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Advancing photonic design with topological latent diffusion generative model

Conventional photonic device design often relies on manual trial-and-error processes and simplistic algorithms, in which design processes are severely constrained by intuition-based models and limited adjustable parameters, leading to time-consuming inefficiencies. Although optimization methods like evolutionary algorithms have been introduced, they are insufficient in addressing multi-objective tasks. Deep generative model methods, particularly Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs), have shown promise in directly generating complex metasurface in multi-objective optimizations. However, the instability and high modeling costs associated with GANs pose challenges. The performance of VAEs also falls short in tasks involving high-fidelity design generation. To overcome these challenges, advanced machinery such as the recently proposed diffusion generative model is needed to manage the multi-domain, hyper-dimensional design space, and high-quality design generation. In this work, we combined the topology optimization (TO) with deep generative models, specifically VAE and diffusion model, as the Topological Latent Diffusion Model (TLDM). We applied an efficiency prediction model-embedded conditional U-net within TLDM to realize precise guided generation and demonstrated substantial efficiency improvement compared with state-of-the-art generative model benchmarks.

Focus areas

Primary authors: CHEN, Yuheng (Purdue University); BEZICK, Michael (Purdue University); WILSON, Blake (Purdue University); Prof. KILDISHEV, Alexander (Purdue University); Prof. SHALAEV, Vladimir (Purdue University); BOLTASSEVA, Alexandra (Purdue University)