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Joint cooperative beamforming and artificial noise design for secure AF relay networks with energy-harvesting eavesdroppers

Key words: Simultaneous wireless information and power transfer; Physical layer security; Relay networks; Cooperative beamforming; Artificial noise

Corresponding author: Bang-ning Zhang
E-mail: zbnlgdx2015@sina.com

Motivation

- We consider the scenario of co-located ER and eavesdropper, e.g., we treat the ER as potential eavesdropper.
- We consider AN rather than the ES method in related references, in which a pseudo-random ES is transmit by the relay and can be totally cancelled at the IR.
- We considered the case of multi-antenna eavesdropper, which can be seen as a extension of single-antenna eavesdropper.

Main idea

- Multiple single-antenna relays cooperatively forward the information from the source to a legitimate IR in the presence of multiple multiple-antenna ERs.
- Relays employ CBAN scheme to fulfill secure communication and meet the EH requirement for ER.
- Relays have perfect CSI of the IR, but imperfect CSI of the ER.
- Relays are subjected to both total and individual power constraints.

Method

- We propose a two-level optimization method to solve the worst case secrecy rate maximization problem.
- The outer problem is solved by one-dimensional search.
- The inner problem can be efficiently solved by the Semi-definite relaxation (SDR).
- By analyzing the Karush-Kuhn-Tucker (KKT) optimality, the tightness of the SDR is established.

Major results

- Our robust CBAN scheme can achieve better secrecy rate performance than other schemes.

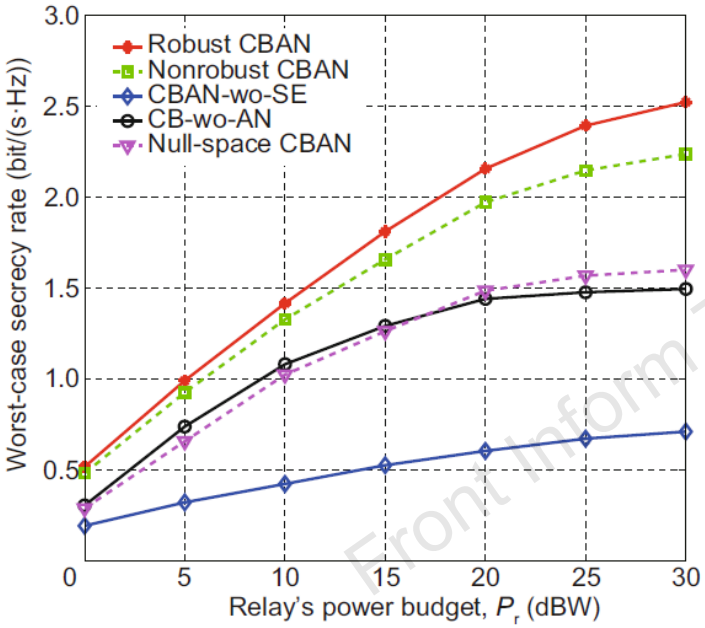

Fig. 2 Worst-case secrecy rate versus the relays' power constraint (CB: cooperative beamforming; AN: artificial noise; CBAN: joint CB and AN; wo: without; SE: security)

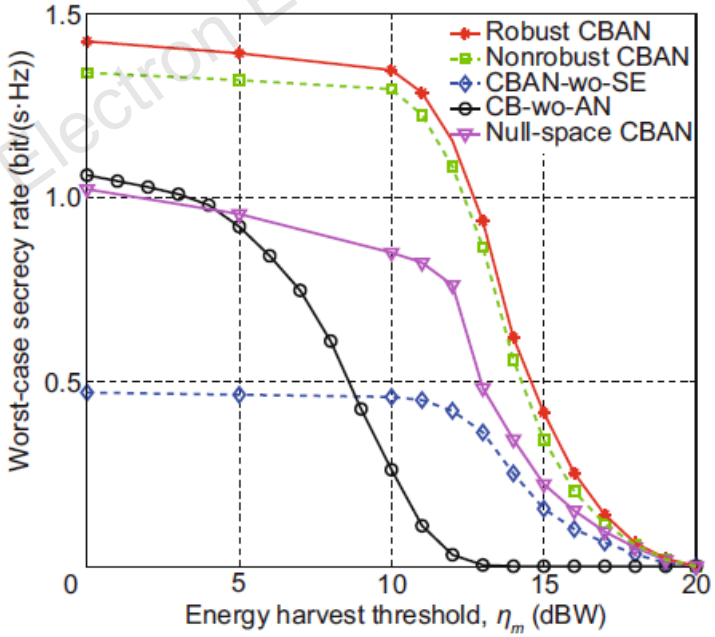

Fig. 4 Worst-case secrecy rate versus the energy harvesting threshold (CB: cooperative beamforming; AN: artificial noise; CBAN: joint CB and AN; wo: without; SE: security)

Conclusions

- In this paper, we have investigated a robust CBAN scheme for secure SWIPT in AF relay networks.
- We reformulated the WCSRM problem by using the one-dimensional search based two-level optimization.
- Furthermore, we provided a tightness analysis for this optimization problem, which shows the optimal solution must be rank-one.
- Simulation results demonstrated the effectiveness of the proposed design.