Journal Watch

IEEE Transactions on Wireless Communication October 2016

B.Balaprasad

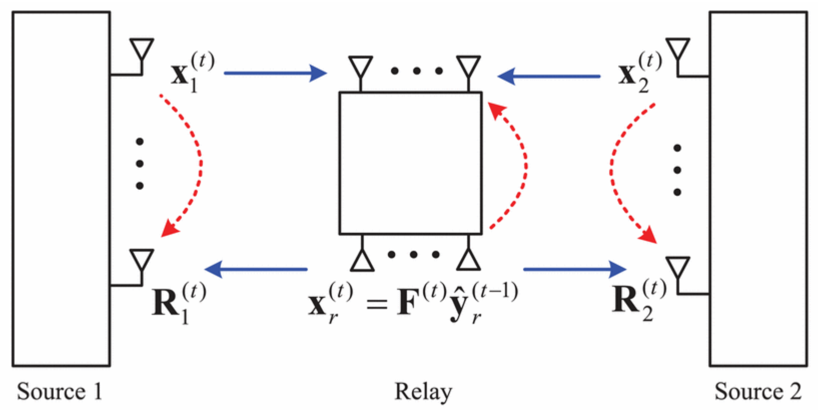
SPC Lab, IISc

Oct 22, 2016.

Beamforming Design for Full-Duplex Two-Way Amplify-and-Forward MIMO Relay
(Yeonggyu Shim,Wan Choi,Hyuncheol Park)

- Contributions
  - Optimized Relay Beamforming matrix
  - Optimized Receive Beamforming matrices at sources
- System Model
  - Consider a two-way FD AF relaying system consisting of two source nodes s_1 and s_2 with N_s antennas, and one relay node r with N_r antennas, where all nodes operate in the FD mode.
  - Channel links are modelled as Frequency-flat fading channels and assumed to be static in Time slot.
  - CSI between two nodes is assumed to be perfectly known.
  - CSI of the loopback channels is assumed to be imperfect.
  - focuses on loopback Self Interference.

System



$\mathbf{x}_1^{(t)}$
$\mathbf{x}_2^{(t)}$
$\mathbf{R}_1^{(t)}$
$\mathbf{x}_r^{(t)} = \mathbf{F}^{(t)}\hat{\mathbf{y}}_r^{(t-1)}$
$\mathbf{R}_2^{(t)}$
Source 1
Relay
Source 2

Received signals with imperfect loopback SI cancellation:

- At relay in time slot $t-1 (t \geq 2)$ is given by,

$$\begin{aligned}\hat{\mathbf{y}}_r^{(t-1)} =& \mathbf{H}_{1,r}^{(t-1)}\mathbf{x}_1^{(t-1)} + \mathbf{H}_{2,r}^{(t-1)}\mathbf{x}_2^{(t-1)} + \mathbf{n}_r^{(t-1)} \\ &+ \sum_{i=0}^{t-2} \Big\{ \prod_{j=1}^{t-1-i} (\boldsymbol{\Delta}_{r,r}^{(t-j)}\mathbf{F}^{(t-j)}) \\ &\times (\mathbf{H}_{1,r}^{(i)}\mathbf{x}_1^{(i)} + \mathbf{H}_{2,r}^{(i)}\mathbf{x}_2^{(i)} + \mathbf{n}_r^{(i)}) \Big\} \end{aligned} \tag{1}$$

- At source l is,

$$\begin{aligned}\hat{\mathbf{y}}_l^{(t)} =& \mathbf{H}_{r,l}^{(t)}\mathbf{F}^{(t)}\mathbf{H}_{\bar{l},r}^{(t-1)}\mathbf{x}_{\bar{l}}^{(t-1)} + \mathbf{H}_{r,l}^{(t)}\mathbf{F}^{(t)} \\ & \sum_{i=0}^{t-2} \left\{ \prod_{j=1}^{t-1-i} (\boldsymbol{\Delta}_{r,r}^{(t-j)}\mathbf{F}^{(t-j)})(\mathbf{H}_{l,r}^{(i)}\mathbf{x}_l^{(i)} + \mathbf{H}_{\bar{l},r}^{(i)}\mathbf{x}_{\bar{l}}^{(i)} + \mathbf{n}_r^{(i)}) \right\} \\ &+ \mathbf{H}_{r,l}^{(t)}\mathbf{F}^{(t)}\mathbf{n}_r^{(t-1)} + \boldsymbol{\Delta}_{l,l}^{(t)}\mathbf{x}_l^{(t)} + \mathbf{n}_l^{(t)}. \end{aligned} \tag{2}$$

