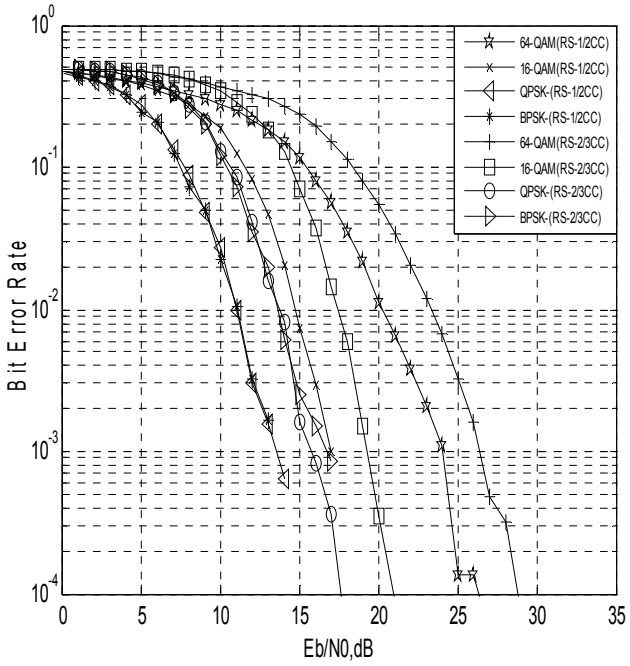

Fig .9 BER Comparison of COFDM System with RS codes and 1/2, 2/3 convolution codes in Rayleigh Channel

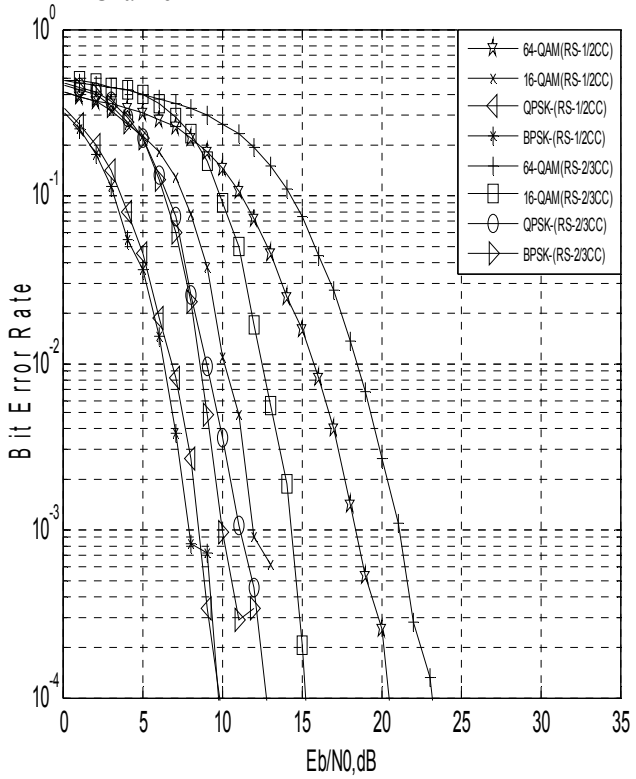

Fig. 10 BER Comparison of COFDM System with RS codes and 1/2, 2/3 convolution code in Nakagami-3 fading environment

