Channel Estimation of Frequency Selective Channels Using Sparse PARAFAC Model

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***Abstract*—The abstract goes here.**

I. Introduction

Notation: A scalar is denoted in italic, e.g. a. A column vector is a bold lowercase letter, e.g. $\mathbf{a}$ whose ith entry is $\mathbf{a}(i)$. A matrix is denoted by a bold uppercase letter, e.g. $\mathbf{A}$ with (i,j)th entry $\mathbf{A}(i,j)$; $\mathbf{A}(:,j)$ is the jth column of $\mathbf{A}$. A third-order tensor is a caligrafic uppercase letter, e.g. $\mathcal{A}$ with (i,j,k)th entry $\mathcal{A}(i,j,k)$. The vec $\{.\}$ operator stacks the columns of its argument into one big column vector; $\otimes$ stands for the Kronecker product and $\odot$ is the Khatri-Rao product (column-wise Kronecker product) [1], [2].

II. System Model

Consider a single user multiple-input multiple-output (MIMO) system with transmitter and receiver equipped with N_t and N_r antennas, respectively. Assume that both transmitter and receiver have a hybrid beamforming structure with M_t and M_t chains.

Consider a $N_r \times N_t$ channel matrix between transmitter and receiver composed by a summation of N_c delay tap matrices $\mathbf{H}_d$, $d = \{0, 1, \ldots, N_c - 1\}$. The variable ρ denotes the average received power and $\mathbf{z}_n \sim \mathcal{N}(0, \sigma^2\mathbf{I})$ the circularly symmetric complex Gaussian distributed noise vector, therefore, the received signal is expressed as

$$\mathbf{r}_{i,n} = \sqrt{\rho} \sum_{d=0}^{N_c-1} \mathbf{H}_d \mathbf{f}_i s_{n-d} + \mathbf{z}_{i,n}, \tag{1}$$

where s_n is the nth non-zero of the training frame of length $N + N_c - 1$

$$\mathbf{s} = [0, \ldots, 0, s_1, s_2, \ldots, s_N]. \tag{2}$$

At the receiver, and a $radiofrequency(RF)$ combiner $\mathbf{w}_k$ is applied over the training frame, so that the combiner output is expressed as

$$y_{k,i,n} = \sqrt{\rho}\mathbf{w}_k^T \sum_{d=0}^{N_c-1} \mathbf{H}_d \mathbf{f}_i s_{n-d} + z_{k,i,n}, \tag{3}$$

where $z_{k,i,n} = \mathbf{w}_k^H \mathbf{z}_{i,n}$ The output signal can described in term of tensor notation

$$y_{k,i,n} = \mathcal{H} \times_1 \mathbf{w}_k \times_2 \mathbf{f}_i \times \mathbf{s}_n, \tag{4}$$

where $\mathcal{H}$ is generated from the concatenation in the third dimension of the N_c delay taps. Assuming a collection of transmitter and receiver beams, i.e. $i = \{1, \ldots, I\}$ and $k = \{1, \ldots, K\}$, respectively, and the N time instants within the training frame, we can express the signal model as the third-order tensor [1], [3]

$$\mathcal{Y} = \mathcal{H} \times_1 \mathbf{W} \times_2 \mathbf{F} \times_3 \mathbf{S} + \mathcal{Z} \times_1 \mathbf{W}, \tag{5}$$

where $\mathbf{S}$ is toeplitz because there is a convolution operation over the third dimension.

III. Conclusion

The conclusion goes here.

Acknowledgment

References

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