Efficient Noise Clipping Scheme for OFDM Systems using SUI Channel

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Abstract* - Noise in the signals due to high density of the wireless network environments are creating huge problem. Making communication systems better and better to fulfill high demands. This would be the major task to provide quality of service and performance of the upcoming systems. In the same context this work working towards mitigating the effects of noise and interference by clipping noise. In this work investigates a Performance Evaluation of OFDM Signals Noise clipping using SUI Channel model. The crucial requirement is a better bit error rate (BER) performance of the proposed system. The work analyzes and compares the performance of proposed system, BER over an SUI channel with respect to different noise clipping ratios (γ) with 16-QAM scheme. The simulation results show that with an minimization in bit error rate, with OFDM Signals Noise Clipping using SUI Channel.

Keywords- OFDM, Noise Clipping, BER (bit error rate), SUI Channel model, AWGN channel, QAM.

I. INTRODUCTION

Wireless communication has become gradually more important worldwide not only for professional applications but also for many fields in our daily routine. In early 90s, a mobile telephone was a quite expensive gadget, whereas today almost everyone has a personal mobile. A clear example of this may be found in the Indian telecom industry, which has a high pace of market liberalization and growth since 1990s and now it has become the world's most competitive telecom markets.

Orthogonal Frequency Division multiplexing (OFDM), the multi-carrier modulation (MCM) technique, has been seen to be very effective for communication over channels with frequency selective fading. It is very difficult to handle frequency selective fading in conventional communication receivers as the design of the receiver becomes hugely complex. OFDM technique efficiently utilizes the available channel bandwidth by dividing the channel into low bandwidth contineous channels. Instead mitigating frequency selective fading as a whole, OFDM mitigates the problem by converting the entire frequency selective fading channel into number of narrow bandwidth flat fading channels.

Wireless channel is an unguided dielectric media and hence the frequency ranges it can support are ideally infinite. Still due to many reasons, full available spectrum cannot be utilized. Bandwidth limitations, propagation loss, noise and interference make the wireless channel a narrow pipe that does not readily accommodate rapid flow of data. The propagation conditions in such environments are frequency selective due to dispersive multipath nature of wireless channels and hence Inter Symbol Interference (ISI) is introduced. OFDM is a parallel transmission scheme that distributes a serial data stream with high data rate into a set of low data rate parallel sub streams by modulating with orthogonal subcarriers. As these low data rate symbols undergo flat fading in radio environment, the ISI effect of the channel can be mitigated. In this technique, though the spectra of the individual orthogonal subcarriers overlap, the information can be completely recovered without any interference from other subcarriers. OFDM is extensively utilized in many applications like European Digital Audio Broadcasting (DAB), 3GPP Long Term Evolution (LTE) system, Wireless Local Area Network (WLAN) of IEEE 802.11a/g standard and WiMAX of IEEE 802.16 standard. On the other hand, the ever increasing demand for wireless communication system requires a high spectral efficiency.

The wireless channel is characterized by multipath propagation, where the transmitted signal arrives at the receiver using various paths of different lengths including Line of Sight (LOS) path. These multiple versions of the transmitted signals reach the receiver at different time instants. These reflected or delayed waves interfere with the direct wave and cause ISI, which results significant degradation of network performance. This problem can be solved by means of frequency diversity, which relies on the principle that signals are transmitted on different frequencies so that the multipath propagation in the media is exploited. Transmitting signals over different frequencies are referred as multicarrier transmission.

The OFDM signal can be viewed as a set of closely separated FDM sub-carriers. In the frequency domain, each transmitted sub-carrier results in a sinc function spectrum with side lobes that produce overlapping spectra between sub-carriers. This is presented in Figure.1.1. This results in sub-carrier interference except at orthogonally spaced frequencies. At orthogonal frequencies, the individual peaks of sub-carriers align with the nulls of all other sub-carriers. This overlap of spectral energy does not interfere with the system's ability to recover the original signal. The receiver multiplies the incoming signal by the known set of sinusoids to recover the original set of bits sent. The use of orthogonal sub-carriers facilitates large number of sub-carriers per bandwidth resulting in an increase in spectral efficiency.

