

Efficient Multi Carrier MIMO System with OFDM and Windowing Techniques

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Abstract - The modern wireless communication system are all equipped with the OFDM technology and almost exist everywhere. The high data rate is achieved in wireless technology is because of the OFDM and integration of other research being invented with hardware as well soft computing techniques. The hurdles to achieve optimum performance of the system are inter channel interference (ICI) and it is need to be reduced to develop efficient communication which must be easier to maintain and less noisy. This paper proposes a efficient way to optimize OFDM system and reduces the bit error rate (BER). The proposal utilizes raised cosine windowing with technique to reduce BER we have proposed the raised cosine windowing with 16-QAM modulation to achieve high data rate and less noise effect. The OFDM system is also designed with multi carrier with variable FFT size and this is visible in the simulation outcomes which shows the increased performance better than previous system.

Keywords: Multi Career OFDM, Raised Cosine Window, 16-QAM, ICI, FFT & BER.

I. INTRODUCTION

As the demand for high data rate communication has been increasing rapidly, it is required to overcome the problems associated with high speed communications. As the transmission signal passes through the channel it effects by many degradations, such as noise, attenuation, multipath, interference, time variation, non-linearity's. for a particular channel the communication designer must decide how to efficiently utilize the available channel bandwidth in order for reliable transmission within the transmitted power constraint and receiver complexity constraint. In case of low speed communications, the degradation parameter effects are small. In single carrier communication, degradation can be reduced by signal processing techniques at the receiver.

The ever increasing demand for very high rate wireless data transmission calls for technologies which make use of the available electromagnetic resource in the most intelligent way. Key objectives are spectrum efficiency (bits per second per Hertz), robustness against multipath propagation, range, power consumption, and implementation complexity. These objectives are often conflicting, so techniques and implementations are sought

which offer the best possible tradeoff between them. The Internet revolution has created the need for wireless technologies that can deliver data at high speeds in a spectrally efficient manner. However, supporting such high data rates with sufficient robustness to radio channel impairments requires careful selection of modulation techniques. Currently, the most suitable choice appears to be OFDM (Orthogonal Frequency Division Multiplexing). Orthogonal frequency division multiplexing (OFDM) is becoming the chosen modulation technique for wireless communications. OFDM can provide large data rates with sufficient robustness to radio channel impairments.

Different methods like adaptive equalization and channel coding can be used to increase the performance. However it is difficult use these methods at high data rate because inherent delay also increases with bit rate. Therefore alternative approach is multicarrier communication. Orthogonal frequency division multiplexing (OFDM) is an example of multicarrier communication and is preferred modulation scheme in modern high data rate wireless communication systems. The basic principle of OFDM technique is to split the available spectrum into N number of sub-channel bandwidths and transmission of signal using orthogonal carriers through these sub-channels. OFDM converts the frequency selective channel to frequency flat channel so that it can completely eliminate Inter symbol interference (ISI). This is the major advantage of OFDM (which is multi carrier communication) over single carrier communication.

As we know In Parallel data transmission, an available frequency band is divided into several channels by independently modulating a number of carriers of different frequency. Since each channel occupies a relatively narrow frequency band, parallel transmission is effective in combating the effects of amplitude and delay distortion and

Impulsive noise. But to eliminate inter channel interference problem, it is required to avoid spectral overlap of channels, which leads to poor spectral

efficiency. If spectral overlap is allowed, Higher signaling rates can be achieved and some orthogonality relationship is used to minimize the interference between adjacent channels.

