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PERFORMANCE IMPROVEMENT ANALYSIS OF TIME DISPERSIVE CHANNEL USING DISCRETE WAVELET TRANSFORM

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ABSTRACT

This paper presents a model which is discrete wavelet transform based (orthogonal frequency division multiplexing) OFDM system for next generation wireless communication. Fourier transform based OFDM system signals only overlap in the frequency domain while the wavelet transform signals overlap both in the time and frequency domain so there is no need of the cyclic prefix(CP) in the proposed model. There are different types of wavelet transform are available .the performance of the wavelet based OFDM system using modulation QAM was assessed by various parameters such as Bit error rate and constellation diagram. In OFDM inter symbol interference and the inter carrier interference exist. Due to the multipath wireless channel. wavelet based transmission is investigated and its shown that this technique is better at suppressing ISI and ICI than conventional OFDM. the results presented in this paper are based on computer simulation performed using MATLAB software.

1. INTRODUCTION

Over the last few years, the subscribers of wireless communications have exponential growth. The ongoing progress in radio technology provides more and more new and improved services. With the severe shortage of spectrum in conventional cellular bands, the range of frequencies between 3 and 300 GHz have been attracting growing attention for higher demand of cellular applications (Akdeniz et al., 2014). Current wireless services include transmission of fax, voice and low-speed data flexibly. With the use of interactive multimedia services like video-on-demand like television viewing and internet access for transferring essential data high-frequency band is utilized to support wireless communications (Islam, 2012). Many researchers are investigating and analyzing to meet the high data rate for future generation as the data rate is increasing exponentially with the increase of users. One of the emerging techniques is OFDM which is implemented in wireless communication (Hwang et al., 2009).

In OFDM the cyclic prefix is used to mitigate the intersymbol interference and to increase the delay spread of the channel. The drawback of the cyclic prefix is that it utilizes 20% to 25% of the total bandwidth (Galande & Shah, 2016). Wavelet transform has been used in OFDM which eliminates the use of cyclic prefix; hence the efficiency of bandwidth is enhanced (Gupta et al., 2014). The other advantages of wavelets are flexibility and less sensitivity to signal distortion. Wavelets have been used in various fields of wireless communication systems such as channel modeling, the design of transmitter and receiver for data representation and compression, performance improvement by mitigating interference and signal denoising (Lakshmanan & Nikookar, 2006). The loss of signal also occurs in the channel due to various factors such as multipath, due to obstacles along the path and due to improper tuning between the transmitter and receiver. To overcome these diversity techniques are implemented which helps to reduce the signal loss in terms BER and increase the capacity of the channel. Multiple antennae are used to provide antenna gain or diversity gain which helps to improve the system performance by reducing BER or improving Signal to noise ratio (Mietzner & Schober, 2009).

In this paper, section two describes the overview of diversity techniques used in a wireless communication system to mitigate the fading effect of the signal. Next, section three gives the fundamental of the signal representing DWT and their various types of wavelets and comparative study of fast fourier transform-OFDM replace with

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Discrete wavelet transforms-OFDM to improve the BER and other parameters of the system by various methods. Section four explains the proposed technique Discrete wavelet transforms-OFDM with MIMO diversity in wireless communication for the future generation, and finally, we conclude in section five.

Diversity techniques used to mitigate the fading in multipath environment over wireless channels. Space diversity is used for wireless channels and for this, many transmitter and receiver antennas used [1]. MIMO increases the fundamental gain that enhance spatial multiplexing, which causes more spectral efficienciant.
OFDM expanded as Orthogonal Frequency Division Multiplexing and uses mutually perpendicular sub carries of frequencies for signal transmission. Since subcarriers are mutually orthogonal to each other the OFDM facilitate very high bit rates in the presence of multipath radio propagation. To eliminates ISI OFDM uses spatial-multiplexing receivers which is called as MIMO-OFDM and it is provided at the cost of computational complexity. It ensures the bandwidth of subcarriers to overlap without Inter Carrier Interference (ICI) providing that modulated carriers are orthogonal.

Prefix appended before transmitting the signal to channel. However, wavelet based transmission technique has stronger capability of suppressing ISI and ICI than the OFDM scheme. In conventional OFDM system, FFT changed with Discrete Wavelet Transform (DWT) to enhance bit error rate, interference minimization, and improvement in bandwidth efficiency.