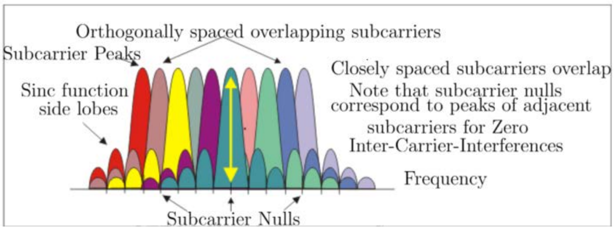

Fig. 1.1 OFDM Signal Frequency Spectra.

In a perfect OFDM signal, orthogonality prevents interference between overlapping carriers which is also known as Inter Carrier Interference (ICI). In OFDM systems, the sub-carriers interfere with each other only if there is a loss of orthogonality. To maintain its orthogonality and to reduce BER in this examination an efficient noise clipping scheme for OFDM Systems has been proposed and simulated using SUI Channel model.

II. SYSTEM MODEL

In a mobile communication when a transmitter and receiver transmit and receive data and signal it uses channel. So, channel model is a crucial issue in all communication. A channel model is a set of rules or ways from which data or signal will smoothly sent or receive through the channel. A good channel model is essential for a high class of communication. A nice channel model could save bandwidth, signal power that increases the system capability.

Actual wireless environments are too complex to model accurately. In practice, most simulation studies use empirical models that have been developed based on measurement data taken in various real environments. In order to design an accurate channel model, sufficient knowledge about the characteristics of reflectors, including their placement and movement, and the power of the reflected signal is essential. The channel model may also vary with the antenna configuration along with the number of transmitting and receiving antennas. Different channel models may be valid with respect to their applications in indoor and outdoor environment. Considering all these, several empirical channel models have been developed during the past few decades.

The channel state information can be obtained through training, blind and semi blind channel estimation techniques. The blind channel estimation is based on the statistical information of the channel and certain properties of the transmitted signals. The training-based channel estimation is based on the training data (pilots) sent from the transmitter that is known a priori at the receiver. Though the former has the advantage of not having overhead loss, it is only applicable to slow time–varying channels due to its need for a long data record. In general, the mobile wireless applications are fast time–varying and hence the training based channel estimation is a preferable one. Further, the semi–blind channel techniques are hybrid of blind and training estimation techniques, which utilizes pilots and other natural constraints to perform channel estimation.

The additive white Gaussian channel model is the one of the simplest channel model in wireless communication. It is very simple because a white noise is only added with the wireless channel. In additive white noise a specific and equal amount of noise is added in every frequency spectrum. The AWGN channel model does not consider any fading effect, Inter-symbol interference that"s why it is very simple and straight forward. It is a simple mathematical model it only consider the thermal noise and short noise.

Channel model represent a predefined scenario according to specific requirement of a system as it is impossible to virtually simulate a real scenario. This SUI channel model is to account for 30 degree directional antenna. The parameters were selected based upon statistical model parameter.

Table 2.1 The SUI model could be summarized according to the following tables.

Terrain types	SUI channels
C	SUI-1,SUI-2
B	SUI-3,SUI-4
A	SUI-5,SUI-6

Table 2.2 Terrain types related to SUI channel.

Doppler	Low delay spread	Moderate delay spread	High delay spread
Low	SUI-3		SUI-5
High		SUI-4	SUI-6

The general structure of SUI channel model has shown in Fig 2.1.

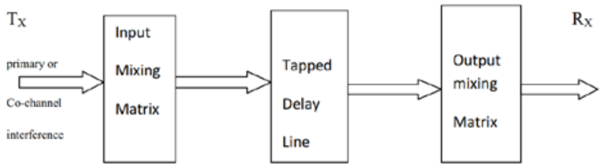

Fig.2.1 SUI model structure.

III. PROPOSED METHODOLOGY

In the field of wireless communication system orthogonal frequency division multiplexing is a multi-bearer transmission strategy that is generally embraced in various communication applications. OFDM systems bolster high information rate transmission.

