Mitigation of Impulse Noise with Adaptive Thresholding Technique in OFDM System

Yamuna.P, Punithavathi.K, Ramassamy.E

Abstract— **Orthogonal Frequency Division Multiplexing is a multicarrier modulation in which data to be transmitted are spread over carrier modulated at a low rate. One of the major drawback of Orthogonal Frequency Division Multiplexing is impulsive noise which destroys the subcarriers within the OFDM symbol. Due to the impulse noise the performance of the OFDM system gets degraded. In the existing technique blanking scheme is used in order to combat the impulsive noise. In the proposed system a new Adaptive Thresholding technique is introduced to combat the impulse noise and to recover the corrupted OFDM signal. In this technique at the transmitted data, decision are made at the received input sample of noise component is estimated to get the threshold value. When this noise component exceeds the threshold then it indicates there is a presence of impulse in which it can be eliminated and BER can be analyzed.**

Index Terms— **OFDM, Impulsive noise, Adaptive Thresholding, BER.**

I. INTRODUCTION

As the demand for high data rate increases for wired and wireless links. A new modulation scheme such as Orthogonal Frequency Division Multiplexing is introduced [3]. The widely used multiplexing technology is Orthogonal Frequency Division Multiplexing due to its unique features it is applicable in wireless standards such as worldwide interoperability (WIMAX), and the 4G technology. In the wired technology OFDM plays its role majorly in digital video transmission, and power line communication (PLC) [8]. The main advantage of OFDM includes system complexity reduction due to fast fourier transform and bandwidth efficiency. OFDM systems are inherently robust to impulsive noise, but this may turn in to disadvantage when the noise component exceeds the certain threshold. Impulsive noise arises due to lightning or motors which is a common impairment in communication system. When the impulse noise exceeds the certain threshold then it corrupts the entire OFDM symbols. In addition to burst error, multipath fading is another source of disturbance for the communication system [1]. This can be overcome by using many fading technique available. Different methods are available for suppression of impulsive noise. A common and simple method is the time domain clipping [5]. But problem with the technique rests in the large peak-to- average power ratio of the signal. So different approach is taken into consideration to remove the impulsive noise. The decision directed method which is referred as the Adaptive Thresholding technique is utilized to improve the OFDM immunity and system performance [2].

Manuscript received February, 2015*.*
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II. MITIGATION OF IMPULSE NOISE

One of the common impairment in the communication system is the impulse noise due to lightning or motors or high voltage cables. It is not that much easy to model the impulsive noise interference which is a complicated work. Hence the impulsive noise is analyzed with methodology is as follows

A. Existing Technique

In the existing technique the approach is based on time domain. This approach is based on the assumption that the impulses noise will have a much larger magnitude when compared to the received signal. Automatic gain controller is used any sudden drop or changes in the AGC indicates that there is a presence of the impulse noise. The decoder is placed for the monitoring for the sudden drops. This process takes place in iteration if this occurs for time domain samples for several times then the decoder predict and finds that there is a presence of the impulsive noise and erasure the respective symbols. This approach is more efficient and effective in the poor loops such that the signals are attenuated and will be weaker than the impulse obtained. The problem with this technique will lead to the high peak to average power ratio of the OFDM system [5]. Due to this drawback at the frequency side of the receiver the magnitude of this ratio AGC gain value should be kept small. At the frequency domain same operation is performed.

B. Proposed Technique

A new Adaptive Thresholding technique is proposed to mitigate the impulse noise and to recover the OFDM symbol which is corrupted. At first decisions are made to get the threshold values. Based on the decisions at the receiver side

ISSN: 2278 – 909X

the signal which is received with noise from the transmitted data is analyzed and noise component of each received input sample is estimated [1]. When these estimated values exceeds the threshold then this indicates that there is a presence of the impulse noise and this estimated value is subtracted before demodulating the signal. Otherwise no changes will be made on the input signal. Fig shows the proposed block diagram of a receiver.

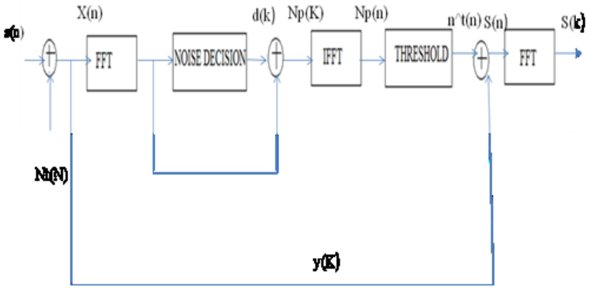

Fig 1. Block diagram at the receiver

At the receiver the received OFDM signal is given as

$$N_p(i) = y(i) - d(i) \quad (1)$$

$N_p(i)$ indicates the observed noise power, y(i) is the received noise component which is subtracted from the decision that is made d(i).

