Reaction Report VI: A Theory of Fermat Paths for Non-Line-of-Sight Shape Reconstruction

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Identify one idea in the paper that you feel is a major contribution or a major limitation, explain it, and discuss why it is important

I think the main contribution of this research is to prove that Fermat paths correspond to discontinuities in the transient measurements. The basic idea is that the paths of light between a visible scene and an unseen object obey specular reflection or are reflected by the object's boundary. Therefore, it is possible to recover the shape of complex objects in both diffuse and specular settings, and even through a diffuser, using constraints from the spatial derivative of the Fermat pathlength. This derivative uniquely determines both the depth and normal of a hidden scene point. I think this proof is important since it creates a solid theoretical foundation for later research in NLoS. Furthermore, this method is universal and could be used with various transient imaging settings to reconstruct with mm-scale to micron-scale accuracy.

Describe one idea of yours that builds on the paper and expand on that idea as much as possible

I think one direction to extend this idea is to take into account scenarios with multiple objects that have different properties. For example, the hidden scene might have highly diffuse objects and a collection of mirrors, which would make the light transport modeling much more complex. Perhaps we can treat the n-bounce lights as the direct light, as we did in the inverse light transport paper. Additionally, if the objects in the scene move around, it may be possible to extract some properties of the scene. We could also combine this method with traditional techniques such as time-of-flight or structured illumination to increase the amount of captured information.