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Known-Interference Aware Iterative MMSE Filter Design for Non-Regenerative Multi-Way Relaying

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***Abstract*—A multi-way relaying scenario is considered. Each node has to transmit an individual message and has to receive the messages of all other nodes. These multi-way communications between the multi-antenna nodes are performed via an intermediate non-regenerative multi-antenna relay station. An iterative MMSE approach is proposed to jointly design the transceive filter at the relay station and the receive filters at the nodes. For this approach, self- as well as known-interference cancellation are exploited at the nodes and are considered for the derivation of the relay transceive filter. The proposed iterative MMSE approach achieves significantly higher sum rates compared to conventional approaches.**

I. Introduction

Relaying techniques are highly beneficial in wireless communication systems to overcome shadowing effects, to increase the communication range, to improve the energy efficiency and to increase the achievable throughput [1].

In [2] and [3], the relay transceive filter design for one-way relaying with multiple antennas is investigated considering a single-pair scenario. Two-way relaying is proposed in [4] to overcome the duplexing loss of conventional one-way relaying schemes. In [5], non-regenerative multi-antenna two-way relaying in a single-pair scenario is investigated and a minimum mean square error (MMSE) relay transceive filter exploiting self-interference cancellation is derived. Non-regenerative multi-pair two-way relaying with single-antenna nodes and a multi-antenna relay station has been considered in [6]–[8]. The design of network codes for multi-user multi-hop networks has been investigated in [9] and references therein. Considering multi-antenna nodes and exploiting the multiplexing gain increases the achievable sum rates. The authors of [10], [11] investigate a pairwise communication of multi-antenna nodes via an intermediate multi-antenna relay.

Applications such as video conferences or multiplayer gaming as well as emergency or sensor network applications usually require the data exchange between multiple nodes. If each node of a group wants to share its data with all other nodes within its group, multi-way communications can be performed [1], [12]–[14]. To improve the performance of multi-way communications via an intermediate relay station, multi-antenna techniques can be exploited. In [1], the full-duplex multi-group multi-way relay channel is investigated. Non-regenerative multi-way relaying via a half-duplex multi-antenna relay station for a single group as well as for a multi-group scenario is considered in [12] and [13], [14], respectively. However, a joint a design of the filters at the multi-antenna nodes and at the multi-antenna relay station has not been investigated for multi-way relaying, so far.

In this paper, a single group multi-way relaying scenario consisting of multiple multi-antenna nodes and an intermediate half-duplex multi-antenna relay station is considered. For this scenario, an iterative MMSE approach is proposed to jointly design the relay transceive filter and the receive (Rx) filters at the nodes. For the filter design, the self- and known-interference cancellation capabilities of the nodes are exploited and weighting parameters are introduced to increase the achievable sum rates.

The remainder of the paper is organized as follows. In Section II, the system model is given. The iterative MMSE based filter design is introduced in Section III. Simulation results in Section IV confirm the analytical investigations and Section V concludes the paper. [3]

II. System Model

As shown in Figure 1, a single-group multi-way relaying scenario consisting of K multi-antenna nodes and a multi-antenna relay station, termed RS, is considered. The communications are performed via a single subcarrier and, in general, $K \geq 2$ nodes are considered. The term S_k, $k = 1, 2, ..., K$, is used to label the nodes. Each node is equipped with M antennas and all nodes simultaneously transmit one data stream per antenna. In the following, the system equations are presented in the equivalent baseband.

The transmit power at each node and at the relay station RS is limited by $P_{\mathrm{MS,max}}$ and $P_{\mathrm{RS,max}}$, respectively. The channel $\mathbf{H}_k \in \mathbb{C}^{L\times M}$ from node S_k to RS is assumed to be constant during one transmission cycle of the multi-way scheme which is described in the following and channel

[3] Throughout this paper, boldface lower case and upper case letters denote vectors and matrices, respectively, while normal letters denote scalar values. The superscripts $(\cdot)^{\mathrm{T}}$, $(\cdot)^*$ and $(\cdot)^{\mathrm{H}}$ stand for matrix or vector transpose, complex conjugate and complex conjugate transpose, respectively. The operator $\otimes$ denotes the Kronecker product of matrices. The operators $|\cdot|$, $||\cdot||_2$, $||\cdot||_{\mathrm{F}}$ denote the norm of a complex number, the Euclidean norm of a complex vector and the Frobenius norm of a complex matrix, respectively. The operators $\Re[\cdot]$ and $\mathrm{E}[\cdot]$ denote the real part of a scalar or a matrix and the expectation over the random variables within the brackets, respectively. The vectorization operator $\mathrm{vec}(Z)$ stacks the columns of matrix Z into a vector. The operator $\mathrm{vec}^{-1}_{M,N}(\cdot)$ is the revision of the operator $\mathrm{vec}(\cdot)$, i.e., a vector of length MN is sequentially divided into N smaller vectors of length M which are combined to a matrix with M rows and N columns. $\mathbf{I}_M$ denotes an identity matrix of size M.

