Equalization for Underwater Acoustic Coded OFDM Communication System Over Multipath Fading Via Simulation Platform

Padmasree challa, M. Satya Anuradha, V.Shireesha, P.Chaya Devi

***Abstract:** In underwater shallow acoustic communication (UWSAC) channel, due to the reflections from bottom and surface, multiple paths propagated resulting Inter Symbol Interference (ISI). In this paper we present the bit error performance of convolution coded orthogonal frequency division multiplexing (CCOFDM) UWSAC system with the implementation of adaptive equalization to minimize the ISI over AWGN and Rayleigh fading based on **Recursive least square (RLS) and Filtered Error Least Mean Squares (FELMS) Algorithms.** From the simulation results it is observed that FELMS shown to improve BER as compared to an RLS with CCOFDM system..*

***Keywords:**UWSAC,CCOFDM,Channel Equalization, FELMS, RLS.*

I. INTRODUCTION

UWAC has beenemployed in military affairs, ocean exploration, pollution monitoring[1],etc. In view of these applications, UWAC Technology shows great potential as an area of research. The UWSAC channel has severe ISI due to channel dispersion,thathinders the efficiency of communication devices [2–4].CCOFDM a robust method of encoding digital data on multiple carrier frequencies is used for modulationand has the ability to render ISI negligible by embedding a cyclic prefix. To increase the communication reliability, the receiver will often employ theadaptive equalizer in order to reduce the channel distortion. Specific algorithms are needed to update the filter coefficients and track the channel variations[5]. In this paper RLS and FELMS algorithms are exist.The paper is organized as follows.

In section 2, we discuss the system model and introduce the adaptive filtering algorithms RLS and FELMS for the channel tap coefficients, Section3describes performance of equalization methods over multipath fading that are based on simulation platform. Finally Section 4 is the conclusion of the paper.

Revised Manuscript Received on December 13, 2019.

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II. CHANNEL EQUALIATION IN CONVOLUTION CODED OFDM SYSTEM

The performance of CCOFDM system explanation can be seen in [6]. Let us considered the coded OFDM, at transmitter convolution encoding and data interleaving are used as encoding methods and at receiver the data will be decoded by signal de mapper using de-interleaver and Viterbi algorithm. The transmitted data $s[l]$ is to be on the l_{th} subcarrier passed through UWSAC channels. The transmitted signal in the pass band is then given by

$$u(t) = \mathrm{Re}\left\{[\sum_{l\in n} s[l]e^{j2\pi l\Delta ft} o(t)]e^{j2\pi f_c t}\right\}, t \in [0, T+T_g]$$

(1)

Where $o(t)$ describes the pulse shaping function . The channel impulse response of channel can be expressed as

$$i(\tau,t) = \sum_a P_a(t)\delta(\tau - \tau_a(t)) \quad (2)$$

(2)

Where P_a is the amplitude of the path and $\tau_a(t)$ is the time- varying path delay. Hence the receiver signal in the pass band is then

$$\hat{c}(t) = u(t) * i(\tau,t) + \hat{v}(t) \quad (3)$$

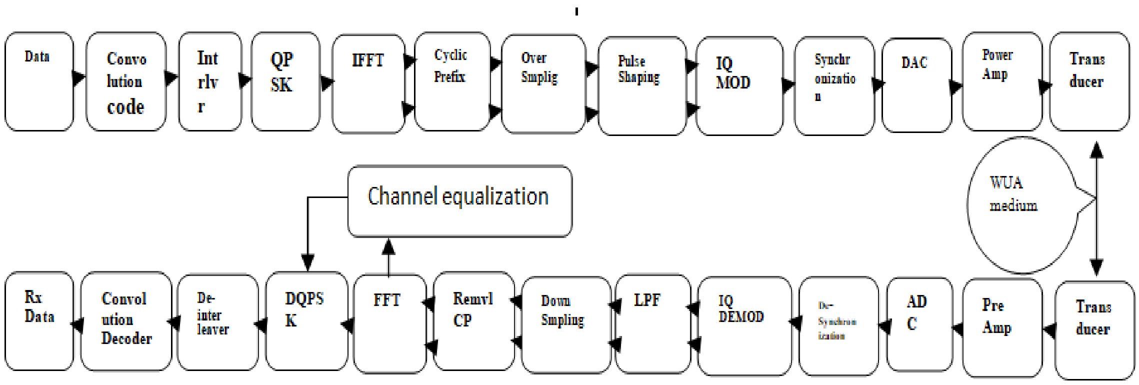


Fig1.Block diagram of CCODED OFDM transceiver system

$$\hat{c}(t) = \mathrm{Re}\left\{ \sum_{p} P_a [\sum_{k\in S} s[l] e^{j2\pi l\Delta f(t+pt-\tau_a)} o(t+pt-\tau_a)] e^{j2\pi f_c(t+pt-\tau_a)} \right\}$$

$$+ \hat{v}(t), t \in [0, T+T_g]$$

(4)

