Parameter Estimation and Error Reduction for OFDM Based WLANs

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Abstract

We consider parameter estimation and error reduction for orthogonal frequency-division multiplexing (OFDM) based high-speed wireless local area networks (WLANs). We devise or select algorithms that can provide benefit to the *overall* system performance and can be efficiently implemented in real-time. In particular, first, we give a channel model which is especially useful for assessing the channel parameter estimation methods devised for OFDM based WLANs. Second, we provide a sequential method for the estimation of carrier frequency offset (CFO), symbol timing, and channel response, by exploiting the structure of the packet preamble specified by the IEEE 802.11a standard. Finally, to correct the residue CFO induced phase error using the pilot tones, we consider maximum-likelihood phase tracking and least-squares phase fitting approaches; to improve the channel estimation accuracy using the decoded data, we present a semi-blind channel estimation method; to mitigate the sampling clock induced time delay error, we provide a sampling clock synchronization approach that obviates the need of an automatic frequency control clock recovery circuit. The overall system performance of using our algorithms is demonstrated via several numerical examples.

Index Terms

OFDM, WLAN, channel model, symbol timing, carrier synchronization, channel estimation, pilot tones, sampling clock synchronization, WLAN standards.

IMPORTANT CONTRIBUTIONS

We have devised or selected channel parameter estimation and error reduction algorithms to improve the overall system performance for the OFDM based WLANs and to be readily implemented in real-time. In particular, first, we have given a channel model which can be used to characterize the true channels for the OFDM signaling. Second, by exploiting the structure of the packet preamble specified by the IEEE 802.11a standard, we have provided a sequential method for the estimation of CFO, symbol timing, and channel response. Unlike some of the existing channel parameter estimation methods, our method works well for the true channels and is 70 times more efficient than an existing method. Finally, to correct the CPE using the pilot tones, we have considered ML phase tracking and LS phase fitting approaches. The proper phase fitting can yield a gain of up to 1.2 dB. Moreover, a semi-blind channel estimation method has been presented to improve the channel estimation accuracy, which results in an additional gain of up to 1.5 dB. Furthermore, to correct the sampling clock error, we have provided a sampling clock synchronization approach that avoids the use of an AFC circuit. The algorithms given herein can be readily extended to the case of multiple receive antennas. We are currently implementing our algorithms on the DSP hardware.

IMPOTANT CITATIONS

- [1] proposed an FIR (finite impulse response) filter channel model for the simulation of the time-dispersive fading channels for the OFDM-based communication systems.

REFERENCES

[1] N. Chayat, "Tentative criteria for comparison of modulation methods," *Document: IEEE P802.11-97/96*, September 1997.