On the Performance of a Maximum Likelihood Method with Delayed Correlation for the Coarse Carrier Frequency Offset Estimation of OFDM Signals with Multiple Preamble Symbols

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Abstract

Estimation of carrier frequency offset (CFO) is an important issue in the design of a wireless receiver that employs orthogonal frequency division multiplexing (OFDM) techniques. In this paper, using the ten short training symbols specified in the signal format of the IEEE 802.11a WLAN, we investigate the performance of a coarse CFO estimation scheme for OFDM signals with multiple preamble symbols. This scheme, which we call DC-ML, employs the maximum likelihood (ML) method with delayed correlation (DC). For AWGN channels under moderate signal to noise ratio (SNR) conditions, we develop an analysis to evaluate the variance of estimation error (VEER). The analysis is corroborated in light of simulations, and compared with the formulated Cramer-Rao lower bound (CRLB). VEER of the DC-ML in a multipath environment is studied via simulations. Numerical results show that a certain parameter combination can result in minimum VEER. Simulation results justify that the probability of estimation error (PEER) approximates Gaussian distribution in both AWGN and multipath scenarios. We also present a Two-Branch DC-ML (TBDC-ML) scheme, which comprises two correlation branches of DC-ML, and an associative ambiguity resolution algorithm. Numerical examples reveal that TBDC-ML outperforms DC-ML in both VEER and PEER. Assuming that the estimation error resulting from the two branches is jointly Gaussian, we derive the joint probability density function (pdf) and validate it via simulations.

Keyword：Carrier Frequency Offset, CRLB, DC-ML, OFDM, TBDC-ML