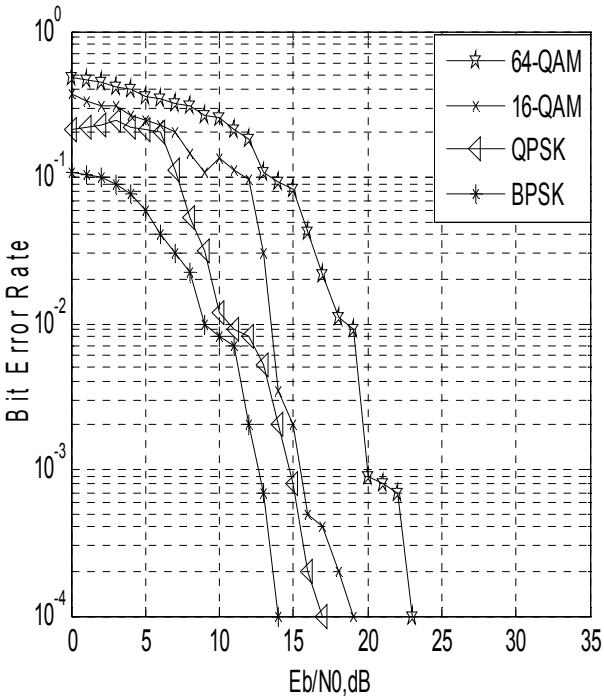

Fig. 11 (a) BER Comparison of COFDM using Turbo codes in Rayleigh fading

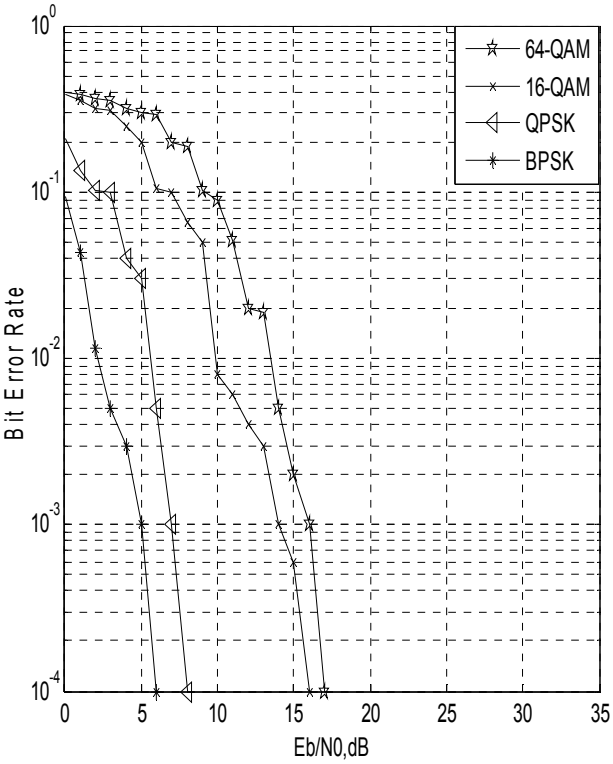

Fig. 11 (b) BER Comparison of COFDM using Turbo codes in Rician fading Environment.

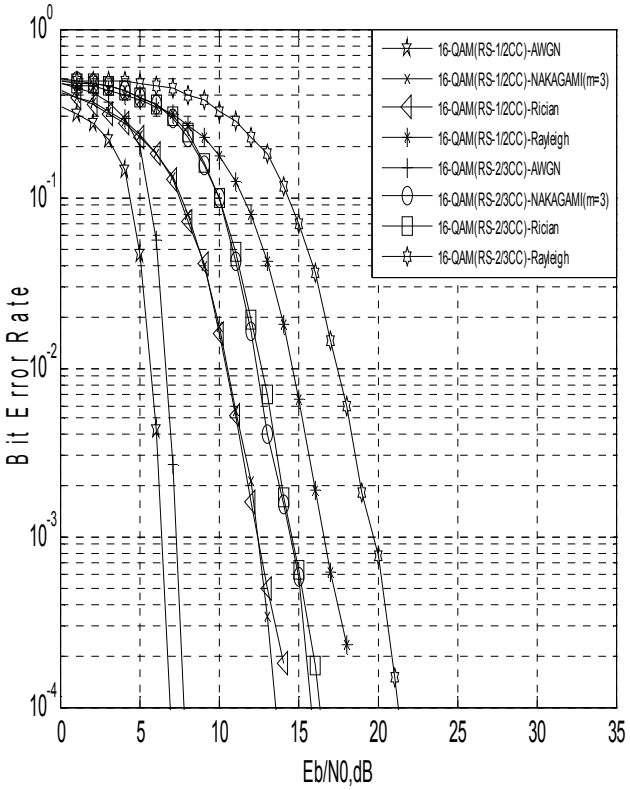

Fig. 12 BER Comparison of COFDM System with RS Codes and 1/2, 2/3 Convolution Code in AWGN, Rayleigh, Rician and Nakagami fading for 16-QAM mapping

