A Theory of Fermat Paths for Non-Line-of-Sight Shape Reconstruction

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Non-line-of-sight (NLOS) setup

Femtosecond-scale reconstructions

What are Fermat paths

Fermat paths: specular or boundary

How to find Fermat paths

transient discontinuous at Fermat pathlengths

Why Fermat

Fermat’s principle: paths of stationary length

How to reconstruct a point and its normal

Fermat pathlength: spherical constraint

$\mathbf{x}_F \in \text{sphere} (\mathbf{v}, \tau/2)$

Fermat flow: ray constraint

$n_{\mathbf{x}_F} = -\nabla_\mathbf{v} \tau_F (\mathbf{v})$

NLOS reconstruction pipeline

densely scan wall  reconstruct points & normals

detect discontinuities  locally fit polynomials

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