A Downlink Pre-coding Scheme for Multi-user Distributed MIMO System with Antenna Selection

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A linear pre-coding scheme named LR-BD-ZF (Lattice Reduction-Block Diagonalization-Zero forcing) pre-coding scheme is proposed for downlink in multi-user Distributed MIMO (D-MIMO) system with antenna selection. The perfect channel state information (CSI) at both the transmitters and receivers is assumed. The average symbol error rate (SER) of the LR-BD-ZF algorithm in D-MIMO system is investigated through Monte Carlo simulation. The performance of the BD-ZF and LR-BD-ZF scheme in centralized MIMO (C-MIMO) system are also given to compare with that in D-MIMO system.

It is assumed that there are K users where each user has N_r antennas and M APs (Access Point) where each AP has N_t antennas, thus the total receive antennas are $NR=K*N_r$ and total AP antennas are $NT=M*N_t$ ($NT \geq NR$). Antenna selection is presented to satisfy requirements of BD and LR algorithm. NR AP antennas with the strongest average signal power to K users is selected. The channel matrix through the antenna selection and BD algorithm is $\mathbf{G}=[\mathbf{G}_1^T\ \mathbf{G}_2^T...\mathbf{G}_K^T]^T$, where $\mathbf{G}_i=[\mathbf{0},...,\mathbf{H}_i\mathbf{V}_i,...\mathbf{0}]=\mathbf{H}_i\mathbf{W}_i$ and $\mathbf{W}_i=[\mathbf{0},...,\mathbf{V}_i,...\mathbf{0}]$. The matrix processed through LR is $\bar{\mathbf{G}}=\mathbf{G}\bullet\mathbf{P}$, where $\mathbf{P}$ is a $NR\times NR$ unimodular matrix. It is noted that $\bar{\mathbf{G}}_i=\mathbf{G}_i\mathbf{P}=\mathbf{H}_i\mathbf{W}_i\mathbf{P}$. The pre-coding matrix of i-th user is $\mathbf{F}_i=\mathbf{W}_i\mathbf{P}\mathbf{A}_i$. $\mathbf{A}_i$ is the ZF pre-coding matrix for the equivalent single-user system where its channel matrix is $\bar{\mathbf{G}}_i$.

The average SER versus the signal to noise ratio (SNR) is simulated to evaluate the performance of the pre-coding scheme proposed. Due to singularity of transformation of the channel matrix, the proposed LR-BD-ZF scheme outperforms the traditional BD-ZF scheme. The average SER of LR-BD-ZF and BD-ZF pre-coding scheme in both D-MIMO and C-MIMO systems are investigated. Through comparing LR-BD-ZF with BD-ZF algorithm, the simulation results show that 5dB and 4.5dB SNR gain is obtained in D-MIMO and C-MIMO system, respectively, when SER is 10^{-2} and the number of users is 10. Moreover, 3dB gain is achieved by the LR-BD-ZF pre-coding scheme in D-MIMO system comparing to that in C-MIMO system when SER is 10^{-3}. Antenna selection is introduced in D-MIMO system to further improve the performance with lower average path loss. It is shown that 2.8dB improvement in SNR is achieved between the LR-BD-ZF scheme with and without antenna selection when SER is 10^{-2}.