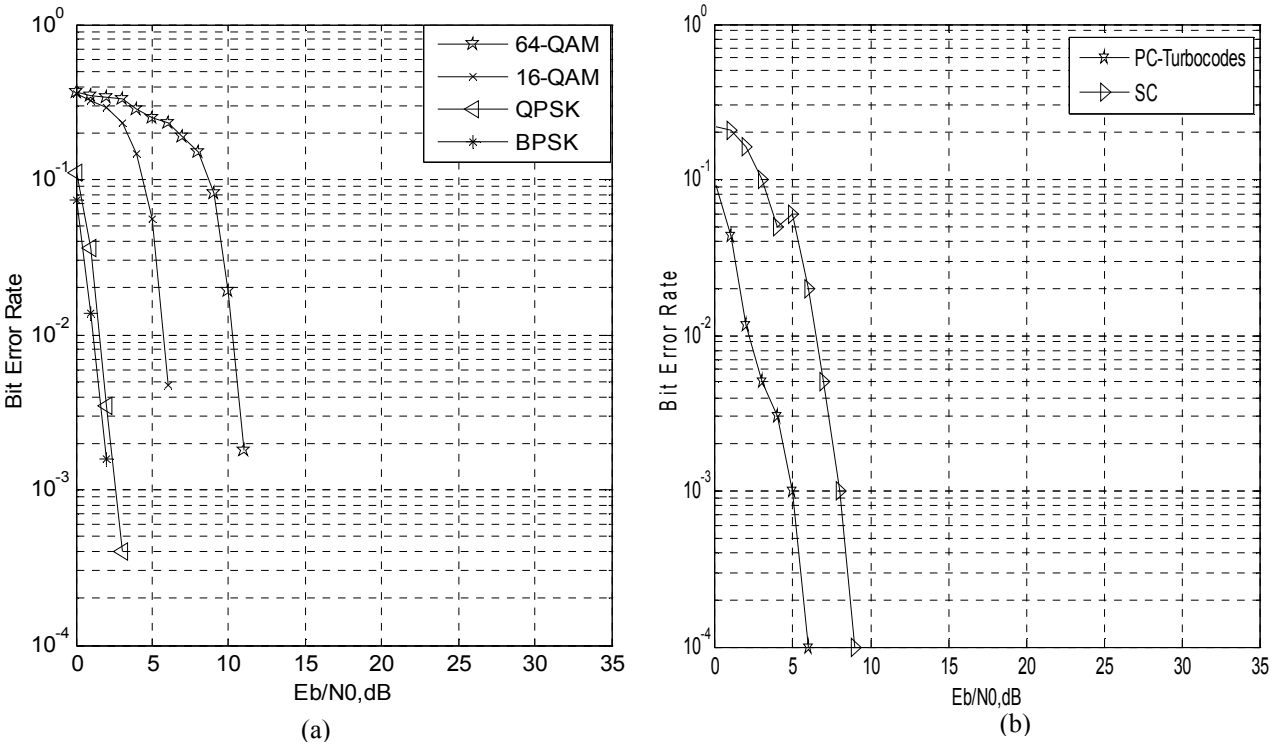

Fig. 13 (a) BER of COFDM using Turbo codes in Nakagami fading (b) Comparison of serial and parallel concatenation

