
Discrete-Phase Constant Envelope Precoding for Massive MIMO Systems

Abstract:

We consider downlink of a multiuser massive multiple-input multiple-output (MIMO) system and focus on reducing the hardware costs by using a single common power amplifier and separate phase shifters (PSs) for antenna front-ends. In the previous literature, the use of analog PSs in this setup has been considered. Here, we study the use of practical digital PSs, which only support a limited set of discrete phases. Considering the sum of interference powers as a metric, we formulate the corresponding nonlinear discrete optimization problem and solve for the phases to be used during transmission. We devise a low-complexity algorithm, which employs a trellis structure providing suboptimal, but efficient and effective solutions. We demonstrate via examples that the proposed solutions have comparable performance to conventional analog PS-based algorithms. Furthermore, we prove that by utilizing discrete-phase constant envelope precoding, the interference can be made arbitrarily small by increasing the number of antennas. Therefore, the asymptotic gains promised by massive MIMO systems are preserved. We also obtain closed-form expressions for the rate loss due to errors in the phase and amplitude of the PSs, for both low and high SNR regimes.