$\mathbf{F}^{(t)}$, $\mathbf{R}_l^{(t)}$ are the relay Beamforming matrix and receive Beamforming matrix respectively.

- **MMSE Based Beamforming design**
  - Proposes an iterative algorithm which decouples the primal problem into two subproblems and solve them alternately; one is for relay beamforming design and the other is for receive beamforming design at sources.
- **Results:**
  - Closed form expressions for Relay Beamforming and Receive Beamforming matrices are derived.
  - An Iterative Algorithm is proposed for joint Beamforming Design.

Resource Allocation for D2D Communication Underlaid Cellular Networks Using Graph-Based Approach

(Tuong Duc Hoang,Long Bao Le,Tho Le-Ngoc)

- **Contributions**
  focuses on the radio resource allocation for D2D communications in cellular networks for the first scenario and the developed algorithm for scenario I is employed to tackle the resource allocation for scenario II
  - Novel Iterative Rounding algorithm is proposed solve the subband assignment problem based on the combination of linear programming and efficient rounding techniques. Specifically, each iteration solves a relaxed version of the subband assignment problem for unallocated subbands and network links.
- *Scenario I*: Each active (admitted) D2D link is assigned one subband and each subband is exploited by at most one D2D link.
- *Scenario II*:Each active (admitted) D2D link can be assigned multiple subbands and each subband is exploited by at most one D2D link.

- *Scenario III*:Each active (admitted) D2D link can be assigned multiple subbands and each subband can be exploited by multiple D2D links.
- **System model:**
  - The spectrum sharing problem among multiple D2D and cellular links in the uplink direction.
  - Let $\mathcal{N} = \{1, 2, ..., N\}$ with size $|\mathcal{N}| = N$ be the set of subbands in the system.
  - We denote $\mathcal{K}_c = \{1, 2, ..., K_c\}$ as the set of cellular links, $\mathcal{K}_d = \{K_c + 1..., K_c + K_d\}$as the set of D2D links, and $\mathcal{K} = \mathcal{K}_c \cup \mathcal{K}_d$ as the set of all communications links with size $|\mathcal{K}| = \mathcal{K}_c + \mathcal{K}_d = K$.
  - Assumption: Each subband can be allocated to at most one cellular and one D2D link.

- The signal to interference plus noise ratio (SINR) achieved by link $k \in \mathcal{K}$ on subband n can be expressed as

$$\Gamma_k^{[n]}(\mathbf{p}^{[n]}, \boldsymbol{\rho}^{[n]}) = \frac{\rho_k^{[n]} p_k^{[n]} h_{kk}^{[n]}}{\sigma_k^{[n]} + \sum_{l \in \mathcal{K} \setminus \mathcal{K}_k} \rho_l^{[n]} p_l^{[n]} h_{kl}^{[n]}}, \tag{3}$$

- The achievable rates of link $k \in \mathcal{K}$ on subband n and all the subbands can be expressed as

$$r_k^{[n]}(\mathbf{p}^{[n]}, \boldsymbol{\rho}^{[n]}) = \log_2\left(1 + \Gamma_k^{[n]}(\mathbf{p}^{[n]}, \boldsymbol{\rho}^{[n]})\right),$$

$$r_k(\mathbf{p}, \boldsymbol{\rho}) = \sum_{n \in \mathcal{N}} r_k^{[n]}(\mathbf{p}^{[n]}, \boldsymbol{\rho}^{[n]}),$$