II. SYSTEM MODEL

The Orthogonality among the carriers can be maintained if the OFDM signal is defined by using Fourier transform procedures. The OFDM system transmits a large number of narrowband carriers, which are closely spaced. Note that at the central frequency of the each sub channel there is no crosstalk from other sub channels. In an OFDM system, the input bit stream is multiplexed into N symbol streams, each with symbol period Ts, and each symbol stream is used to modulate parallel, synchronous sub-carriers. The sub-carriers are spaced by 1/NTs in frequency, thus they are orthogonal over the interval (0, Ts). A typical discrete-time baseband OFDM transceiver system is shown in Figure 2.1. First, a serial-to-parallel (S/P) converter groups the stream of input bits from the source encoder into groups of log2M bits, where M is the alphabet of size of the digital modulation scheme employed on each sub-carrier. A total of N such symbols, Xm, are created. Then, the N symbols are mapped to bins

of an inverse fast Fourier transform (IFFT). These IFFT bins correspond to the orthogonal sub-carriers in the OFDM symbol

Above OFDM is a multi-carrier modulation technology where every subcarrier is orthogonal to each other. The "orthogonal" part of the OFDM name indicates that there is a precise mathematical relationship between the frequencies of the carriers in the system. It is possible to arrange the carriers in an OFDM Signal so that the sidebands of the individual carriers overlap and the signals can still be received without adjacent carrier's interference. In order to do this the carriers must be mathematically orthogonal. Two signals are orthogonal if their dot product is zero. That is, if we take two signals multiply them together and if their integral over an interval is zero, then two signals are orthogonal in that interval.

III. PROPOSED METHODOLOGY

OFDM is simply defined as a form of multi-carrier modulation where the carrier spacing is carefully selected so that each sub carrier is orthogonal to the other sub carriers. Two signals are orthogonal if their dot product is zero.

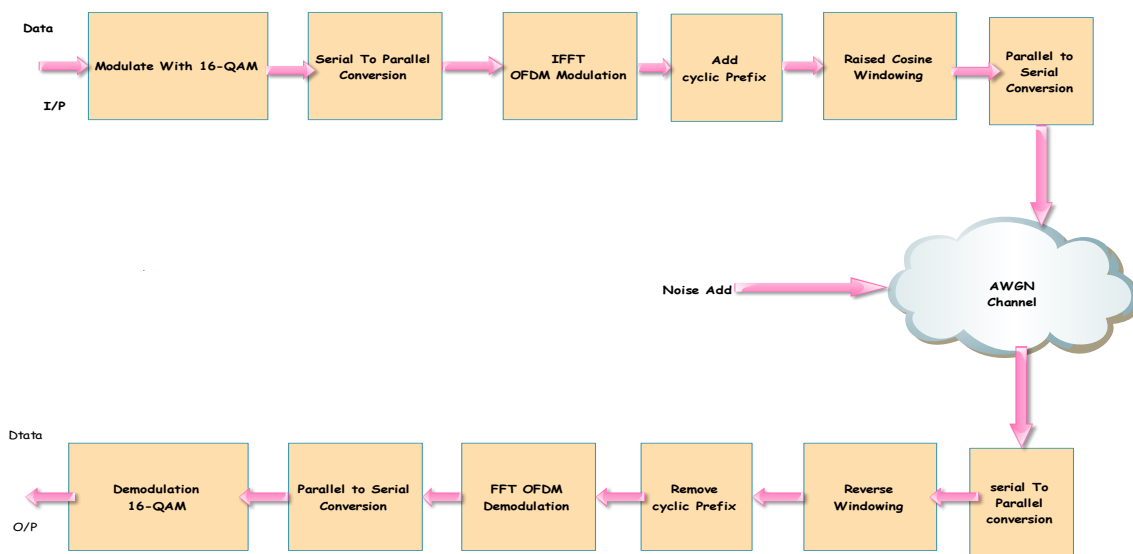


Figure 3.1 block diagram of proposed system.

That is, if you take two signals multiply them together and if their integral over an interval is zero, then two signals are orthogonal in that interval. Orthogonality can be achieved by carefully selecting carrier spacing, such as letting the carrier spacing be equal to the reciprocal of the useful symbol period. As the sub carriers are orthogonal, the spectrum of each carrier has a null at the center frequency of each of the other carriers in the system. This results in no interference between the carriers, allowing

them to be spaced as close as theoretically possible. Mathematically, suppose we have a set of signals ψ then:

$$\int_0^T \psi_p(t) \psi_q^*(t) dt = k \quad \text{for } p = q$$

$$= 0 \quad \text{for } p \neq q$$

Where ψ_p and ψ_q are pth and qth elements in the set.

