SUMMARY OF Ph.D. DISSERTATION

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Title

Digital Compensation Schemes for Signal Distortion in OFDM Receivers

Abstract

Orthogonal division frequency multiplexing (OFDM) is currently a dominant modulation scheme in broadband wireless systems. A receiver for an OFDM system is required to satisfy the conditions such as high-performance, low power consumption, small size, and low cost. However, in the receiver for the broadband signal, more accuracy of analog components is necessary and it leads to larger cost and power consumption. To implement a low cost and low power consumption receiver, compensation of signal distortion in a digital domain is required. The signal distortion compensation in the digital domain brings more scalability and flexibility. In this dissertation, digital signal compensation schemes for the signal distortion due to radio frequency (RF) components, timing jitter, and baseband filter in OFDM receivers are proposed and investigated.

Chapter 1 introduces the background of the OFDM receivers and the motivation of the research.

In Chapter 2, compensation schemes in a direct conversion receiver are investigated. The direct conversion receiver architecture suffers from DC offset, frequency offset, and IQ imbalance. In the proposed schemes, the key idea is to use a differential filter for the reduction of the DC offset. From the outputs of the differential filter, the frequency offset is estimated. The IQ imbalance is calculated in time domain using a simple equation without the impulse response of a channel. However, the accuracy of the proposed IQ imbalance estimation in the time domain is deteriorated when the frequency offset is small. To overcome this problem, frequency domain IQ imbalance estimation scheme is also proposed. It is shown that estimation accuracy and bit error rate (BER) performance can be improved even if the frequency offset is small. Thus, the combination of two low-complexity IQ imbalance estimation schemes is suitable for low-cost and low-power-consumption direct conversion receivers.

In Chapter 3, signal distortion caused by timing jitter is discussed. As one of new receiver architectures, a RF-sampling receiver has been proposed, which directly processes analog discrete samples. In this architecture, a phase locked loop (PLL) exhibits the phase noise and then causes the timing jitter. In Chapter 3, the effect of the timing jitter on quadrature sampling in the RF-sampling receiver is analyzed.

In Chapter 4, compensation schemes in fractional sampling (FS) OFDM receivers are evaluated. The OFDM system with FS can achieve diversity with a single antenna. However, as the number of subcarriers and the oversampling ratio increase, the correlation among the noise components over different subcarriers deteriorates the BER performance. First, a correlated noise cancellation scheme in FS orthogonal frequency and code division multiplexing (OFCDM) system is investigated. To reduce the correlated noise, an alternative spreading code (ASC) is used in the FS OFCDM system. However, this alternative spreading code reduces the number of available spreading codes. For applicability to OFDM systems, the effect of the correlation among the noise components in FS OFDM system is derived.

Chapter 5 summarizes the results of each chapter and concludes this dissertation.