However, OFDM systems have the undesirable feature of a large noise of the transmitted signals. The transmitted signal has a non-constant envelope. Therefore, to prevent distortion of the OFDM signal, the transmitter must operate in its linear regions. Along these lines, power amplifiers with a substantial powerful range are required for OFDM systems. Lessening the distortion is critical to diminishing the cost of OFDM systems.

Wireless systems always give several errors to the transmitted bits due to several transmission and system impediments. The techniques of power control also increase the bit error rate in end to end transmission. To address this need, an efficient noise clipping Scheme for OFDM Systems using SUI Channel has modeled and simulated in MTALAB. Fig. 3.1 shows the block diagram of proposed system.

The primary component block in proposed system is

(1) 16-QAM Modulation

(2) OFDM Modulation (IFFT)

(3) SUI Channel

(4) OFDM Demodulation (FFT)

(5) 16-QAM Demodulation

(1) Quadrature Amplitude Modulation QAM Modulation

For higher data rates, PSK has limitations. QAM provides the higher throughput rate required for data transfers by combining ASK and PSK. Two different signals are sent simultaneously on the same carrier frequency. The result of this combination provides two variable (amplitude and phase of the signal) to assign binary values. As the number of states is increasing, greater throughput is achieved.

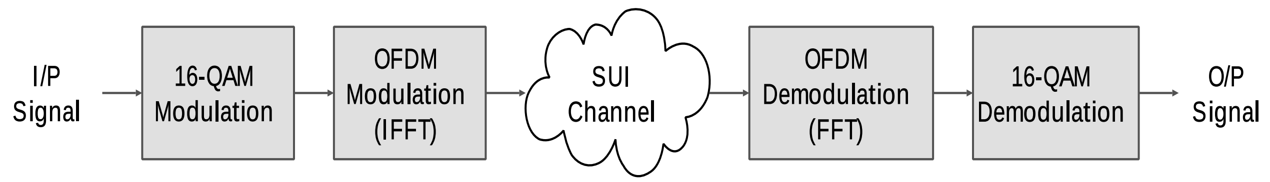

Figure 3.1 Block Diagram of Proposed System.

The diagram in Figure 3.2 represents the four quadrants of possible phase change and four groups of symbols or possible data combinations that can be delivered with the varying amplitude and phase shifts of the signal. As the complexity of QAM increases, the possibility of data loss also increases.

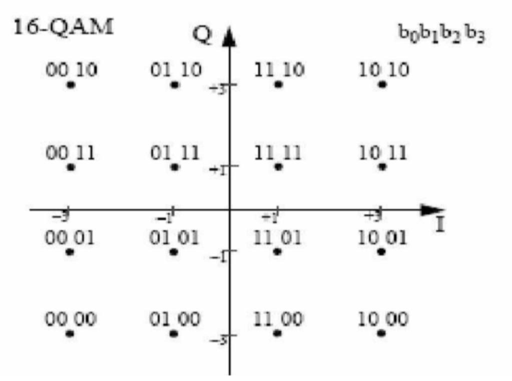

Fig. 3.2 Constellation Diagrams for 16 QAM.

(2) OFDM Modulation (IFFT)

The Fourier transform allows transformation from time domain to frequency domain. The conventional Fourier transform identifies with constant signals which are not restricted to in either time or frequency. Signal processing is made less demanding if the signals are sampled. Signal sampling with a vast spectrum prompts associating, and the processing of signals which are not time limited can prompt issues with storage space.

The number 'x' decides the signal star grouping of the comparing subcarrier, for example, 16 QAM. The intricate numbers are regulated in the baseband by the inverse FFT (IFFT) and changed over back to sequential information for transmission.

(3) Stamford University Interim (SUI) Channel Model

A SUI channel model is used to propagate transmitted signal through it a SUI channel has better performance as compared to AWGN channel Model.

