Abstract

In the rapid development of digital wireless communications, have increased demands for wireless systems with high efficiency performance. In this paper, an efficient OFDM system has been proposed based on dual-tree complex wavelet transform (DT-CWT). The mathematics behind the proposed OFDM system is explained. Moreover, comparative study has been made between the traditional OFDM and the OFDM based on DT-CWT. The proposed scheme achieves excellent improvements in bit error rate (BER) over conventional OFDM and wavelet packet modulation (WPM) systems. The proposed technique gives a significant improvement in Bit Error Rate (BER) performance in Additive White Gaussian Noise (AWGN) channels, flat fading channels (FFC), and multi-path selective fading channels (SFC) compared with traditional techniques. The simulation results performance is described in BER as a function of Signal to Noise Ratio (SNR).
1. A. R. S. Bahai, et al., Multi-carrier digital communications : theory and applications of OFDM, 2nd ed. New York: Springer, 2004.

2. W. Wei, et al., "Adaptive IP/optical OFDM networking design," in Optical Fiber Communication (OFC), collocated National Fiber Optic Engineers Conference, 2010 Conference on (OFC/NFOEC), 2010, pp. 1-3.

3. J. G. Andrews, et al., Fundamentals of WiMAX : understanding broadband wireless networking. Upper Saddle River, NJ: Prentice Hall, 2007.

4. Y. S. Cho, MIMO-OFDM wireless communications with MATLAB. Singapore ; Hoboken, NJ: J. Wiley & Sons (Asia), 2010.

5. B. G. Negash and H. Nikookar, "Wavelet-based multicarrier transmission over multipath wireless channels," Electronics Letters, vol. 36, pp. 1787–1788, 2000.

6. G. W. Wornell and A. V. Oppenheim, "Wavelet-based representations for a class of self-similar signals with application to fractal modulation," IEEE Transactions on Information Theory, vol. 38, pp. 785–800, 1992.

7. B. Farhang-Boroujeny and H. Moradi, "OFDM Inspired Waveforms for 5G," IEEE Communications Surveys & Tutorials, vol. 18, pp. 2474-2492, 2016.

8. M. J. Manglani and A. E. Bell, "Wavelet modulation in Gaussian and Rayleigh fading channels," in Proceedings of the IEEE Military Communications Conference (MILCOM '01), Electrical Engineering, Virginia Polytechnic Institute and State University, McLean, Va, USA, October, 2001.

9. E. Lawrey, "The Suitability of OFDM as A Modulation Technique for Wireless Telecommunications, with A CDMA Comparison," thesis, James Cook University, Australia, 1997.

10. T. J. Yew, "Multiwavelets and Scalable Video Compression," Ph.D. Thesis, Department of Electrical and Computer Engineering, National University of Singapore, Singapore, 2002.

11. R. Mirghani and M. Ghavami, "Comparison between Wavelet-based and Fourier-based Multicarrier UWB Systems," IET Communications, vol. 2, pp. 353-358, 2008.

12. S. D. Sandberg and M. A. Tzannes, "Overlapped discrete multitone modulation for high speed copper wire communications," IEEE Journal on Selected Areas in Communications, vol. 13, pp. 1571-1585, 1995.

13. K. Anoh, et al., "PAPR reduction of wavelet-OFDM systems using pilot symbols," in 2018 IEEE International Symposium on Power Line Communications and Its Applications (ISPLC), 2018, pp. 1-6.

14. D. Karamehmedovic, et al., "Performance of Wavelet Packet Modulation and OFDM in the Presence of Carrier Frequency and Phase Noise," in Proceedings of the 1st European Wireless Technology Conference, EuMA, Amsterdam, Netherlands, 2008, pp. 166-169.

15. M. Weeks, Digital signal processing using MATLAB and wavelets, 2nd ed. Sudbury, Mass.: Jones and Bartlett Publishers, 2011.

16. U. Khan, et al., "Performance Comparison of Wavelet Packet Modulation and OFDM for Multipath Wireless Channel," presented at the International Conference Computer, Control and Communication, Karachi, 2009.

17. F. Farrukh, et al., "Performance comparison of DFT-OFDM and Wavelet-OFDM with zero-forcing equalizer for FIR channel equalization," in Proceeding International Conference Electrical Engineering, 2000, pp. 1-5.

18. A. Jamin and P. Mahonen, "Wavelet Packet Modulation for Wireless Communications," Journal of Wireless Communications and networking, vol. 5, pp. 123-137, Mar. 2005. .
19. I. W. Selesnick, et al., "The Dual-Tree Complex Wavelet Transform," IEEE Signal Processing Magazine, pp. 123-151, 2005.

20. N. G. Kingsbury, "Image Processing with Complex Wavelets," Philosophical Transactions of the Royal Society A: Mathematical, vol. 357, pp. 2543-2560, 1999.

21. H. Hu, "Multiscale Illumination Normalization for Face Recognition using Dual-Tree Complex Wavelet Transform in Logarithm Domain," Computer Vision and Image Understanding, vol. 115, pp. 1384-1394, 2011.

22. L. Hanzo, OFDM and MC-CDMA for broadband multi-user communications, WLANs, and broadcasting. Piscataway, N.J. Chichester, England; Hoboken, NJ: IEEE Press, John Wiley, 2003.

23. J. S. Geronimo, et al., "Fractal Functions and Wavelet Expansions Based on Several Scaling Functions," Journal of Approximation Theory, vol. 78, pp. 373-401, 1994.

24. N. Kingsbury, "Shift invariant properties of the dual-tree complex wavelet transform," in Proceedings IEEE International Conference on Acoustics, Speech, and Signal Processing, ICASSP '99, Phoenix, AZ., 1999, pp. 1221-1224.

25. V. Strela, "Multiwavelets: Theory and Applications " Doctor of Philosophy in Mathematics, Department of Mathematics Massachusetts Institute of Technology, 1996.

26. M. B. Martin, "Applications of multiwavelets to image compression," M.S. thesis, Electrical Engineering Department, Virginia Polytechnic Institute and State University (Virginia Tech), USA, 1999.

27. M. H. M. Nerma, et al., "On DT-CWT Based OFDM: PAPR Analysis," in Multi-Carrier Systems & Solutions 2009, ed: Springer, 2009, pp. 207-217.

28. S. Plass, et al., Multi-Carrier Systems & Solutions 2009: Proceedings from the 7th International Workshop on Multi-Carrier Systems & Solutions, May 2009, Herrsching, Germany vol. 41: Springer Science & Business Media, 2009.

29. V. Strela and A. T. Walden, "Orthogonal and biorthogonal multiwavelets for signal denoising and image compression," Orlando, FL, USA, 1998, pp. 96-107.

Index Terms

Computer Science Wireless

Keywords

OFDM; Wavelet; DWT; WPT; DT-CWT; FFT; Multicarrier Modulation; BER.