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REVIEW ON: MIMO-OFDM IN RAYLEIGH FADING CHANNEL WITH LDPC

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Abstract— To analyse and improve the performance of MIMO-OFDM (Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing) system in Rayleigh Fading Channel. MIMO-OFDM system is very popular technique for mobile communication .The objective is to analyses the performance of system. here describes the results based on the Ergodic capacity with various number of transmitting and receiving antennas and performance measures in SNR , BER etc .We find Ergodic channel capacity has some limitation in MIMO-OFDM system. Ergodic channel capacity optimization is necessary and improves the performance of MIMO-OFDM System. For improving the system performance we have work on LDPC encoder and 64 QAM modulation techniques. Also we propose to improve the cost and will try to ensure that complexity of system does not increase. We have described the new combined method that consists of a cooperative approach of several different algorithms for improving the performance of system.

Keywords: - MIMO, OFDM, LDPC, 64 QAM, SNR, BER and Rayleigh channel

I. INTRODUCTION

NOW A day's integration of Orthogonal Frequency division Multiplexing (OFDM) technique with Multiple Input Multiple Output (MIMO) systems has been an area of interesting and challenging research in the field of broadband wireless communication. Multiple input multiple output (MIMO) system using multiple transmit and receive antennas are widely recognized as the vital breakthrough that will allow future wireless systems to achieve higher data rates with limited bandwidth and power resources, provided the propagation medium is rich scattering or Rayleigh fading[1].On the other hand, traditionally, multiple antennas have been used to increase diversity to combat channel fading. Hence, A MIMO system can provide two types of gains: spatial multiplexing or capacity gain and diversity gain. If we need to use the advantage of MIMO diversity to overcome the fading then we need to send the same signals through the different MIMO antennas. If we want to use MIMO concept for increasing capacity then we need to send different set of data at the same time through the different MIMO antennas without the automatic-repeat request of the transmission [2]. OFDM has many advantages, which make it an attractive scheme for high-speed transmission links. However, one major difficulty is OFDM's large Peak to Average Power Ratio (PAPR). Those are created by the coherent summation of the OFDM subcarriers. When N signals are added with the same phase, they produce a peak power that is N times the average power. These large peaks cause saturation in the power amplifiers, leading to inter modulation products among the subcarrier and disturbing out of band energy. Hence, it becomes worth while reducing PAPR. Towards this end there are several proposals such as clipping, coding and peak windowing. Respectively, reduction of PAPR comes at a price of performance degradation, mainly in terms of rate and BER. This paper proposes to use the LDPC codes as powerful coding techniques for IEEE 802.11x OFDM standard combined with PAPR scheme [7]. LDPC codes can for out a good solution first to overcome the disadvantage of OFDM modulations and second to keep a robustness regarding the BER performances. Low density parity check (LDPC) codes were developed by Robert Gallager in his PhD thesis at MIT in 1962. These codes were ignored for about 30 years and rediscovered in the late 1990s by D. J. C. MacKay and R. M. Neal. LDPC codes are set

to be used as a standard in Digital Video Broadcasting (DVB-S2) and 4G mobile communications. Another advantage of LDPC codes is that they are highly parallelizable in hardware. Also, their minimum distance (dmin) increases proportionally with an increase in the block length. In addition to using channel coding for better error performance, the technique used for modulating the coded signal is also very important as it transforms the signal waveforms and enables them to better withstand channel distortions. A number of QAM modulation techniques are currently in use out of which 64 QAM are known to be the best. As stated above, channel coding adds redundancy to the uncoded signal and thus increases the bandwidth in the process. So a modulation technique is needed which is spectrally efficient and also has good error performance. Therefore much research has been done on the concatenation of LDPC codes with 64 QAM modulation techniques. Also, the earlier studies reveal that uncoded signal has error in the performance of system. Therefore we needs to be established is 64 QAM with channel coding, specifically LDPC codes to remove error from the signal.
This paper is organized as follows. Section II gives an overview of the system model. In section III, LDPC codes are presented. Digital modulation is discussed in Section IV. The fading model used is described in Section V. The simulation details are given in section VI. Finally, in section VII, the simulation results and conclusion are presented

II. SYSTEM MODEL

In this section we describe communication system model. The system model used is shown in Fig. 1.

