MULTICARRIER CODE DIVISION MULITPLE ACCESS BASED ON WAVELET

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ABSTRACT

In this paper an alternative strategies will be demonstrated that mitigate interference without relying on the fact that the effective channel is shorter than the CP. Wavelet-based MC-CDMA has gained popularity in the literature recently. Due to very high spectral containment properties of wavelet filters, wavelet-based MC-CDMA can be better combat narrowband interference and is inherently more robust with respect to ICI than traditional FFT filters. The classic notion of a guard band does not apply for (DWT-MC-CDMA), hence data rates can enhanced those of FFT implementations.

1. Introduction

In the 4G communication systems the high-bit-rate transmission is required for high quality communications. To fulfill these demands, a new scheme, which combines wireless and digital modulation and multiple access was proposed which combines OFDM with CDMA called MCCDMA. The basic main block in the system is the OFDM (Orthogonal frequency division multiplexing) which provides an efficient means to handle high-speed data streams on a multipath fading environment that causes serious intersymbol interference (ISI) and intercarrier interference (ICI). Adding a cyclic prefix (CP) is the main way for Fourier based OFDM to eliminate the interference. But this can decrease the bandwidth (BW) efficiency greatly, which means that we have a long way to go to improve the BW efficiency [1] [2] [3].

To decrease the BW waste brought by adding CP, wavelet base is proposed due to its excellent orthogonality between subcarriers and wonderful spectral containment. Wavelet OFDM is better combat narrowband interference and it's more robust with respect to ICI than Fourier OFDM. Haar wavelet will be employed due to its simplicity. This chapter gives the performance comparisons of Fourier OFDM and wavelet OFDM on three different channel models will be given. Simulation results will show that DFT-OFDM and DWT-OFDM perform different when the transmission scenarios different. The BER performance of OFDM system will be considered with different orthogonal bases on AWGN channel, flat fading channel and selective fading channel [4] [5].

2. Proposed System for DWT-MCCDMA

The block diagram of the proposed system for MCCDMA is depicted in figure (1).

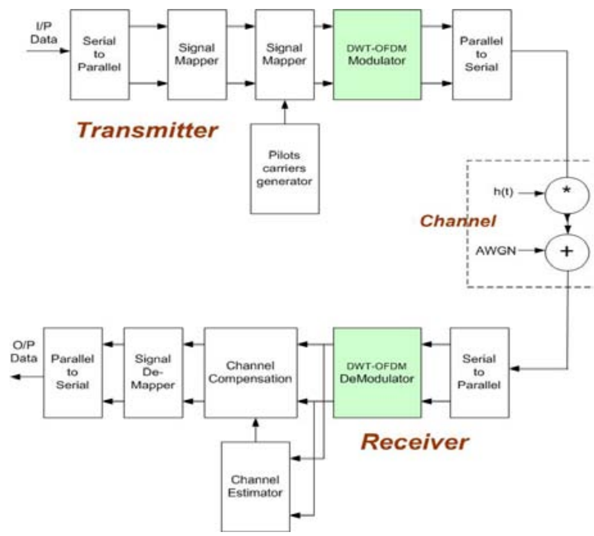
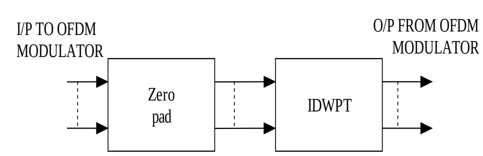
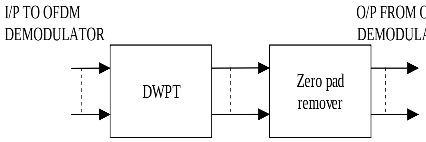


Figure (1): Block Diagram of DWT-MCCDMA System

The overall system of OFDM is shown as in figure (2). The only difference is the OFDM modulator and demodulator. The wavelet based OFDM modulator and demodulator that used are shown in the figure below:



(a) DWT-OFDM modulator



(b) DWT-OFDM demodulator

Figure (2): DWT-OFDM modem system

The processes of the S/P converter, the signal demapper and the insertion of training sequence are the same as in the system of FFT-OFDM. Also the zeros will be added as in the FFT based case and for the same reasons. After that the inverse discrete wavelet transform (IDWT) will be applied to the signal.

The main and important difference between FFT based OFDM and DWT based OFDM is that the wavelet based OFDM will not add a cyclic prefix to OFDM symbol. Therefore the data rates in wavelet based OFDM can surpass those of the FFT implementation. After that the P/S converter will convert the OFDM symbol to its serial version and will be sent it through the channel.