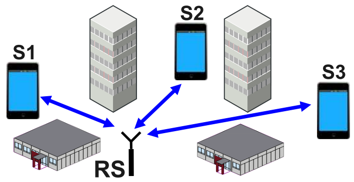

Fig. 1. Multi-way relaying scenario consisting of $K = 3$ multi-antenna nodes and a multi-antenna relay station, termed RS.

reciprocity is assumed. RS is assumed to have perfect channel state information (CSI) and the nodes have receive CSI and can subtract self- and known-interferences. All signals are assumed to be statistically independent and the noise at RS and at the nodes is assumed to be additive white Gaussian with variances $\sigma^2_{\mathrm{n,RS}}$ and σ^2_{n}, respectively. The transmit signal of S_k is given by $\mathbf{s}_k \in \mathbb{C}^{M\times 1}$ with $\mathrm{E}[\mathbf{s}_k\mathbf{s}_k^{\mathrm{H}}] = \mathbf{I}_M$ and the transmit filter at S_k is assumed to be $\mathbf{Q}_k = \sqrt{\frac{P_{\mathrm{MS,max}}}{M}} \cdot \mathbf{I}_M$. In the first time slot $t = 1$, all nodes are simultaneously transmitting to RS and the received signal at RS is given by

$$\mathbf{y}_{\mathrm{RS}} = \sum_{k=1}^{K} \mathbf{H}_k\mathbf{Q}_k\mathbf{s}_k + \mathbf{n}_{\mathrm{RS}}, \tag{1}$$

where $\mathbf{n}_{\mathrm{RS}}$ represents the complex white Gaussian noise vector at RS. Afterwards, the transmissions from RS to the nodes are performed in $K-1$ time slots. Thus, K time slots are required to perform the multi-way communications of all nodes. In time slots $t = 2$, $t = 3$,..., $t = K$, RS linearly processes the received signal $\mathbf{y}_{\mathrm{RS}}$ using the transceive filter matrices $\mathbf{G}_2$, $\mathbf{G}_3$,..., $\mathbf{G}_K$, respectively, and retransmits the linearly processed signals back to the nodes. The received signal $\mathbf{y}_{\mathrm{S}_{k,t}}$ using the Rx filter $\mathbf{D}_{k,t} \in \mathbb{C}^{M\times M}$ at node S_k in time slot t is given by

$$\mathbf{y}_{\mathrm{S}_{k,t}} = \mathbf{D}_{k,t}(\mathbf{H}_k^{\mathrm{T}}\mathbf{G}_t\mathbf{y}_{\mathrm{RS}} + \mathbf{n}_{k,t}), \tag{2}$$

where $\mathbf{n}_{k,t}$ represents the complex white Gaussian noise vector at S_k [14].

To perform the retransmissions at RS, we consider the network coding multi-way (NCMW) transmit strategy of [14]. Thus, the signal $\mathbf{s}_u$, termed unicast (UC) signal, is desired at node S_{m_t} and the signal $\mathbf{s}_{m_t}$, termed multicast (MC) signal, is desired at the remaining nodes in time slot t, where u and m_t are the indices of the UC and the MC signal in time slot t, respectively. We assume that $u = 1$ and $m_t = t$ as it is considered in [14]. Furthermore, self- and known-interferences are considered. The signal $\mathbf{s}_k$ is considered as self-interference at node S_k and the signal $\mathbf{s}_u$ is considered as known-interference at the nodes which desire the MC signal. Additionally, the signals which have been considered as a desired signal at node S_k in a previous time slot are considered as known-interferences at node S_k in time slot t [14]. The indices of the signals which are considered as self- or known-interferences at node S_k in time slot t are collected in the subset $\mathcal{N}_{k,t}$. To cancel self- and known-interferences, the overall channels $\mathbf{H}_k^{\mathrm{T}}\mathbf{G}_t\mathbf{H}_l\mathbf{Q}_l, \forall l \in \mathcal{N}_{k,t}$ are assumed to be perfectly known at S_k.

