Downlink training design for FDD massive MIMO systems in the presence of colored noise

ABSTRACT

Massive multiple-input multiple-output (MaMi) systems have attracted much research attention during the last few years. This is because MaMi systems are able to achieve a remarkable improvement in data rate and thus meet the immensely ongoing traffic demands required by the future wireless networks. To date, the downlink training sequence (DTS) for the frequency division duplex (FDD) MaMi communications systems have been designed based on the idealistic assumption of white noise environments. However, it is essential and more practical to consider the colored noise environments when designing an efficient DTS for channel estimation. To this end, this paper proposes a new DTS design by exploring the joint use of spatial channel and noise covariance matrices, when the channel is not reciprocal but the coherence block length remains limited. We derive an analytical solution for the mean square error (MSE) based on the proposed training design with colored noise. In addition, this paper exploits the method of random matrix theory to provide an analytical solution for the downlink (DL) achievable sum rate of the regularized zero forcing beamforming (RZFBF) precoder. Numerical results demonstrate that using the proposed DTS design, the MSE of the channel estimate is significantly reduced compared with the conventional training designs with white noise. Furthermore, the results show that the proposed pilot design markedly improves the DL achievable SR over the conventional training designs, especially at relatively low signal-to-noise-ratio (SNR) levels. This enables FDD MaMi systems to operate under more practical scenarios of colored noise and limited coherence time environments.

Keyword: Massive MIMO systems; Channel estimation; Sum rate maximization; Mean square error minimization; Spatial correlation; Training sequence; FDD; Colored noise