Raised Cosine Window Filter is generalized by below equation

$$H(f) = \begin{cases} T, & |f| \leq \frac{1-\beta}{2T} \\ \frac{T}{2} \left[1 + \cos\left(\frac{\pi T}{\beta} \left[|f| - \frac{1-\beta}{2T} \right] \right) \right], & \frac{1-\beta}{2T} < |f| \leq \frac{1+\beta}{2T} \\ 0, & \text{otherwise} \end{cases}$$

Prefixing it with a cyclic prefix of length $L-1$, the OFDM symbol obtained is:

$$\mathbf{x} = [x[N-L+1], \dots, x[N-2], x[N-1], x[0], x[1], \dots, x[N-1]]^T$$

Where x is signal in time domain.

Figure 3.1 shown the proposed methodology for the Performance Optimization of Multi Carrier OFDM System using Raised Cosine Windowing the flow chart for the proposed system is shown in figure: 3.2 there are mainly three component in the proposed system a transmitter a receiver and a channel.

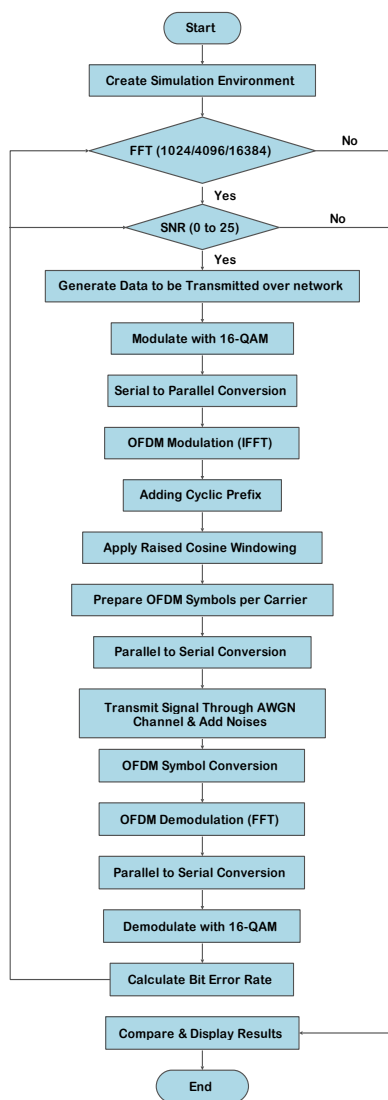


Figure 3.2 Flow chart of Proposed System

Channel

Transmitter

In transmitter section there is a 16 QAM modulator which modulate first the input signal similar to any other OFDM system there is a serial to parallel convert which convert the modulated signal in parallel then again it pass through the IFFT modulation a cyclic prefix added to the IFFT modulated signal that the receiver can easily determine the start bit and end bit of symbol. Then cosine windowing is raised to the signal which is ready to transmit.

Modulated signal is now passed through AWGN channel during passing through channel some external noise is added to it

Receiver

A receiver having a serial to parallel conversion windowing is removed from received signal cyclic prefix is removed from reversed windowing signal FFT OFDM demodulated signal converted from parallel to serial form and finally 16 QAM demodulated from signal.

Formula Used

$$\text{Bit Error Rate} = \frac{N_e}{N_t}$$

Where $N_e = \text{No. of Error Bits}$

$N_t = \text{Total Number of Bits}$

$$\text{Signal to Noise Ratio} = \frac{P_s}{P_n}$$

Where $P_s = \text{Signal Power}$

$P_n = \text{Noise Power}$

The bit error rate of the system will be calculated on the different signal to noise ratio values so that performance of system can be analyzed in different power levels and when power is dissipated on the objects.

IV. SIMULATION OUTCOMES

The simulation of previously explained wireless communication system is performed here. The simulation is performed by considering different parameters in mind and it also helps to analyze system better. The simulation results of proposed methodology is compared with the existing results of reference paper.

Simulation graph shows the characteristics of bit error rate for different signal to noise ratio (SNR). The parameters

varied to simulate the system are different number of symbols and carriers. The characteristics are compared among different FFT sizes of 1024, 4096 and 16384 with previous results using FRLS and ZF.