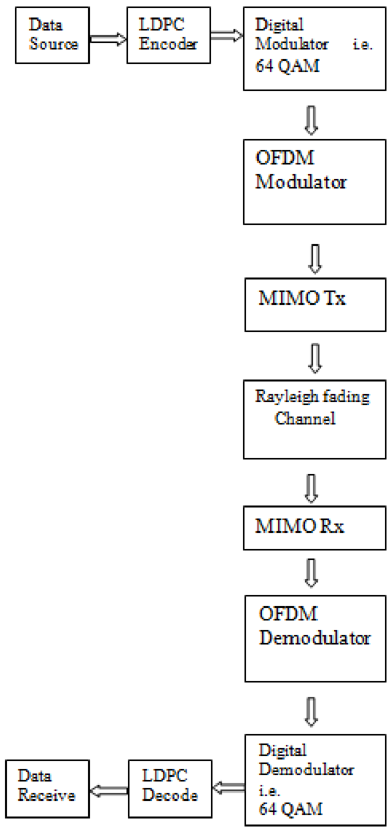

Figure 1: Block diagram MIMO-OFDM SYSTM

The data to be transmitted over the channel was randomly generated and was in the uncoded form. This data is coded by using LDPC codes. After the coded bit sequence has been obtained, it is applied to digital modulator which may 64 QAM modulation techniques. This modulated waveform is transmitted over the Rayleigh fading channel in the presence of AWGN (Additive White Gaussian Noise). The received signal is passed through demodulator and LDPC decoder where the errors are detected and corrected. After that we analyze that how much BER reduces by using LDPC encoder with different modulation techniques. If BER reduces then our performance is good and we get better result than the previous result. The various blocks used in the model have been described in detail below.

III. LDPC CODE

In 2001, T.J Richardson, A. Shokrollahi, and R. Urbanke proved that the performance of LDPC codes is close to the Shannon limit (the limit of reliable communication over unreliable channels). It has been further demonstrated by simulations that LDPC codes of block length 10^7 approach the Shannon limit within 0.0045dB. Because of their excellent forward error correction properties, their minimum distance (dmin) increases proportionally with an increase in the block length. As the name suggests, LDPC codes are characterized by a parity check matrix which is sparse. A sparse matrix is one in which the number of 1's is very less as compared to the number of 0's. Due to the sparse property of the matrix, the size of the matrix can be increased without an increase in the number of 1's, which means that we can achieve better distance properties without increasing the decoding complexity. The LDPC codes are represented graphically by Tanner graphs in which there are two types of nodes, check nodes and bit nodes . This graphical representation helps to easily understand the iterative decoding algorithm of LDPC codes. Unlike other codes which are decoded by ML (Maximum Likelihood) detection, LDPC codes are decoded by iterative decoding algorithm called message passing algorithm. The decoding can be hard decision or soft decision. At the time when these codes were developed, they were ignored partly because of the parallel development of concatenated codes and also because the hardware at that time could not support such a complex decoder design. In today's world with the rapid development of DSP (Digital Signal Processing) and VLSI (Very Large Scale Integration), these codes can be effectively implemented and hence they are set to be the codes of the coming wireless generations.

In order to prove that some mathematically result about Low Density Parity Check code, the channel model considered here are called symmetric binary input channel. By this we mean a time discrete channel, for which the input is a sequence of binary digits 0 and 1, and the output is corresponding sequence of letter from a discrete or continues alphabet.

If a symmetric binary input channel used without coding a sequence of binary digit would be transmitted through the channel and receiver would guess the transmitted symbol one at time from the received symbol. If coding were used, however, the coder would first take sequence of binary digits carry the information from the source and would map these sequence into longer redundant sequence called code words

Here we define the rate R of such codes and if code word of length n. Then there are 2^{nR} possible sequences from the source that are mapped into n-length code words. Thus only a fraction $2^{-n(1-R)}$ of different n-length sequence can be used as code words.

At the receiver, the decoder with its knowledge of which sequence are code words can separate the transmitted n-length code words from the channel noise. Thus the code words are mapped back into the nR information digits.

The decoding scheme described in LDPC avoids the intermediate decision and operate directly with a posteriori probability of input symbol conditionals on the corresponding received symbol. The code described here with special example of parity check codes. The code words of parity-check code are formed by combining a block of binary information digits with block of check digit. Each check digit is the module 2 sum of a pre-specified set of information digits.

These formation rules for the check digits can be represented conveniently by parity check matrix, as shown in equation 1.The matrix represents a set of linear homogeneous module 2 equations called parity-check equations and set of code words is a set of solutions of this equation. We call the set of digits contained in a parity check equation a parity check set. For example the first parity check set in equation 1 is the set of digits.

$$n(1-R)\begin{bmatrix}1 & 1 & 1 & 0 & 1 & 0 & 0\\ 1 & 1 & 0 & 1 & 0 & 1 & 0\\ 1 & 0 & 1 & 1 & 0 & 0 & 1\end{bmatrix} \qquad (1)$$

The use of parity check code makes coding relatively simple implement. Also if a typical parity check code of long block length is used on a BSC, and if the code rate is between critical rate and channel capacity then probability of decoding error will be almost as small as that for best possible code of that rate and block length.

Low Density Pairty Check codes are codes specified of matrix containing mostly 0's and relatively flow 1's. In particular, an (n, j, k) low density code is a code of block length n with matrix like that in equation 1, where each column contain a small fixed number j of 1's and each row contain a small fixed number k of 1's. This type of matrix has the check digit appearing in diagonal form as in equation 1.

