



Spatial Multiplexing in Near Field MIMO Channels with Reconfigurable Intelligent Surfaces

Marco Di Renzo

Université Paris-Saclay, CNRS, CentraleSupélec, Laboratoire des Signaux et Systèmes
3 Rue Joliot-Curie, 91192 Gif-sur-Yvette, France
marco.di-renzo@universite-paris-saclay.fr

In this talk, we consider a multiple-input multiple-output (MIMO) channel in the presence of a reconfigurable intelligent surface (RIS). Specifically, our focus is on analyzing the spatial multiplexing gains in line-of-sight and low-scattering MIMO channels in the near field. We prove that the channel capacity is achieved by diagonalizing the end-to-end transmitter-RIS-receiver channel, and applying the water-filling power allocation to the ordered product of the singular values of the transmitter-RIS and RIS-receiver channels. The obtained capacity-achieving solution requires an RIS with a non-diagonal matrix of reflection coefficients. Under the assumption of nearly-passive RIS, i.e., no power amplification is needed at the RIS, the water-filling power allocation is necessary only at the transmitter. We refer to this design of RIS as a linear, nearly-passive, reconfigurable electromagnetic object (EMO). In addition, we introduce a closed-form and low-complexity design for RIS, whose matrix of reflection coefficients is diagonal with unit-modulus entries. The reflection coefficients are given by the product of two focusing functions: one steering the RIS-aided signal towards the mid-point of the MIMO transmitter and one steering the RIS-aided signal towards the mid-point of the MIMO receiver. We prove that this solution is exact in line-of-sight channels under the paraxial setup. With the aid of extensive numerical simulations in line-of-sight (free-space) channels, we show that the proposed approach offers performance (rate and degrees of freedom) close to that obtained by numerically solving non-convex optimization problems at a high computational complexity. Also, we show that it provides performance close to that achieved by the EMO (non-diagonal RIS) in most of the considered case studies.

Further information about the technical content of this presentation can be found in [1].

REFERENCES

- [1] Giulio Bartoli, Andrea Abrardo, Nicolò Decarli, Davide Dardari, Marco Di Renzo: Spatial Multiplexing in Near Field MIMO Channels with Reconfigurable Intelligent Surfaces. CoRR abs/2212.11057 (2022).