LDPC CODED ADVANCED COMMUNICATION SYSTEM WITH IMPROVED PAPR

Mr. Anil Sangwan[1] Ms. Monika Jain[2]

[1]Assistant Professor, University Institute Of Engineering & Technology
Maharshi Dayanand University,Rohtak Haryana,India
anilsangwan1979@gmail.com
[2] M.Tech. Scholar, University Institute Of Engineering & Technology
Maharshi Dayanand University,Rohtak Haryana,India
monikajain24@gmail.com

Abstract

In this paper LDPC coded communication system are proposed using MATLAB to provide excellent error performance under extreme noisy channel conditions of different data rate applications with suitable modulation schemes and shown that diversity concept along with LDPC codes is very helpful for further improving the performance under fading conditions. Linear coding technique using LDPC encoder is proposed to improve the performance of today‘s high data rate wireless system by reducing the PAPR value in OFDM. MIMO technology is further applied to solve the poor signal reception problem.

Keywords: *Orthogonal Frequency Division Multiplexing, Peak-to-Average Power Ratio, LDPC, Turbo Coding.*

1. Introduction

1.1 Communication system

ln the late l940`s. Claude Shannon of Bell Laboratories developed a mathematical theory of information that profoundly altered our basic thinking about communication and stimulated considerable intellectual activity both practical and theoretical. He started the field of coding theory by demonstrating that it is theoretically possible to achieve error free transmission on noisy communication channel through coding. This theory, among other things, gives us some fundamental boundaries within which communication takes place. Recently, LDPC codes have attracted much attention because of their excellent error correcting performance and highly parallelizable decoding scheme. LDPC codes are a class of linear block codes.

ln basic communication system. the modulator is the block that maps the information to the physical channel. Due to thc continuous nature of most physical channels, the modulator needs to transform discrete waveforms to continuous waveforms that adapt to the channel. Because the physical channel attenuates the transmitted signal, creates random noise and present interference. The continuous waveforms should be chosen to cope with attenuation, noise and interference. For example in mobile wireless communications the frequency phase and bandwidth of the modulated signal are selected properly to reduce the fading effects of the wireless channel, consumption of random noise and interference among users, in modem communications, the modulating function should be understood as any method to efficiently adapt to the channel. For example, these methods may include improving the signal to high frequency, spreading the spectrum of` the signal. Modulating the signal with many carriers or even sending the signal to many antennas.

The demodulator processes the received continuous waveforms that are corrupted by random factors of the physical channel. Usually the demodulator tries to replace the received continuous waveforms by finite dimensional vectors to enable the calculation of the decision variable based on the joint density Functions of random variables.

However, the coding process in communications solves this problem of random noise on the physical channel digitally or in the discrete time domain. The encoder can be divided into two blocks namely the source encoder and the channel encoder, in this paper main concern is about the channel encoder. The encoder also tries to create waveforms to transmit effectively the information message against random factors of the channel as in the modulator block. But this is done in the discrete domain.

1.2 LDPC codes

Low-density parity-check (LDPC) codes are a class of linear block LDPC codes. The name **L** comes from the characteristic of their parity-check matrix which contains only a few 1's in comparison to the amount of 0's. Their main advantage is that they provide a performance which is very close to the capacity for a lot of different channels and linear time complex algorithms for decoding. Furthermore are they suited for implementations that make heavy use of parallelism?

They were first introduced by Gallager in his PhD thesis in 1960. Gallager, But due to the computational effort in implementing coder and en-1960coder for such codes and the introduction of Reed-Solomon codes, they were mostly ignored until about ten years ago. Representations for LDPC codes basically there are two different possibilities to represent LDPC codes. Like all linear block codes they can be described via matrices. The

second possibility is a graphical representation.

Matrix Representation .Lets look at an example for a low-density parity-check matrix first.