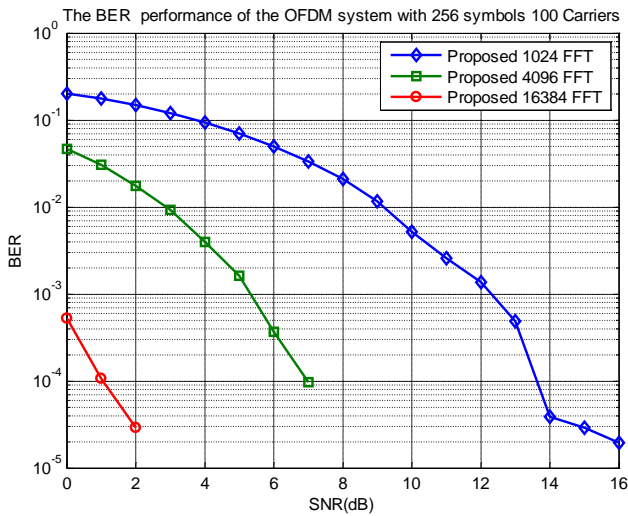


Fig. 4.1 Performance of Proposed System using 100 Carriers and 256 Symbols with Different FFT Sizes

Table 1: Bit Error Rate Comparison with Previous Work

SNR	100 Carriers	200 Carriers
0	5.27×10^{-4}	9.22×10^{-3}
1	1.07×10^{-4}	4.01×10^{-3}
2	2.93×10^{-5}	1.42×10^{-3}
3	0	3.66×10^{-4}
4	0	6.84×10^{-5}
5	0	1.46×10^{-5}

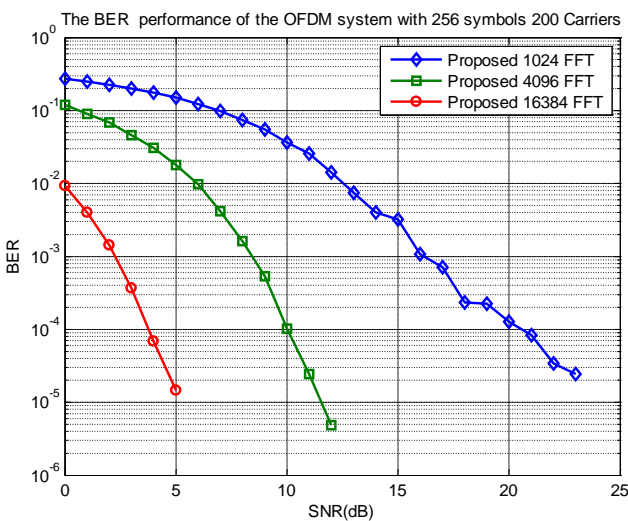


Fig. 4.2 Performance of Proposed System using 200 Carriers and 256 Symbols with Different FFT Sizes

Fig. 4.1 shows the BER vs SNR graph of proposed system using 256 symbols and 100 carriers. From the results it is clearly visible that the proposed results are better than the existing results and higher FFT is better for lower error as well as lower power requirements. The optimum results of BER is 10^{-5} 1024 FFT size and 1.9×10^{-5} with 16384 FFT size.

Fig. 4.2 shows the BER vs SNR graph of proposed system using 256 symbols and 200 carriers. From the results it is clearly visible that the proposed results are better than the existing results and higher FFT is better for lower error as well as lower power requirements. The optimum results of BER is 1.46×10^{-5} 1024 FFT size and 2.25×10^{-5} with 16384 FFT size.

The comparison table of bit error rate versus signal to noise ratio with all the parameter variations are shown in table 1.

V. CONCLUSION AND FUTURE SCOPE

The proposed system has raised cosine windowing utilized in the system and the simulation results comparison concludes that the proposed methodology performs better with system and produce lesser error and consumes lesser power than the previous works. The methodology has also utilizing 16-QAM modulation which is great for higher data rate and larger capacity of the system. In future the system can be equipped with the better hybrid detection as well as filtering technique to reduce error rate and improve system stability and reliability.

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