Proposal for a student project / master thesis

Topic:
Design of photonic devices with deep neural networks

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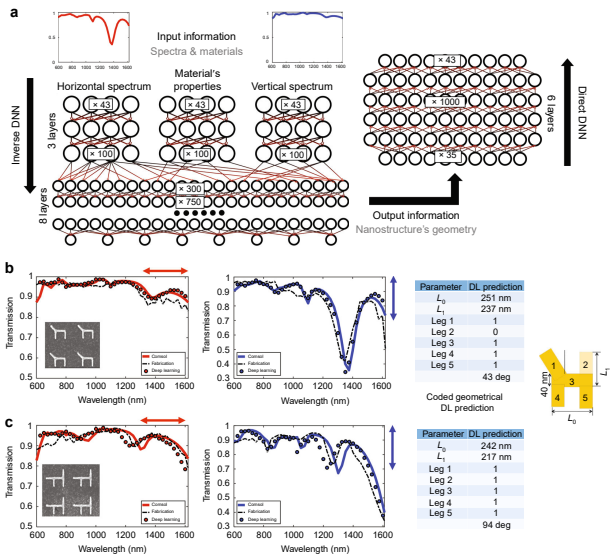
Embedding: Theoretical Electrical Engineering (TET)

Description:

Nowadays, deep neural networks are increasingly used for the design and optimization of photonic devices. On the one hand, the design process is significantly accelerated by the use of deep neural networks. On the other hand, complex relationships, such as the coupling between individual components of the devices, can be easily incorporated into the network.

In the student project proposed here, a deep neural network shall be used to design photonic devices consisting of nanoantennas or subwavelength nanoresonators. The well-known open source library of TensorFlow is used to implement the neural network. The training and test database for training the deep neural network has to be generated in the project itself and will not be provided. Therefore, a familiar handling of simulation software such as CST Microwave Studio or Comsol Multiphysics is required. This requirement will be checked at the beginning of the project. After training the deep neural network, the quality of the output will be evaluated by designing a specific photonic device.



Example by Malkiel et al. [1] showing the design of plasmonic nanostructures with a deep neural network that exhibit a desired far-field behaviour.

Objective:

- Acquire basic knowledge about the built-in subcomponents (nanoantennas or subwavelength nanoresonators) in the photonic devices and the design of photonic devices with neural networks (see literature [1-3]).
- Generation of a training and test database with CST or Comsol
- Training of different deep neural networks
- Evaluation of the trained network by designing a specific photonic device

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[1] Malkiel, I., Mrejen, M., Nagler, A. et al. Plasmonic nanostructure design and characterization via Deep Learning. Light Sci Appl 7, 60 (2018).

[2] Jiang, J., Chen, M. and Fan, J.A. Deep neural networks for the evaluation and design of photonic devices. Nat Rev Mater (2020).

[3] Ma, W., Liu, Z., Kudyshev, Z.A. et al. Deep learning for the design of photonic structures. Nat. Photonics 15, 77–90 (2021).