A null-scattering path integral formulation of light transport

Bailey Miller, Iliyan Georgiev, Wojciech Jarosz

Unbiased rendering of heterogeneous media uses null-collision methods to generate free flight distances and estimate transmittance.

Challenge: Null-collision methods employ black-box rejection sampling algorithms such as delta tracking or ratio tracking. These algorithms do not provide path pdfs, making their combination via multiple importance sampling (MIS) difficult.

Our Approach: We derive a path integral formulation of light transport from the null-collision radiative transfer equation (RTE). We then cast null-collision methods as path sampling techniques with known pdfs, which enables their straightforward MIS combination.

Previous Work:
- Spectral tracking (derived from null RTE, forgoes complete MIS): [Kutz et al. 2017]
- MIS through tabulated sampling: [Szirmay-Kalos et al. 2017], [Gamito 2018]

Recursive estimation of the volume rendering equation can be done via a series of direction ω and distance samples t:

Classical path integral
- Considers real scattering only
- Evaluates heterogeneous transmittance

Null RTE
- [Galtier et al. 2013]
- Unable to adjust density.
- Only can compute transmittance analytically in simple media.

Our null-scattering path integral
- Considers real and null scattering
- Evaluates simple homogeneous transmittance

Multiple scattering
- Unidirectional sampling
- Next-event estimation
- Equiangular sampling
- Bidirectional path tracing (t=0.5=3)

Our path integral formulation allows us to combine unbiased null-collision techniques and their spectral variants through MIS into more robust volumetric light transport estimators.

References:

Come to our talk to learn more! Tuesday, 9 - 10:30 am in Room 152.