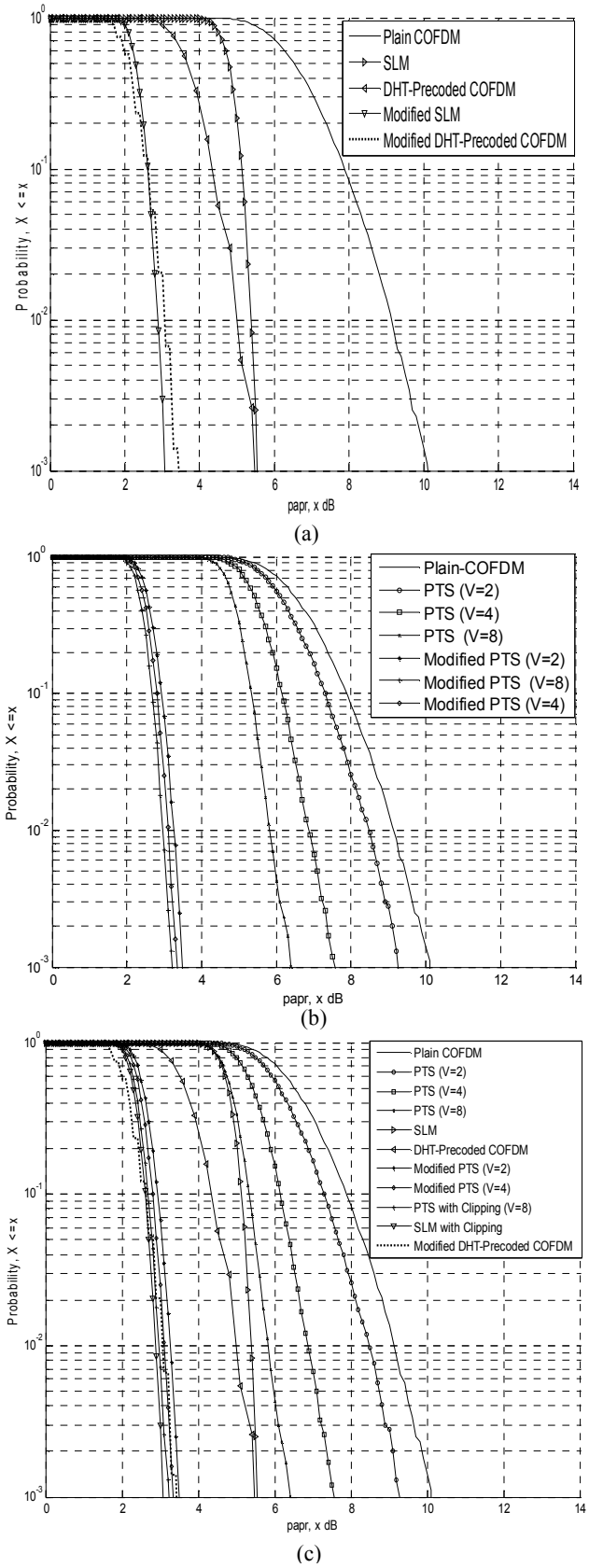

Fig. 14 PAPR Comparison of (a) DHT-precoded, SLM and their modified versions (b) PTS (V =2, 4, 8) and Modified PTS for COFDM (c) all schemes with 16-QAM

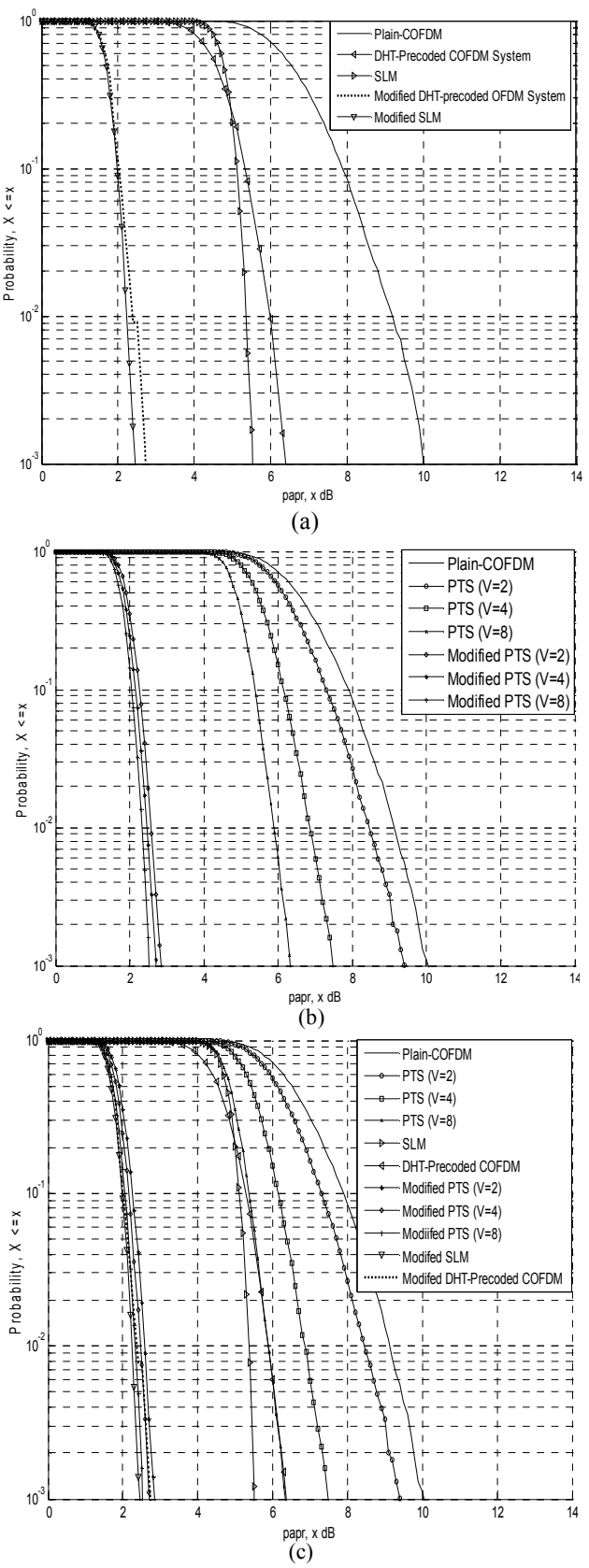

Fig. 15 PAPR Comparison of (a) DHT precoded, SLM and their modified versions (b) PTS (V =2, 4, 8) and Modified PTS for COFDM (c) all schemes with 64-QAM