Let us consider the channel coefficient $h_{k,l,t,i}$ for the transmission of the i^{th} data stream from S_k to S_l in time slot t given by $h_{k,l,t,i} = \mathbf{d}_{l,t,i}\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{H}_k\mathbf{q}_{k,i}$, where $\mathbf{q}_{k,i}$ is the i^{th} column vector of $\mathbf{Q}_k$ and $\mathbf{d}_{l,t,i}$ is the i^{th} row vector of $\mathbf{D}_{l,t}$. Furthermore, let us consider the channel vector $\mathbf{g}_{j,l,t,i} = \mathbf{d}_{l,t,i}\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{H}_j\mathbf{Q}_j$. Now, the signal-to-interference-plus-noise ratio (SINR) after self- and known-interference cancellation for the transmission of the i^{th} data stream from S_k to S_l in time slot t with $k = m_t$ if $l \neq m_t$ and $k = u$ if $l = m_t$ can be written as

$$\mathrm{SINR}_{k,l,t,i} = \frac{|h_{k,l,t,i}|^2}{\sum_{j=1, j\neq\mathcal{N}_{l,t}}^{K} \left(\|\mathbf{g}_{j,l,t,i}\|_2^2\right) - |h_{k,l,t,i}|^2 + \sigma^2_{\mathrm{n},l,t}}, \tag{3}$$

where $\sigma^2_{\mathrm{n},l,t} = \sigma^2_{\mathrm{n,RS}}||\mathbf{d}_{l,t,i}\mathbf{H}_k^{\mathrm{T}}\mathbf{G}_t||_2^2 + ||\mathbf{d}_{l,t,i}||_2^2\sigma^2_{\mathrm{n}}$ is the expected received noise power at S_k in time slot t, $k = 1, 2, ..., K$.

The achievable multi-way rate for the transmission of the i^{th} data stream of S_k is determined by the minimum over the achievable rates to any node. Thus, assuming that optimal Gaussian codebooks are used for each data stream, the achievable multi-way rates for the UC and the MC signals after linear receive processing and self- and known-interference cancellation at the nodes are given by

$$C_{\mathrm{UC}} = \frac{K-1}{K}\sum_{i=1}^{M}\min_{t, t\neq 1} \log_2(1 + \mathrm{SINR}_{u,m_t,t,i}), \tag{4a}$$

$$C_{\mathrm{MC}} = \frac{K-1}{K}\sum_{i=1}^{M}\sum_{t=2}^{K}\min_{l, l\neq m_t} \log_2(1 + \mathrm{SINR}_{m_t,l,t,i}), \tag{4b}$$

respectively. Thus, the achievable sum rate is given by

$$C_{\mathrm{sum}} = C_{\mathrm{UC}} + C_{\mathrm{MC}}. \tag{5}$$

III. Iterative MMSE based filter design

In this section, we propose a self- and known-interference aware iterative weighted MMSE filter design, termed Iterative WMMSE-SKI, to increase the achievable sum rates using the NCMW transmit strategy introduced in [14]. The sum rate maximization is a non-convex problem and an analytical solution cannot be obtained. Thus, we propose to tackle the sum rate maximization by a weighted MMSE approach as considered in [15] for the multiple-input multiple-output (MIMO) broadcast channel.

We propose a suboptimal weighted MMSE approach considering weighting parameters $v_{k,t}$ for weighting the mean square error (MSE) at each node. For given Rx filters $\mathbf{D}_{k,t}$ at the nodes, the MMSE problem is convex with respect to the relay transceive filter $\mathbf{G}_t$ and an analytical solution can be obtained. For a given $\mathbf{G}_t$, the MMSE problem is convex with respect to the Rx filters $\mathbf{D}_{k,t}$ and an analytical solution can be obtained as well. However, the MMSE solution for $\mathbf{G}_t$ depends on $\mathbf{D}_{k,t}$ and vice versa. Thus, to jointly optimize $\mathbf{G}_t$ and $\mathbf{D}_{k,t}$, we propose an alternating optimization between the relay transceive filter $\mathbf{G}_t$ and the Rx filters $\mathbf{D}_{k,t}$ at the nodes.

This alternating optimization can be performed solely at RS and no signaling is required because the nodes can determine the Rx filters based on the CSI of the overall channels. For the proposed approach, the weighting parameters are numerically optimized to achieve high sum rates (5).

