Model-based deep learning for efficient synthesis of high-dimensional frequency selective surfaces

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1 Objectives

The main objective of the internship is to create a neural-network to synthesize frequency selective surfaces (FSS) (i.e. determine its geometry parameters like width, length, etc.) based on constraints on its electromagnetic response (notably its S-parameters), while avoiding heavy full-wave simulations. Physical insight will be incorporated into the structure of the proposed neural network by the use of equivalent circuits as an intermediate step in the prediction process. As a consequence, the developed method will be *model-based*.

A second objective of this project is to verify and clearly demonstrate the advantage of using this model-based strategy incorporating physical insight. To do so, an exhaustive comparison with classical approaches will be carried out.

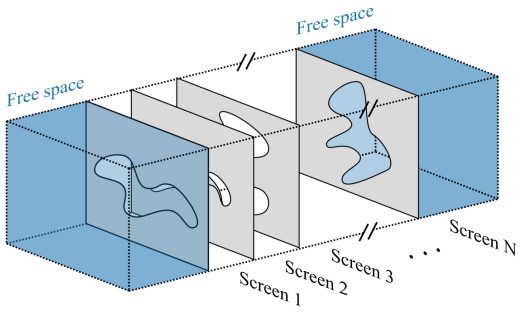

Figure 1: Example of FSS with many DoFs

2 Novelty

Model-based deep learning (DL) has been introduced recently as a trade-off between signal processing and machine learning [1] and led to promising results in various fields of signal processing for the physical layer [2–6]. On the other hand, classical machine learning methods have been applied to the design of radio-frequency (RF) structures for some time [7–12]. However, these papers do not take advantage of the underlying physics to build of model-based learning methods, and therefore still require heavy full-wave simulations. On the other hand, model-based DL has been used by the team hosting the internship for the analysis of FSS (predicting the S-parameters from the geometry). This project will be therefore the first time that model-based learning is applied to the synthesis of RF devices.

3 Potential

Reducing the computational burden of EM synthesis with many degrees of freedom is a subject of great interest for many research fields involving electromagnetics. In fact, this DL-assisted EM synthesis is one of the objectives of the HERMES platform of IETR [13]. The results of this project could be leveraged well beyond the scope of FSS synthesis, to be integrated in the platform in the form of a tool for synthesizing different kinds of devices.

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