However for coding purpose in equation represented by this matrix can always be solved to give the check digit a explicit sum of information digits.

IV. 64 QAM

Quadrature amplitude modulation (QAM) is generated by changing both the phase and amplitude of signal. The bits are mapped to two analogue signals by changing the amplitude and phase. The two analogue signals (sinusoid) are out of phase with each other by 90◦, making them orthogonal. Based on structure of the constellation diagram, different types of QAM exist. QAM having a rectangular structure are denoted by rectangular-QAM; likewise circular symmetry constellations are called circular-QAM. Each constellation performs different under different channel conditions. Rectangular-QAM is much easier to modulate and demodulate due to its regular structure, which is generated by amplitude modulations in phase and Quadrature. On the other hand, circular-QAM has the advantage of performing better in channels effected by phase noise. Furthermore, with help of digital signal processing it is now possible to implement such schemes. Basically Quadrature amplitude modulation (QAM) can be viewed as a combination of ASK and PSK. That means the digital information is carried in both the phase and the amplitude of the carrier signal. The baseband equivalent representation, $u_m(t)$, of the QAM signal can be expressed as

$$u_m = \left(A_m^I + jA_m^Q\right)g(t) \quad m=1, 2, 3....M \qquad (2)$$

Where A_m^I and A_m^Q € {±1∆, ±3∆…….± (√M-1) ∆} (∆ is a constant whose value is determined by the average transmitted power) are referred to the inphase (I) and quadrature (Q) amplitudes corresponding to the M possible symbols in the two-dimensional space, as shown for 64-QAM in

Figure 1, for example. The function g(t) is a real-valued signal pulse whose shape influences the spectrum of the transmitted signal. The $u_m(t)$ in (1.15) can also be represented in polar form as.

$$u_m(t) = A_m e^{j\theta_m} \quad m=1, 2..........M \qquad (3)$$

Where A_m and θ_m denote the amplitude and phase of the m symbol, and are given by

$$A_m = \sqrt{(A_m^I)^2 + (A_m^Q)^2} \qquad (4)$$

$$Q_m = tan^{-1}\frac{A_m^I}{A_m^Q} \qquad (5)$$

The baseband signal described by (21) can be expressed as a bandpass signal, $s_m(t)$, which is chosen from one of M possible signalling waveforms.

$$S_m(t) = Re\{u_m(t)e^{j2\pi f_c t}\} = A_m g(t)cos(2\pi f_c t + \theta_m) \qquad (6)$$

Since the modulator output frequency is often lower than the desired transmission frequency, the modulator frequency must be up-converted to the appropriate radio frequency (RF) for transmission. "64-QAM" results when 64 =M for M-ary QAM. QAM transmits K $=\log_2 M$ bits of information during each symbol period. For 64-QAM, there are 64 possible symbols each containing 6 bits. The mapping of the bits into symbols is frequently done in accordance with the Gray code which helps to minimize the number of bit errors occurring for every symbol error. Because Gray-coding is given to a bit assignment where the bit patterns in adjacent symbols only differ by one bit , this code ensures that a single symbol in error likely corresponds to a single bit in error. The rectangular constellation of a Gray-coded unfiltered 64-QAM signal is shown in figure 2.

1011 1	1011 01	1001 01	1001 11	0001 11	0001 01	0011 01	0011 11
1011 10	1011 00	1001 00	1001 10	0001 10	0001 00	0011 00	0011 10
1010 10	1010 00	1000 00	1000 10	0000 10	0000 00	0010 00	0010 10
1010 11	1010 01	1000 01	1000 11	0000 11	0000 01	0010 01	0010 11
1110 11	1110 01	1100 01	1100 11	0100 11	0100 01	0110 01	0110 11
1110 10	1110 00	1100 00	1100 10	0100 010	0100 00	0110 00	0110 10
1111 10	1111 00	1101 00	1101 10	0101 10	0101 00	0111 00	0111 10
1111 11	1111 01	1101 01	1101 11	0101 11	0101 01	0111 01	0111 11

Figure 2: Cancellation diagram for 64 QAM

The modulation of the System shall be Quadrature Amplitude Modulation (QAM) with 64 points in the constellation diagram. The constellation diagrams represent the signal transmitted in the wireless communication system. As shown in figure 2, the constellation points in Quadrant 1 shall be converted to Quadrants 2, 3 and 4 by changing the three MSB (i.e. Ik and Qk) and by rotating the q LSBs. Prior to modulation, the I and Q signals shall be square-root raised cosine filtered. The roll-off factor shall be 0.15

V. CONCLUSION

To proposed 'designing an Efficient modelled of MIMO-OFDM system which increase the Ergodic capacity of system by reducing PAPR problem. PAPR is biggest problem of OFDM which limited the Ergodic capacity of system. Therefore to overcome this problem, LDPC encoder is used. To increase spectral efficiency 64 QAM modulation is implemented.

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