PARALLEL BEAMFORMING DESIGN IN FULL DUPLEX SYSTEMS WITH PER-ANTENNA POWER CONSTRAINTS

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Introduction

- Full duplex doubles the spectral efficiency compared to half-duplex transmission.
- Strong self-interference (SI).
- Suppresses the SI to ground noise level.
- Antenna separation and analog domain suppression.
- Digital domain suppression.
- A majority of research on FD has focused on power reduction, rate maximization, and second-order approximations.
- High-complexity especially when the number of antennas or users becomes large.
- Parallel low-complexity beamforming design for large-scale networks.
- The minimum weighted downlink SINR is maximized to achieve a better trade-off between user requirement and fairness.
- Per-antenna power constraint is considered.
- Alternating direction method of multipliers (ADMM) is adopted.

System model

- FD-BS simultaneously serves $E_u$ downlink users and $E_u$ uplink users.
- FD-BS is equipped with $N_u = N_d$ antennas.
- The transmitted downlink signal is $x_u = \sum_m w_m y_m$.
- The uplink signal sent by $E_d$ is $y_d = \sum_m w_m^* y_m$.

Minimum weighted downlink SINR maximization Problem

- Downlink transmission: The received SINR at $m$th downlink user is $\gamma_m = \frac{\|H_m y_d\|^2}{\|H_m y_d\|^2 + \sigma^2}$.
- Uplink transmission: The received SINR at $n$th uplink user is $\gamma_n = \frac{\|H_n^* x_u\|^2}{\|H_n^* x_u\|^2 + \sigma^2}$.

- Problem formulation:
  - Problem (I): 
    \[ \text{Maximize} \quad \frac{1}{N} \sum_{m=1}^{N_u} \psi_m \gamma_m \quad \text{s.t.} \quad \|H_{m,n}^* y_d - w_m^* y_m - x_u\|_2^2 \leq P \]
  - Problem (II): 
    \[ \text{Maximize} \quad \min_{m=1}^{N_u} \gamma_m \quad \text{s.t.} \quad \|H_{m,n}^* y_d - w_m^* y_m - x_u\|_2^2 \leq P \]

ADMM-based parallel beamforming design

- Proposition 1: The QP dual problem for this max-min fairness problem is
  \[ \text{Minimize} \quad \lambda \quad \text{s.t.} \quad \sum_{m=1}^{N_u} \gamma_m \geq \lambda \]

Step 1: Problem reformulation

- Introduce an non-negative parameter $\lambda$, problem (5) is rewritten as
  \[ \text{Maximize} \quad \frac{1}{N} \sum_{m=1}^{N_u} \psi_m \gamma_m \quad \text{s.t.} \quad \|H_{m,n}^* y_d - w_m^* y_m - x_u\|_2^2 \leq P \]

Step 2: Successive convex approximation (SCA)

- Problem (7) is solved iteratively and in each iteration, SCA is adopted.

ADMM-based parallel beamforming design

- Step 3: ADMM-based parallel beamforming design to solve problem (10)
  - Decouple problem (10) by introducing local variables of coupled variables $\{x_u(n), y_d(n), w_m(n)\}$, $\{x_u(n), y_d(n), w_m(n)\}$.

SIMULATION RESULTS

- We have proposed a low-complexity parallel beamforming algorithm to maximize the minimum weighted downlink SINR with uplink SINR constraints and per-antenna constraints in FD systems.
- The SCA-method and ADMM are utilized.
- Extensive numerical experiments have been carried out to evaluate the performance of our proposed scheme.

Conclusions

- From Fig. 6, the proposed SCA-ADMM scheme outperforms SCS schemes for both small- and large-scale systems, especially when $N_d = 50$.

References

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