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A Robust Multi Carrier Frequency Domain Equalization With Proper Channel Estimation

J. P. Upadhyay[1*], Rakesh Mishra[2], Mohsin Khan [3]

[1,2,3]Dept. of Electronics and Communication Engg, SRIST, Jabalpur,M.P., India

Corresponding Author: jpupadh@gmaill.com, Tel.: +91-7999622740

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Abstract**—** This work deals with the channel estimation and channel equalization for OFDM system. In present scenario every communication system demands high data rate wireless access and larger bandwidth is. This is a challenging task to develop such wireless communication system. The major challenge in the OFDM system is to achieve better channel estimation and channel equalization with lower values of BER (Bit Error Rate) and MSE (Mean Square Error). In this work a low complexity modified iterative linear minimum mean square error (MI -LMMSE) channel estimation algorithm with modified iterative NLMS (MI-NLMS) channel equalization algorithm integrated with CC-OFDM system is proposed.

Keywords—*OFDM, NLMS,BER,Robust,Equalization*

I. INTRODUCTION

During the last some years, there has been an increasing demand in wireless technology. To achieve such an objective, the next generation personal communication networks will need to be support a wide range of services which will include high quality voice, data, images and streaming video. These future services are likely to include applications which require high transmission rates of several Mega bits per seconds (Mbps). Orthogonal Frequency Division Multiplexing (OFDM) is one of the promising candidates to mitigate the ISI. In an OFDM overall bandwidth is divided into many sub channels which are transmitted in parallel. Each sub channel is typically chosen narrow enough to eliminate the effect of delay spread [2].

In last decades, Orthogonal Frequency Division Multiplexing (OFDM) communication system has been identified as one of key transmission techniques for wireless communication systems. The main factor of OFDM is handling the multi-path interference, and mitigates inter-symbol interference (ISI) causing bit error rates in frequency selective fading environments [2].

II. RELATED WORK

During the last some years, there has been an increasing demand in wireless technology. To achieve such an objective, the next generation personal communication networks will need to be support a wide range of services which will include high quality voice, data, images and streaming video. These future services are likely to include applications which require high transmission rates of several Mega bits per seconds (Mbps). Orthogonal Frequency Division Multiplexing (OFDM) is one of the promising candidates to mitigate the ISI. In an OFDM overall bandwidth is divided into many sub channels which are transmitted in parallel. Each sub channel is typically chosen narrow enough to eliminate the effect of delay spread [2].

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III. METHODOLOGY

In this channel estimation algorithm initially LS i.e least square channel estimation algorithm is used to find the channel response H. After finding H given as name H_{LS} . The M-LS output of detector is obtained given it name $S_{M\text{-}LS}$.

After that channel response of MI-LMMSE is obtained from the M-LS algorithm output.

M-LS estimator reduces the square error between estimation and detection to estimate channel h[n]. In matrix form, the actual output can be written as y=X.h and the error is $e=(\bar{y}-y)$ is the expected output.
The square error (S) can be defined as

$$S = |e|^2$$
$$= (\bar{y} - y)^2$$
$$= (\bar{y} - y) * (\bar{y} - y)^t$$
$$= (\bar{y} - Xh) * (\bar{y} - Xh)^t$$

where t stands for the complex transpose of matrix. The final equation is:

$$h = (X^t X)^{-1}.X^t.y$$

and $h(n) = y/x$;

The LS channel estimation is given as:

$$H_{LS} = X^{-1} Y \text{ or } Y/X.$$

The output of M-LS detector is given as:

$S_{M-LS} = S_{M-LS} + \lambda * (H - H_{LS})' * (H - H_{LS})$

Modified Iterative -Linear Minimum Mean Square Error (MI-LMMSE) Estimation:

MI-LMMSE detection is based on the minimum mean square error criterion which minimizes the MSE after detection.

The modified iterative linear MMSE is given by:

$$W_{MI\text{-}LMMSE} = \frac{R_{hh}}{(R_{hh} + \beta/SNR.\ I)}$$

Where R_{hh} = Channel auto correlation

$R_{hh} = E\{hh^H\}$

& β is a constant depending on the signal constellation for BPSK modulation β = 1 & for 16 QAM modulation β = 17/9.

