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Efficient detection methods for amplify-and-forward relay-aided device-to-device systems with full-rate space-time block code

Key words: Device-to-device; Relay; Detection; Full-rate space-time block code

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Motivation

- Device-to-device (D2D) communication is considered as the competent technology in fifth-generation (5G) cellular networks.
- Relay-aided D2D communication is a complement to D2D communication.
- There is limited work focusing on the design of the transmission scheme for relay-aided D2D systems, especially the system configured with multiple antennas.
- Research on the efficient transmission schemes for multiple-input multiple-output (MIMO) relay-aided D2D systems enables the system to achieve high transmission efficiency and low error rate.

Main idea

- Two low-complexity detection methods for amplify-and-forward relay-aided D2D systems with full-rate space-time block code (FSTBC) are proposed, i.e., the detection methods with ML-combining (MLC) algorithm and joint conditional ML(JCML) detector.
- The diversity analysis for the proposed detection methods is also provided, which has been demonstrated by simulations.

Method

1. The detection method with MLC algorithm first uses MLC algorithm to convert the relay-aided D2D system into an equivalent D2D system and then adopts the ML detector for point-to-point MIMO systems to recover symbols.
2. The JCML detector preprocesses the received signals in two phases to get the sufficient statistics for symbol detection, so that the detection algorithm for systems with the FSTBC can be utilized.

Major results

- The proposed two detection method achieve almost the same SEP performance as that of the traditional ML detection method.

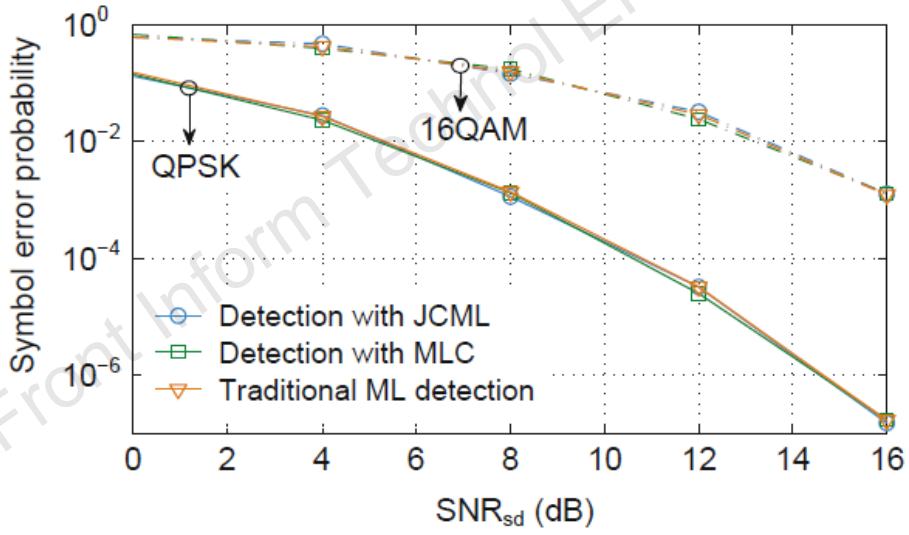

Fig. 2 Comparison of symbol error probability (SEP) performances for different detection methods with $N_r = N_d = 2$ (16QAM: 16-quadrature amplitude modulation; QPSK: quadrature phase shift keying)

Major results (Cont'd)

- The relay-aided D2D transmission with FSTBC outperforms the spatial multiplexing (SM) relay-aided D2D transmission scheme.