At the receiver, also assuming synchronization conditions are satisfied, first S/P converts the OFDM symbol to parallel version. After that the DWT will be done. Also the zero pad will remove and the other operations of the channel estimation, channel compensation, signal demapper and P/S will be performed in a similar manner to that of the FFT based OFDM.

3. Results of Proposed Systems

In this section a simulation of the two systems FFT-MCCDMA, DWT-MC-CDMA have been made using MATLAB 7. and the BER performance of the two systems are studied in different channel model which is AWGN, flat fading and selective fading channel. Table (1) shows the parameters of the system that used in the simulation, the simulation work on 5Mhz bandwidth.

Modulation Type	**BPSK**
Spreading code	**Walsh-Hadamard**
No. of Sub-carriers	**64**
Channel Model	**AWGN**
	Flat Fading
	Selective Fading

Table 1 Simulation Parameters

A. Performance of DWT-MCCDMA in AWGN channel

In this section, the result of the simulation for the proposed DMWT-OFDM system is calculated and shown in figure 3, which give the BER performance of DMT-MCCDMA in AWGN channel. It is shown clearly that the DWT-MCCDMA is much better than the system FFT-MCCDMA. This is a reflection to the fact that the orthogonal bases of the wavelet is much significant than the orthogonal bases used in FFT-MCCDMA.

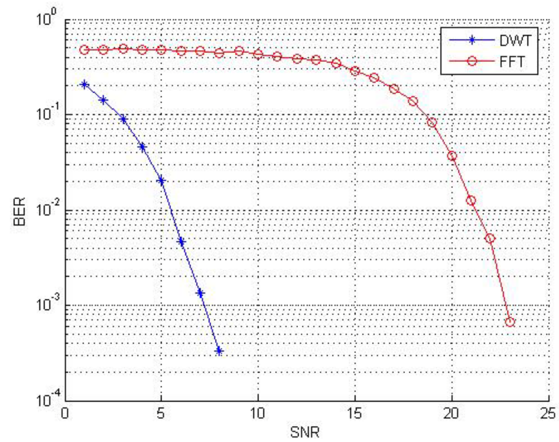


Figure 3 BER performance of DMWT-OFDM in AWGN channel model.

B. BER Performance of DWT-MCCDMA in Flat Fading Channel.

In this section, the channel model that was considered is the flat fading channel that assumed all the frequency components of the transmitted signal are changed correlated in phase and magnitude. Maximum Doppler Shift taken in three different cases in 5Hz, 500Hz and for a large Doppler Shift 1100Hz, as shown in figure 4, 5 and 6.

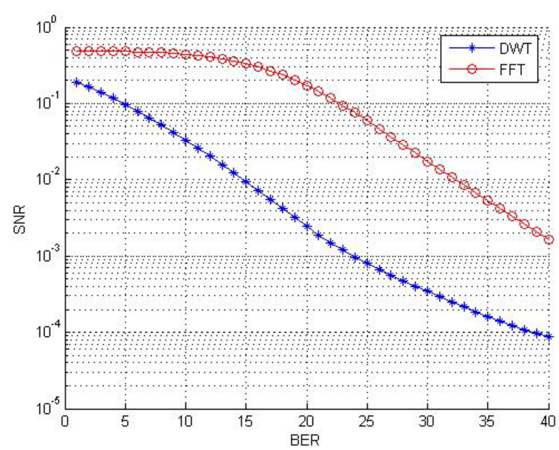


Figure 4: The BER performance of DWT-MCCDMA in Flat Fading Channel at Max. Doppler Shift=5Hz.

The simulation results in figure 4 showed that wavelet based MC-CDMA is still better than the other MC-CDMA system that based on FFT transform. Where the wavelet based MC-CDMA have BER=10^{-3} at SNR=25dB, while in FFT based MC-CDMA system, the BER=10^{-3} achieved approximate at SNR=40dB. Which mean a gain about 15dB.

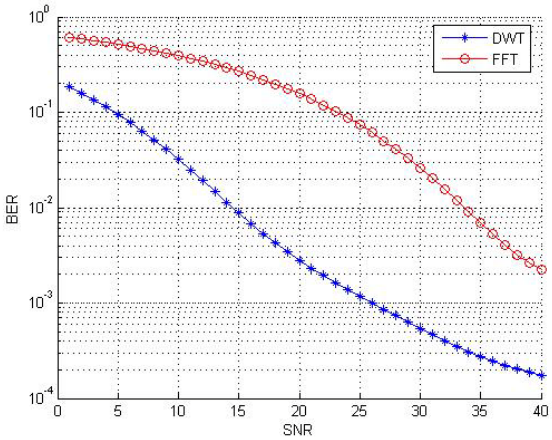


Figure 5: The BER performance of DWT-MCCDMA in Flat Fading Channel at Max. Doppler Shift=500Hz.

