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IMPROVED ICI REDUCTION METHOD IN OFDM COMMUNICATION SYSTEM

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ABSTRACT

The higher data rate of future mobile networks is achieved by employing OFDM over the multipath environment. The inter-carrier-interference (ICI) produced by the phase noise of transceiver local oscillator is a serious problem. Bit error rate (BER) performance is degraded because the orthogonal properties between the sub-carriers are broken down. In this project ICI self cancellation by data-conjugate method is implemented to minimize CPE and ICI. The improvement of C/I could reach 10 dB when the normalized 3 dB bandwidth of phase noise is 0.4. The result is CPE becomes zero in the OFDM of the data-conjugate method. Besides in the OFDM system with phase noise, the data-conjugate method makes remarkable improvement in the BER performance and it is better than the data-conversion method and the normal OFDM.
Keywords:- BER , ICI ,OFDM, Mobile Networks,

1.INTRODUCTION

The huge uptake rate of mobile phone technology, Wireless Local Area Networks (WLAN) and the exponential growth of the Internet have resulted in an increased demand for new methods of obtaining high capacity wireless networks. OFDM technology promises to be a key technique for achieving the high data capacity and spectral efficiency requirements for wireless communication systems of the near future. Most WLAN systems currently use the IEEE802.11b standard, which provides a maximum data rate of 11 Mbps. Newer WLAN standards such as IEEE802.11a and HiperLAN2 are based on OFDM technology and provide a much higher data rate of 54 Mbps. However systems of the near future will require WLANs with data rates of greater than 100 Mbps, and so there is a need to further improve the spectral efficiency and data capacity of OFDM systems in WLAN applications.

The higher data rate of future mobile networks will be achieved by increasing the amount of spectrum allocated to the service and by improvements in the spectral efficiency by employing OFDM in physical layer of fourth generation mobile systems. OFDM is a special case of multi-carrier modulation. Available bandwidth is divided into several sub channels that is symbol duration of each sub carrier in OFDM is N times longer than that of single carrier system. (If N sub carriers are used) to mitigate ISI. Implementation of OFDM has become easy especially with the use of Fast FourierTransforms (FFT), which are an efficient implementation of the DFT.The advances in integrated circuit technology have made the implementation of OFDM cost effective.

A well known problem of OFDM, however, is its sensitivity to frequency offset between the transmitted and received signals, which may be caused by Doppler shift in the channel, or by the difference between the transmitter and receiver local oscillator frequencies. This carrier frequency offset causes loss of orthogonality between sub- carriers and the signals transmitted on each carrier are not independent of each other, leading to inter-carrier interference (ICI).This project proposes the data conjugate self cancellation scheme to minimize the ICI in the OFDM Systems.

2.OFDM Versus FDM

OFDM is different from FDM in several ways. In conventional broadcasting each radio station transmits on a different frequency, effectively using FDM to maintain a separation between the stations. There is however no coordination or synchronization between each of these stations. With an OFDM transmission such as DAB, the information signals from multiple stations is combined into a single multiplexed stream of data. This data is then transmitted using an OFDM ensemble that is made up from a dense packing of many sub carriers. All the sub carriers within the OFDM signal are time and frequency synchronized to each other, allowing the interference between sub carriers to be carefully controlled. These multiple sub carriers overlap in the frequency domain, but do not cause Inter-Carrier Interference (ICI) due to the orthogonal nature of the modulation. Typically with FDM the transmission signals need to have a large frequency guard-band between channels to prevent interference. This lowers the overall spectral efficiency. Figure 1.1 shows the spectrum of FDM and the OFDM System. However with OFDM the orthogonal packing of the sub carriers greatly reduces this guard band, improving the spectral efficiency.

3.OFDM GENERATION AND RECEPTION.

OFDM signals are typically generated digitally due to the difficulty in creating large banks of phase lock oscillators and receivers in the analog domain. Figure 2.1 shows the block diagram of a typical OFDM transceiver. The transmitter section converts digital data to be transmitted, into a mapping of subcarrier amplitude and phase. It then transforms this spectral representation of the data into the time domain using an Inverse Discrete Fourier Transform (IDFT). The Inverse Fast Fourier Transform (IFFT) performs the same operations as an IDFT, except that it is much more computationally efficiency, and so is used in all practical systems. In order to transmit the OFDM signal the calculated time domain signal is then mixed up to the required frequency.

4.OFDM STANDARDS

Table 1List the Standard followed in OFDM System transmission.

