A Dataset for Benchmarking Time-Resolved Non-Line-of-Sight Imaging

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Abstract

Transient imaging has made it possible to look around corners by exploiting information from indirect light bounces. We present a public dataset of synthetic time-resolved Non-Line-of-Sight (NLOS) scenes with varied complexity aimed at validation, benchmarking, and new data-driven methods, boosting research to bring the technology closer to its real-world applications.

Introduction

Time-resolved imaging partially disambiguates diffuse light paths, making it possible to recover information from surfaces beyond the line of sight of the imaging device [4]. This effectively allows us to look around corners [3], a technology with multiple applications such as security, spatial exploration, autonomous driving, or rescue operations.

Typically, Non-Line-of-Sight imaging works with light paths formed by three bounces, first on a visible diffuse wall, second on a hidden surface and third back on the initial wall (see Figure 1 left). Many works have successfully exploited this information to obtain 3D representations of hidden parts of scenes [1,3,6,7,8]. However, the scenarios used to validate them so far have been very simple; most often isolated planar diffuse objects in controlled environments. This kind of setup has been used extensively to highlight third-bounce information and obtain cleaner reconstructions. However, the real world is rarely that simple. Indirect light from multiple visible and hidden surfaces contribute to the time-resolved image, causing artifacts in their reconstructions.

Other computer vision tasks have proven that having readily accessible, labelled data and error metrics can be essential to improve the effectiveness of reconstruction methods, including other problems based on time-resolved data [5]. Klein and colleagues [9] released a synthetic dataset and benchmark platform for various NLOS reconstruction problems, including geometry reconstruction. For this problem, the dataset contains 16 scenes entirely made from hidden objects floating in isolation, following the canonical setups used in previous works. These are too few and simple to obtain deeper insights from them or attempt data-driven approaches in NLOS imaging. In this work, we present a new synthetic dataset for NLOS reconstruction (see Figure 2), that contains an order of magnitude more examples and includes complex scenarios with challenging light transport conditions.

Our Dataset

Inspired by these efforts, we release a synthetic dataset of time-resolved images from 86 distinct NLOS scenes. Considering variations in BRDFs and capture parameters, the dataset will contain around 300 time-resolved images for hidden geometry reconstruction, surpassing the quantities in previous datasets. In contrast with previous works, our goal is to cover a wider range of scenarios, from simple environments containing complex geometry, to complex real-world use-cases (see Figure 1), opening the field to data-driven works while providing an accessible means for benchmarking existing ones and simplifying the work of researchers. We consider two types of scenes separately: those with single hidden objects in canonical NLOS setups, and real-world-like scenes of indoor and outdoor spaces. The simpler scenes being useful to quickly diagnose reconstruction problems and benchmark methods to compare with other works. The more complex scenes are much more challenging and offer better approximations of the expected performance of a reconstruction method when applied in the real world.

To increase the generality and variety of the dataset, each simulation uses a different high-resolution pattern for the illumination and capture of a visible planar wall, all containing 65,536 illumination and capture pairs. The simulations are made leveraging

the recent advances on transient light transport simulation by Jarabo and colleagues [2]. To facilitate research, each light bounce is stored independently in the dataset, making it possible to work on the simpler three-bounce case first, and then on minimizing the effects of the additional light bounces on the reconstructions.

All data is already available on-line[1]. We hope this dataset will become an integral part in the development and testing process of new algorithms for NLOS imaging.

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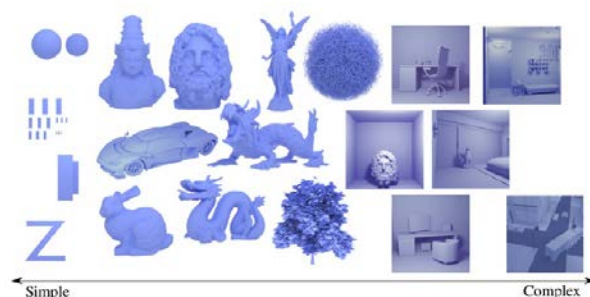
Figure 1 Geometry and scenes from our dataset ordered on a range from simplest to most complex, the latter being representations of indoor and outdoor scenarios.

Figure 2 The input scenes contain a virtual capture and illumination device aiming at a visible wall or planar surface. We then simulate a grid of points on this surface to produce time-resolved images. These are used by reconstruction algorithms to get probability volumes.