III. SIMULATION RESULTS

MATLAB software was utilized for the simulation. In this section the data symbol are of QPSK modulated. Fig 2 block diagram of the general transmission, where as fig 3 shows the input signal of the OFDM transmitted data. After passing through the channel due the presence of noise and fading the signal gets distorted.

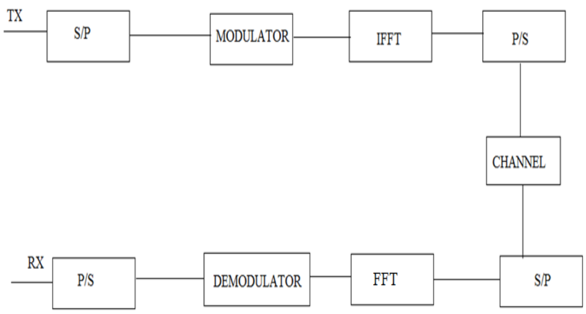

Fig 2. Block of general OFDM transmission

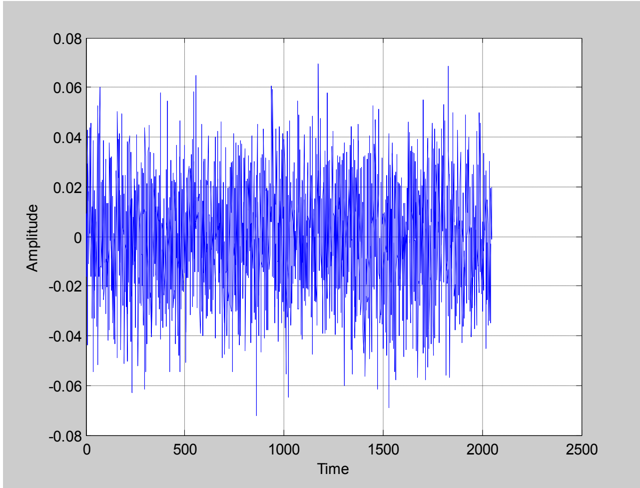

Fig 3. Input signal

Fig 4 shows the block diagram with presence of additive white Gaussian noise. In presence of channel noise and various channel effect such as fading, the received signal forms the noisy version of the original signal. Fig 5 shows the signal which is added by the additive white Gaussian noise. In general the power spectral density of the Gaussian noise is affected, while its probability density function is not. Gaussian noise degrades slowly the quality of the signal and OFDM system performance.

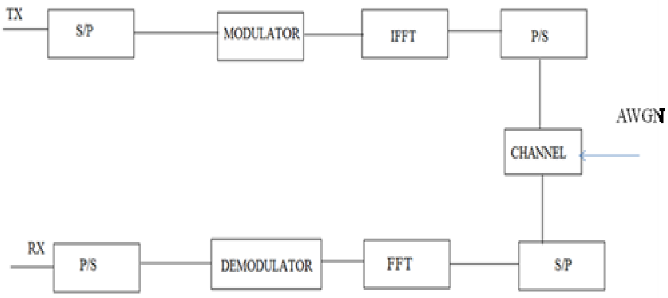

Fig 4. Block diagram with AWGN

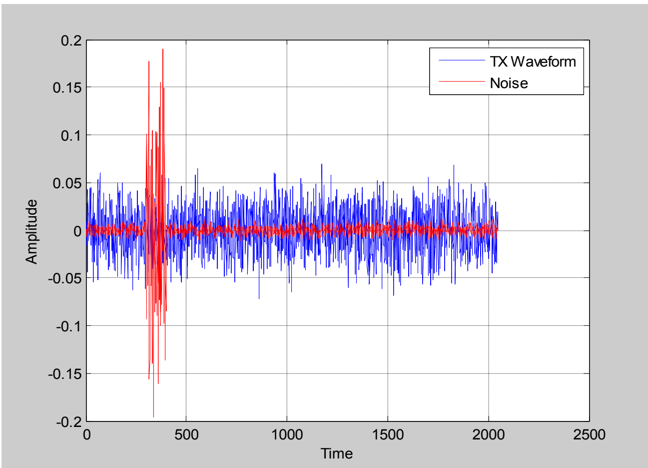

Fig 5. Received signal with AWGN noise

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Fig 6 represents the actual noise transmitted that is the additive white Gaussian noise, along with the impulse noise which is constructed.