Parameter	**Value**
Data rate	6, 9, 12 , 18 , 24 , 36 , 48 , 54 Mbps
Channel Spacing	20 MHz
IFFT used for 20 MSPS	64
Data Subcarriers	48
Pilot Subcarriers	4
Carrier Spacing (F_c)	20 MHz/64 = 312.5kHz
Nominal Bandwidth	312.5kHz*(48+4) = 16.25 MHz
Useful Symbol Period	1/ F_c = 1/312.5kHz = 3.2µs
Guard Period	0.8 µs
Modulation schemes	BPSK, QPSK, 16-QAM, 64-QAM
Coding Rate	½, 2/3 , ¾

Table 1 OFDM Standards

4.1Issues in OFDM

1. High PAR (Peak to average power ratio)in transmitted signal due to Power Amplifier Non-linearity
2. OFDM sensitive to phase noise due to Transceiver oscillator frequency inaccuracy
3. High Sensitivity to Frequency Offset Errors due to Doppler shift
4. Bandwidth loss due to guard interval
5. Time variations of mobile channel

5.Simulations And Results

Results

The data conjugate method is compared with that of the original OFDM and the data conversion method in terms of BER Performance. For the simulations in this project, MATLAB was employed. The simulations were performed using an AWGN channel.

Table 2: Simulation parameters

PARAMETERS	VALUES
Number of carriers (N)	52
Modulation (M)	BPSK

Phase noise variance σ_{Φ}^{2}	0.02,0.03&0.05
No. of OFDM symbols	100
Bits per OFDM symbol (BPS)	N*log2(M)
E_b-N_o	1:20
IFFT size	64
Data rate	48Mbps
Sub carrier spacing (Δf)	0.3125MHz
FFT period (1/ Δf)	3.2 μsec
Channel	AWGN
Symbol time	4 μsec

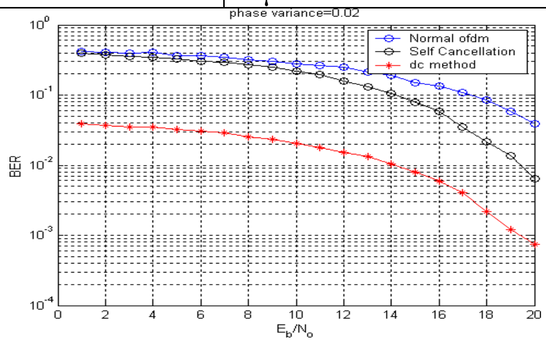

Figure 5.1: BER performance with Phase noise variance of 0.02

Figure 5.1 shows that the Bit error rate values for data conjugate method is comparatively small compared with the normal OFDM and Data conversion method OFDM.

CONCLUSION

The simulation result shows that BER performance is improved using the data conjugate method compared to data conversion method and normal OFDM. The BER performance degrades as Phase noise variance increases. Table 4 shows the BER performance analysis for E_b/No = 20 dB.

Phase variance	Normal OFDM BERvalue	Self Cancellation BERvalue	Data Conjugate BERvalue
ε =0.02	0.066923	0.013269	0.002150
ε =0.03	0.146920	0.042115	0.021045
ε =0.05	0.300906	0.199014	0.012496

Table 3 BER performance analysis for Eb/No = 20 dB

So it is necessary to maintain the interference due to phase noise within a tolerable limit. Since Common Phase error is minimized in this method the CIR performance is improved remarkably compared to the other two methods. Table 5 shows the CIR performance analysis for Eb/No = 3 dB.

Phase variance	Normal OFDM CIR(dB)	Self Cancellation CIR(dB)	Data Conjugate CIR(dB)
ε =0.1	16.2482	33.4623	45.5725
ε =0.2	9.7108	28.9833	40.8129
ε =0.3	4.8718	21.8956	39.6146

Using the simulation results, it is verified that the ICI self-cancellation scheme obviously decreases the amount of the ICI caused by phase noise and the improvement of C/I could reach 10 dB when the normalized 3 dB bandwidth of phase noise is 0.4. When closed loop bandwidth is 1-3 kHz which is a proper value of design parameter for minimum phase noise in a DH-PLL system, switching speed has the least about 3 times fast performance as compared with conventional PLL's one.

It means that using the DH-PLL system we can achieve minimum phase noise and high-speed frequency synthesis at the same time. From the analysis, the CPE of the data-conjugate is shown to be zero hence CIR is improved in this method. Overall, with respect to the BER, the

OFDM system of the data-conjugate method shows the best performances compared with the original OFDM, OFDM with convolution coding and the data-conversion method. So, data conjugate ICI self-cancellation method may be very useful to the multi-carrier system of the high transmission quality.

Future work

The self cancellation scheme data conjugate method can be applied to the Raleigh channel along with convolutional coding. For Better Bandwidth efficiency the alphabet size of data symbol can be increased. OFDM can be also applied to recorded voice signal as the input data and interference level can be measured and analyzed.

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