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Estimation and Removal of Noise for OFDM Systems

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ABSTRACT: Wireless Communication is the fastest growing division of Communication Industry and captures attention of media. Though in wireless medium there are many technologies for communication but orthogonal frequency division multiplexing has its particular importance in it, but this system is influenced by environment. Noise plays an intensive role in degradation of data on any communication system. There are many types of noise which have impact over OFDM system, but Impulse noise is superior amongst all and difficult to estimate and remove from the system. This paper is to Study the impact of impulse noise, Estimate, and Remove from the OFDM System. This paper uses an algorithm that utilizes free space or null subcarriers of the guard band. The proposed system will improve the communication medium and efficiently recovered the desired data. The long term goal is achieve by suppressing the noise effect which helps in fastest and secure communication.

KEYWORDS: OFDM, Impulse noise, multicarrier systems.

I.INTRODUCTION

The demand for the wireless communication has taken a pace with the rapid changing environment. Many communication technologies are in a queued to meet these upcoming challenges to fulfil the basic needs of common man and also to connect the world together with a different view. One of them is orthogonal frequency division multiplexing (OFDM) also known as Discrete Multi-Tone (DMT) or Multi-carrier modulation scheme. It divide the available spectrum into many sub-carrier and transmit them orthogonally which is a peculiar property which distinct OFDM from others technology, having many advantages over. The three most significant channel properties like noise, multipath propagation and attenuation on which the performance of any communication system is depend. Noise plays an intensive role and classified into five classes such as follows: The first two types i.e. coloured background and narrowband noise can be encapsulated as background noise. The third and fourth are related to impulsive noise i.e. periodic impulsive noise asynchronous to main frequency and periodic impulsive noise synchronous to main frequency. The fifth one is asynchronous impulsive noise. The periodic consists of longer duration occurring periodically and aperiodic occurring at random times, for short duration of time.

The impulse noise could occur due to power switching, failure in circuit and erasure channels, vehicle ignition system etc. This results in the performance degradation of the OFDM system in a major impact. Thus, many techniques and steps are taken towards to decrease the impact of impulsive noise for better communication.

The paper is formulated as follows: In section II, Impact of impulse noise is described in brief, in section III, Simulation of system is done and results and discussion are shown in graphs and tabular form, in section IV, final conclusion.

II. IMPACT OF IMPULSE NOISE

The concept of AWGN is familiar in the field of wireless communication and has been well documented, but impulse noise is concept which tends to spread very quickly. Most of the time, to simulate impulsive noise Gated additive white Gaussian noise (GAWGN) is used. The impulsive noise i_k is commonly accepted as shown below in expression after attributing to previous research work.

$$I_k = b_k\, g_k \qquad \text{…(1)}$$

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Where, b_k is a Bernoulli process which indicates the arrival of the impulse noise event and g_k is the random Gaussian process with variance σ_i^2 and mean zero. b_k contains independently distributed zeros and ones where the ones indicate the arrival of impulsive noise events. The Impulsive noise arrival rate of the events is represented as p=P (b_k=1)

To facilitate the condition of varying noise, the two parameters (arrival and variance) are altered. In this $g_{k'}$ s are independent identically distributed (i.i.d) circularly symmetric complex Gaussian random variable with variance σ_g^2 whose p.d.f is given by

$$P_{gk}(x) = \frac{1}{2\pi\sigma_g^2}\exp\left(\frac{-n^*n}{2\sigma_g^2}\right)\ldots\ldots\ldots\ldots(2)$$

The impulse noise variable $i_{k'}$s are also i.i.d with variance σ_i^2 and the p.d.f is given by model (Middleton's class A).

$$P_{ik}(x) = e^{-A}\delta(x) + \sum_{m=1}^{\infty} e^{-A}\frac{A^m}{m!}\frac{1}{2\pi\sigma_m^2}\exp\left(\frac{-n^*n}{2\sigma_m^2}\right)\ldots.(3)$$

With n^* denoting the complex conjugate of n also the parameter A is called impulsive index.

$$\sigma_m^2 = \frac{\frac{m}{A}+T}{1+T}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

or

$$\sigma_m^2 = \frac{\sigma_i^2\, m}{A}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where T indicates ratio between mean power of Gaussian to mean power of impulsive noise component. For small values of A, only 9.5% samples are hit by impulses thus noise is structured highly. A parameter $\Gamma=\sigma_g^2/\sigma_i^2$ is defined as Gaussian to impulse noise power ratio for convenience. When A is infinite, noise get Gaussian distributed and when it is small it get more structured/impulsive. The characteristic of impulsive noise in time domain can have significant difference when compared to transmitted signal and can be epitomized as follows: (1) the peak amplitude of impulsive noise much higher than that of transmitted signal. (2) the energy of impulse noise is concentrated into short periods.

