비직교다중접속 기반 바이스터틱 백스캐터러 통신

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Bistatic Backscatter Communication with NOMA

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요 약

We consider a bistatic backscatter communication network with a multi-antenna transmitter and reader supporting multiple backscatter devices. For the system, the rate fairness is maximized by optimizing the transmit beamforming, the receive beamforming and the power fraction reflected by the devices.

Ⅰ. Introduction

Backscatter communication (BC) transmits the data by reflecting an incident signal, has been considered as a encouraging nominee for the low power Internet of Things (IoT) [1]. This paper considers a bistatic BC network (BCN) with multiple backscatter devices in nonorthogonal multiple access (NOMA). For the system, the beamformings (BF) and power fraction are optimized to maximize the fairness.

Ⅱ. System model and problem formulation

Consider a bistatic BCN with a transmitter and a reader equipped with N_t and N_r antennas respectively and K single antenna devices. We assume channel reciprocity and independent Rayleigh fading. The channel between the k-th BD and the transmitter and the reader are denoted by $\boldsymbol{g}_k \sim \mathbb{CN}(\boldsymbol{0}, \omega_{t,k}\boldsymbol{I}_{N_t})$ and $\boldsymbol{h}_k \sim \mathbb{CN}(\boldsymbol{0}, \omega_{r,k}\boldsymbol{I}_{N_r})$, where $\omega_{i,k} = 10^{-3} d_{i,k}^{2.5}$ is the path loss at the distance $d_{i,k}$. The transmit signal to all the BDs is $\sqrt{P_T}\boldsymbol{v}$, where P_T is the transmit power and $\boldsymbol{v}$ is the BF vector with $\|\boldsymbol{v}\|^2 \leq 1$. If we assume that the self-interference is canceled perfectly [2], the backscatter signals received at the reader are expressed as

$$\boldsymbol{y} = \sum_{l=1}^{K} \sqrt{P_T \beta_k} \boldsymbol{h}_l \boldsymbol{g}_l^T \boldsymbol{v} s_l + \boldsymbol{n} \qquad (2)$$

where $\beta_k \in [0,1]$ is the power fraction, s_k is the symbol from the k-th BD with $E\left[|s_k|^2\right] = 1$, and $\boldsymbol{n} \sim \mathbb{CN}(\boldsymbol{0}_{M\times 1}, \sigma^2 \boldsymbol{I}_M)$ is the noise at the reader. The SINR in detecting the symbol s_k is given as

$$\gamma_k = \frac{P_T \beta_k |\boldsymbol{w}_k^H \boldsymbol{h}_k \boldsymbol{g}_k^T \boldsymbol{v}|^2}{\sum_{l>k}^{K} P_T \beta_l |\boldsymbol{w}_k^H \boldsymbol{h}_l \boldsymbol{g}_l^T \boldsymbol{v}|^2 + \sigma^2 \|\boldsymbol{w}_k\|^2} \qquad (3)$$

where $\boldsymbol{w}_k$ is the receive BF for the k-th BD.

This paper aims at maximizing the rate fairness of the BDs by optimizing receive BF (RB), transmit BF (TB) and reflection coefficients (RC). This is equivalent to max-min SINR as

$$\max_{\boldsymbol{W}, \boldsymbol{v}, \boldsymbol{\beta}} \left\{ \min_{1 \leq k \leq K} \log_2 \gamma_k \right\} \quad \text{s.t. } \|\boldsymbol{v}\|^2 \leq 1,\ \boldsymbol{\beta} \leq 1. \qquad (4)$$

where $\boldsymbol{W} = [\boldsymbol{w}_1, \boldsymbol{w}_2, ..., \boldsymbol{w}_K]$ and $\boldsymbol{\beta} = [\beta_1, \beta_2, \cdots, \beta_K]^T$. The problem (4) can be solve by the alternating optimization algorithm proposed in [3] that is derived without resorting the SINR balancing condition.

Ⅲ. Numerical results and conclusions

For performance evaluation, we consider $M = 4$, $K = 8$, $P_t = 1$ W, $\sigma^2 = -90$ dBm, BDs are located at a distance d from the transmitter, which is at 10 m from the reader. In Fig. 1, the average max-min rate obtained with the alternating algorithm of the RB, TB and RC. The results show a significant gain when the TB or RC are optimized with SIC in the average max-min rate.

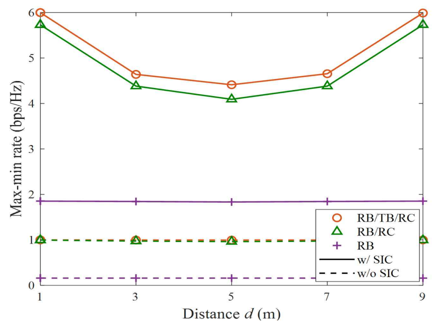

Fig. 1 Max-min rate of a bistatic BC according the location of with 10 m distance between the source and reader when $M = 4$ and $K = 8$.

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References

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