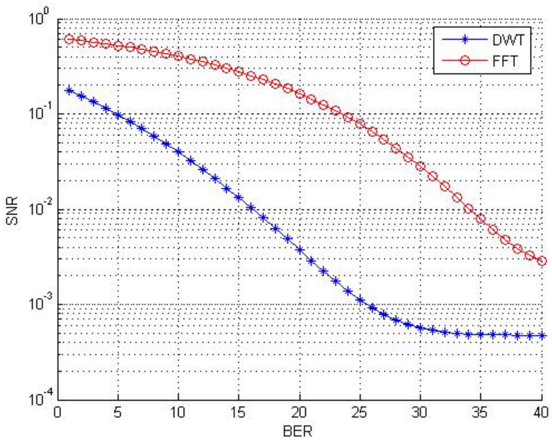


Figure 6: The BER performance of DWT-MCCDMA in Flat Fading Channel at Max. Doppler Shift=1100Hz.

C. BER Performance of DWT-MCCDMA in Selective Fading Channel.

In this type of channel, the frequency complements of the transmitted signal are affected by uncorrelated changes, where the parameters of the channel in this case corresponding to multipath the two paths are chosen, the LOS and second path.

In selective fading channel many models have been taken to compare the BER performance of the two systems, the influence of the attenuation, delay and Maximum Doppler Shift of an echo is successfully discussed.

First, the Doppler shift parameter have been taken in interest, the model that have been used in the simulation set the Doppler shift to 5Hz, 500Hz and 1100Hz. The path delay have set to 1 sample and the path gain to -8dB.

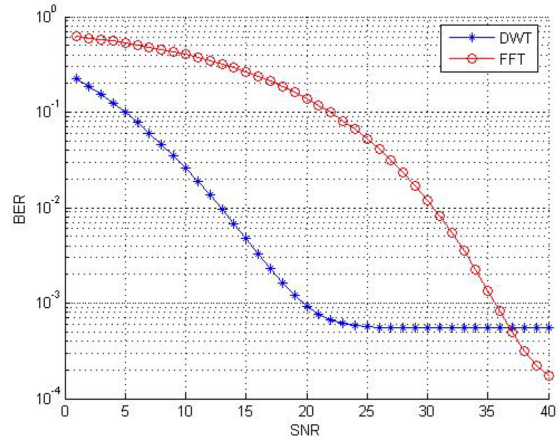


Figure 7: The BER performance of DMWT-OFDM in Selective Fading Channel at Max Doppler Shift=5Hz.

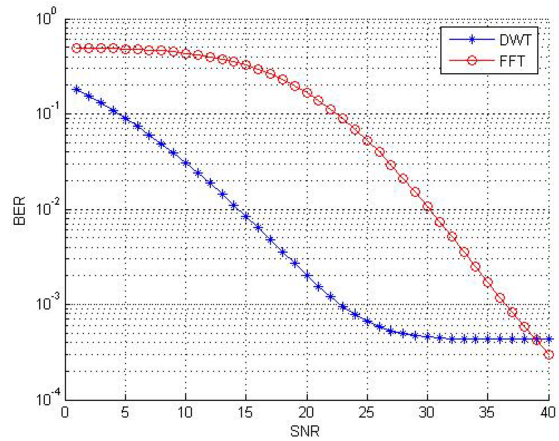


Figure 8: The BER performance of DMWT-OFDM in Selective Fading Channel at Max Doppler Shift=500Hz.

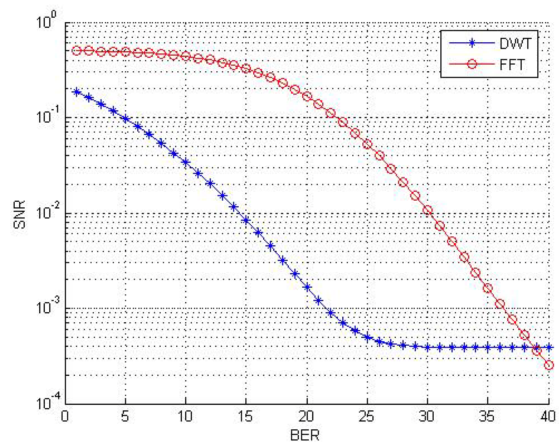


Figure 9: The BER performance of DMWT-OFDM in Selective Fading Channel at Max Doppler Shift=1100Hz.