To decrease the impact of impulsive noise some techniques are used as, Thresholding scheme, precoding techniques, frequency domain algebraic interpolation technique, compressive sensing (CS) based on convex relaxation using L1 minimization and also recently sparse signal recovery algorithm based on many ways etc. In this paper free guard band i.e. utilizing free space or null carriers is used.

III.SIMULATION RESULTS AND DISCUSSION

The OFDM system is simulated in MATLAB. For this simulation BPSK modulation is used with 256 total number of sub-channels, 64 pilots symbol, channel length 16 and SNR value is varied from 0 db to 30 db.

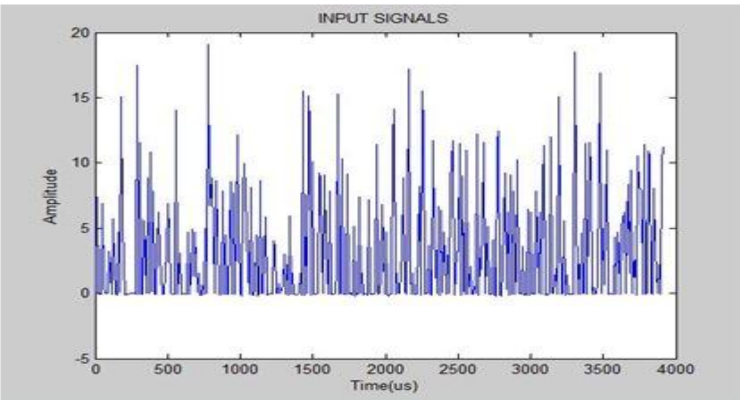

Fig. 1 Input signal

The figure shown above is the input signal which is been applied to the OFDM system in a bit of stream to perform simulation test and evaluate the performance of the system.

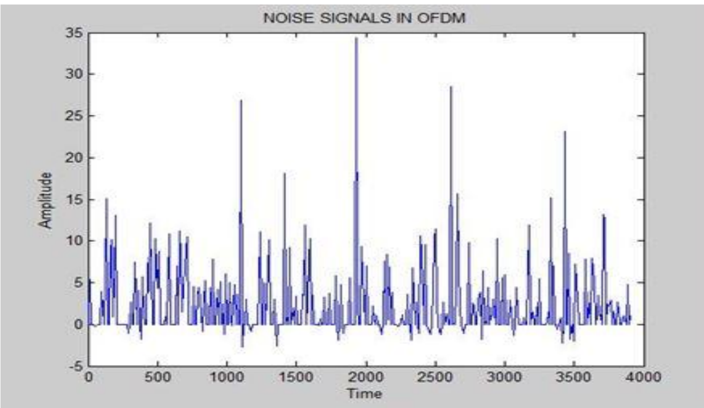

Fig. 2 Noise signal

Noise can be defined as an unwanted signal which disturbs the data in the course of transmission. There are many types of noise having severed impact on the communication, but impulse noise leads the most.

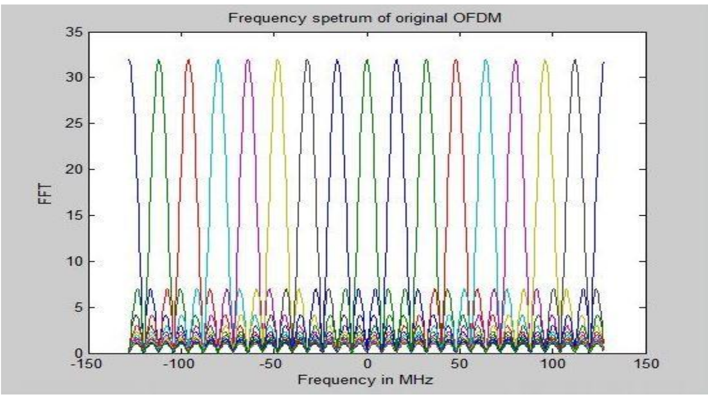

Fig. 3 Frequency Spectrum

It is the representation of signal in frequency domain, generated by taking Fourier transform of that signal. The graph is plotted between frequency and FFT. Here FFT is used in case of DFT, due to many advantageous features.

