and slow due to double properties	1. Double Orthogonal Property 2.Reduce Iteration using ICI scheme upto 35-40%
Kalman Filter	1. Applicable for liner and Gaussian model.	1. Ability to provide quality of the estimate and reduce error 45% more. 2. Low complexity due to filtering properties. 3. Able to account qualities which are ignored by other techniques.

4. Conclusion

OFDM is a method for digital data encoding on multiple frequencies. This technique has been developed to be used in television, digital systems, copper wires, DSL broadband and 4G communications. MIMO used to put and receive multiple signals at the same time with same frequency band and time slot due to multiple antennas. The main purpose of using MIMO is to increase link capacity with reliability. OFDM and MIMO are the fundamental elements for future wireless standards to maintain reliability, range and speed. During the transmission of data level of signal reduce due to bit error rate. There are many techniques which have been studied in this paper. Every technique has its pros and cons. Some techniques gives better result but are complex and highly computational. Some techniques are easy to use but results are not noise free. Two phase kalman filtering is the best technique to reduce bit error rate by eliminate noise and increase the performance of the system.

References

[1] R. Malik, "Spread Spectrum Secret Military Technology to 3G", IEEE, 2011

[2] Moe Z. Win and Robert A. Scholtz, " Ultra-Wide Bandwidth Time-Hopping Spread-Spectrum Impulse Radio for Wireless Multiple-Access Communications", IEEE, 2012

[3] Satoshi Gounai and Tomoaki Ohtsuki, "Performance Analysis of LDPC Code with Spatial Diversity," IEEE, international conference on Vehicular Technology, pp 1-5, 2005.

[4] D. G. Brennan, "Linear diversity combining techniques," Proc. IRE, vol. 47, pp. 1075-1102, June 1959.

[5] Rizvi, Yilmaz, Janssen, Weber and louin, "Performance of Equal Gain Combining with Quantized Phases in Rayleigh Fading Channels", IEEE Transactions on Communications, Vol-59 , Issue: 1 , pp-13 – 18,
January,2011

[6] Y. Nasser , J.F. Helard and M. Crussiere, "Bit Error Rate Prediction of Coded MIMO-OFDM Systems", IEEE, 2008

[7] Ali Jemmali, Jean Conan, Mohammad Torabi, "Bit Error Rate Analysis of MIMO Schemes in LTE Systems", The Ninth International Conference on Wireless and Mobile Communications, ICWMC 2013

[8] Zhongshan Zhang, Lu Zhang, Mingli You and Ming Lei "Bit Error Rate Approximation of MIMO-OFDM Systems with Carrier Frequency Offset and Channel Estimation Errors", Springer, 2009

[9] Parul Wadhwa, Gaurav Gupta, "BER Analysis & Comparison of Different Equalization Techniques for MIMO-OFDM System", IJARCSSE, Volume 3, Issue, June 2013

[10] M. Huang, X. Chen, L. Xiao, S. Zhou and J. Wang, "Kalman-filter-based channel estimation for orthogonal frequency-division multiplexing systems in time-varying channels", IET Commun., 2007,1(4), pp. 795–801

[11] Debasis S.N Das, Sarmistha Satrusallya , Mihir N. Mohanty," Reduction of PAPR in MIMO-OFDM Broadcasting System", SpecialIssue of International Journal of Computer Applications (0975 – 8887) International Conference on Computing, Communication and Sensor Network (CCSN) 2012.

[12] Theodore S. Rapp port, "Wireless Comm.: Principles and Practice",2nd Edition,Prentice-Hall,India.