The matrix defined in equation (1) is a parity check matrix with dimension n ×m for a (8, 4) code. We can now define two numbers describing this matrix. wr for the number of 1's in each row and wc for the columns. For a matrix to be called low-density the two conditions wc << n and wr >>m must

H = 1 1 1 0 0 1 0 0
0 0 1 0 0 1 1 1
1 0 0 1 1 0 1 0

2 The Coding Theorem

Shannon defined the channel capacity C as the maximum rate for which information can be transmitted over a channel. he stated that if it is possible to distinguish reliably M different signal functions of duration T on a channel , we can say that the channel can transmit $\log_2 M$ bits in the time T. The rate of transmission is then $(\log_2 M)/T$. more precisely, the channel capacity may be defined as ,

$$C = \lim_{h\to\infty}\left(\frac{\log 2M}{T}\right)$$

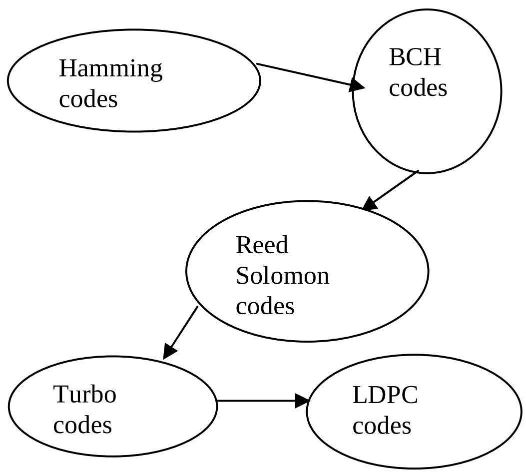
He approached the maximum rate of the transmission of binary digits by,

$$C = W \log\left(1 + \frac{P}{N}\right)$$

Where, W is the channel bandwidth starting at zero frequency, and P/N is the signal to noise ratio. Ordinarily, as we increase W, the noise power N in the band will increase proportionally; $N=N_0$ where N_0 is the noise power per cycle. In this case, we have

$$C = W \log 2\left(1+\frac{P}{N_0 W}\right)$$

3. EVOLUTIONS IN CHANNEL CODING



4. LDPC CODES BETTER THAN TURBO CODES

Turbo codes were considered to be the best channel codes but now LDPC codes are hottest channel linear block codes. Ldpc codes were ignored for long time, but now they are used even more than turbo codes because of their good block error correcting performance, low error flow and their suitability for parallel implementation. This has been possible now because of the availability of iterative decoding schemes, parallel decoding structures and message passing algorithm. And moreover turbo codes provide good performance for high data rate applications only but now LDPC cods are equally

ISSN (Online): 2231-5268
www.ijcsms.com

suited for both low data rate as well high data rate applications depend upon the modulation being used. .it is possible to achieve the performance of turbo codes or even better performance using LDPC codes with less decoding complexity and much ease of implementation due to the structure of LDPC codes. LDPC codes are more flexible in terms of parameter selection compared to turbo codes.

In the later part of dissertation it is shown that for PAPR reduction in OFDM- MIMO based system the performance of LDPC codes is better than turbo codes. In 2008, LDPC beat conventional turbo codes as the FEC schemes for the ITU-T G.hn standard.

5 LDPC Communication System Design

Using the LDPC codes as channel codes the communication systems are designed in MATLAB. All the functional parts as in the block diagram of a basic communication system are designed using the MATLAB software, Communication systems are designed to provide excellent error performance for different data rate applications under noisy channel conditions. To meet the above mentioned objective proper selection of channel code and modulation scheme is important.

LDPC code is the honest channel linear block code that w ill be used along with the modulation schemes such as BPSK for low data rate & short distance applications. QPSK for satellite communication & television broadcasting and QAM for medium & high data rate general and wireless systems to provide best error performance under noisy channels like AWGN and fading channels

There are two ways of designing LDPC code based communication systems using MATLAB:

i. Using MATLAB Programming.

ii. Using Simulink Models which are directly simulated or BER Analysis Tool- Monte Carlo can be used for performance analysis.