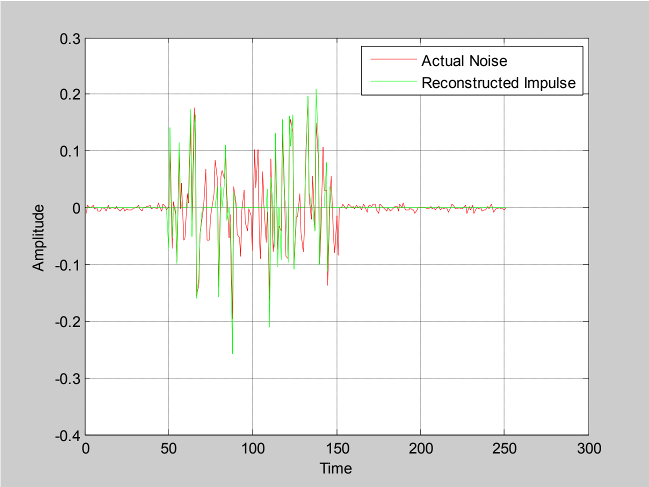

Fig 6. AWGN noise with reconstructed impulse

Fig 7 shows the block diagram with the constructed impulse noise with consecutive sequence of noises and the AWGN. Fig 8 shows that transmitted data is suppressed and affected severely by the impulse noise environment and received at the receiver without the mitigation of the impulse noise.

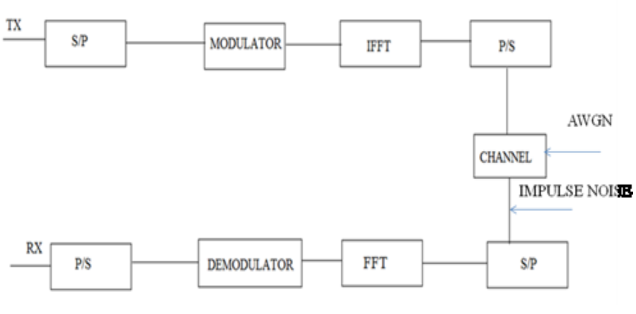

Fig 7. Block diagram with AWGN and impulse noise

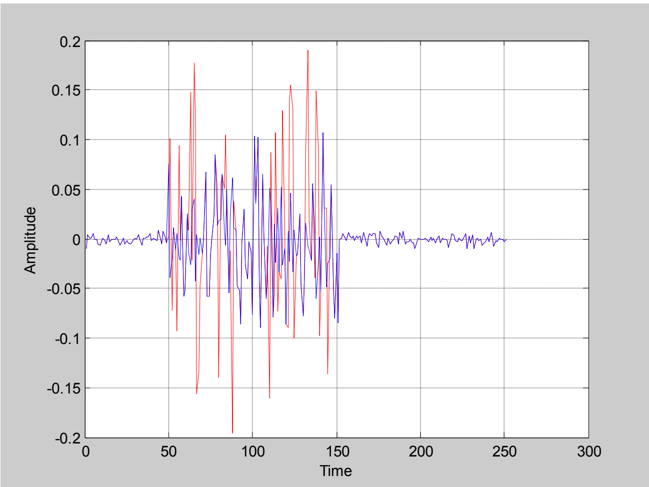

Fig 8. Received data with impulse noise without mitigation

Fig 9 shows the signal in presence of impulse noise and also after mitigation. It shows that after use of mitigation technique most of the noises are removed, before demodulation. So that it is easy to demodulate the signal

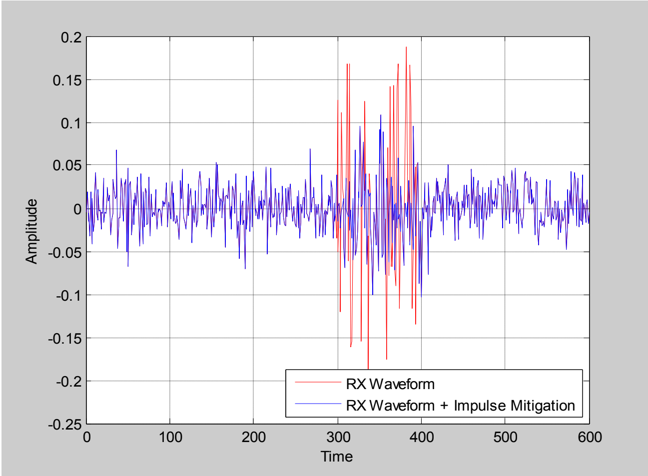

Fig 9. Received data with impulse noise after mitigation

The performance of OFDM system has been analyzed in presence of noisy environment in channel with AWGN and impulse noise which create the burst error. In fig 10, the fading considered in this analyze is the Rayleigh fading.

