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A wide band QAM receiver based on DFE to reject ISI in wireless time varying fading channel

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ABSTRACT

Quadrature Amplitude Modulation (QAM) system with high data rate suffers from Inter-Symbol-Interference (ISI) in frequency-selective wireless channel. To reduce this ISI signal, Decision Feedback Equalizer (DFE) is used. When the channel impulse response is time varying, the channel's coefficients need to be adaptively estimated. Adaptive implementation of the forward filter on the conventional DFE can track the time variation of the channel coefficients, but its tracking capability depends on the covariance matrix of the receiver vector and the speed of channel variation. In this paper, wide band QAM receiver is proposed with new arrangement of the DFE filters. Data diversity at the receiver is achieved by using N antennas at its input. The forward filter of the DFE will be used as a Maximum-Ratio-Combiner (MRC) as well as a channel compensator. By first removing the ISI signal from the received vector, the tracking performance of the forward filter will be enhanced. The new performance of the proposed receiver will be compared with the conventional DFE receiver. The tracking performance of the forward filter using LMS and RLS algorithms in the new arrangement is compared with that of the conventional DFE receiver.

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1. Introduction

In wireless fading channels, signals suffer from distortions due to multipath fading. The effect is a serious degradation of the system error-rate performance. Frequency-selective fading channel results in a delay spread and a Doppler shift. Therefore, the transmitted symbol will suffer from time-varying ISI. To mitigate this performance degradation, adaptive equalizer is used. A variety of adaptive equalizer structures have been proposed to combat ISI. Among the various equalizer structures and algorithms, DFE with LMS algorithm may be used but the one with RLS algorithm is more efficient in such environments [1].

Although Orthogonal Frequency Division Multiplexing (OFDM) system is proposed to reduce the fading effects on frequency-selective channels, the wide-band-single-carrier QAM system is still used in high-speed broadband communication systems, such as Digital Video Broadcasting systems (DVB), home phone line networks and many other systems. The OFDM system has a lot of advantages if it is compared with a single-carrier QAM system. But the structure of OFDM system is more complex, and it suffers from inter-carrier-interference problem when the orthogonality between the subcarrier is lost. This is the reason why we are interested to find a new solution to the problem of multipath fading in wide band QAM system.

The wide-band-single-carrier QAM system can reach the capacity of the OFDM system, however the modulated symbols are transmitted on the whole transmission bandwidth with a single carrier instead of separate sub-carriers (sub-channels) as in the OFDM system. In this case, the coherent bandwidth of the channel is smaller than the transmitted signal bandwidth. The channel is considered frequency selective where the transmitted signal spectrum suffers from one or more nulls through its bandwidth. This frequency distortion is occurred due to the multipath propagation of the transmitted signal. The received multipath signals have random phase shifts and random gains. They are added constructively or destructively at the receiver input causing the fading phenomenon. The frequency components of the modulated signal are differently affected by the fading phenomenon. This gives rise to ISI and the dispersion of the received wide-band-single-carrier QAM signal.

While the wide-band QAM signaling has the disadvantage of frequency distortion in the received signal, the high data rate by

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