OR $W_{MI\text{-}LMMSE} = (H^{H.} H + \sigma^2 I_{Nr})^{-1} .H^H$

The output of Modified iterative LMMSE output is given by:

$H_{MI\text{-}LMMSE} = W * H_{M\text{-}LS}$;

$S_{MI\text{-}LMMSE} = S_{MI\text{-}LMMSE} + S_{M\text{-}LS} * \lambda * ((H - H_{MI\text{-}LMMSE})' * (H - H_{MI\text{-}LMMSE}))$

IV. CHANNEL EQUALIZATION

Channel Equalizer is needed to eliminate the effect of noise effect or ISI. The key goal of working with channel equalization is to minimize the MSE as minimum as possible.

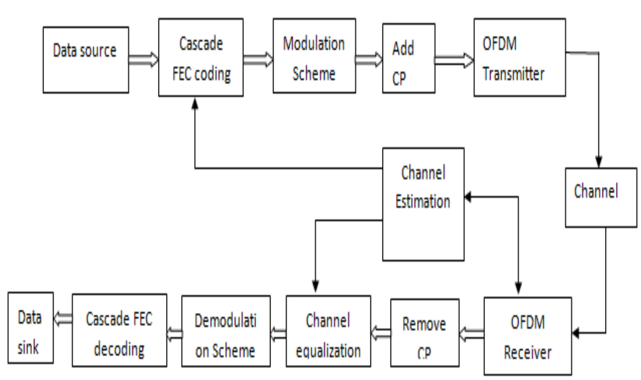


Figure 4.1 Block Diagram of Proposed Algorithm

V. EXPERIMENATL RESULT

Simulations results based on the MATLAB [7.8.0.347(R2009a)] have been carried out to evaluate the performances of the proposed algorithm with the other conventional algorithm have been performed in the presence of a reference signal. The convergence performances of these algorithms are compared on the basis of average squared error (e^2) obtained. All these results have been obtained for the different values of input SNR.

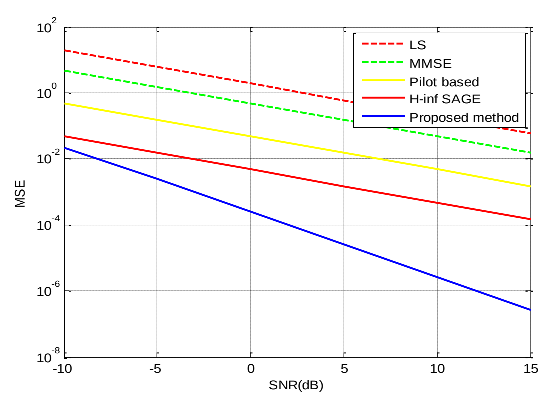
In this section, we compare the performance of the proposed channel estimation with channel equalization technique with the conventional approaches through computer simulations.

To confirm the effectiveness of the proposed methods, two metrics, that is, MSE and BER are adopted for performance evaluation.

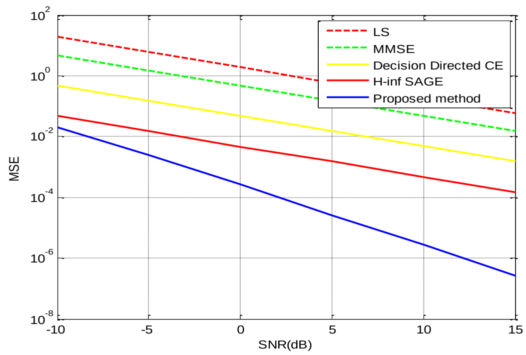
The simulation method has been deployed to investigate the performance of the proposed algorithm for channel estimation & channel equalization. The simulation parameter is listed in Table 1. The number of the subcarriers of the OFDM system, *N*, is equal to 256, and the CP length is equal to 1/4. The bandwidth of the system is 20MHz. The transmitted signal is BPSK modulated, and the Doppler shift is 100 Hz.

