BER Performance of LDPC Code with TH-PPM over UWB Channel

P.Murugeswari,SJanardhana Prabhu,D.Prabha

Abstract-In this paper,the impact of Low density parity check code(LDPC) on performance of system under TH-PPM model over UWB channel is investigated. Single band UWB that is time hopping technique is used to randomizing the multi access capability without interference. The bit error rate of proposed system is simulated for different gain level by varying number of users.Low bit error rate is achieved even number of users gets increased. The low density parity check code is one of the superior error correcting code and are known to achieve the Shannon limit.LDPC Codes adds redundancy to the uncoded input data to make it more immune to channel impairements.The TH-PPM modulation which adapts its number of time hops depending on the required bit error rate and eliminates near far effect in multiple access communication.The proposed system is used to achieve fast,error free and secure communication in medical field.

Keywords:Time hopping Modulation,UWB,LDPC code,UWB channel model,MAI,near far effect

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1 INTRODUCTION

Ultra wide band technology is a form transmission that occupies very wide bandwidth.UWB is also known as pulse radio or carrier less communication.The range of UWB spectrum is allocated in the range of 3.1GHz to 10.6GHz by federal communications commission in 2002[1][2].The UWB transmitting information spread over 500MHz.Ultra wide band does not interfere with narrow band and carrier waves used in the same frequency.The features are short broadcast time and short pulses.Due to transmission short signal pulse over wide spread spectrum,the reflected signal does not overlap with original source.so multipath effect is ignored. Compared to narrow band communication, ultra wide has several advantages that are high data rate and low transmission power.[3].Under multiuser environment, the major source of interference is transmitting multiuser signal at the same time.MAI is the factor limiting the performance and capacity of system when more than one user is active. This multiple access interference can be reduced by increasing the number of time hops in Time hopping multiple access techniques[4]-[6].The IEEE 802.15 defines modified SV model as the standard model to measure the best data.[7]

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The low density parity check code were developed by Robert Gallegar in 1962.[9]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 not only have a simple description of code their code structure and also have a fully parallelizable decoding implementation.[10] Section II elaborates encoding,decoding and structure of codes.Section III provides modulation which are used to reduce interference.Section IV describes system model of LDPC code with TH-PPM UWB system.Section V gives about channel model available for UWB communications.Section VI imbibes simulation results and discussion.Section VII concludes present work.

2 LOW DENSITY PARITY CHECK CODING

LDPC is a block of linear code in which transmitted information is processed on a block by block manner.The parity check matrix of code have small number of ones compared to zeros.so it is called low density parity check code.

2.1 Representation of ldpc codes

Low density parity check code can be represented in two ways.They are Matrix representation and graphical representation.In matrix representation,a low density parity check matrix H with dimension (n,m) for a (8,4) is defined in equation(1).Here two notations(Wc,Wr) are used to define number of 1's in H.Wc defines number of ones in column and Wr defines number of ones in row.The condition to be satisfied for low density are Wc<<n and Wr<<m.The matrix size of code and code rate should be higher to achieve better performance. LDPC is classified as regular and irregular codes.The regular LDPC code have fixed number of 1's in each

row and column(Wr=Wc) where as the irregular code have unequal number of ones in both rows and columns(Wr≠Wc).

$$H = \begin{pmatrix} 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 & 0 & 1 \end{pmatrix} \quad (1)$$

In graphical representation,the bipartite graph or Tanner graph is used to represents low density parity check matrix.In tanner graph,two types of nodes i.e variable node and check node are used.The check node defines number of parity bits in matrix where as variable node defines number of bits in a codeword. The parity check matrix will be vary for different codes.

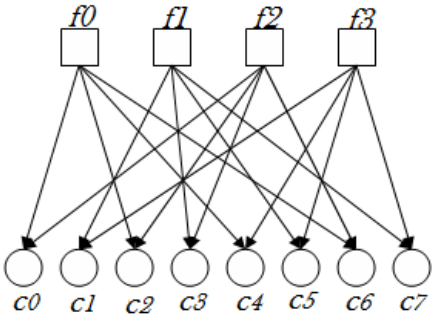

Figure1: Tanner graph

Here variable nodes(cj) and check nodes(fi) have same number of incoming edges.so this tanner graph represents regular LDPC.The check node fi is connected to variable node cj if the element of H is one.