In the following, the transceive filter design at RS is presented assuming given Rx filters $\mathbf{D}_{k,t}$ at the nodes. Afterwards, the Rx filter design at the nodes is presented assuming a given relay transceive filter $\mathbf{G}_t$ for each time slot t. Finally, an alternating optimization between the relay transceive filter $\mathbf{G}_t$ and the Rx filters $\mathbf{D}_{k,t}$ at the nodes is proposed for each time slot t.

A. Relay transceive filter design

In the following, we extend the MMSE-SKI filter of [14] by considering the weighting parameters $v_{k,t}$, $0 \leq v_{k,t} \leq 1$. For the MMSE based relay transceive filter design, we consider that the nodes can scale the received signals by introducing a receive coefficient α_t. By this approach, the MMSE solution for $\mathbf{G}_t$ also considers the noise powers at the nodes. Thus, the joint optimization problem for the relay transceive filter and the receive coefficient α_t with respect to the transmit power constraint at RS in time slot t is considered which is given by

$$\{\alpha, \mathbf{G}_t\} = \underset{\alpha,\mathbf{G}_t}{\arg\min}\ \mathrm{E}\left[\sum_{l=1}^{K} v_{l,t}||\mathbf{s}_k - \alpha_t \hat{\mathbf{s}}_{k,l}||_2^2\right], \tag{6a}$$

$$\text{s.t.} \sum_{l=1}^{K} ||\mathbf{G}_t\mathbf{H}_l\mathbf{Q}_l||_{\mathrm{F}}^2 + ||\mathbf{G}_t||_{\mathrm{F}}^2 \sigma_{\mathrm{n,RS}}^2 \leq P_{\mathrm{RS}}, \tag{6b}$$

where $k = m_t$ if $l \neq m_t$ or $k = u$ if $l = m_t$ is the index of the desired MC or UC signal at S_l in time slot t, respectively, and

$$\hat{\mathbf{s}}_{k,l} = \mathbf{D}_{l,t}\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t \sum_{\substack{j=1 \\ j\notin\mathcal{N}_{l,t}}}^{K} \mathbf{H}_j\mathbf{Q}_j\mathbf{s}_j + \mathbf{D}_{l,t}(\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{n}_{\mathrm{RS}} + \mathbf{n}_{l,t}). \tag{7}$$

is the estimate of $\mathbf{s}_k$ at node S_l. Thus, the MSE for the transmission from S_k to S_l in time slot t is given by

$$\begin{aligned}\mathrm{E}\left[||\mathbf{s}_k - \alpha_t\hat{\mathbf{s}}_{k,l}||_2^2\right] &= M - 2\Re\left[\mathrm{tr}\left(\alpha_t\mathbf{D}_{l,t}\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{H}_k\mathbf{Q}_k\right)\right] \\ &+ |\alpha_t|^2\mathrm{tr}\left(\sum_{\substack{j=1 \\ j\notin\mathcal{N}_{l,t}}}^{K} \mathbf{D}_{l,t}\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\boldsymbol{\Upsilon}^{(j)}\mathbf{G}_t^{\mathrm{H}}\mathbf{H}_l^{*}\mathbf{D}_{l,t}^{\mathrm{H}}\right) \\ &+ |\alpha_t|^2\mathrm{tr}\left(\mathbf{D}_{l,t}\left(\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{G}_t^{\mathrm{H}}\mathbf{H}_l^{*} + \sigma_{\mathrm{n}}^2\mathbf{I}_M\right)\mathbf{D}_{l,t}^{\mathrm{H}}\right).\end{aligned} \tag{8}$$

Assuming α_t to be positive real-valued, a unique solution for problem (6) can be obtained by using Lagrangian optimization. Let matrices $\boldsymbol{\Upsilon}^{(k)}$ and $\boldsymbol{\Upsilon}$ be given by

$$\boldsymbol{\Upsilon}^{(k)} = \mathbf{H}_k\mathbf{Q}_k\mathbf{Q}_k^{\mathrm{H}}\mathbf{H}_k^{\mathrm{H}}, \tag{9a}$$

$$\boldsymbol{\Upsilon} = \sum_{k=1}^{K} \mathbf{H}_k\mathbf{Q}_k\mathbf{Q}_k^{\mathrm{H}}\mathbf{H}_k^{\mathrm{H}} + \sigma_{n,\mathrm{RS}}^2\mathbf{I}_L. \tag{9b}$$