Table 1: Simulation Parameters

S.No.	Parameters	Values
1.	FFT Size	64,128, 256
2.	CP	¼
3.	Coding	Convolutional coding
4.	Constraint length	7
5.	SNR	-10 to 15 dB
6.	Modulation	BPSK, 16 QAM, 64 QAM
7.	Code rate	½
8.	Channel length	4,8,16



a)N= 64, L=4



b)N= 64,L=8

Figure 1: MSE Plot V/S SNR a) N= 64, L=4 & b) N= 64,L= 8

Table 6.3 Comparisons between different modulation tehniques of proposed algorithm

S.no	Eb/No (db)	BER		
		BPSK	***16 QAM***	***64 QAM***
1	2	0.2476	0.123	0.1899
2	3	0.3767	0.0574	0.1116
3	4	0.0454	0.0321	0.0593
4	5	0.00087	0.0136	0.0667
5	6	6.16 x 10^-3	0.0023	0.0129
6	7	1 x 10^-4	4.5 x 10^-3	0.0042
7	8	3.45 x 10^ -8	3.23 x 10^-5	0.0016
8	9	1.21 x 10^-11	9.56 x 10^-7	1.77 x 10^-4
9	10	9.68 x 10^-16	9.45 x10^-9	1.562 x10 ^-5
10	11	2.89 x 10^-21	2.99 x 10^-11	8.15 x 10^-7
11	12	2.65 x 10^-28	1.64 x 10^-14	2.03 x 10^-8
12	13	3.22 x 10^-38	1.57 x 10^-18	1.98 x10^-10
13	14	2.11 x 10^-48	1.21x 10^-23	5.21 x10^-13
14	15	1.55 x10^-62	3.65 x 10^-30	3.12 10^-16

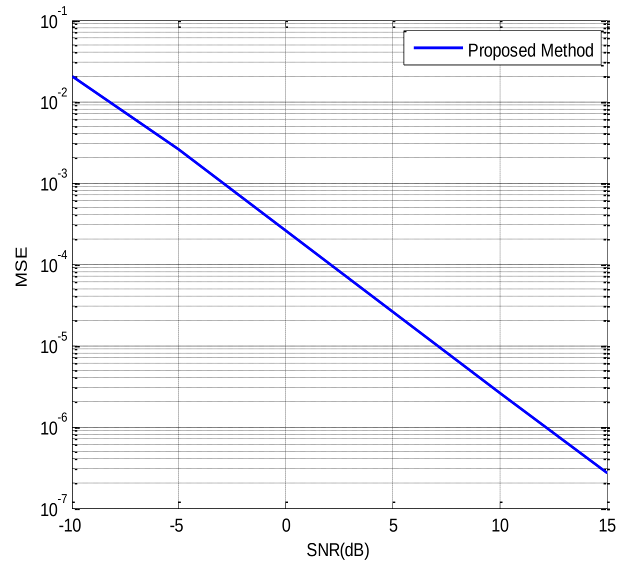


Figure 2: Shows the performance of proposed method

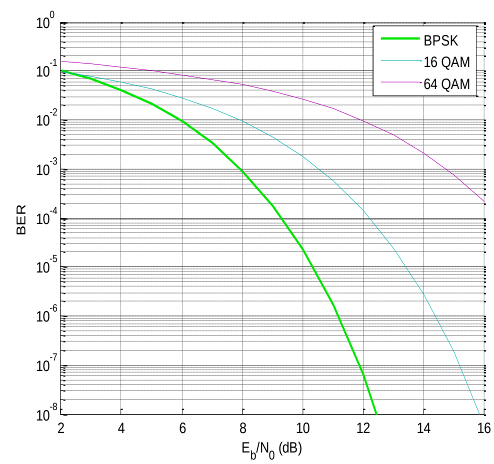


Figure 3: BER V/S Eb/No. performance for different modulation technique

VI. CONCLUSION

This work investigates the performance of CC-OFDM based modified iterative LMMSE-CE & NLMSCE system for multi carrier communication in frequency domain under various fading channels using different modulation schemes. The 3 fading channels namely AWGN, Rayleigh and Rician are examined. It is concluded that performance of AWGN channel is best among all.

By slightly increasing the number of OFDM subcarriers, lower value of MSE can be achieved. The simulation result shows that the proposed algorithm gives better performance with BPSK modulation. Results measures are in BER, MSE, and speed of convergence with better suppression of the distortions.

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