2.2 LDPC encoding

Channel encoding is the addding of redundant bits to correct transmitted data if any error exist due to channel impairements.The encoding matrix G is used in equation(2) computes the parity bits enclosed with original data.

$$G=[\ I_k \quad p] \quad (2)$$

The inverse of encoding matrix gives the parity check matrix H

$$H=[-P^T \ I_{n-k}] \quad (3)$$

The identity matrix I_k repeats the transmitted message to find original message when codeword is received at decoding step.The P matrix has the ability to correct errors.In encoding method,fixed bit position is identified and translated only the fixed number 0 or 1 instead translating the entire message of variable node and check node.

2.3 LDPC decoding

LDPC codes are decoded iteratively using message passing algorithm(MPA).In MPA,messages are communicated among the edges of bipartite graph.Depending upon the message passing type there are different types of message passing algoritham namely bit flipping algorithm in which data is communicated back and forward and belief propagation algorithm in which message probabilities are exchanged between nodes.The performance of LDPC code can be improved by increasing the number of iterations.All the message passing algorithm is fixed with 20 iterations.The advantage of LDPC decoding is that the iteration is stopped once valid codeword is found and the failure to converge to a codeword is always detected.LDPC code has minimum decoding complexity rather than turbo codes.

3 Time Hopping Pulse Position Modulation

Time hopping is one of the multiple access techniques for ultra wide band.UWB use uniformly spaced short pulses to transmit information.The uniformly spaced pulses are vulnerable to near far effect.To eliminate this catastrophic collisions each user is assigned with different pulse shift pattern.Time hopping pulse has low duty cycle.so it requires only low transmission power.Time hopping achieves low probability of interception and anti jamming.LPI is achieved by changing the transmission time randomly.

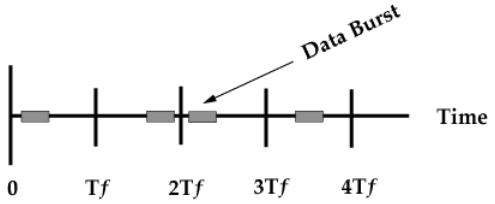

Figure2.Time hopping spread spectrum

Each burst is transmitted with k bits.The time taken for transmission of data is determined by randomly generated PN sequence.Time hopping is combined with frequency hopping to use the beneficial properties of the systems utilized.Pulse position modulation is one of the modulation techniques used to carry the secured information.The PPM requires constant transmitting power since the pulse have constant amplitude

and duration.The duration covered by the pulse position modulation is twice that of BPSK modulation.PPM provides better modulation efficiency and spectral performance and encodes the information by modifying the time duration and hence position of the pulse.

4 System Model

This section introduces the system model of LDPC code with TH-PPM UWB system as shown in figure3.Transmitter side consists of source coder,LDPC encoder,TH-PPM modulator where as the receiver side having demodulator and decoder.The source encoder provides randomly generated data that is to be transmitted.The LDPC encoder adds parity check matrix with small number of ones to the original data.The information **u** is mapped to a codeword **c** by using the generator matrix(**G**) explained in section II.The mapping can performed with matrix multiplication c=uG.The encoded data is spreaded using the randomly generated PN sequence.Then the spreaded data is modulated by pulse position modulation.In PPM,position of the information is changed,this is more suited for ultra wideband communications. The encoded and modulated data is transmitted over UWB channel.The received noisy data is decoded and demodulated using the same PN sequence which are used in the transmitter side.Then the bit error rate is calculated between transmitted and received data.

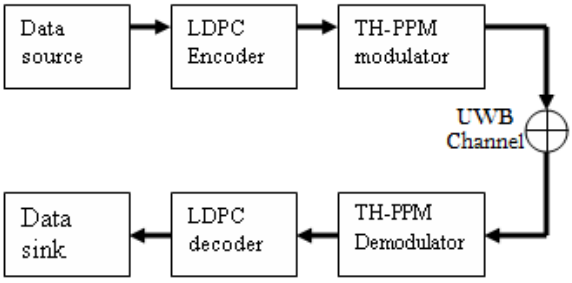

Figure3.system model of single band UWB system

5 UWB Channel Model

To measure the best data,IEEE 802.15 defined three channel model,namely

1.Tap delay line Rayleigh fading

2.Delta k model

3.Saleh-valensula model.

Three of which the modified saleh-valensuela is best suited because it provides more accurate mode of paths of arrival times.Four measuring environments in SV model are CM1,CM2,CM3and CM4.CM1 defines LOS path with less than 4m distance between transmitter and receiver.CM2 defines NLOS path with same distance.CM3 defined for NLOS with 4-10m distance.CM4 describes the environments with 25ns delay.

6 Results And Discussion

The bit error rate performance of LDPC code is measured for diffent user.BER is measure based on two conditions that are keeping user as constant and varying user.The input parameter is considered as the number of user and Eb/No values.The output parameter is bit error rate.As number of users increases,the bit error gets increased.The UWB system is simulated for SNR values 0.5,1.5 and 2.5 by increasing users.

