Iterative Distributed Minimum Total MSE Approach for Secure Communications in MIMO Interference Channels

In this paper, we consider the problem of jointly designing transmit precoding (TPC) matrix and receive filter matrix subject to both secrecy and per-transmitter power constraints in the multiple-input multiple-output (MIMO) interference channel, where K legitimate transmitter-receiver pairs communicate in the presence of an external eavesdropper. Explicitly, we jointly design the TPC and receive filter matrices based on the minimum total mean-squared error (MSE) criterion under a given and feasible information-theoretic degrees of freedom. More specifically, we formulate this problem by minimizing the total MSEs of the signals communicated between the legitimate transmitter-receiver pairs, while ensuring that the MSE of the signals decoded by the eavesdropper remains higher than a certain threshold. We demonstrate that the joint design of the TPC and receive filter matrices subject to both secrecy and transmit power constraints can be accomplished by an efficient iterative distributed algorithm. The convergence of the proposed iterative algorithm is characterized as well. Furthermore, the performance of the proposed algorithm, including both its secrecy rate and MSE, is characterized with the aid of numerical results. We demonstrate that the proposed algorithm outperforms the traditional interference alignment algorithm in terms of both the achievable secrecy rate and the MSE. As a benefit, secure communications can be guaranteed by the proposed algorithm for the MIMO interference channel even in the presence of a sophisticated/strong eavesdropper, whose number of antennas is much higher than that of each legitimate transmitter and receiver.