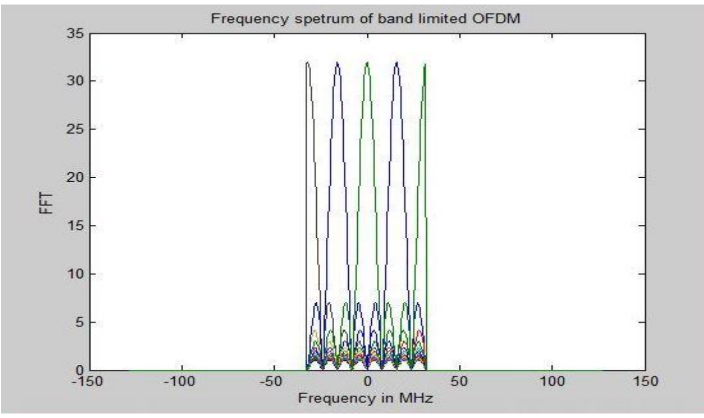

Fig. 4 Frequency Spectrum of band limited

The above figure shows the limiting of signal to zero above a certain finite frequency; results function is analytic and can be calculated finite number of Fourier series from that signal.

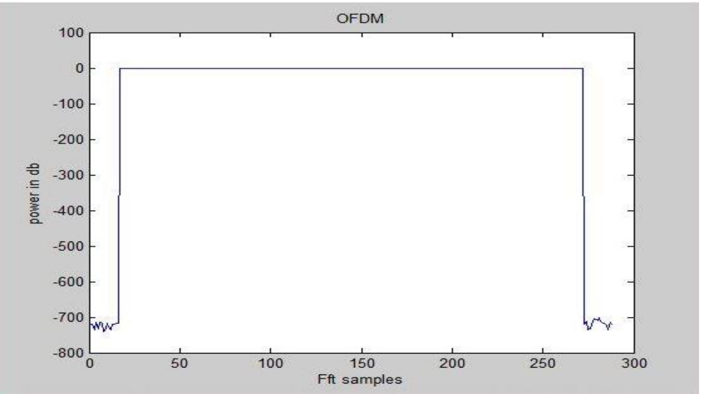

Fig. 5 FFT Samples

It is an algorithm, which widely used for many applications and computes fast transformation as compare to DFT.

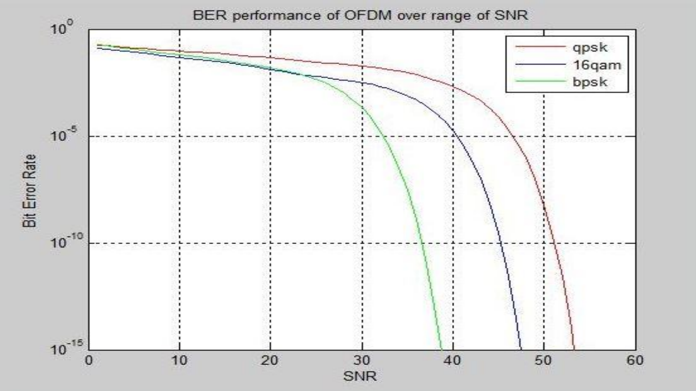

Fig. 6 BER performance of OFDM over range of SNR

Now days the communication is mostly in the form of digital having limited spectrum available for long distance communication. In this case in fact, type of modulation plays an important role. Here performance curve is shown between three modulation schemes Q-PSK, 16QAM, BPSK. In this paper for better performance BPSK modulation scheme is used.

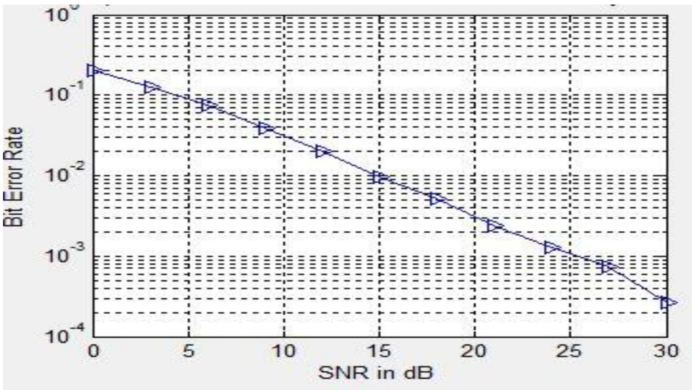

Fig. 7 Impact on BER due to AWGN noise

Since the bit error rate can be calculated as number of bits errors per unit time. The above figure shows the impact on BER due to additive white Gaussian noise (AWGN) which used to mimic the outcome of many random processes and added to any noise.

