BRAIN STATION 23

ENHANCED LIGHT–MATTER INTERACTIONS IN DIELECTRIC NANOSTRUCTURES VIA MACHINE-LEARNING APPROACH

Version 1.0

Enhanced light–matter interactions in dielectric nanostructures via machine-learning approach

Dated: 05-03-2025

REVISION HISTORY

Ver. No	Date of Release	Prepared By	Reviewed/ Approved By	List of changes from Previous Version
1.0	05-03-2025	MD. MEHEDI HASSAN		Document created.

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1 Enhanced light–matter interactions in dielectric nanostructures via machine-learning approach

1.1 Forward Model for Metasurface Response Prediction

Requirement ID	1.1 Forward Model for Metasurface Response Prediction
Requirement Type	Functional
Description/Business Logic	
The system shall implement a forward model to predict the transmittance curve of a metasurface based on its geometrical parameters. The model will take three primary inputs—length, width, and offset—and compute the corresponding transmittance spectrum. The forward model will be built using numerical simulations or a pre-trained deep-learning model to establish a mapping between the geometrical design space and the optical response. The predicted transmittance curve will provide insights into resonance properties such as peak position, bandwidth, and intensity. This model will serve as a foundational tool for design validation, enabling rapid evaluation of metasurface behavior before experimental fabrication.	
API	
Clarification	N/A
Dependency	Trained deep-learning model and Dataset
Data Definition	
Input: Length, width, and offset of the metasurface structure. **Output:** Transmittance curve, including spectral response over a defined wavelength range.	

1.2 Inverse Model for Metasurface Design Prediction

Requirement ID	1.1 Inverse Model for Metasurface Design Prediction
Requirement Type	Functional
Description/Business Logic	
The system shall implement an inverse model that predicts the optimal geometrical parameters (length, width, and offset) of a metasurface based on a given transmittance curve. This model will utilize deep-learning techniques or optimization algorithms to determine the best-fitting structural parameters that produce the desired spectral response. Unlike the forward model, which maps geometrical parameters to optical responses, the inverse model tackles the more complex problem of retrieving design parameters from spectral data. It will be trained on a large dataset of transmittance curves and their corresponding geometrical configurations. This model is essential for automated metasurface design, allowing researchers to specify a target transmittance behavior and receive the corresponding structural parameters without manual tuning.	
API	
Clarification	N/A
Dependency	Trained deep-learning model and Dataset
Data Definition	
Input: Target transmittance curve (spectral response over a defined wavelength range). **Output:** Predicted length, width, and offset values that generate the closest matching transmittance curve.	