8. Conclusion

The results of all above simulations for various codings, fading and mapping schemes can be summated as follows:

Based on fading

$$BER_{AWGN} < BER_{Nakagami-m} < BER_{Rician} < BER_{Rayleigh}$$

Based on Modulation scheme

$$BER_{BPSK} < BER_{QPSK} < BER_{16-QAM} < BER_{64-QAM}$$

Based on convolution coding

$$BER_{1/2-conv} < BER_{2/3-conv}$$

Based on concatenation

$$BER_{PC-turbo} < BER_{SC}.$$

Results show that BPSK scheme has best BER performance when mapping is concerned. In Serial concatenation RS-1/2 CC gives better performance tan RS-2/3 CC combination. In terms of concatenation Parallel concatenation using Turbo codes gives a better performance than their serial counterparts. Nakagami fading environments suits well for practical data and fading is most severe in Rayleigh fading.

In terms of PAPR analysis, the PAPR performance for post -clipped and filtered versions (modified) for PTS, SLM and DHT precoded system versions is better than unclipped versions. However this is achieved at cost of increase in complexity of circuit. Value of PAPR (in dB) for a given CDF value is given below:

Table 3. PAPR (in dB) Comparison For Various Schemes

SCHEME	16-QAM	64-QAM
Plain- COFDM	*7.9*	*8.6*
DHT Precoded	*5.2*	*5.6*
SLM	*5.1*	*5.3*
PTS (V=2)	*7.3*	*7.9*
PTS (V=4)	*6.2*	*6.5*
PTS (V=8)	*5.4*	*5.7*
Modified DHT	*2*	*2.2*
Modified SLM	*2*	*2.2*
Modified PTS (V=2)	*2.3*	*2.4*
Modified PTS (V=4)	*2.2*	*2.3*
Modified PTS (V=8)	*2*	*2.2*

We can see the modified scheme brings down PAPR drastically. With PTS, further increasing the block size V, PAPR reduces more. DHT precoded schemes also proved as a better candidate as a PAPR reduction technique.

References

[1] Haitham .J.Taha, M.F.M. Salleh “Multi-carrier rransmission Techniques for Wireless Communication Systems: A Survey”, *WSEAS Trans. On Commun*., Vol. 8, Issue 5, 2009, pp.457-472.

[2] Richard Van Nee, Ramjee Prasad, “ *OFDM for Wireless Communications*”, Boston: Artech House, 2000

[3] IEEE 802.11 detailed documentation [Online]. Available: http://standards.ieee.org/getieee802 ,Last accesed on 18/08/2012

[4] A. Joshi, Davinder S. Saini, "Performance Analysis of Coded OFDM for Various Modulation Schemes in 802.11a Based Digital Broadcast Applications", *in Proceedings of International Conference (BAIP 2010), Springer, LNCS-CCIS*, 2010, pp. 60-64.

[5] K. Thenmozhi, V. Prithiviraj, “Suitability of Coded Orthogonal Frequency Division Multiplexing (COFDM) for Multimedia Data Transmission in Wireless Telemedicine Applications”, *in Proceedings of IEEE onference on Computational Intelligence and Multimedia Applications*, Vol. 4, Dec.2007 , pp.288 - 292, 13-15.

[6] A. Joshi, Davinder S. Saini, "COFDM performance in various Multipath fading environment ", *in proceedings of IEEE International Conference (ICCAE 2010)* , Vol.3, 2010 , pp 127-131.

[7] A. Joshi, Davinder S. Saini, “Performance Analysis Of Coded-OFDM with RS-CC and Turbo codes in Various Fading Environment *", in proceedings of IEEE International Conference (ICIMU-2011),* 2011, pp.1-5.

[8] Steven S Pietrobon, “Implementation and Performance of aTurbo/MAP Decoder”, *International Journal of Satellite Communications*, Vol. 16, 1998, pp. 23-46.

[9] W. J. Blackert, E. K. Hall, and S. G. Wilson, “Turbo Code Termination and Interleaver Conditions”, *IEE Electronics Letters*, Vol. 31, Issue 24, 1995, pp. 2082–2084.