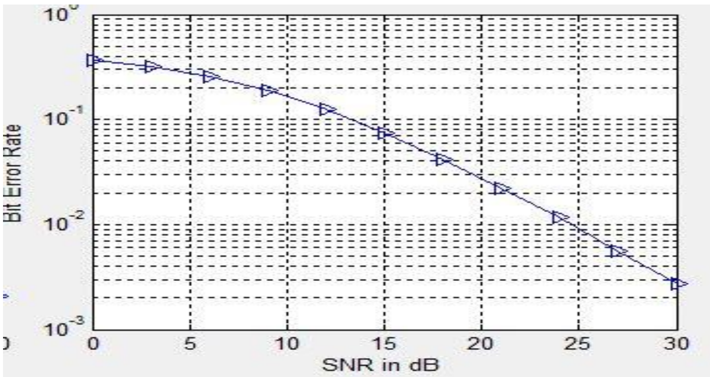

Fig. 8 Impact on BER due to Impulsive noise

Impulsive noise is characterized in periodic and aperiodic noise. In this we focus on aperiodic noise which can occur at any time with high power, so impact is higher as compare to AWGN and any other form of noise.

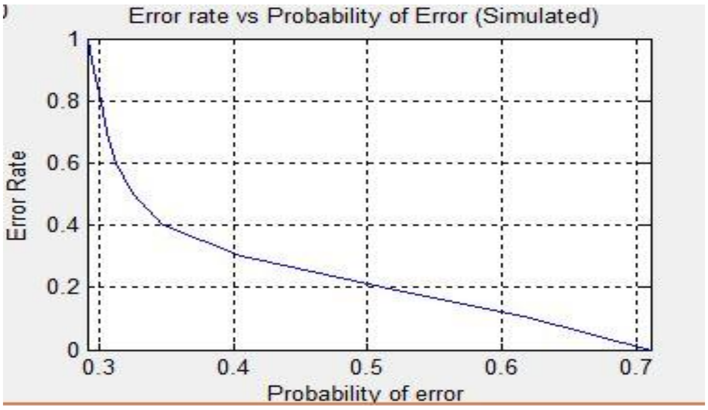

Fig. 9 Error rate vs Probability of Error

Here after the formulation and impact on the system, the graph is plotted between Probability of Error and Error rate shown by the curve line.

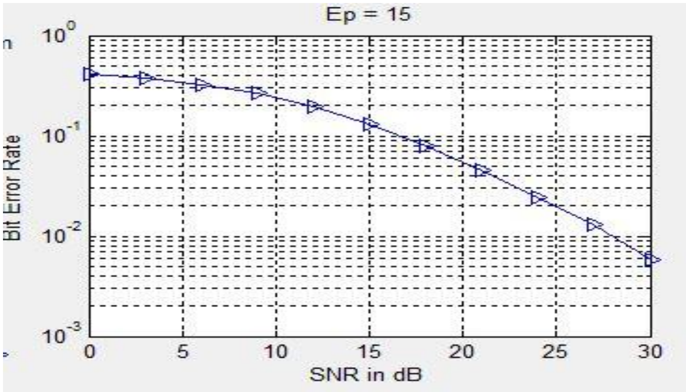

Fig. 10 For SNR Ep=15

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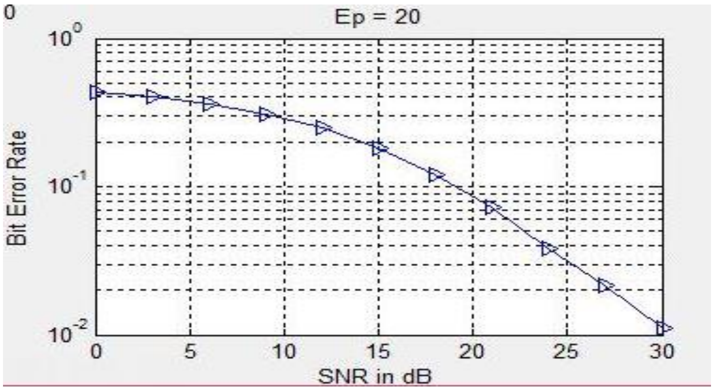

Fig. 11 For SNR Ep=20

In the above figure the graph is plotted between SNR vs BER having Ep=15 and Ep=20.

Table I. Comparision Table of BER Ep

Sr. No.	SNR in db	BER Ep=15	BER Ep=20
1.	0	0.40	0.42
2.	5	0.34	0.38
3.	10	0.24	0.28
4.	15	0.15	0.19
5.	20	0.051	0.078
6.	25	0.020	0.021
7.	30	0.007	0.010

The table depicts the value of Ep at (Ep=15 and Ep=20) having fluctuation with the change in SNR value, concludes that with the increasing and decreasing value in SNR the performance of the system also affected.

IV.CONCLUSION

In this paper, the impulsive noise has been studied and concludes a best way to deal with this kind of noise in future. The simulation results will show difference between output of OFDM system with and without effect of noise.

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