Adaptive Equalization: LMS, RLS and CMA

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Abstract

This poster presents performance evaluation of adaptive equalizers (LMS, RLS and CMA) using different Quadrature Amplitude Modulation (QAM) techniques (4-QAM, 8-QAM); using Frequency Flat Fading and Frequency Selective Fading.

Introduction

BERTool is used to do comparison under MATLAB software package. For this purpose, two arbitrary channel response are selected. Flat Fading Channel transfer function is [1 0.7 0.5] and Frequency Selective Fading Channel Transfer function is [0.9 0.7 0.5 0.3]. Flat Fading Channel is used to model rural area effect on signal transmission and Frequency Selective Fading is used to model urban area. LMS, RLS use channel estimation techniques to first estimate the behavior of channel by using training symbols and then equalize its effect by creating opposite response to channel; while CMA works on blind estimation i.e. it does not know the behavior of channel it uses general algorithm to equalize channel.

Objective

The main function of the adaptive channel equalization is to eliminate intersymbol interference (ISI) and the additive noise as much as possible in a communication

Analysis & Results

- **Figures 1 and 2 show BER versus Eb/No for 4-QAM and 8-QAM using Flat Fading Channel equalized by Linear equalizers respectively. In both figures, it can be seen that CMA works accurately before SNR is 8 dB but then it goes straight. This is the fact because LMS and RLS use training symbols in every frame to estimate channel effects then equalize it; while CMA uses constant modulus algorithm. As noise power decreases, efficiency of LMS and RLS becomes better but not CMA.**

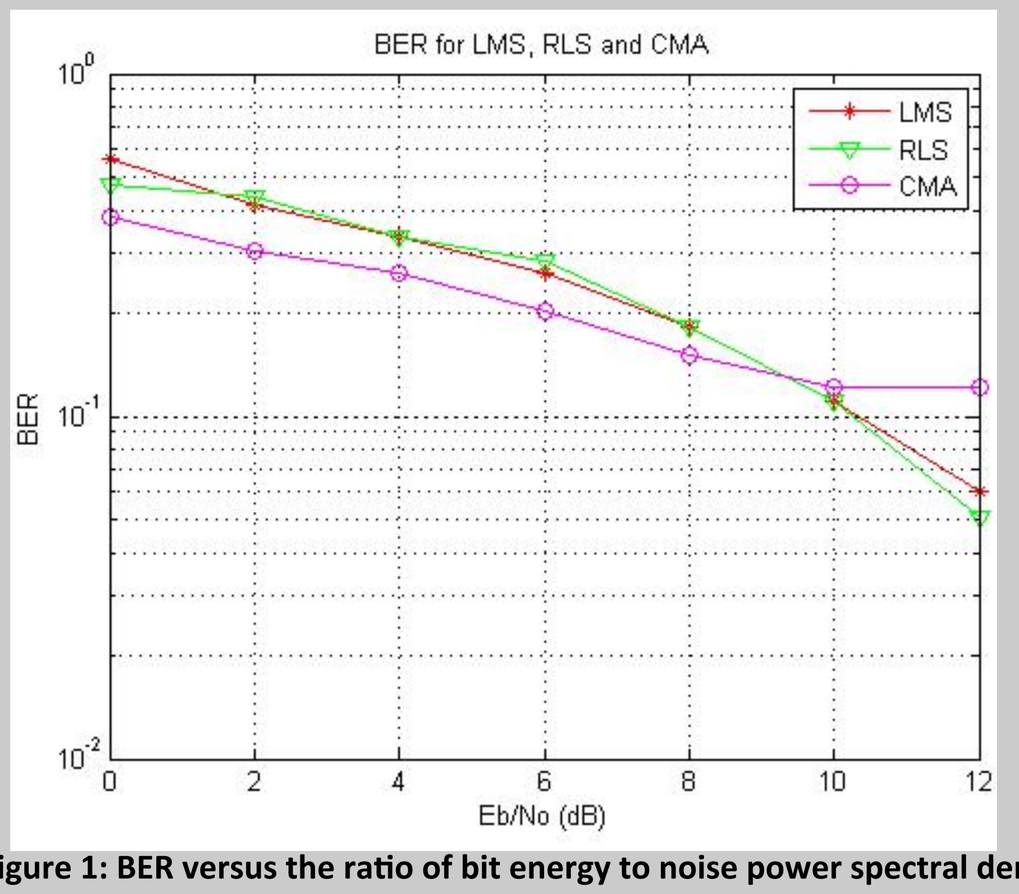

Figure 1: BER versus the ratio of bit energy to noise power spectral density (Flat Fading Channel, 4-QAM)

- **Figures 3 and 4 show BER versus Eb/No for 4-QAM and 8-QAM using Frequency Selective Fading Channel equalized by Linear equalizers respectively. As frequency selective fading is hard to equalize, it can be seen that CMA works accurately before SNR is 6 dB but then it goes straight. As LMS and RLS use training symbols in every frame to estimate channel effects then equalize it; while CMA uses constant modulus algorithm so the results are somehow similar for LMS and RLS as in Figure 1 and Figure 2.**

Analysis & Results

Figure 2: BER versus the ratio of bit energy to noise power spectral density (Flat Fading Channel, 8-QAM)