2. RELATED WORK

Literature survey on MIMO-OFDM system using different modulation techniques, Wavelet Transforms and DWT MIMO-OFDM system presented.
In a research paper of Weijun Hong, Shufang Li [3] In this work, wavelet transform technology used for improvement of the effectiveness of image compression Whole image transformed with wavelet transform which provides very high compression ratio. No blocking effects at the stage of image recomposing as that exist in DCT In this, the draw back is, geometric distortion not filtered in extreme high compression ratio environment.
Similarly, a recent paper of Kamrul Hasan Talukder and Koichi Harada [4] presented a image transmission scheme using wavelet transform. In this, digital image transformed from spatial domain into frequency domain using discrete wavelet transform. Accuracy of the reconstructed image obtained using Haar wavelet transformation with increased transmission time.
A.Vamsidhar [5] worked on the performance of Discrete Wavelet Transform (DWT) based Multi-user MIMO-OFDM. In this, MIMO-OFDM system used for performance comparison with FFT. From the simulation, the results evaluated for bit error rate to the transmission ability.The results shows that the DWT constructed multicarrier scheme was superior to the predictable OFDM scheme. In proposed work, Daubecheis and Biorthogonal wavelets used to give more accuracy.
Pitcheri Praveen Kumar, at.el. [6] implements MIMO-OFDM system with the Wavelets have effective MRA (Multi Resolution Analysis) capabilities to extract the optimum response of the signal using DWT based OFDM. Efficiency of performance compared with the FFT based OFDM by establishing the bit error rate (BER) appearance with BPSK and QPSK as a modulation technique in the presence of AWGN channel. The proposed system uses QAM modulation technique that is immune to noise.
D.Meenakshi, S.Prabha, N.R.Raajan [7] analyses the performance of ripple based Multi-user MIMO OFDM systems and compared with a FFT based MIMO-OFDM. In this, Simulation created with DWT, Haar model and multiple antennas scheme and dual modulation schemes using BPSK and QPSK as in AWGN. For establishing presentation to the transmission ability, DWT constructed multicarrier scheme establish higher transmission ability against bit error rate than predictable OFDM scheme. In the proposed work, Daubecheis and Biorthogonal wavelets used to give more accuracy.

I. MIMO-OFDM USING WAVELET TRANSFORMS In wireless communication, popular OFDM technique is used for high data transmission. OFDM with multiple-input multiple-output (MIMO) configuration used to increase the diversity gain or system capacity both on time-varying and frequency-selective channels. In OFDM, processing speed is increased with use of IFFT and FFT which also reduces the complexity at transmitter and receiver.

Wavelets (little waves) transform are most appropriate for non stationary signals and are the functions that are concentrated around a central point in time and frequency. The image information

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divides into approximation and detail sub signal by this Wavelet analysis. The wavelet representation shows a multi resolution expression of a signal with localization in both time and frequency. The signal decomposed into a set of basis functions using wavelet transforms. DWT is a discrete wavelet transform and it uses any wavelet transform for discrediting into samples. Wavelet transform offers high side lobes suppression ratio hence DFT/IDFT replaced with DWT and for implementation; DWT MIMO-OFDM is used. Wavelet transform has several advantages such as flexibility, lesser sensitivity against channel distortion and least significant interference with better consumption of spectrum. Hence, Wavelet transform used with MIMO-OFDM and proposed to design the sophisticated wireless communication systems.

3. DIVERSITY TECHNIQUES

To improve system performance in fading channels diversity technique is used to decrease the fading effect. Some of them are Frequency diversity, Time diversity, Polarization diversity, Angle diversity, Antenna/Spatial diversity. Multiple antennas are used to send signals with information at the transmitter to receive at the receiver to provide multiple independent fading paths in space diversity. Most common and popular used diversity technique is antenna diversity technique, so the next section describes the overview of different antenna diversity such as transmit diversity, receive diversity and MIMO diversity.

3.1. Transmit /Receive Diversity

A simple transmit diversity technique was proposed by considering one receive antenna and two transmitter antenna which provides diversity order similar to maximal-ratio receiver combining (MRRC) and any feedback is not required from the receiver to the transmitter (Alamouti, 1998). Lee et al., (2000) have discussed the advantages of space frequency OFDM over space-time OFDM in frequency selective fading channel with transmit diversity technique in wireless communication (K. F. Lee & Williams, 2000). The expression for computing average bit error rate (BER) was derived for different modulation schemes like BPSK, QPSK, 4 PAM and 16 QAM by maximum ratio diversity technique in ricean flat fading channel with different values of Ricean factor k and channel estimation error effect was also considered (Cao & Beaulieu, 2005). Ghavami et al., (2008) analyzed BER performance in wideband code division multiple access (WCDMA) downlink channels with correlated Nakagami fading at transmitter antenna selection was invoked. At receiver to improve ratio of the signal to noise MRC technique and cancels out multiple access interference linear correlating detectors was used. Received signals are combined at the receiver to achieve diversity gain. The commonly used techniques are selection combining, switching receiver, maximal ratio combining (MRC) and equal gain combining.

