Material Appearance

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Modeling and rendering material appearance is important in many applications. In games and cinema, the material appearance helps set the scene. Peeling paint, water stains, and rusty pipes contribute to the impression of being in an old environment, whereas smooth, clean surfaces and shiny metal communicate new structures. In industrial design, the material appearance can make the difference between a plain, unappealing product and an attractive one. In training applications, the material appearance can be critical to users learning to make quick judgments based on what they see.

Research Areas
Recent computer graphics research in material appearance falls roughly into two areas.

First, general methods include measurement techniques, analytical models, and rendering techniques. Research in measurement has been driven by the increased availability of instruments with digital output, particularly digital cameras, and the need for more accurate material models. Research in analytical models has progressed as researchers seek compact representations for measured data that can be intuitively edited and easily rendered. Efficient rendering continues to be a challenge, as applications demand the simulation of complex spatially varying and volumetric media.

Second, specialized material models involve many classes of materials needed for different applications. Some applications, such as city rendering, often need only plausible (rather than predictive) rendering but need materials that can be rendered on a large scale. Other applications, such as automobile design, need accurate predictive rendering focused on imaging a single object. Modeling some specialized materials, such as decorative paints, can be difficult because of the need for correct, accurate directional reflectance. Modeling other specialized materials, such as fabrics woven from threads of varied fibers, can be difficult because of their complex geometric structure.

In This Issue
This issue features four articles. The two articles on general methods consider two distinct issues: measurement and efficient rendering. The other articles examine two extremely different types of specialized materials, illustrating the variety of application requirements and constraints.

General Methods
In “Modeling and Verifying the Polarizing Reflectance of Real-World Metallic Surfaces,” Kai Berger and his colleagues introduce an approach for measuring materials and validating material models. They use ellipsometry to measure surface polarization and reflectance. They demonstrate the differences between a variety of measured metals and the same types of metals rendered with models and data from the existing literature. Understanding these effects is critical in applications that demand accurate predictive rendering.

In “A Parallel Architecture for Interactively Rendering Scattering and Refraction Effects,” Daniele Bernabei and his colleagues examine the rendering of heterogeneous volumetric materials that exhibit both low-spatial-frequency effects due to multiple scattering and high-spatial-frequency effects due to refraction. They present a novel combination of lattice-Boltzmann and ray-marching calculations that can execute in parallel. This approach enables the rendering of extraordinarily complex volumetric materials.
Specialized Materials

In “Simulating How Salt Decay Ages Buildings,” Nicolas Merillou and his colleagues introduce an approach to simulating weathering. Although salt decay is a rather specific process, it produces a variety of visual effects that are important in applications rendering built environments. On the basis of this physical process, the authors devised a way to produce compelling visualizations of the result of the complex mechanical and chemical decay.

In “Visualizing the Surface of a Living Human Brain,” Llyr ap Cenydd and his colleagues deal with surgery simulation. This application requires more than a plausible simulation because doctors must make critical decisions during surgery. The authors discuss the difficulties of acquiring data for creating an appropriate model of light scattering. They then show how to create an effective model and report the results of a user study conducted to validate the model.

Together, these articles illustrate the difficulties that continue to make material appearance an active area of computer graphics research. Even more research is needed on physical modeling and measurement, compact mathematical models, efficient rendering, and human perception of materials. Although these articles show significant steps forward, we’re still far from having methods for easily and reliably specifying and applying materials to objects and scenes and obtaining the desired visual results.

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