A Novel Hybrid Beamforming Algorithm With Unified Analog Beamforming by Subspace Construction Based on Partial CSI for Massive MIMO-OFDM Systems

Abstract:

Hybrid beamforming (HB) has been widely studied for reducing the number of costly radio frequency (RF) chains in massive multiple-input multiple-output (MIMO) systems. However, previous works on HB are limited to a single user equipment (UE) or a single group of UEs, employing the frequency-flat first-level analog beamforming (AB) that cannot be applied to multiple groups of UEs served in different frequency resources in an orthogonal frequency-division multiplexing (OFDM) system. In this paper, a novel HB algorithm with unified AB based on the spatial covariance matrix (SCM) knowledge of all UEs is proposed for a massive MIMO-OFDM system in order to support multiple groups of UEs. The proposed HB method with a much smaller number of RF chains can achieve more than 95% performance of full digital beamforming. In addition, a novel practical subspace construction (SC) algorithm based on partial channel state information is proposed to estimate the required SCM. The proposed SC method can offer more than 97% performance of the perfect SCM case. With the proposed methods, significant cost and power savings can be achieved without large loss in performance. Furthermore, the proposed methods can be applied to massive MIMO-OFDM systems in both time-division duplex and frequency-division duplex.