Moreira et al., (2002) evaluated various diversity techniques such as antenna selection, equal gain with both coherent and incoherent and maximum ratio combining in a Hiperlan/2 receiver. Alkurd et al., (2014) analyzed the average error rate performance of cooperative maximum ratio combing receiver over fading channels using different coherent modulation techniques and approximate average BER was calculated. Crawford et al., (2017) investigated the performance of multicarrier index keying OFDM with hybrid low complexity detection and diversity reception using MRC and Selection combining. Villanueva et al., (2017) studied the effect of the Signal input and multiple output (SIMO) spatial diversity on the OFDM mobile radio signal propagating by using two receiving antennas at the diversity and calculated capacity improvement. Khelil et al., (2017) proposed single carrier frequency division multiple access techniques using one transmitter and two or three receivers that is SIMO with MRC in the receiver. The result was used to identify channel capacity and BER.

3.2. MIMO diversity

Martin et al., (2009) studied the performance of MIMO systems in Rayleigh fading channels with co-channel interference and thermal noise using maximum ratio transmission with two different receive antenna array configuration and derived expression for average bit error rate or symbol error rate. Lee, (2018) analyzed the performance of dual selection (i.e., combining user selection and transmit antenna selection) with MRC in a MIMO system and derived the exact and approximate cumulative density function and probability density function for the dual selection with MRC over non-identical imperfect channel estimation. Akhtar et al., (2018) analysis of a MIMO-OFDM model in Rayleigh Fading and AWGN channel with different MIMO configuration scheme using QAM modulation to reduce the BER with mitigating the interference with adding cyclic prefix with FFT.

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Singh & Prakasa Rao, (2017) studied the performance of MIMO system over various modulation orders and various diversity orders in wireless communication. Different modulation techniques improve the quality of MIMO wireless channel, transmit diversity with coding using complex algorithm is used in MISO channel, receiver diversity like MRC, selection diversity is used in SIMO channel. Channel estimation and equalization is necessary to prevent the loss of signal in MIMO channel with spatial multiplexing or beamforming. MIMO systems have the features to provide multipath propagation in a scattering environment by using many antennas at transmitter and receiver to improve the performance in terms of capacity.

4. METHODOLOGY TO IMPLEMENT THE PROPOSED SYSTEM

Wavelet Transform analyzes the changes of time and corresponding change in frequency. The basis functions from Wavelet transforms vary both in frequency range and in spatial range. The frequency of the signal and time related with the frequency can be provided using wavelet; this makes it very convenient in faulty detection.

DWT operates on pixel basis and it transforms the information from spatial domain into frequency domain. DWT divides the high frequency and low frequency on pixel basis

The implementation is performed as a multistage transformation. In DWT domain an image is decomposed as four sub-bands at level 1 like LL, LH, HL and HH.Among four sub-bands LH, HL and HH denote the finest scale wavelet coefficients and LL sets for the coarse-level coefficients. Another level of decomposition is obtained with LL sub-band.

DWT operates on pixel basis and it transforms the information from spatial domain into frequency domain. DWT divides the high frequency and low frequency on pixel basis

5 ALGORITHM

Step 1: Initially the values are been assigned i.e. number of subcarrier = 96, number of pilots = 8, cyclic prefix length = 14 and number of transmitting frames = 100.

Step 2: To generate and code the data as per the values assigned in step 1.

Step 3: The signal is modulated according to the level of QAM modulation selected i.e. 16QAM, 64QAM, 256QAM. The signal constellation is rectangular or cross shaped and the nearest pair of points in the constellation is separated by 2.

Step 4: The IDWT operation is performed. The signal or image extension mode is set for discrete wavelet and wavelet packet transforms.

Step 5: measuring of power using DWT OFDM with and without AWGN noise.. The dB SNR specifies the scalar Signal to Noise Ratio per sample.

Step 6: dimensional wavelet decomposition is performed with respect to a particular wavelet that are Haar wavelet, Daubecheis wavelet and Biorthogonal wavelet. The approximation coefficients vector cA and detail coefficients vector cD are calculated by a wavelet decomposition of the OFDM signal. The received DWT signal is demodulated. The value of M is 16, 64 and 256 which must be an integer or power of 2.

Step 7: Based on the received signal, the BER is calculated for different wavelet transforms.

CONCLUSION

The wireless communication has raised many hopes as the technology is changing from one generation to other generation. Each generation has some advanced features for transferring the information, multimedia and entertainment. Wavelets have been considered for future generation as increase the spectral efficiency. The flexibility and orthogonality are also the advantages of wavelets. However, the researchers are focused on how to enhance the DWT-OFDM with more convolution coding, modulation, and other features. Moreover, the Multiple inputs and multiple outputs (MIMO) have also been used to meet the requirements of the next generation. In future this can be considered on MIMO-OFDM with wavelets to inhance the rate of the data, progress the enactment of the communication scheme in terms of BER, spectrum efficiency and capacity of the network is also improved. There are many advantages of using wavelets transform in OFDM is analyzed. The DWT-OFDM performs better due to avoiding of the cyclic prefix. They also have a feature of multicarrier modulation. Multiple inputs and multiple output antenna are used to prevent the loss of signal and improve the performance of the system. DWT-OFDM with multiple input and multiple outputs can be used for future generation.

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