Capturing, simulating, and differentiating light

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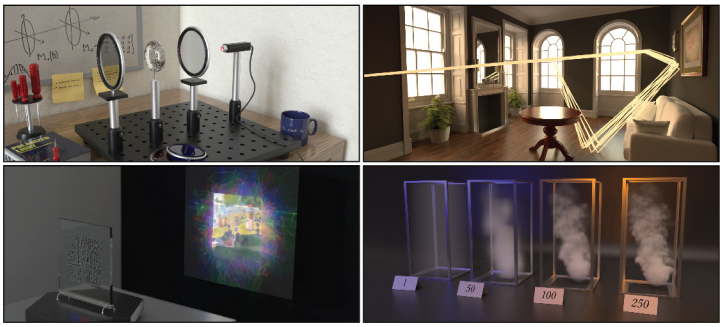

Realism has been a major driving force since the inception of the field of computer graphics, and algorithms that generate photorealistic images using physical simulations are now in widespread use. These algorithms are normally used in a "forward" sense: given an input scene, they produce an output image. In this talk, I will present two recent projects that turn this around, enabling applications to problems including 3D reconstruction, material design, and acquisition.

The first is "Mitsuba 2", a new rendering system that is able to automatically and simultaneously differentiate a complex simulation with respect to millions of parameters, which involves unique challenges related to programming languages, just-in-time compilation, and reverse-mode automatic differentiation. I will discuss several difficult inverse problems that can be solved by the combination of gradient-based optimization and a differentiable simulation: surface/volume reconstruction, caustic design, and scattering compensation for 3D printers.

In the second part of the talk, I will present an ongoing effort that aims to build a large database of material representations that encode the interaction of light and matter (e.g. metals, plastics, fabrics, etc.). Capturing this "essence" of a material is challenging problem both from an optical and a computer science perspective due to the high-dimensional nature of the underlying space. I will show how an inverse approach can help evade the curse of dimensionality to acquire this information in a practical amount of time.

Reference:

Merlin Nimier-David, Delio Vicini, Tizian Zeltner, and Wenzel Jakob. 2019. Mitsuba 2: A Retargetable Forward and Inverse Renderer. In *Transactions on Graphics (Proceedings of SIGGRAPH Asia)* 38(6).

Jonathan Dupuy and Wenzel Jakob. 2018. An Adaptive Parameterization for Efficient Material Acquisition and Rendering. In *Transactions on Graphics (Proceedings of SIGGRAPH Asia)* 37(6).

Biography: Wenzel Jakob is an assistant professor at EPFL's School of Computer and Communication Sciences, and is leading the Realistic Graphics Lab. His research interests revolve around material appearance modeling, rendering algorithms, and the high-dimensional geometry of light paths. Wenzel is the recipient of the ACM SIGGRAPH Significant Researcher award and the Eurographics Young Researcher Award. He is also the lead developer of the Mitsuba renderer, a research-oriented rendering system, and one of the authors of the third edition of "Physically Based Rendering: From Theory To Implementation".

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