STAGE DE MASTER II 2022

Cooperative Beamforming Techniques via Distributed Reconfigurable Intelligent Large Surfaces

Among the candidate transceiver approaches for 5G-and-beyond communications, a recently emerged technology, with the potential for enhanced energy and spectral efficiency as well as increased coverage, is the so-called reconfigurable intelligent surface (RIS) [1]. A RIS is a meta-surface equipped with integrated electronic circuits that can be programmed to alter an incoming electromagnetic field in a customizable way.

Even more recently a "massive" version of RIS was proposed [2] consisting of a huge number of sensing or radiating elements, aiming to effectuate a continuous electromagnetically active surface. The elements of a large RIS may interact with the incident signals in a smart and power efficient way. The authors in [2] considered such a large (massive) RIS-assisted wireless communication system and developed efficient solutions that design the involved large interaction (reflection) matrices with negligible training overhead. More specifically, they introduced a novel large RIS architecture where only a small number of the RIS elements are active (connected to the baseband). Then, they developed two solutions that design the RIS reflection matrices for this new architecture with almost no training overhead. The first solution leverages compressive sensing tools to construct the channels at all the antenna elements from the sampled channels seen only at the active elements. The second approach exploits deep learning tools to learn how to predict the optimal RIS reflection matrices directly from the sampled channel knowledge.

In this thesis the aim is to study the case of multiple spatially distributed massive RISs [3] which serve several wireless users at the same time. It is expected that the already established benefits of RISs can be further enhanced by dynamically determining the beamformers of the BaseStations as well as by optimally choosing the coefficients of the RIS's reflection elements. To this end a coordinated training procedure will be developed for designing the reflection matrices of the involved RISs. To eliminate the need for training, reinforcement learning methods may also be sought.

References:

[1] Chongwen Huang, Alessio Zappone, Senior Member, George C. Alexandropoulos, Mérouane Debbah and Chau Yuen, "Reconfigurable Intelligent Surfaces for Energy Efficiency in Wireless Communication", IEEE Transactions on Wireless Communications, Volume: 18, Issue: 8, Aug. 2019.

[2] A. Taha, M. Alrabeiah, and A. Alkhateeb, "Enabling Large Intelligent Surfaces with Compressive Sensing and Deep Learning," IEEE Access, vol. 9, pp. 44304–44321, 2021.

[3] Zhaohui Yang, Mingzhe Chen, Walid Saad, Wei Xu, Mohammad Shikh-Bahaei, H. Vincent Poor and Shuguang Cui, "Energy-Efficient Wireless Communications with Distributed Reconfigurable Intelligent Surfaces", IEEE Transactions on Wireless Communications (Early Access), 2021.

Other information:

The stage will be held in the IETR Lab and in the CentraleSupélec premises in Rennes; Some travel to Patras University should be planned. The stage will be paid.

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