Efficient Unbiased Rendering using Enlightened Local Path Sampling

Most global illumination algorithms today solve the light transport problem using Monte Carlo ray tracing. These algorithms are capable of producing photo-realistic imagery and in addition have few limitations with respect to the kind of input (geometry, reflection models, etc.) they support. The downside to using these algorithms is that they can be slow to converge. Due to the nature of Monte Carlo methods, the results are random variables subject to variance. This manifests itself as noise in the images, which can only be reduced by generating more samples. The reason these methods are slow is because of a lack of effective methods of importance sampling. Most global illumination algorithms are based on local path sampling, which is essentially a recipe for constructing random walks. Using this procedure paths are built based on information given explicitly as part of scene description, such as the location of the light sources or cameras, or the reflection models at each point. In this work we explore new methods of importance sampling paths. Our idea is to analyze the scene before rendering and compute various statistics that we use to improve importance sampling. The first of these are adjoint measurements, which are the solution to the adjoint light transport problem. The second is a representation of the distribution of radiance and importance in the scene. We also derive a new method of particle sampling, which is advantageous compared to existing methods. Together we call the resulting algorithm enlightened local path sampling and demonstrate how the algorithm improves efficiency in some hard scenes.
The propagation of ultrasound in an austenitic weld
The propagation of ultrasound through an austenitic weld is investigated experimentally as well as in a numerical simulation. The weld is insonified at normal incidence to the fusion line with a longitudinal contact transducer. In order to experimentally trace the ultrasound through the weld, slices of different thicknesses from the original weld have been fabricated. Through-transmission A-scans have then been produced for each weld slice and compared with the corresponding numerical simulation. A comparison of the direction of ultrasound propagation through the weld for the two approaches shows quite good agreement. However, attenuation due to scattering at grain boundaries in the weld is poorly modelled in the simulation. In order to improve this, a better model of the weld is needed.

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