(4) OFDM Demodulation

Received OFDM signals are demodulated using OFDM FFT at receiver end and the number of carriers corresponds to the number of complex points being processed in FFT. The process of transforming from the time domain representation to the frequency domain representation uses the Fourier transform itself.

(5) QAM Demodulation

16-QAM demodulation is used to demodulated 16 QAM modulated signals received from FFT demodulation block to extract information signal.Fig. 3.3 shows the process flow of proposed work the steps of simulation of proposed model in Matlab is given as follows.

(1) Start simulation in Matlab.

(2) Initialize simulation environment.

(3) Start simulation by generating data signal.

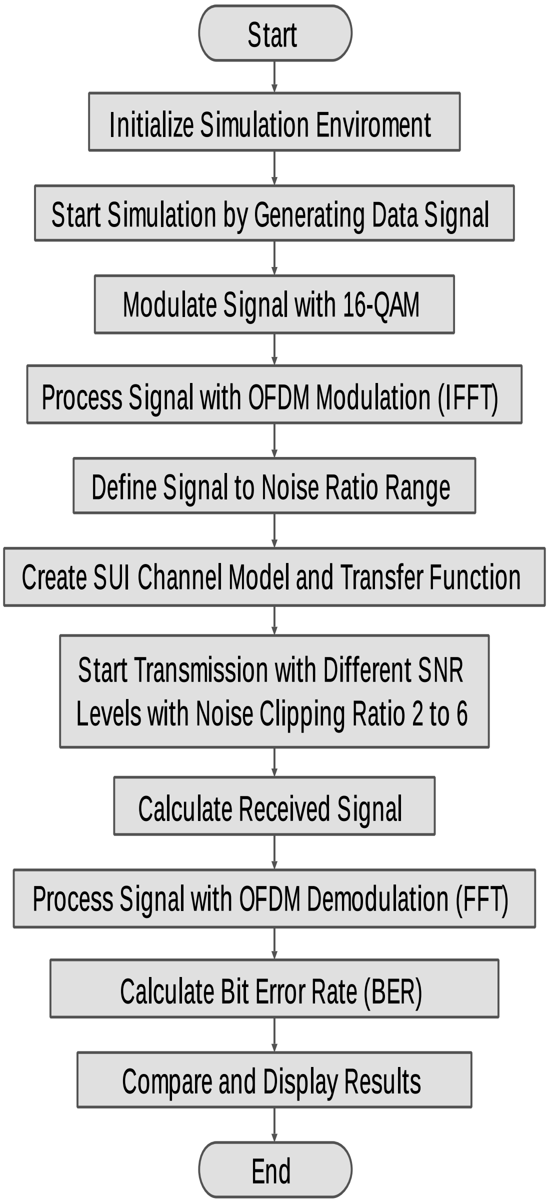

Figure 3.3 Flow Chart of Proposed Methodology.

(4) Modulate signal with 16-QAM.

(5) Process signal with OFDM modulation (IFFT).

(6) Define signal to noise ratio range.

(7) Create SUI channel model and transfer function.

(8) Start transmission with different SNR levels with noise clipping ratio 2 to 6.

(9) Calculate received signal.

(10) Process signal with OFDM demodulation (FFT)

(11) Calculate bit error rate BER.

(12) Compare and display results.

(13) End.

IV. SIMULATION RESULTS

Simulation of proposed work has carried out in MATLAB simulation environment. BER performance of OFDM systems over clipping ratio (CR) are studied and simulated. A noise clipping technique for distortion reduction on OFDM systems by modulation order.

First, transmitted binary source data is randomly generated in Matlab Simulation environment. This random data is '1' or '0' and it happens equally likely. Next, this random generated data is mapped through 16-QAM modulation constellation. The 16-QAM mapped signal is complex value. Then, 16-QAM mapped signal is loaded on each subcarrier, and goes through serial to parallel conversion. And IFFT is performed. IFFT output signal is operated with clipping for reducing noise, and then this signal is transmitted. The receiver structure has reciprocal architecture to the transmitter.

Fig. 4.1 shows the Matlab Scope waveform of Bit Error Rate Performance of the proposed Methodology for noise clipping in OFDM system using SUI channel.