Using matrices $\boldsymbol{\Upsilon}^{(k)}$ and $\boldsymbol{\Upsilon}$ of (9) in (6), the Lagrangian function with the Lagrangian multiplier η results in

$$\begin{aligned}L\left(\mathbf{G}_t, \alpha_t, \eta\right) = &\sum_{l=1}^{K} v_{l,t}F(\mathbf{G}_t, \alpha_t, l) \\ &- \eta\left(\mathrm{tr}\left(\mathbf{G}_t\boldsymbol{\Upsilon}\mathbf{G}_t^{\mathrm{H}}\right) - P_{\mathrm{RS,max}}\right),\end{aligned} \tag{10}$$

where k is again the index of the desired UC or MC signal at S_l in time slot t and $F(\mathbf{G}_t, \alpha_t, l) = \mathrm{E}\left[||\mathbf{s}_k - \alpha_t\hat{\mathbf{s}}_{k,l}||_2^2\right]$ of (8). From the Lagrangian function, the Karush-Kuhn-Tucker (KKT) conditions can be derived and the Lagrangian multiplier η can be computed [14]. To solve the optimization problem by using the KKT conditions, we define the matrix $\mathbf{K}_t$

$$\begin{aligned}\mathbf{K}_t = &\sum_{l=1}^{K}\sum_{\substack{j=1 \\ j\notin\mathcal{N}_{l,t}}}^{K} v_{l,t}\left[\boldsymbol{\Upsilon}^{(j)\mathrm{T}} \otimes \left(\mathbf{H}_l^{*}\mathbf{D}_{l,t}^{\mathrm{H}}\mathbf{D}_{l,t}\mathbf{H}_l^{\mathrm{T}}\right)\right] \\ &+ \sum_{l=1}^{K} v_{l,t}\left[\sigma_{\mathrm{n,RS}}^2\mathbf{I}_L \otimes \left(\mathbf{H}_l^{*}\mathbf{D}_{l,t}^{\mathrm{H}}\mathbf{D}_{l,t}\mathbf{H}_l^{\mathrm{T}}\right)\right] \\ &+ \left[\boldsymbol{\Upsilon}^{\mathrm{T}} \otimes \frac{KM\sigma_n^2}{P_{\mathrm{RS,max}}}\mathbf{I}_L\right].\end{aligned} \tag{11}$$

Thus, the weighted transceive filter at RS which solves problem (6) is given by [14],

$$\mathbf{G}_t = \frac{1}{\alpha_t}\cdot\mathrm{vec}_{L,L}^{-1}\left(\mathbf{K}_t^{-1}\ \mathrm{vec}\left(\sum_{l=1}^{K} v_{l,t}\mathbf{H}_l^{*}\mathbf{D}_{l,t}^{\mathrm{H}}\mathbf{Q}_k^{\mathrm{H}}\mathbf{H}_k^{\mathrm{H}}\right)\right), \tag{12}$$

where k is again the index of the desired signal at S_l in time slot t and

$$\alpha_t = \sqrt{\frac{\mathrm{tr}\left(\widetilde{\mathbf{G}}_t\boldsymbol{\Upsilon}\widetilde{\mathbf{G}}_t^{\mathrm{H}}\right)}{P_{\mathrm{RS,max}}}}, \tag{13}$$

with the auxiliary matrix $\widetilde{\mathbf{G}}_t$ given by

$$\widetilde{\mathbf{G}}_t = \mathrm{vec}_{L,L}^{-1}\left(\mathbf{K}_t^{-1}\ \mathrm{vec}\left(\sum_{l=1}^{K} v_{l,t}\mathbf{H}_l^{*}\mathbf{D}_{l,t}^{\mathrm{H}}\mathbf{Q}_k^{\mathrm{H}}\mathbf{H}_k^{\mathrm{H}}\right)\right). \tag{14}$$

B. Receive filter design at nodes

To compute the Rx filters at the nodes in time slot t, let us assume a given relay transceive filter $\mathbf{G}_t$. Now, the overall MIMO channel for the transmission from S_k to S_l and the overall noise at S_l in time slot t can be written as

$$\mathbf{H}_{k,l,t} = \mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{H}_k\mathbf{Q}_k, \tag{15}$$

$$\mathbf{N}_{l,t} = \sigma_{\mathrm{n,RS}}^2\mathbf{H}_l^{\mathrm{T}}\mathbf{G}_t\mathbf{G}_t^{\mathrm{H}}\mathbf{H}_l^{*} + \mathbf{I}_M\sigma_{\mathrm{n}}^2, \tag{16}$$

respectively. Thus, the MMSE Rx filters in time slot t can be obtained according to [16] by

