Camera Model Design, by Voicu Popescu

Camera models are essential infrastructure in computer graphics, visualization, and vision. The most frequently used model is the planar pinhole camera, because it approximates the human eye well, producing familiar images, and because it is simple, enabling efficient software and hardware implementations. However, the requirement that all rays pass through a common point is restrictive and relatively little has been done to remove this pinhole constraint. We believe that the apprehension regarding non-pinhole camera models is based largely on misconceptions, such as the belief that these cameras do not produce useful images or that they are inherently inefficient.

We introduce a novel paradigm for interactive computer graphics based on devising efficient and effective non-pinhole camera (NPHC) models. Instead of using one of the few "off the shelf" cameras, the camera model is designed to meet the application's needs and is dynamically optimized for the data set at hand. We show that powerful NPHC models can be designed with fast projection, which enables efficient feed-forward rendering. To exemplify the proposed paradigm we introduce the graph camera, a malleable but efficient non-pinhole that creates comprehensive images of heavily occluded environments.