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Optimal signal design strategy with improper Gaussian signaling in the Z-interference channel

Key words: Z-interference channel; Improper Gaussian signaling; Sum-rate; Pareto boundary; Covariance; Pseudo-covariance

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Motivation

1. Proper conventional signals with independent and equal variance on the real and imaginary components seem very convenient, but this does not necessarily hold in practice.

2. Improper signals can provide larger degrees of freedom and outperform proper Gaussian signals in different interference channels.

3. The characterization and computation of the capacity of the IC with certain range of channel parameters has been an attractive and open problem in general, excluding some special cases of the strong and very strong interference regime.

Main idea

1. We propose a thoroughly optimal signal design strategy to achieve the Pareto boundary with improper Gaussian signaling on the Z-interference channel.

2. To achieve the optimal signal design strategy, we also provides a simple way to achieve the required rate region, with which we also derive a closed-form solution to quickly find the circularity coefficient that maximizes the sum rate.

Method

1. Introduce the concept Pareto boundary and design the changing rules of the parameters.
2. Derive several concise closed-form expressions to calculate each user's optimally transmitted power, covariance, and pseudo-covariance of improperly transmitted signals..
3. Provide an in-depth discussion of the structure of the relationship between the maximum sum rate and the Pareto boundary.

Major results

- Our strategy can prove a better performance.

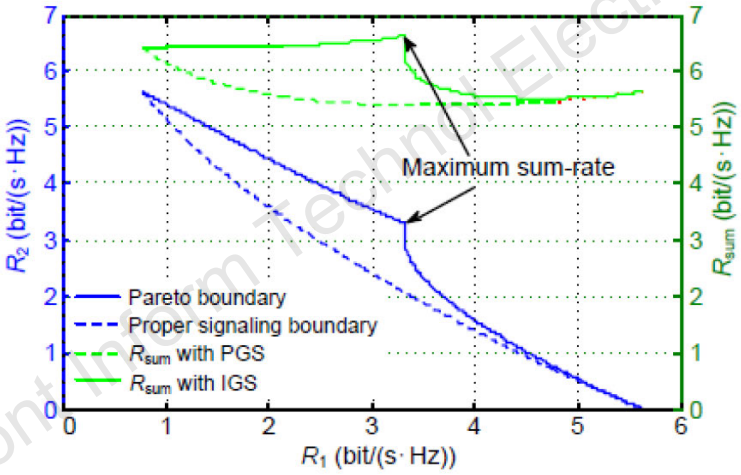

Fig. 9 Optimal rate region boundary and sum-rate with IGS and PGS for $|h_{11}|^2 = 3.25$, $|h_{12}|^2 = 4.5$, and $|h_{22}|^2 = 3.25$

Conclusions

1. We propose a thoroughly optimal signal design strategy to achieve the Pareto boundary with IGS in the Z-IC.

2. It is proved that the achievable rate region with IGS always contains the achievable rate region when the signal is proper, which shows the great superiority of IGS.

3. An easy solution to achieve the required rate region is proposed through an optimal strategy, which is designed to optimize the covariance and pseudo-covariance with IGS.

4. We derived a closed-form solution to achieve the maximal sum-rate, which requires less calculation to find the corresponding variable pair, i.e., covariance and pseudo-covariance.