$$\mathbf{D}_{l,t} = \frac{\mathbf{H}_{k,l,t}^{\mathrm{H}}\left(\mathbf{H}_{k,l,t}\mathbf{H}_{k,l,t}^{\mathrm{H}} + \mathbf{N}_{l,t}\right)^{-1}}{||\mathbf{H}_{k,l,t}^{\mathrm{H}}\left(\mathbf{H}_{k,l,t}\mathbf{H}_{k,l,t}^{\mathrm{H}} + \mathbf{N}_{l,t}\right)^{-1}||_{\mathrm{F}}}, \tag{17}$$

where $k = m_t$ if $l \neq m_t$ or $k = u$ if $l = m_t$ is again the index of the desired signal at S_l in time slot t, $l = 1, 2, ..., K$.

C. Alternating optimization

To jointly design the relay transceive filter and the Rx filters at the nodes, we propose an alternating optimization as follows

1) compute $\mathbf{G}_t$ for time slot $t = 2, 3, ..., K$ according to (12) assuming $\mathbf{D}_{k,t} = \mathbf{I}_M$ and $v_{k,t} = 1\ \forall k, t$.
2) compute the Rx filters $\mathbf{D}_{k,t}$ at the nodes according to (17) for the $\mathbf{G}_t$'s of step 1).
3) perform a numerical optimization of the weighting parameters $v_{k,t}$ and compute $\mathbf{G}_t$ for time slot $t = 2, 3, ..., K$ using the optimized weights and the $\mathbf{D}_{k,t}$'s of step 2).
4) repeat step 2) and 3) until the changes in the achievable sum rate (5) are comparatively small depending on the required accuracy.

To perform the numerical optimization of the weighting parameters, the $v_{k,t}$'s which achieve the highest sum rate C_{sum} (5) are selected.

IV. Simulation Results

In this section, numerical results on the achievable sum rates for the proposed NCMW transmission strategy are presented. It is assumed that $P_{\text{MS,max}} = P_{\text{RS,max}}$ and $\sigma^2_{\text{RS}} = \sigma^2_{\text{n}}$. The path-loss on the i.i.d. Rayleigh fading channels is represented by an average receive signal to noise ratio (SNR) at RS. An average receive SNR at RS of 15dB is assumed.

For comparison, the MMSE and zero-forcing (ZF) relay transceive filters of [13] are considered using the hybrid uni-/multicasting strategy presented in [13]. Furthermore, the MMSE-SKI approach of [14] is considered. For all approaches, it is assumed that self- and known-interference cancellation can be performed at the nodes.

The average achievable sum rates over different numbers L of antennas at RS for a scenario with $K = 4$ multi-antenna nodes are shown in Fig. 2 considering $M = 2$ antennas at each node. The ZF relay transceive filter requires $L \geq 8$ antennas to separate the signals at RS. The proposed Iterative WMMSE-SKI approach clearly outperforms the other approaches due to a joint design of the Rx filters at the nodes and the relay transceive filter and due to considering weighting parameters for increasing the sum rate, e.g. the gain of the proposed Iterative WMMSE-SKI approach compared to the MMSE-SKI approach of [14] is approximately 34% for $L = 8$.

V. Conclusions

A non-regenerative multi-group multi-way relaying scenario has been investigated. An iterative MMSE based filter design has been proposed to jointly design the relay transceive filter and the receive filters at the nodes. The proposed filter design achieves significantly higher sum rates compared to conventional approaches.

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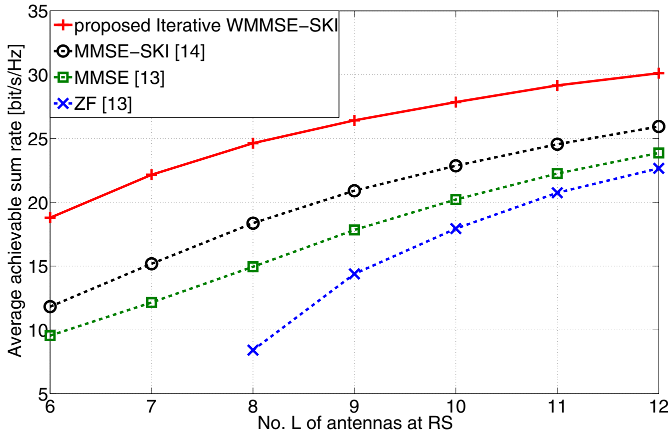

Fig. 2. Average achievable sum rates over number L of antennas at RS for multi-antenna nodes, $K = 4$, $M = 2$.

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