Scattering: Acquisition, Modeling, and Rendering

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Volumetric scattering has witnessed a renaissance in the past decade, in both academic research and industry. Until recently, volumetric-scattering effects were treated as complicated special cases, both from a practical viewpoint and in their theoretical formulations. The established mental model of solid surfaces embedded in a vacuum was pervasive, relegating more general volumetric-scattering effects as an afterthought for specialized methods and tools. This was due partly to volumetric scattering's increased computational and conceptual complexity. Luckily, computational and research advances have started to bridge this gap.

Scattering plays a fundamental role in the physical world's appearance, and the surface-centric legacy is changing. Volumetric-scattering effects have become increasingly central to the visual look, atmosphere, and even storytelling in films and games. Digital characters such as Gollum in *Lord of the Rings*, the expansive cloud-filled environment of Pandora in *Avatar*, or the magical revival by Rapunzel in *Tangled* wouldn't have been the same without sophisticated scattering effects. Scattering also has important practical applications in other fields—for example, estimating weather conditions in meteorology or predicting the visual appearance of skin or pigments in medical physics, cosmetics, or fabrication processes.

The catalyst for this special issue was a series of courses at Siggraph and Siggraph Asia that began in 2008 that surveyed the wide set of recent scattering techniques and applications in computer graphics and computer vision—ranging from acquisition, to rendering, to image processing.[1] This issue continues in these footsteps and serves as a capstone to those courses. Even in the few years since the courses, the landscape of volumetric-scattering techniques has evolved rapidly.[2–6] The articles in this issue highlight how these techniques are expanding our abilities to author increasingly complex visual appearance.

In This Issue

We received very good submissions from top European and US research centers. At least three expert reviewers carefully reviewed each submission; after some discussion, we selected four articles for conditional acceptance. We then requested the authors to improve their articles on the basis of the reviewers' comments, before final acceptance.

"Estimating Diffusion Parameters from Polarized Spherical-Gradient Illumination" deals with affordable acquisition. Yufeng Zhu and his colleagues use cross-polarized spherical-gradient illumination on curved surfaces to estimate subsurface-scattering properties of heterogeneous translucent materials. They obtain these parameters using only four observations under such illumination, without applying a fitting process. They show results for a wide range of materials with different characteristics.

The sky's the limit for the next article. In "Adding a Solar-Radiance Function to the Hošek-Wilkie Skylight Model," Lukáš Hošek and Alexander Wilkie add a solar-radiance function that matches the conditions of the sky dome described by their state-of-the-art skylight model. They express this function as an analytical model, including sophis-

 Published by the IEEE Computer Society

ticated effects such as limb darkening. The results include rendered examples of synthetic scenes with extremely realistic illumination, under different solar conditions.

"Real-Time Screen-Space Scattering in Homogeneous Environments" follows a current trend in real-time approaches. Oskar Elek, Tobias Ritschel, and Hans-Peter Seidel propose a practical algorithm to compute light scattering in screen space, simplifying the complexities of true 3D scattering simulations. They model scattering effects by applying physically based point-spread functions. An anisotropic filter based on projected distances avoids unwanted illumination leaking between objects at different depths. Smart engineering solutions allow the authors to report speeds of hundreds of frames per second for their approach.

Finally, in "Double- and Multiple-Scattering Effects in Translucent Materials," Nicolas Holzschuch and Jean-Dominique Gascuel observe that multiple subsurface scattering inside a translucent material correlates strongly with the result after only two scattering events. This leads to an efficient implementation for computing double-scattering events, which are much simpler to compute because they involve shorter paths. By extrapolating from these double-scattering computations, the authors can efficiently approximate multiple scattering events.

We hope you enjoy these articles. We believe that the acquisition, analysis, simulation, editing, and application of scattering theory and effects will be a vibrant research field for many years. The field certainly has no lack of challenges.

References

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