Journal Watch
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Super-Resolution Channel Estimation for mmWave Massive MIMO With Hybrid Precoding

Contributions

- Iteratively reweighted super-resolution mmWave channel estimation
- Low complexity SVD based preconditioning

System Model

$$\mathbf{Y} = \mathbf{W}^H\mathbf{HPS} + \mathbf{N} = \mathbf{W}^H\mathbf{HX} + \mathbf{N}$$

$$\mathbf{H} = \sum_{l=1}^{L} z_l \mathbf{a}_R(\theta^{az}_{R,l}, \theta^{el}_{R,l})\mathbf{a}^H_T(\theta^{az}_{T,l}, \theta^{el}_{T,l}) = \mathbf{A}_R(\boldsymbol{\theta}'_R)\ diag(\mathbf{z}')\ \mathbf{A}^H_T(\boldsymbol{\theta}'_T)$$

$$\min_{\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T} \|\mathbf{z}\|_0 \quad s.t. \quad \|\mathbf{Y} - \mathbf{W}^H\mathbf{HX}\|_F \le \epsilon$$

Solution

$$\min_{\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T} G(\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T) \triangleq \left\{ \sum_{l=1}^{L} log(|z_l|^2+\delta) + \lambda\|\mathbf{Y}-\mathbf{W}^H\mathbf{H}\mathbf{X}\|_F^2 \right\}$$

$$\min_{\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T} S^{(i)}(\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T) \triangleq \left\{ \lambda^{-1}\mathbf{z}^H\mathbf{D}^{(i)}\mathbf{z} + \|\mathbf{Y}-\mathbf{W}^H\mathbf{H}\mathbf{X}\|_F^2 \right\}$$

$$\mathbf{D}^{(i)} \triangleq diag\left\{ (log(|z_l^{(i)}|^2+\delta))^{-1} \right\}$$

$$\mathbf{z}_{opt}^{(i)}(\boldsymbol{\theta}_R,\boldsymbol{\theta}_T) \triangleq arg \min_{\mathbf{z}} S^{(i)}(\mathbf{z},\boldsymbol{\theta}_R,\boldsymbol{\theta}_T)$$

- $\lambda = \min(d/r^{(i)}, \lambda_{max})$
- $\boldsymbol{\theta}_R$ & $\boldsymbol{\theta}_T$ found via Gradient Descent
- SVD based preconditioning performed to reduce complexity

Low-Complexity Multiuser MIMO Precoder Design Under Per-Antenna Power Constraints

Contributions

- Precoder design for MU-MIMO Systems with Per-Antenna Power Constraints (PAPC)
- Minimization of distance between Sum Power Constraint and PAPC decoders
- Iterative algorithm with Newton's method to solve the dual

System Model

$$\mathbf{y}_k = \mathbf{H}_k \mathbf{x} + \mathbf{n}_k, \quad \mathbf{x} = \sum_{k=1}^{K} \mathbf{W}_k \mathbf{b}_k$$

- $\mathbf{W} = [\mathbf{W}_1, \mathbf{W}_2, \ldots, \mathbf{W}_K]$
- SPC: $\mathbb{E}[tr(\mathbf{x}\mathbf{x}^H)] = tr(\mathbf{W}\mathbf{W}^H) \leq p_t$
- PAPC: $\mathbb{E}[diag(\mathbf{x}\mathbf{x}^H)] = diag(\mathbf{W}\mathbf{W}^H) \leq \mathbf{p}$

Solution

- ZF precoder for SPC: $\mathbf{W}_{SPC,k} = \mathbf{V}_k \mathbf{A}_k$
- ZF precoder for PAPC: $\mathbf{W}_k = \mathbf{V}_k \mathbf{B}_k$
- Distance between SPC and PAPC:
  $d(\mathbf{W}, \mathbf{W}_{SPC}) = \|\mathbf{W} - \mathbf{W}_{SPC}\|^2 = tr((\mathbf{W} - \mathbf{W}_{SPC})(\mathbf{W} - \mathbf{W}_{SPC})^H)$

$$\min_{\mathbf{W}} d(\mathbf{W}, \mathbf{W}_{SPC}) \quad s.t. \quad diag(\mathbf{W}\mathbf{W}^H) \leq \mathbf{p}$$

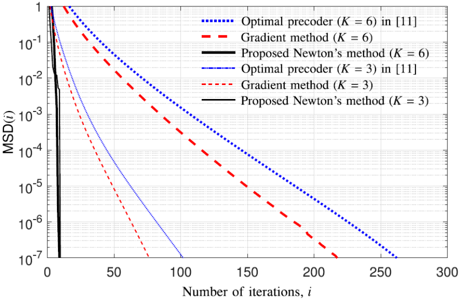
$$Primal: \quad \max_{\mathbf{B}} \sum_{k=1}^{K} tr(\mathbf{A}_k \mathbf{B}_k^H + \mathbf{B}_k \mathbf{A}_k^H)$$