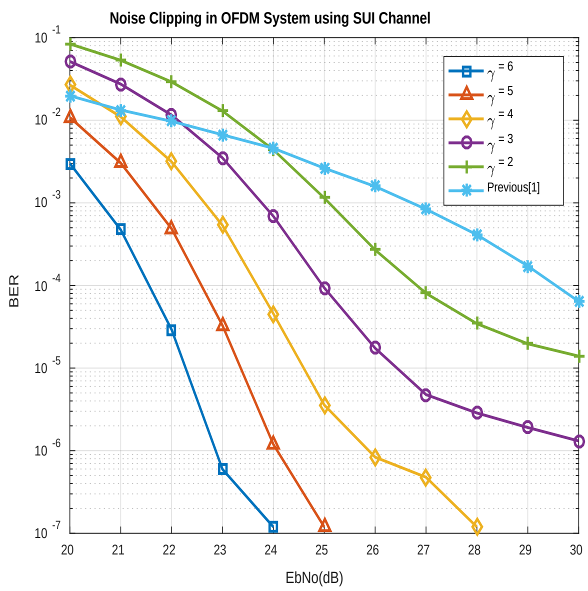

Fig.4.1 Bit Error Rate Performance of the proposed Methodology.

Table 1 shows the comparison analysis of BER values with previous results

this examination shows that proposed model has better performance as compared to previous work.

Table 1: Comparison of BER Values with Previous Results[1]

Eb/No	Previous[1]	Proposed (Our)				
		γ= 6	γ= 5	γ= 4	γ= 3	γ= 2
20	1.98×10^{-2}	3.01×10^{-3}	1.08×10^{-2}	2.67×10^{-2}	5.15×10^{-2}	8.40×10^{-2}
21	1.33×10^{-2}	4.72×10^{-4}	3.04×10^{-3}	1.10×10^{-2}	2.74×10^{-2}	5.32×10^{-2}
22	9.71×10^{-3}	2.92×10^{-5}	4.86×10^{-4}	3.14×10^{-3}	1.16×10^{-2}	2.91×10^{-2}
23	6.67×10^{-3}	5.96×10^{-7}	3.28×10^{-5}	5.34×10^{-4}	3.50×10^{-3}	1.29×10^{-2}
24	4.58×10^{-3}	1.19×10^{-7}	1.19×10^{-6}	4.55×10^{-5}	6.88×10^{-4}	4.39×10^{-3}
25	2.63×10^{-3}	-	1.19×10^{-7}	3.58×10^{-6}	9.37×10^{-5}	1.14×10^{-3}
26	1.58×10^{-3}	-	-	8.34×10^{-7}	1.74×10^{-5}	2.69×10^{-4}
27	8.37×10^{-4}	-	-	4.77×10^{-7}	4.77×10^{-6}	8.03×10^{-5}
28	4.11×10^{-4}	-	-	1.19×10^{-7}	2.86×10^{-6}	3.45×10^{-5}
29	1.72×10^{-4}	-	-	-	1.91×10^{-6}	1.97×10^{-5}
30	6.41×10^{-5}	-	-	-	1.31×10^{-6}	1.39×10^{-5}

V. CONCLUSION AND FUTURE SCOPES

In this examination, an efficient noise clipping scheme for OFDM systems using SUI channel has been proposed and simulated in MATLAB simulation environment. Various wireless and OFDM the system aspects are presented at first level of this examination. This work examinee and analyzed multi carrier modulation scheme OFDM. In simulation, some of the parameters are considered which effect the wireless transmission of data through OFDM. The BER in system and signal degradations impact on overall system performance. In this examination, noise clipping technique is employed for overall better system performance. Results analysis and comparative analysis of the techniques used are presented in this examination and previous approach shows that proposed system has better performance in terms of noise and BER.

In this examination the proposed OFDM system is working well for SUI channel can be tested to Rayleigh fading channels and some other coding techniques like Trellis, Convoltuional, and Turbo coding techniques can be applied with noise clipping technique for BER reduction.

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