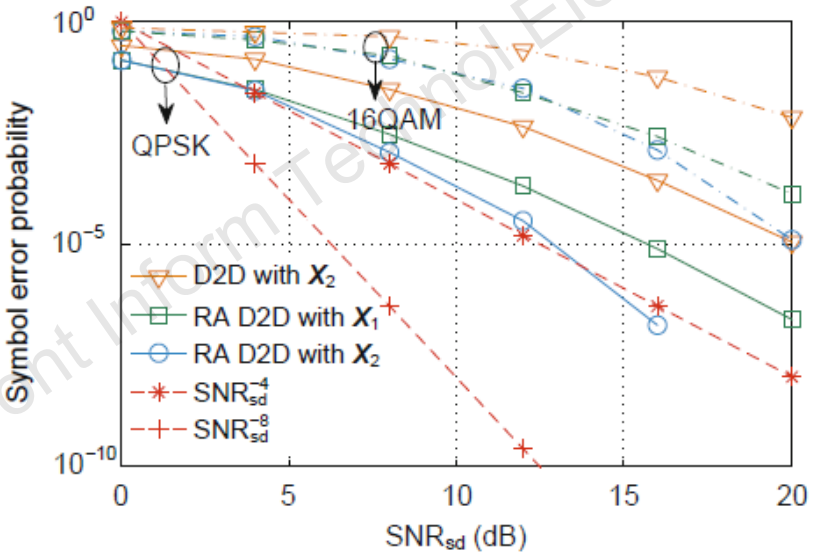

Fig. 3 Comparison of symbol error probability (SEP) performances for different transmission schemes with $N_r = N_d = 2$ (16QAM: 16-quadrature amplitude modulation; QPSK: quadrature phase shift keying)

Major results (Cont'd)

- The diversity order analysis of the proposed detection methods is verified.

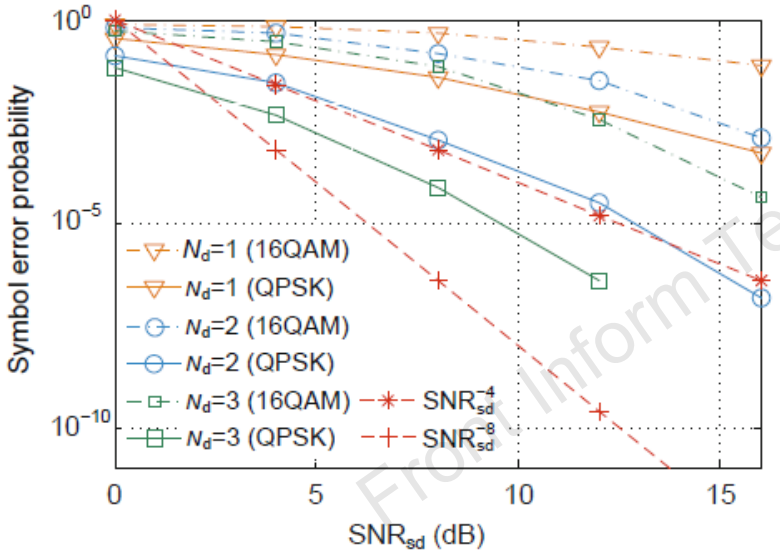

Fig. 4 Effect of N_d on the symbol error probability (SEP) performance of the proposed detection methods with $N_r = 2$ (16QAM: 16-quadrature amplitude modulation; QPSK: quadrature phase shift keying)

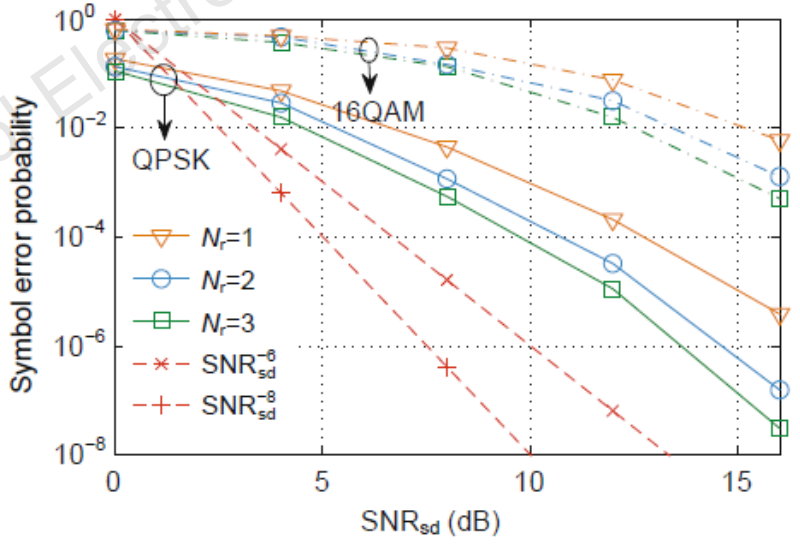

Fig. 5 Effect of N_r on the symbol error probability (SEP) performance of the proposed detection methods with $N_d = 2$ (16QAM: 16-quadrature amplitude modulation; QPSK: quadrature phase shift keying)

Conclusions

- By using the orthogonal structure of the selected FSTBC transmission, the complexity order of the proposed detection methods was reduced to the square root of that for the traditional ML detector.
- The detection method with the JCML detector had a structure which is perfectly suitable for parallel processing.
- Simulation results demonstrated the outstanding SEP performance of the FSTBC transmission scheme with the proposed detection methods and verified their diversity analysis.