[10] G. Burr, G. P. White, “Performance of Turbo-coded OFDM”, *IEE Trans. Of International*

Conference on Universal Personal Communications, 1999.

[11] T.Gnanasekaran , V.Aarthi , "Effect of Constraint Length and Code Rate on the Performance of Enhanced Turbo Codes in AWGN and Rayleigh Fading Channel", *WSEAS Trans. On Commun*., Vol. 10, Issue 5, 2011 pp.137-146.

[12] Haitham J. Taha, M. F. M. Salleh, 'Performance Comparison of Wavelet Packet Transform (WPT) and FFTOFDM System Based on QAM Modulation Parameters in Fading Channels", *WSEAS Trans. On Commun*., Vol. 9, Issue.8, 2010, pp. 453-462.

[13] M. Nakagami, "The m-distribution, a general formula of intensity distribution of rapid fading," in *Statistical Methods in Radio Wave Propagation*,W. G. Hoffman, Ed, Oxford, U.K.: Pergamon, 1960.

[14] Nikola M. Sekulovic, Edis S. Mekic, Dragana S. Krstic, Aleksandra D. Cvetkovic, Martina Zdravkovic, Mihajlo C. Stefanovic, "Performance analysis of dual selection-based macrodiversity system over channels subjected to Nakagami-m fading and gamma shadowing", *WSEAS Trans. On Commun*., Vol. 10, Issue 3, 2011,pp.77-87.

[15] S.Elnoubi, S.A. Chahine, H.Abdallah, "BER performance of GMSK in Nakagami fading channels," in *IEEE Twenty-First National Radio Science Conference,*2004,pp.C13- 18.

[16] J.Armstrong,"Peak-to-average power reduction for OFDM by repeated clipping and frequency domain filtering", *Electronics Letters*, 28TH February 2002, Vol.38, Issue 5, pp-246-247.

[17] Chhavi Sharma, Shiv K. Tomar, A.K.Gupta, "PAPR Reduction in OFDM System using Adapting Coding Technique with Pre distortion Method", *WSEAS Trans. On Commun*., Vol. 10, Issue 9, 2011, pp.255-262.

[18] L. Wang, Ch. Tellambura, "A Simplified Clipping and Filtering Technique for PAPR Reduction in OFDM Systems", *IEEE Signal Processing Letters*, Vol.12, Issue 5, 2005,pp. 453-456.

[19] A. Joshi, Davinder S. Saini, "PAPR Analysis of Coded- OFDM System and Mitigating its Effect with Clipping, SLM and PTS" *, in proceedings of IEEE International Conference (ICIMU-2011)),* 2011,pp. 1-5

[20] Yang, Chung G. Kang, "*MIMO OFDM Wireless communication with MATLAB*", IEEE Press, 2010.

[21] R.J.Baxley, G.T. Zhou, "Comparing Selected Mapping and Partial Transmit Sequence for PAR Reduction," *IEEE Transactions on Broadcasting,* , Vol.53, Issue 4, 2007,pp.797-803.

[22] A.D.S.Jayalath, Ch. Tellambura, "SLM and PTS peak-power reduction of OFDM signals without side information", *IEEE Transactions on Wireless Communications,* , Vol.4, Issue 5, 2005, pp. 2006- 2013.

[23] Hsinying Liang, Zhe Lin, Houshou Chen, Cheng-Ying Yang, "A modified genetic algorithm PTS technique with error correction for PAPR reduction in OFDM systems", *in proceedings of International Symposium on Information Theory and its Applications (ISITA),* 2010, pp.1050-1053.

[24] L.Wang, J. Liu, "Cooperative PTS for PAPR reduction in MIMO-OFDM", *Electronics Letters* , Vol.47, Issue 5, 2011, pp.351 -352.

[25] Chin-Liang Wang, Ching-Hsien Chang, J.L Fan, J.M. Cioffi, "Discrete Hartley Transform Based Multicarrier Modulation", *in proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing*, , Vol.5, 2000. pp. 2513-2516.

[26] Z.Sembiring, M.F.A Malek, H. Rahim, "Low Complexity OFDM Modulator and Demodulator Based on Discrete Hartley Transform", *in Proceedings of Fifth Asia International Conference Modelling Symposium (AMS), 2011*, pp.252-256.

[27] I. Baig, V. Jeoti, "PAPR analysis of DHT-precoded OFDM system for M-QAM", *in Proceedings of IEE conf. on Intelligent and Advanced Systems (ICIAS)*, 2010, pp.1-4.

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