Steps for Calculating the Performance of LDPC Codes:

i. Load H.

ii. Define SNR range. .

iii. Set Maximum number of iterations. i

iv. Set Maximum number of codeword-errors for which to run simulation.

v. Select decoder — MATLAB. •

As LDPC codes are best described in terms of parity check matrix H so firstly H matrix is loaded. Second step defines the SNR range for which system is to he designed and performance is to be evaluated. As iterative decoding is preferred in the ease of LDPC codes so in the third step maximum number of iterations is specified in the forth step maximum number of codeword-errors are specified for which to run the simulation. This step is basically the stopping criteria for the decoding in the last step MATLAB tool is selected as decoder. Whenever communication systems are designed using programming the parameters are specified in the program itself and performance is obtained in Command Window & in terms of plots by running the program.

lf the communication systems are designed using Simulink Models the parameters are set by changing the properties and parameters of the various blocks being used in the Simulink Model. The performance of such systems is obtained by running the Simulink Model directly and in terms of BER plot by running the model in the BER Analysis Tool- Monte Carlo Simulation

6 PAPR Reduction by Linear Coding Techniques for MIMO-OFDM System performance improvement - Using LDPC Encoder

The main challenge of the new generation of wireless cellular systems is the reliability of providing data rate of around l00 Mbps and 30 Mbps for the downlink and uplink physical layer transmission respectively. Therefore researchers have turned their attentions towards the combination of two powerful techniques namely OFDM and MIMO technology. Main drawback of OFDM is its high PAPR.PAPR problem in High Data rate Wireless Systems .OFDM has several significant advantages over traditional serial communications; such as the ability to support high data rates. Robustness to multipath loading and at greater simplification of channel estimation, Due to these advantages OFDM has been adopted in both wireless and wired applications in recent years including wireless networking i.e. IEEE 802.ll, digital terrestrial television broadcasting and Broadband

Radio Access Network known by the term BRAN. However the main drawback of OFDM is its high PAPR

LDPC code based wired systems show excellent performance. In wireless case the channels are fading channels like Rayleigh and Rician Under the lading channels the LDPC code based communication systems will show better performance when combined with the concept of diversity i.e. the performance of a communication system can be further improved by improving the quality of received signal using multiple antennas i.e. diversity concept along with LDPC codes in channel coding under lading conditions

6.1 PAPR Reduction by Linear Coding Techniques for MIMO-OFDM Systems Performance Improvement - Using LDPC Encoder

The main challenge of the new generation of wireless cellular systems is the reliability of providing data rate of around l00 Mbps and 30 Mbps for the downlink and uplink physical layer transmission respectively. Therefore researchers have turned their attentions towards the combination of two powerful techniques namely OFDM and MIMO technology. Main drawback of OFDM is its high PAPR which distorts the signal if the transmitter contains nonlinear components such as power amplifiers and causes some deficiencies such as intermodulation spectral spreading and changing in signal constellation [IS]. Therefore average signal power must be kept low in order to prevent the transmitter amplifier and other circuitry limiting. Minimizing the PAPR allows a higher average power to be transmitted for a fixed peak power.

6.2 Disadvantages of High PAPR

i. High value of PAPR distorts the signal if the transmitter contains nonlinear components such as power amplifiers.
ii. Intemodulation
iii. Spectral spreading
iv. Change in signal constellation

6.3 MIMO-OFDM-Based Linear Coding System for PAPR reduction using LDPC Encoder

LDPC encoder is used for effectively reducing the PAPR problem in OFDM which is the one behind modem handheld television in addition the MIMO antennas technology is implemented to solve reception problem and to further improve the performance of the system.

This proposed linear coding technique using LDPC encoder for PAPR reduction is better than the previous PAPR reduction techniques such as Clipping with Filtering Companding and moreover the performance of LDPC codes in OFDM symbol spreading is better than BCH and Turbo coding.

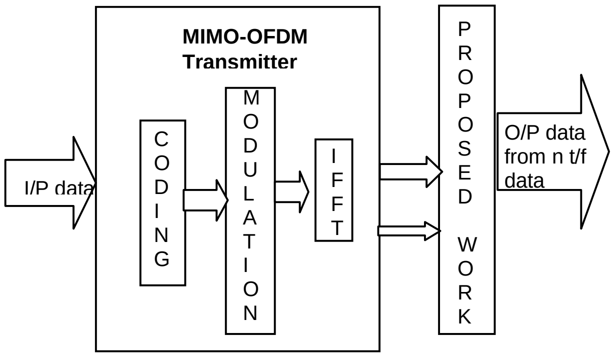


Fig. MIMO—OFDM based Linear Coding Technique based Transmitter for PAPR reduction.

