Fisher-Aware Training of Multiplane Light Conversion for Optical Parameter Estimation

A Singha[1] and K Wang[1]

[1] *Department of Physics, McGill University, Montréal, Canada*
Contact Email: k.wang@mcgill.ca

Optical parameter estimation is often limited not by the estimator, but by the information retained at the detection stage. Conventional systems typically use a fixed optical front end followed by statistical reconstruction or post-processing, which cannot recover information that has already been discarded. Here we propose a Fisher-aware trainable optical front end based on multiplane light conversion (MPLC). The programmable phase planes act as a photonic neural network whose measurement basis is optimized to maximize the classical Fisher information for a target parameter-estimation task. To enable practical in-situ training, we use a proxy Fisher-information objective constructed from output covariance statistics, together with simultaneous perturbation stochastic approximation, avoiding the need for labelled data, explicit gradients, or a fully calibrated optical model. We demonstrate the approach using the canonical problem of estimating the separation of two incoherent point sources. The optimized MPLC learns measurements that approach the relevant Fisher-information benchmark over a broad parameter range and remain robust to centroid misalignment, outperforming direct imaging and conventional SPADE-type measurements. These results suggest a route toward adaptive optical hardware that learns information-efficient measurements for precision sensing and imaging.