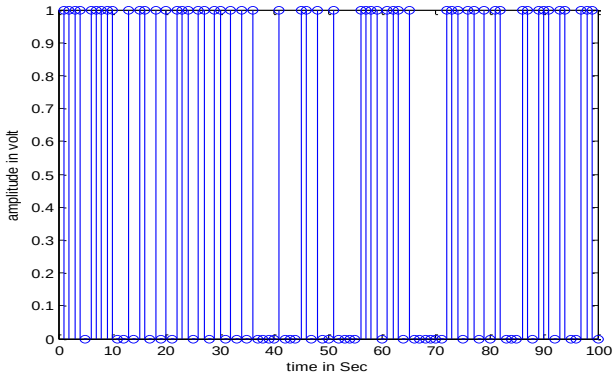

Figure 4.Input signal generation

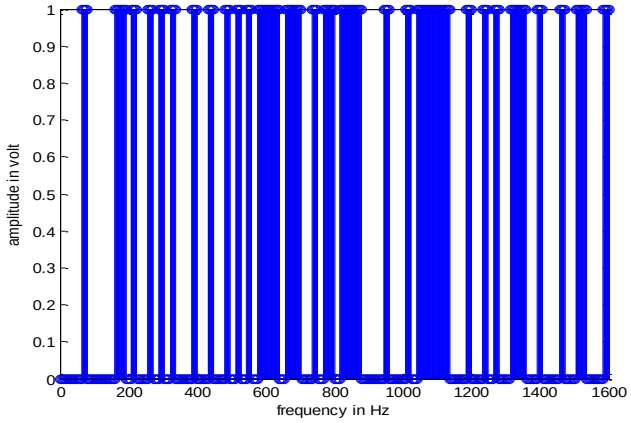

Figure 5.spreaded input signal

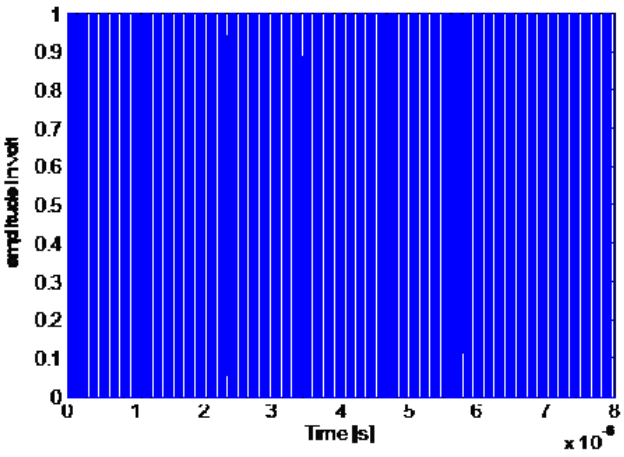

Figure 6.Time-Hopped PPM sequence

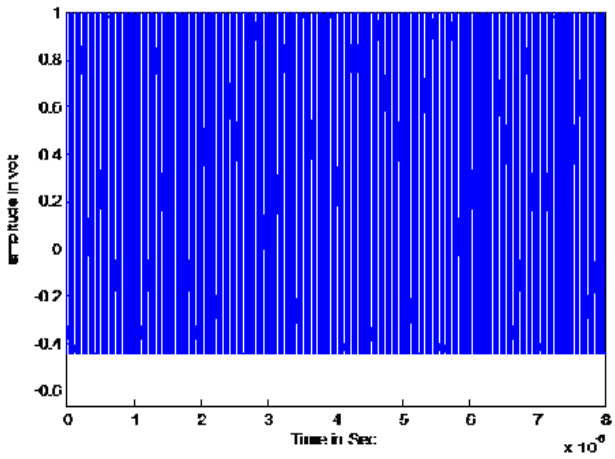

Figure7.transmitted UWB signal

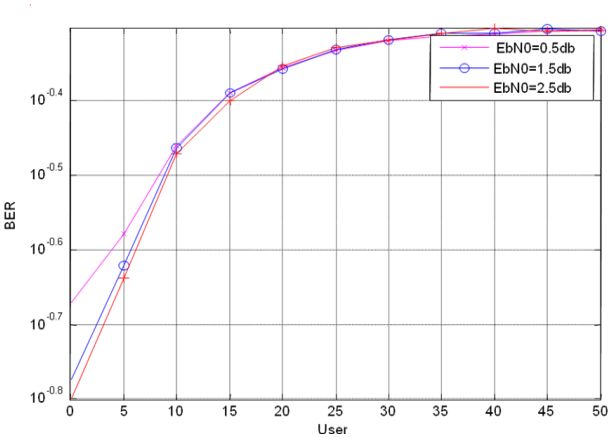

Figure8.BER for 50 users

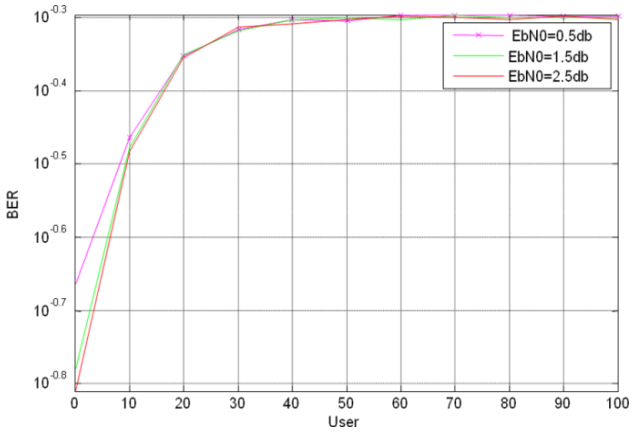

Figure9.BER for 100 users

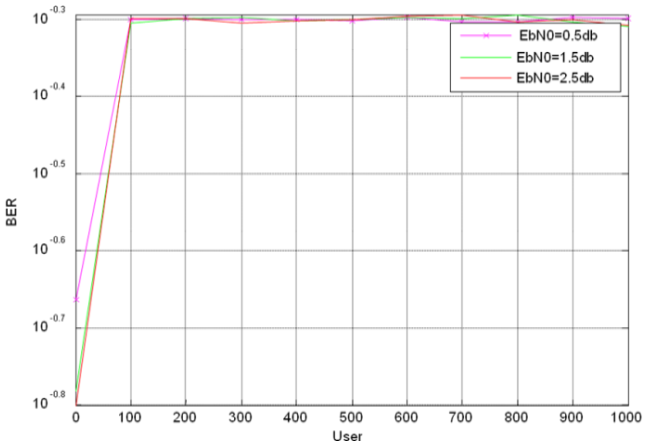

Figure10.BER for 1000 users

7 CONCLUSION

Low density parity check code is designed as iterative decoding system.The structure of LDPC code with iterative decoding approach provides better performance than turbo code.It is observed that the LDPC code with single band UWB modulation improves the performance of UWB system under multi access environment.The future scope of this work will be improving the capacity of UWB system by using hybrid time division multiple access technique.

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REFERENCES

[1] Roberto Aiello and G D Rogerson. 2003 Ultra-Wideband Wireless Systems. In IEEE microwave magazine, 628-635.

[2] J A. N. da Silva and M. L. R. de Campos, "Performance comparison of binary and quaternary UWB modulation schemes," Proc. Globecom, vol 2, 2003, pp 789–793.