- The considered resource allocation problem can now be formulated as

$$\max_{\mathbf{p},\boldsymbol{\rho}} \mathcal{R} = \sum_{k\in\mathcal{K}_c} \alpha r_k(\mathbf{p},\boldsymbol{\rho}) + \sum_{k\in\mathcal{K}_d} (1-\alpha) r_k(\mathbf{p},\boldsymbol{\rho})$$

- Solution:
  - we first characterize the optimal power allocation solution for a given subband assignment.
  - Based on this result, we formulate the subband assignment problem by using the graph-based approach, in which each link corresponds to a vertex and each subband assignment is represented by a hyper-edge.
  - We then propose an iterative rounding algorithm and an optimal branch-and-bound (BnB) algorithm to solve the resulting graph-based problem.

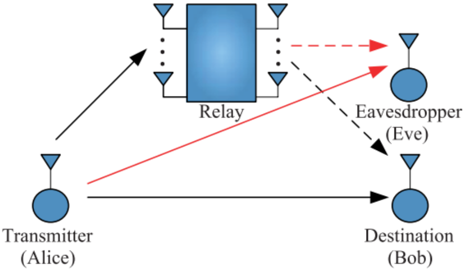
Secure Transmission in Cooperative Relaying Networks With Multiple Antennas

(Yuzhen Huang; Jinlong Wang; Caijun Zhong; Trung Q. Duong; George K. Karagiannidis)

- **Contributions**
  - For ZF/MRC and ZF/SC, we present novel closed-form lower and upper bounds for the secrecy outage probability and the probability of non-zero secrecy capacity, respectively, as well as a simple high SNR secrecy outage analysis.
  - For MRT/MRC and MRT/SC, closed-form approximations for the secrecy outage probability and the probability of non-zero secrecy capacity are provided, respectively.
  - For the CJ/ZF scheme, new exact closed-form expressions for the secrecy outage probability and the probability of non-zero secrecy capacity are derived.

- The analytical results suggest that the ZF/MRC (MRT/MRC) scheme always achieves better performance than that of the corresponding ZF/SC (MRT/SC) scheme. In addition, the ZF/MRC (ZF/SC) scheme outperforms the corresponding MRT/MRC (MRT/SC) scheme in the low SNR regime, while in the high SNR regime, the MRT/MRC (MRT/SC) scheme attains better secrecy performance than the corresponding ZF/MRC (ZF/SC) scheme.

System model: We consider a dual-hop multiple antenna AF relaying network, where both Alice (A), Bob (B), and Eve (E) are equipped with a single antenna, while the relay (R) is equipped with M antennas.



SNR of $A \rightarrow R \rightarrow B$ link is given by,

$$\gamma_{\mathrm{ARB}} = \frac{P_s}{\sigma^2} \frac{\left| \mathbf{h}_{\mathrm{RB}}^{\dagger} \mathbf{W} \mathbf{h}_{\mathrm{AR}} \right|^2}{1 + \left\| \mathbf{h}_{\mathrm{RB}}^{\dagger} \mathbf{W} \right\|_F^2}. \tag{4}$$

SNR of $A \rightarrow R \rightarrow E$ link can be derived as,

$$\gamma_{\mathrm{ARE}} = \frac{P_s}{\sigma^2} \frac{\left| \mathbf{h}_{\mathrm{RE}}^{\dagger} \mathbf{W} \mathbf{h}_{\mathrm{AR}} \right|^2}{1 + \left\| \mathbf{h}_{\mathrm{RE}}^{\dagger} \mathbf{W} \right\|_F^2}. \tag{5}$$

instantaneous SNRs of the main channel under MRC,

$$\gamma_{\mathrm{B_{MRC}}} = \gamma_{\mathrm{AB}} + \gamma_{\mathrm{ARB}}$$

$$\gamma_{\mathrm{E_{MRC}}} = \gamma_{\mathrm{AE}} + \gamma_{\mathrm{ARE}}.$$

The achievable secrecy capacity of the relaying wiretap channels is defined as,

$$C_S \triangleq \frac{1}{2}[\log_2(1+\gamma_{B_i}) - \log(1+\gamma_{E_{MRC}})]^+,$$

The SNR at B and E is maximized using different schemes.