Point source regularisation of the extended source reflector problem

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We address the "freeform optics" inverse problem of designing a reflector surface mapping a prescribed source distribution of light to a prescribed far field distribution, for an extended source / nonzero etendue light. When the source is a point source, the distribution has support only on the optics ray directions. In this setting the inverse problem is well posed for arbitrary source and target probability distributions. It can be recast as an Optimal Transportation problem and has been studied both mathematically and numerically. We are not aware of any similar mathematical results when the source has an "étendue" i.e. has support both in space and directions. We propose to leverage the well-posed variational formulation of the point source problem to build a smooth parameterization of the reflector and the reflector map. We then optimize for the best solution in terms of a loss/misfit function in this class of reflectors. Both steps, the parameterization and the loss, are related to Optimal Transportation distances. We also take advantage of recent progress in the numerical approximation and resolution of these mathematical objects to perform a numerical study.

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