

Physically-Based Analytical Modeling and Monte Carlo Simulation of Light Transmission at Rough Surfaces

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We present a physically based analytical model and a Monte Carlo simulation method for light transmission at rough surfaces. We model the surface to be composed of the microfacets with the orientations following a Gaussian distribution, and each microfacet is homogeneous, isotropic, and microscopically smooth. We consider two types of light transmission events: single scattering and multiple scattering. In the analytical modeling, we derive an analytical expression for the single scattering events. In Monte Carlo simulation, we develop a method to simulate the light transmission events of both two types. We compare the analytical model with both the previous and our own simulations. The results show that, for smoother surfaces, the light transmission is dominated by the single scattering events, and the analytical model agrees very well with the simulations; for rougher surfaces, the multiple scattering events play an important role. We also discuss the contributions of different scattering events to light transmission.