After Doppler shift parameter has been depicted, the second parameter is path gain, the other parameter is set to 1 sample for path delay and 5Hz for Doppler shift. The BER performance is shown in figures 5.12, 5.13, 5.14.

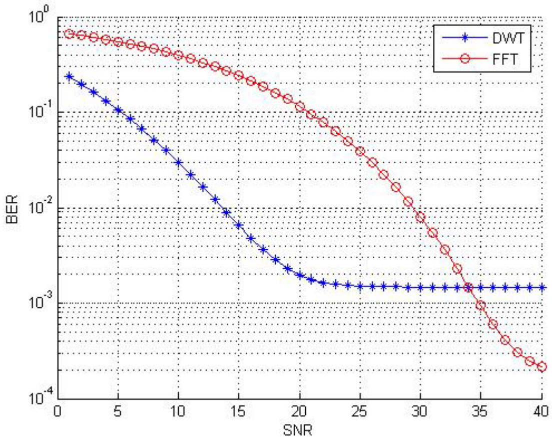


Figure 10: The BER performance of DWT-MCCDMA in Selective Fading Channel at Path Gain=-1dB.

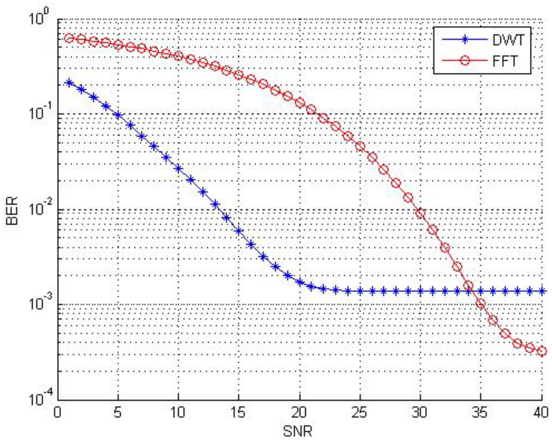


Figure 11: The BER performance of DWT-MCCDMA in Selective Fading Channel at Path Gain=-5dB.

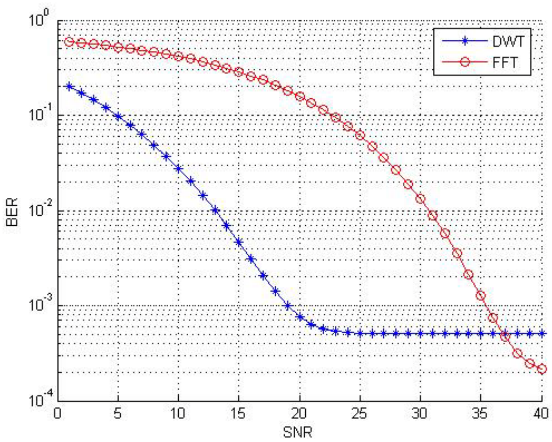


Figure 12: The BER performance of DWT-MCCDMA in Selective Fading Channel at Path Gain=-12dB.

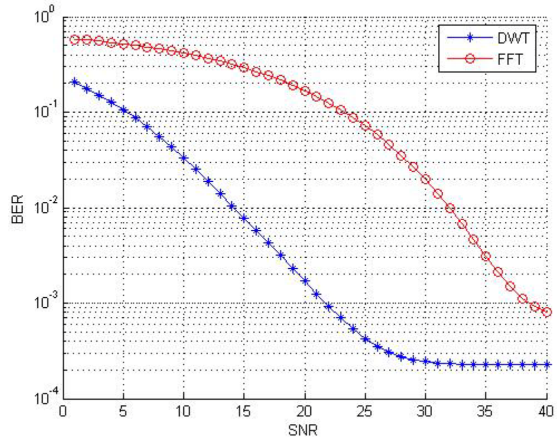


Figure 13: The BER performance of DWT-MCCDMA in Selective Fading Channel at Path Gain=-20dB.

4. Conclusion

In wavelet-based MCCDMA, the IFFT and FFT blocks are simply replaced by an inverse discrete wavelet transform (IDWT) and discrete wavelet transform (DWT), respectively. The subchannels remain orthogonal to one another, inspite of the significant overlap in the frequency domain. Due to the higher spectral containment between subchannels, wavelet-based MCCDMA is better able to ameliorate the effects of narrowband interference and is inherently more robust with respect to ICI than traditional Fourier filters.

DWT-MCCDMA is implemented via overlapped waveforms to preserve data rate. The classic notion of a CP does not make sense in this context. Without the CP, the data rate in wavelet systems can surpass those of Fourier implementations, one of its key motivating factors.

5. References

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