Karlstad Applied Analysis Seminar (2020)

Martijn Anthonissen, Department of Mathematics and Computer Science, Eindh

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A generalized Monge-Ampère equation to compute freeform lens surfaces

Abstract

The key problem in computational illumination optics is to find the shape of an optical surface given a source and desired target light distribution. Our mathematical model is based on the principles of geometrical optics, formulated in terms of the optical map connecting source and target domain, and energy conservation. This leads to a fully nonlinear partial differential equation of generalized Monge-Ampère type subject to the transport boundary condition. We show the derivation of this PDE for several model problems. The numerical solution method is a two-stage procedure. In the first stage it computes the optical map. In the second stage it constructs the shape of the optical surface from the optical map. Both stages are solved using a least squares method. The computation is an iterative process with fast convergence. The resulting algorithm gives accurate results and is very efficient. This is illustrated by numerical experiments. We consider e.g. laser beam shaping, where an incident Gaussian source distribution is transformed into a uniform top hat illuminance