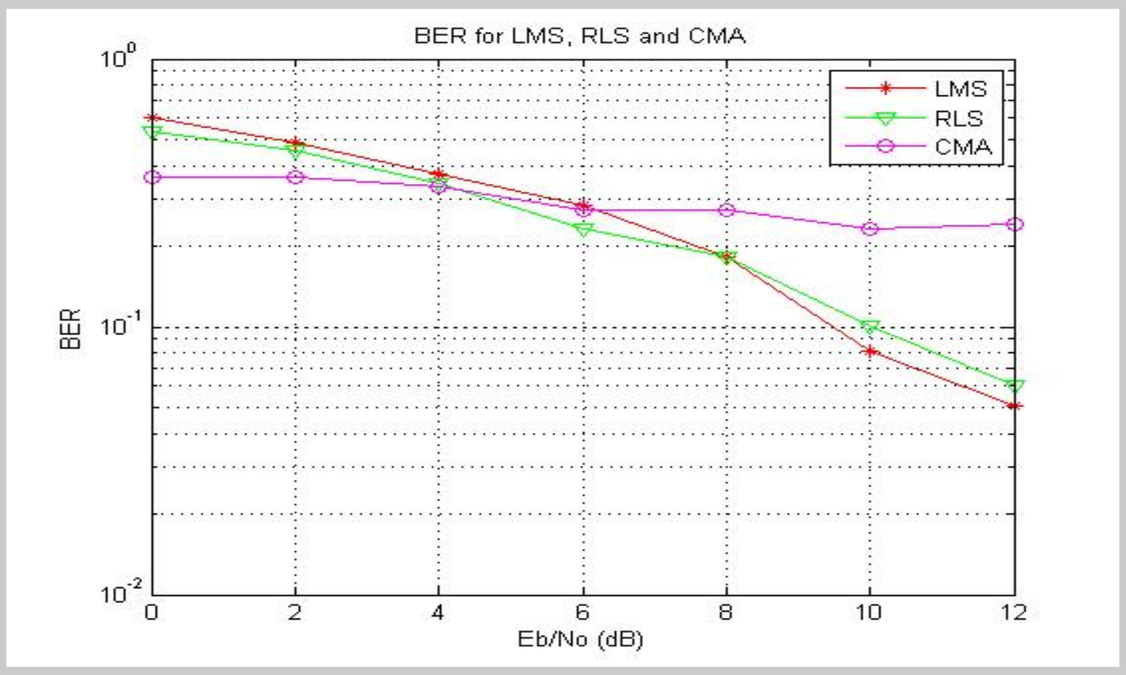

Figure 3: BER versus the ratio of bit energy to noise power spectral density (Frequency Selective Fading Channel, 4-QAM)

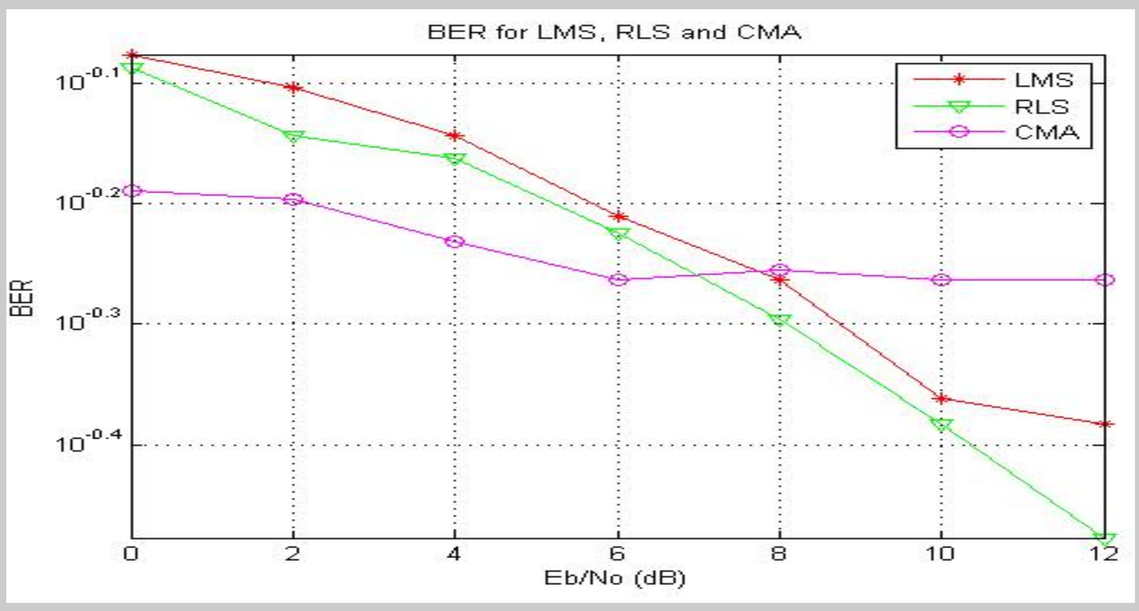

Figure 4: BER versus the ratio of bit energy to noise power spectral density (Frequency Selective Fading Channel, 8-QAM)

Conclusion

Channels have two types of effect on transmitted signal; Noise and Fading. Noise cannot be eliminated from signal but fading effect can be mitigated by using equalizers.

References

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