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), meaning determining its geometry (width, length, etc.) based on constraints on its response (the 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.

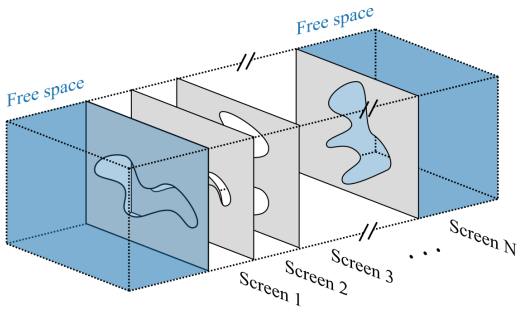

Figure 1: Example of FSS with many DoFs

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 [7–11]. 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 future platform that will be developed within the QOSC platform of IETR. The results of this project could be leveraged well beyond the scope of FSS, to be integrated in the platform.

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