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"Reducing the Control Signalling Overhead of Intelligent Reconfigurable Surfaces Via Tensor-Based Low-Rank Factorizations"

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Helmholtzbau, H2501

Abstract: Passive intelligent reconfigurable surfaces (IRS) are becoming an attractive component of cellular networks due to their ability of shaping the propagation environment and thereby improving the coverage. While passive IRS nodes incorporate a great number of phase-shifting elements and a controller entity, the phase-shifts are typically determined by the cellular base station (BS) due to its computational capability. Since the fine granularity control of the large number of phase-shifters may become prohibitive in practice, it is important to reduce the control overhead between the BS and the IRS controller. In this talk, we discuss low-rank approximation based near-optimal phase-shift designs for reducing the communication overhead on the BS-IRS controller links. The key idea is to represent the potentially large IRS phase-shift vector using a low-rank tensor model. This is achieved by factorizing a tensorized version of the IRS phase-shift vector, where each component is modeled as the Kronecker product of a predefined number of factors of smaller sizes, which can be obtained via tensor decomposition algorithms. We show that the proposed low-rank models drastically reduce the required feedback requirements associated with the BS-IRS control links. Our simulation results indicate that the proposed method is especially attractive in scenarios with a strong line of sight component, in which case nearly the same spectral efficiency is reached as in the cases with near-optimal phase-shifts, but with a drastically reduced communication overhead.

Short biography

Prof. André L. F. de Almeida, Department of Teleinformatics Engineering, Federal University of Ceará, Brazil

André L. F. de Almeida is an Associate Professor with the Department of Teleinformatics Engineering of the Federal University of Ceara. He received a double Ph.D. degree in Sciences and Teleinformatics Engineering from the University of Nice, Sophia Antipolis, France, and the Federal University of Ceara, Fortaleza, Brazil, in 2007. He was awarded multiple Visiting Professor positions at the University of Nice Sophia-Antipolis, France (2012-2019). He served as an Associate Editor for the IEEE Transactions on Signal Processing (2012-2016), and for the IEEE Signal Processing Letters (2016-2020). Dr. Almeida is an elected member of the IEEE Signal Processing Society (SPS) Signal Processing Theory and Methods (SPTM) Technical Committee (2022-2024), and an elected member of the EURASIP Signal Processing for Multi-Sensor Systems Technical Area Committee (SPMuS TAC) (2016-2018 and 2019-2022). In 2021, he was elected as the vice-chair of the SPMuS TAC (2022-2023). He also served on the IEEE SPS Sensor Array and Multichannel (SAM) Technical Committee (2015-2018 and 2018-2021). Prof. Almeida serves as an IEEE SPS Regional Director-at-Large for Regions 7 & 9 (2022-2023). He also served as an Associate Member of the Big Data Special Interest Group (SIG) of the IEEE SPS (2015-2018). He was involved in the organization and chairing of several IEEE SPS conferences. In particular, he was a General Co-Chair of the 2017 IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP'2017), Technical Co-Chair of the IEEE GlobalSIP'2018 and IEEE GlobalSIP'2019 Symposia on Tensor Methods for Signal Processing and Machine Learning, Technical Co-Chair of the 11th IEEE Sensor Array and Multichannel Signal Processing Workshop (SAM'2020), and is the General Co-Chair of the IEEE CAMSAP'2023, Costa Rica. In January 2018 he was elected as an affiliate member of the Brazilian Academy of Sciences. He has published over 240 papers in journals and conferences, 6 book chapters, and is co-inventor of several international patents. His research interests include the topics of channel estimation, sensor array processing, and multi-antenna systems. An important part of his research has been devoted to multilinear algebra and tensor decompositions with applications to communications and signal processing.

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