**Metasurface Design Based on Machine Learning**

Jiajun Chen

Mentor: Younes Ra’di, Ph.D.

Photonics Initiative

Advanced Science Research Center

City University of New York

Abstract

Engineering light-matter interaction requires solving Maxwell's equations, which in most of cases is time consuming and computationally expensive.

Advanced computation methods, especially machine learning, have led to many revolutionary applications, such as image recognition, virtual assistance, and sentiment analysis. Machine learning is an application of artificial intelligence (AI) that provides a system the ability to automatically learn and improve from experience without been explicitly programmed.

Designing an optimized structure for manipulation of electromagnetic waves requires enormous effort and time with traditional numerical methods (i.e., solving electromagnetic properties with each possible structural parameters) and then choosing design parameters that provide closest properties to what we want. However, with machine-learning, it will become time-efficient when it comes to solving an inverse problem, immediately giving out the result compared to traditional method once it has been trained to construct a certain pattern.

In this project, we will employ this revolutionary approach to design metasurfaces. Each neuron in our machine-learning network can be viewed as a variable, representing geometry properties or materials properties or polarization direction. An optimized parameter may represent the mapping from an input to a desired output. During training, parameters will be optimized or updated through backward propagation so that model can fits into desired output in general. Usually, the gap between network output and desired output will be minimized as the model is trained.