Where $\hat{v}(t)$ is the additive noise. The collected data will be processed by inversion process of the same at source except channel equalizer which uses to estimate the signal. In this paper equalization is based on the RLS and FELMS algorithms. Initially error can be calculated from the received data using

$$e(n) = \hat{c}(t) - m(t) \quad (5)$$

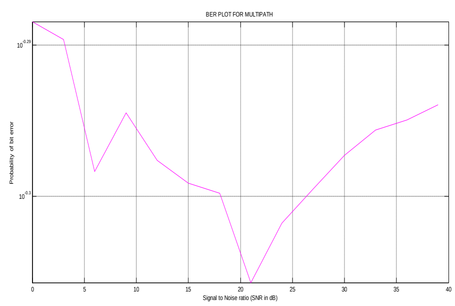
And then filter coefficients are updated by gain vector β it is multiplied by $e(n)$ and input vector $u(t)$ and combine with previous coefficients of the filter. In FELMS without prior knowledge of filter data F it updates the coefficients is given by

$$r_i = r_{i-1} + \beta(i) u_i^* F[e(i)], e(i) = d(i) - u_i r_{i-1}, i \geq 0 \quad (6)$$

III. SIMULATION RESULTS

Simulation result presents the CCODED OFDM with equalization for UWSAC. The BER is evaluated with and without equalization is as shown in fig.2 and fig.3 In this simuation image can be considered as input shown in fig.4 total 49184 number of bits were transmitted at the source. Fig.5 and Fig.6 shows the Received image at SNR 8dB and at SNR 17dB of RLS equalizer respectively. Fig 7 and 8 shows the Received image at SNR6 dB and at SNR 10dB of FELMS equalizer respectively.

Fig 2. BER Performance of CCODED OFDM over multipath without equalization



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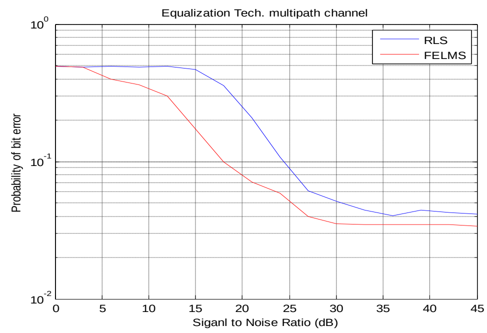

Fig 3. BER Performance of CCODED OFDM over multipath with different channel equalizers.

Fig 4. Original image

Fig 5. Received image at SNR 8 dB of RLS equalizer

Fig 6.Received image at SNR 17dB of RLS equalizer

Fig 7. Received image at SNR 6dB of FELMS equalizer

Fig 8. Received image at SNR 10dB of FELMS equalizer

Table 1 represents the SNR VS BER in simulation and Table 2 shows parameters and design values of CCODED OFDM. The signal is recovered at SNR of 18dB, number of bit errors occurred for RLS is 10831 and for FELMS is 5839.

Table 1. SNR and BER in simulation of CODEDOFDM

Total number of bits transmitted are			
SL.NO	**SNR in dB**	**RLS**	**FELMS**
1	**0**	**49184**	**39810**
2	**3**	**48741**	**35954**
3	**6**	**49123**	**29875**
4	**9**	**46978**	**17303**
5	**12**	**35772**	**9892**
6	**15**	**20817**	**7052**
7	**18**	**10831**	**5839**
8	**21**	**6155**	**3986**
9	**24**	**5113**	**3502**
10	**27**	**4415**	**3454**
11	**30**	**4010**	**3475**
12	**33**	**4440**	**3487**
13	**36**	**4256**	**3485**
14	**39**	**4147**	**3393**

Table 2. parameters and design values of CODED OFDM

Parameters	Values
Modulation scheme	Qpsk
Modulating frequency	6.3KHz
Frequency response	12-19KHz
Length of IFFT	256
Equalization methods	RLS ,FELMS

IV. CONCLUSION

From the simulation results we observed that at SNR of 12dB, 35772 and 9892 bit errors occurred for RLS and FELMS equalizers respectively. The simulation gives us that the FELMS equalizer has better SNR improvement than RLS Equalization.

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