Data-driven Visual Computing: The Strength of Weak Models

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Abstract Submission for Topical Workshop:

☒ Computational Imaging

☐ Computer Vision and Machine Learning

☒ Large Data in Optics

☐ Virtual/ Augmented Reality

Keywords : Data-driven, light fields, weak models

Abstract

Recent advances in technology have opened up novel ways for optical design, especially *computational photography*: the combined development of optics and algorithms towards novel imaging applications. The confluence of *large-scale data processing* and computational photography to *data-driven visual computing* is a particular interest of mine: it enables us to replace strong models of imaging devices – those, which have a powerful predictive capability with only a small number of parameters to be determined – with weaker models that require many more parameters for the same capability, but need much weaker assumptions, and therefore are uniformly applicable to a much wider range of problems.

In the proposed talk, I will discuss the power and versatility of seemingly weak models with examples from my work in the last years, starting with image-space relighting techniques which turn image databases into appearance models using only the linearity of the light transport operator (Figure 1).

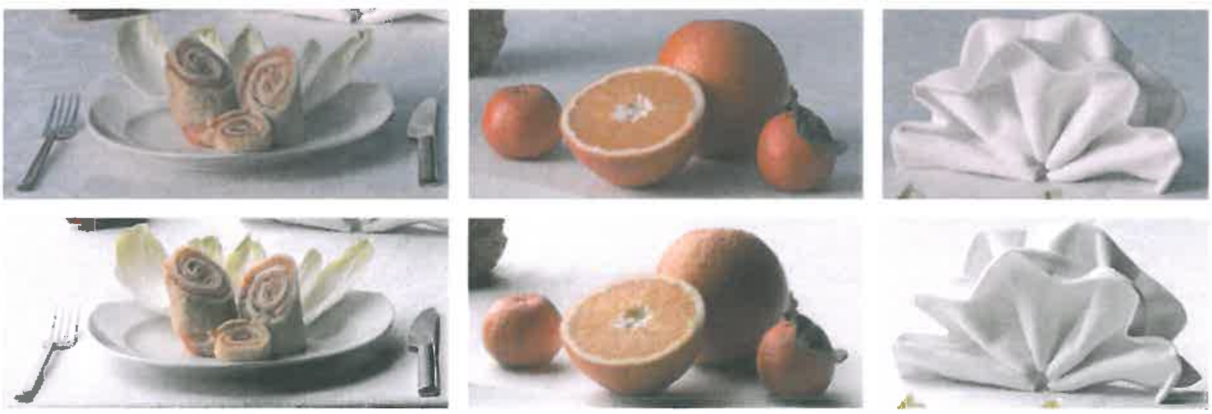

Figure 1: Image-space relighting techniques simulate the appearance of scenes by computing linear combinations of images. Thanks to a sufficiently large input database, they work for real (top) and synthetic (bottom) illumination conditions with near perfection for almost any material (image source: [Fuchs et al. 2005]).

I will continue the discussion with a case study on *household plenoptic imaging* [Wender et al. 2015]: by describing the optical path for every pixel of a camera individually, we can relax the assumptions on our imaging devices to "a-pinhole-camera-with-arbitrary-projective-geometry". This implies, that we can not only image through structured glass, but we can even use it to reconstruct and render a coarse light field (Figure 2). The calibration mechanism for the light transport paths [Wender and Fuchs 2014] is surprisingly simple: its main component is a high-resolution television set.

calibration procedure | input image | rendering focused on foreground | rendering focused on background

Figure 2: Massive calibration permits us to perform light field imaging through household items (image source: [Wender et al. 2015]).

I will conclude the talk with an outlook on further activities of my research group at the VISUS institute of the university of Stuttgart, focusing on the recording of dense light fields, with which we will address the challenges of the *quantitative quality assessment of computational photography* in the recently initiated Transregional Collaborative Research Center 161: Quantitative Methods for Visual Computing.

Acknowledgements:

The presented work received funding by the Max-Planck-Center for Visual Computing and Communication, the Juniorprofessorenprogramm Baden- Württemberg and the X-Rite Chair and Graduate School for Digital Material Appearance.

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