EE 367 Final Project Proposal: Inverse Design of One-dimensional Meta-grating

Introduction:

Metasurface, 2D arrays with submicron meta-structures, is a popular topic in recent decades as it can achieve desired performances with ultra-compact geometries. Traditionally, the metasurface patterns are designed based on physics intuition, where first-principal nano-optic theories are implemented to approach the optimal performances. However, performances achieved are usually limited due to the slow and complex electromagnetic simulation, making the obtained metasurface geometry deviated from the optimal configuration. In recent, with the rapidly developing computation power and optimization techniques, numerical optimization schemes, or inverse design, have been developed forward with powerful performances.

In this final project, the objective is to explore one of the famous metasurface inverse design algorithm, topology optimization. The topology optimization implements the gradient descent optimization accelerated by electromagnetic theory based back-propagation method, adjoint calculation. This project the mathematical backgrounds are reviewed. And previously developed algorithms are implemented to demonstrate the powerfulness by designing a 1D metagrating achieving narrow-band anti-reflection feature.

Timeline:

02/25-03/01: literature review to select an appropriate previously available topology optimization algorithm for demonstration. Review on adjoint calculations to mathematical formulate the corresponding gradient.

03/01-03/09: implement the topology optimization algorithm for designing 1D meta-grating. Specifically, the reflection spectrum is regarded as the loss function with a "ground truth" spectrum set as a narrow-band anti-reflection prototyped spectrum. Try to build the connection between such optimization and imaging processing protocols as we learned from the lecture.

[1] S. Molesky, Z. Lin, A. Y. Piggott, W. Jin, J. Vucković, and A. W. Rodriguez, "Inverse design in nanophotonics," Nat. Photonics 12, 659–670 (2018).