Preamble Based Timing Synchronization for OFDM Receivers

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Abstract. The fast synchronization is an essential function block for the packet based OFDM communication system. In general the synchronization should be completed within a limited period of time where the preamble or training sequence is normally assigned. One of the main goals of the timing synchronization is to locate the end of the preamble. In other words this block tries to find the beginning of each of OFDM symbols which is equivalent to the start point of the FFT window. This paper discusses performances of the preamble based schemes utilizing the pattern and the correlation characteristics of the training sequence of the data packet. The performance comparisons are carried out under various design parameters and wireless channel environments.

Keywords: OFDM, synchronization, preamble, correlation

1 Introduction

Recent explosive demands for data communication systems supporting the high spectral efficiency as well as higher data rate in the wireless channel environment boost the deployment of the OFDM (Orthogonal Frequency Division Multiplexing) based data transmission networks. The OFDM system is suitable for multi-path wireless channels which cause frequency selective fading or equivalently inter-symbol interference in the time domain. Despite of advantages of the OFDM scheme there still exist some problems to be taken care of in the system design stage. This system is relatively sensitive to the synchronization errors due to Doppler shift and the local oscillator instabilities. The problems in the synchronization could cause inter-carrier interference (ICI) and inter-symbol interference (ISI). This eventually affects the overall performance of the system unless it is fixed in the data recovery process at the receiver side [1-2].
2 Timing Synchronization Schemes

The timing synchronization is one of the main blocks in the receiver front-end. This block follows the gain control and should be carried out first before other types of synchronization process which include compensation of carrier frequency offset and sampling frequency offset [3]. In this paper performance of the timing synchronization schemes is analyzed based on the statistical distribution of the sample index errors from the exact timing index.

3 Simulation Results

Simulations are done with various design parameters including correlation delay and moving average window sizes. Channel qualities are also incorporated in the simulation which include signal to noise ratio (SNR) and delay spread of the multi-path channel. Simulation results show that the performances are improved as the window size of the moving average filter although the computational complexity is increased. The delay spread of the wireless channel also affects the jitter of the timing locations. In other words more delay spread results in the increased variance of the estimated timing location. The lower SNR level is also shown to increase the uncertainty of the estimated value as expected.

4 Conclusion

This paper discusses the timing synchronization of the OFDM systems. Performances of the preamble based schemes are compared and analyzed under various channel environments as well as the design parameters. Simulation results show that there exist trade-offs between design complexity and the estimation performance. The results also suggest that the complexity of the timing estimator should be determined by a thorough analysis of the parameters associated with the target block which may include the available samples for the estimation, the resolution of the samples and the channel environment.

References