Special Section Guest Editorial: Advances in Computational Methods for Optical System Forward- and Inverse-Design

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The proliferation of computing power (*e.g.*, GPUs, cloud computing) is providing optical engineers with the tools for highly parallelized and distributed modeling of increasingly complex optical systems. Meanwhile, there is an ever-growing need to better capture the true multiphysics (*i.e.*, structural, thermal, and optical) performances of extreme multiscale optical systems comprised of arbitrary combinations of refractive lenses, diffractive optical elements, GRIN lenses, as well nascent technologies such as nanopatterned metasurfaces. Thus, there is a need to develop new algorithms to exploit the massive computational resources and new architectures (*e.g.*, GPUs, ARM vs. x86 CPUs) and leverage these resources to streamline the optical system design process. Furthermore, emerging techniques such as artificial intelligence (AI) and deep learning (DL) are gaining popularity in the optics community for their potential to learn the "hidden" physics that govern various aspects of nanophotonic and lens system forward- and inverse-modeling.

Our goal for this special section is to present emerging algorithms and design techniques that have the potential to advance the state of the art in optical system forward- and inverse-design. We present here a collection of eight papers that introduce new computational methods, optimization algorithms, and design procedures to accelerate various aspects of optical system design.

A new differential ray tracing formulation is presented by Balasubramanian et al. and exploits modern automatic-differentiation routines to numerically compute gradients without the need for finite-differencing. This approach offers the potential for significant acceleration of complex optical system optimization. Zhu et al. introduce a random walk prediction (RWP)-based channel model for a visible light communication (VLC) communication network with applications to underground mining. Jungwirth introduces a pre-design process for a custom optical alignment system that enables the designer to accurately perform a trade space analysis to tailor the system variables according to their desired preferences. Zhdanov et al. use a progressive backward photon mapping method for efficient virtual prototyping of complex optical systems on many core high performance computing (HPC) workstations. Blanco et al. introduce a new parametric design and optimization tool to evaluate passive axial support positions on circular solid meniscus mirrors and which avoids the intrinsic limitations of methodologies of the reference literature, based on analytical formulations. Wang and Tang propose a scheme based on a dual-parallel phase modulator (PM) to realize optical logical operation and demonstrate exclusive OR (XOR) and not exclusive OR (NXOR) logic using a dual-parallel PM. Zhdanov et al. analyze existing methods for calculating and visualizing parasitic illumination. A software model of the beam propagation criterion is proposed to search for and identify stray light sources in optical devices. Finally, Yu et al. present strategy to achieve color imaging through a dynamic scattering medium based on ghost imaging and deep learning

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