The Geometry of First-Returning Photons for Non-Line-of-Sight Imaging

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None-line-of-sight imaging

Geometry of first-returning photons

Advantages of a framework that uses first-returning photons:
1. Given the illumination and sensing points, the NLOS scene point contributing to the first-returning photon is unique in most setups.
2. Rely on the ToF only and does not require accurate intensity measurement. Thus the proposed method is robust to different NLOS reflectance.
3. New opportunities for sensing requirements.

First-returning photons

We provide a formulation for NLOS shape recovery using the path length associated with first-returning photons.

Observation 1. There are no NLOS scene points in the interior of the ellipsoidal constraint.

Observation 2. Suppose the NLOS scene is locally smooth at \( p' \), the unique supporting hyperplane at \( p' \) is tangential to the ellipsoid.

Observation 3. Under local smoothness of the NLOS scene at \( p' \), the surface normal \( n(p') \) is the angular bisector of the vector from \( p' \) to the illumination and sensing spot, respectively.

Space carving for NLOS imaging

Shape recovery using planar assumption

References