Above figure describes the MIMO-OFDM-based linear coding system. As shown in Fig the input data will go through a coding stage thus a block of k bits oF information data is encoded by a rate r = k/n code. After that, the n coded bits will be modulated to form modulated symbols. Here the modulation scheme is chosen to have QAM constellation Ω. therefore the QAM modulated symbols are formed into blocks of (n/log2 lΩl) QAM symbols and also for the PSK. Then to form an OFDM symbol an N-point IFFT stage is used i.e. each OFDM symbol is constructed from N-sub carriers. After the IFFT stage each OFDM symbol will be processed by the proposed technique with two different spreading ratios, l; 2 and 3 the linul stage is the MIMO block; here in this block the processed signal will be transmitted through transmitter antennas. .

```
Nb_proc =

     1


ans =

     1     1     0     1     0     0     0     0     0
     1     0     0     0     0     1     0     0     0
     0     1     1     1     0     0     0     0     0
     0     1     0     0     0     0     1     0     0
     0     0     1     0     1     0     1     0     0
     0     0     1     0     0     0     0     1     0
     0     0     0     1     1     1     0     0     0
     0     0     0     1     0     0     0     0     1

>>
```

Simulation Result:

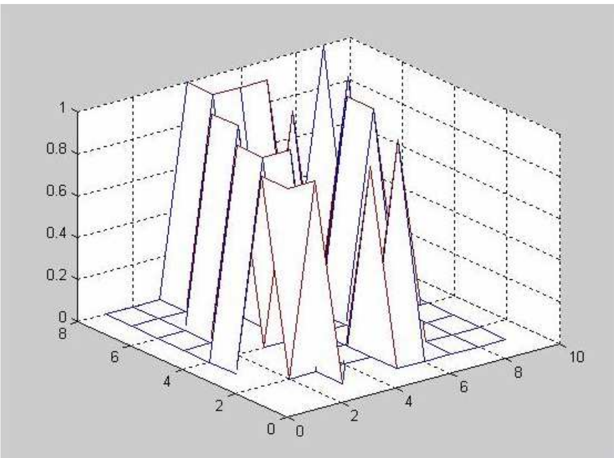


Fig 1

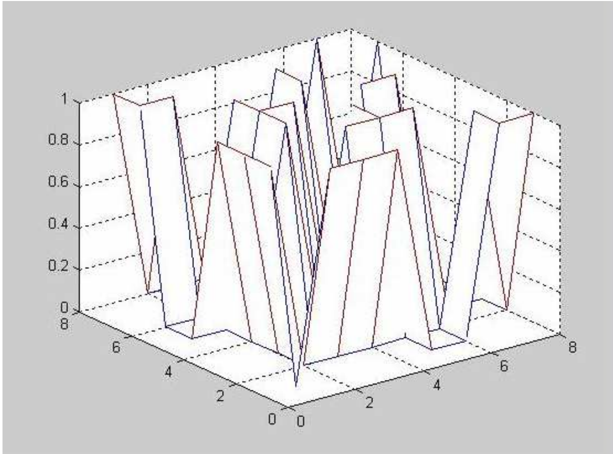


Fig2

Fig one shows the matrix generation & fig two shows that girth is not present absence of girth shows that our matrix does not have poor performance.

Refrences:

[1] C. E. Shannon. "A mathematical theory ol` eommunication" The Bell System Technical Jcumal. vol. 27. pp. 379-423. 623 -656.Jt1ly·October 19-18

[2] S. Haykin. "Baseband Pulse Transmission" in Communication Systems. 4"` ed., John Wiley & Sons, Singapore. 2001. pp. 248-253

[3] R. G. Gallager. "Low dcnsit) parity check c·~tles." |R1·Z 1`rans. lnlorm. Theory. vol. I`l`-8.no. l. pp. 21-28. Jan. 1962.

[4] R. G. Gallziger. Low·Density Parity-(`hcck codes PhD thesis MIT Press. Cambridge, MA, July 1963.

[5] D. J. MacKay. "Good Error—Correcting Codes Based on Very Sparse Matrices", IEEE Trans. Inform. Theory vol. IT-45. pp. 399 — -131 March 1999.

[6] T. Richardson and R. Urbankc "Ellicient encoding of low-density parity check codes IEEE Trans Info Theory vol. 47. pp. 638-656. Feb. 2001.