[3] J. R. Foerster, "Ultra-wideband technology for short- or medium-range wireless communications," *Intel Technology Journal*, vol. 5, no. Q2, pp. 1–11, 2001.

[4].Yang Jie,Weng Li.na.2007 "Performance analysis and simulation of TH-PPM UWB System In image transmission "Journal of communication and Computers(Mar2007)vol 4.No.3

[5] M. Z. Win and R. A. Scholtz, "Ultra-wide bandwidth time hopping spread-spectrum impulse radio for wireless multiple access communications," *IEEE Transactions on Communications*,vol. 48, no. 4, pp. 679–691, 2000.

[6] H. Zhang and T. A. Gulliver, "Biorthogonal pulse position modulation for time-hopping multiple access UWB communications,"*IEEE Transactions on Wireless Communications*,vol. 4, no. 3, pp. 1154–1162, 2005.

[7] A. Saleh and R. Valenzuela, "A Statistical Model for Indoor Multipath Propagation," IEEE JSAC, Vol. SAC-5, No. 2, Feb. 1987, pp. 128-137.

[8] H. Hashemi, "Impulse Response Modeling of Indoor Radio Propagation Channels," IEEE JSAC, Vol. 11, No. 7,Sept. 1993, pp. 967-978.

[9] Gallager, R. G., "*Low Density* Parity Check Codes", Number 21 in Research monograph series. MIT Press, Cambridge, Mass, 1996.

[10] MacKay, D. J. C. and R. M. Neal, "Near Shannon limit performance of low density parity check codes," *Electronics Let-ters,* vol. 32, no. 18, pp. 1645-1646, Aug. 1996.