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Impact of Multiple Detection Terminals on the Error Performance in Collaborative MIMO Reception Systems

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In MIMO transmission systems, a novel form of receiver system is a terminal-collaborated MIMO reception system in which signals from a base station (BS) are shared and collaboratively decoded by nearby mobile terminals. In this paper, we present a new scheme to improve the transmission performance of the terminal collaborative MIMO reception system while reducing the amount of collaboration traffic, and evaluate the error performance through computer simulation.

Consider a system shown in Figure 1. In this system [1], h helper terminals and d detection terminals are prepared in a terminal collaboration group. The helper terminal forwards the detection terminals a digitized received waveform after receiving the signal from the base station. Each detection terminal receives the digitized waveform from the helper terminals and the signal sent from the base station, and thus obtains a different decision result. These decision results are expected to improve the transmission performance while reducing the increase in collaboration traffic because the amount of traffic of the decision results is small. In this study, frequency-domain iterative equalization is employed. The residual error coefficient β obtained by this equalization is used as reliability information. The residual error coefficient β has a strong correlation with bit error ratio (BER) performance. In each frame, the decision result of the i^*-th detection terminal having the minimum β is selected as a final decision.

$$i^* = \underset{i\in\{1,\cdots,d\}}{\arg\min}\, \beta(i) \tag{1}$$

The BS employed four transmit antennas and transmitted four independent signal streams. The transmission packet was composed of QPSK-modulated data sequence of 192 symbols. The normalized maximum Doppler frequency $f_D T_s$ was 6.4×10^{-5}. The amount of collaboration traffic volume was calculated in a unit of a detected bit sequence (DBS). If the detection terminal transferred a DBS of a single stream to the target terminal, the number of transferred DBS (TDBS) increased by one. The collaboration traffic for waveform forwarding was calculated based on the assumption that both I and Q components were linearly quantized at 8 bits. The channel was frequency-flat i.i.d. Rayleigh fading and the average SNR was 10 dB. Figure 2 shows that increasing the number of detection terminals d improves the BER performance with a slight increase in traffic volume. It is also shown that increasing the number of helper terminals h effectively improves the BER performance but significantly increases the amount of traffic.

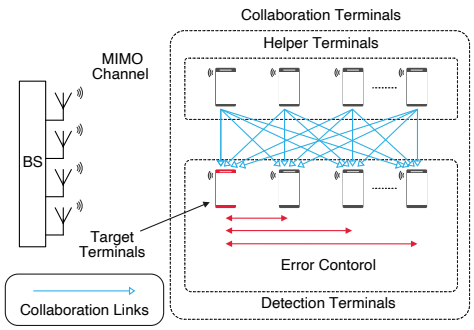

Figure 1. System model.

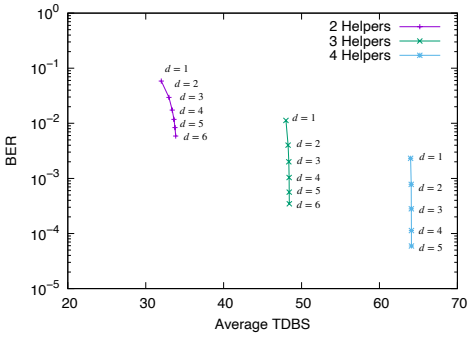

Figure 2. BER performance versus average TDBS.

References

[1] H. Taromaru, H. Murata, T. Nakahira, D. Murayama, and T. Moriyama, "Error control on mobile station sides in collaborative multiple-input multiple-output systems," IEEE Access, Vol. 10, pp. 26493–26500, Mar. 2022.