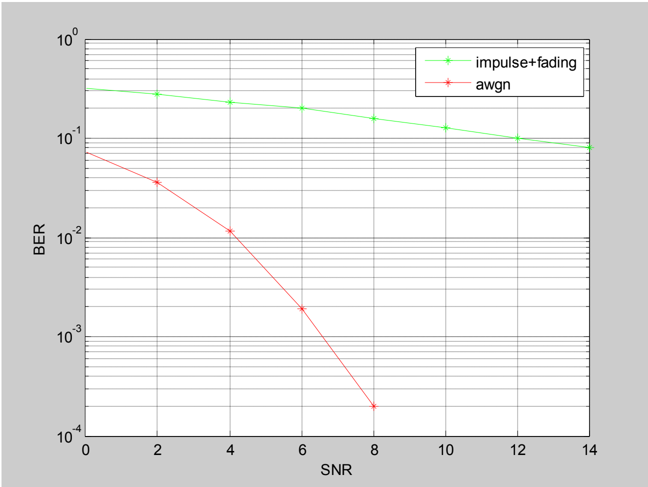

Fig 10. BER in presence of impulse and fading

Fig 11 shows the BER analyze with the impulse noise and AWGN with impulse mitigation with the existing technique in which BER reduced to a level.

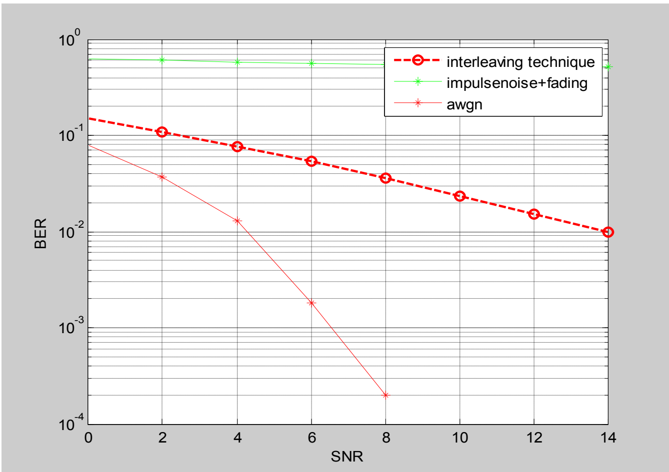

Fig 11. BER analyze after impulse mitigation (Existing method)

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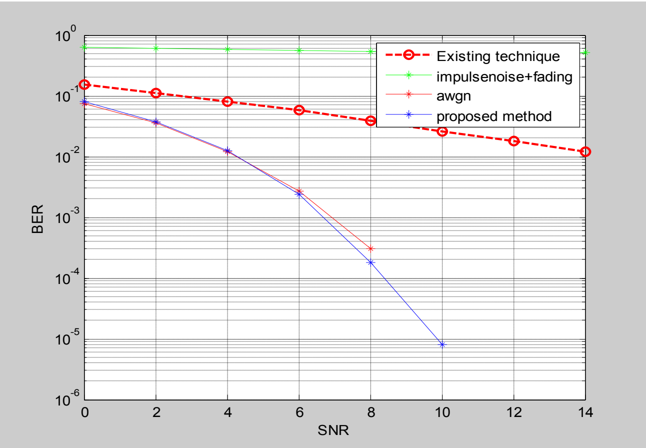

Fig 12. BER analyze after impulse mitigation (Proposed method)

From the fig 12, the existing and the proposed techniques are analyzed in which in the proposed technique normal demodulation is performed at the frequency domain. Assumption of the nearest constellation is made and using the Thresholding method the nearest points are subtracted from the actual point. Keeping only the large spikes others are made zero and the received waveform is subtracted from the original received waveform. After the use of the proposed technique the BER has been reduced.

IV. CONCLUSION

OFDM has high data rate with high bandwidth efficiency. However, its sensitivity to impulse noise, and degrades the performance of the overall system. Hence to avoid this problem, an Adaptive Thresholding technique is proposed to recover impulse noise corrupted OFDM signal. The performance of bit error rate is analyzed with respect to signal to noise ratio in presence of impulse noise and after mitigation of impulse noise and the overall performance is analyzed.

ACKNOWLEDGMENT

I would like to thank my parents, and my friend kodhandaraman for his moral support.

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ISSN: 2278 – 909X