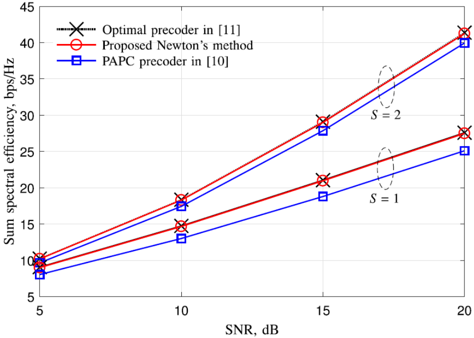
$$s.t. \quad diag(\sum_{k=1}^{K} \mathbf{V}_k \mathbf{B}_k \mathbf{B}_k^H \mathbf{V}_k^H) \leq \mathbf{p}$$

$$Dual: \quad \min_{\boldsymbol{\lambda}} tr\Big(\sum_{k=1}^{K} (\mathbf{V}_k^H \ diag(\boldsymbol{\lambda}) \ \mathbf{V}_k)^{-1} \mathbf{A}_k \mathbf{A}_k^H\Big) + \boldsymbol{\lambda}^T \boldsymbol{p}$$

$$s.t. \quad \boldsymbol{\lambda} \geq 0$$

- Slater's condition satisfied
- Newton Update: $\boldsymbol{\lambda}(i+1) = \boldsymbol{\lambda}(i) - \beta \phi^{-1} \bigtriangledown g$

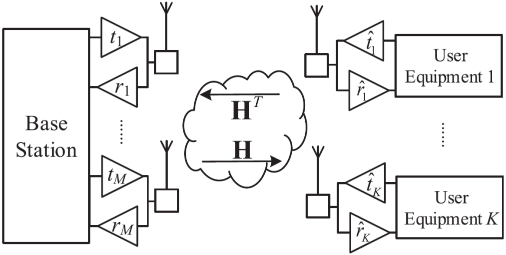




A General Matched Filter Design for Reciprocity Calibration in Multiuser Massive MIMO Systems

Contributions

- Design of Calibration matrix for TDD MU-MIMO System
- Maximization of SINR in the presence of reciprocity mismatch



System Model

- $\mathbf{H}_{UL} = diag(\{r_i\}_{i=1}^{M})\ \mathbf{H}^T\ diag(\{\hat{t}_j\}_{j=1}^{K}) = \mathbf{R}\mathbf{H}^T\hat{\mathbf{T}}$
- $\mathbf{H}_{DL} = diag(\{\hat{r}_j\}_{j=1}^{K})\ \mathbf{H}\ diag(\{r_i\}_{i=1}^{M}) = \hat{\mathbf{R}}\mathbf{H}\mathbf{T}$

- Downlink Channel:

$$\mathbf{y} = \sqrt{\rho_D}\mathbf{H}_{DL}\mathbf{W}\mathbf{x} + \mathbf{n}$$

- Precoding Matrix: $\mathbf{W} = \alpha\mathbf{C}\mathbf{H}_{UL}^*$

$$\Rightarrow \mathbf{y} = \sqrt{\rho_D}\alpha\mathbf{H}\mathbf{T}\mathbf{C}\mathbf{R}^*\mathbf{H}^H\mathbf{x} + \mathbf{n} = \sqrt{\rho_D}\tilde{\mathbf{H}}\mathbf{x} + \mathbf{n}$$

- Matched Filter: $\mathbf{C}_1 = \lambda\mathbf{T}^*\mathbf{R}^{-*} \Rightarrow \tilde{\mathbf{H}}_1 = \alpha\lambda\mathbf{H}\mathbf{T}(\mathbf{H}\mathbf{T})^H$
- Decorrelator: $\mathbf{C}_2 = \lambda\mathbf{T}^{-1}\mathbf{R}^{-*} \Rightarrow \tilde{\mathbf{H}}_2 = \alpha\lambda\mathbf{H}\mathbf{H}^H$
- Optimal C:

$$\max_{\mathbf{C}} R \equiv \max_{\mathbf{C}} \frac{|tr(\mathbf{T}\mathbf{C}\mathbf{R}^*)|^2}{\|\mathbf{T}\mathbf{C}\mathbf{R}^*\|_F^2 + \|\mathbf{C}\mathbf{R}^*\|_F^2/\rho_D}$$

Results

- Proposed design yields the below for perfect CSI

$$\mathbf{C}^{GMF} = \epsilon \mathbf{T}^* \mathbf{R}^{-*} \left(\mathbf{T}\mathbf{T}^* + \frac{\mathbf{I}_M}{\rho_D} \right)^{-1}$$

- Asymptotics:

$$\mathbf{C}^{GMF}_{\rho_D \to 0} = \epsilon \mathbf{T}^* \mathbf{R}^{-*}$$

$$\mathbf{C}^{GMF}_{\rho_D \to \infty} = \epsilon \mathbf{T}^{-1} \mathbf{R}^{-*}$$

- For imperfect CSI

$$\mathbf{C}^{RGMF} = \epsilon \mathbf{T}^* \mathbf{R} \left(\mathbf{T}\mathbf{T}^* \mathbf{R}\mathbf{R}^* + \frac{\mathbf{T}\mathbf{T}^*}{\rho_U} + \frac{\mathbf{R}\mathbf{R}^*}{\rho_D} + \frac{\mathbf{I}_M}{\rho_U \rho_D} \right)^{-1}$$

$$\mathbf{C}^{RGMF}_{\rho_D \to \infty, \rho_D \to 0} = \epsilon \mathbf{T}^{-1} \mathbf{R}$$

Other Interesting Papers

1. Compressed Sensing of Underwater Acoustic Signals via Structured Approximation l_0-Norm
2. Propagation Models and Performance Evaluation for 5G Millimeter-Wave Bands
3. On the Performance of Sliding Window TD-LMMSE Channel Estimation for 5G Waveforms in High Mobility Scenario
4. Partial CSI Acquisition for Size-Constrained Massive MIMO Systems With User Mobility
5. Secure Beamformer Designs in MU-MIMO Systems With Multiuser Interference Exploitation
6. Deep Learning for Super-Resolution Channel Estimation and DOA Estimation Based Massive MIMO System