

The Graph Camera

Paul Rosen, Voicu Popescu, Nicoletta Adamo-Villani

In most visualization applications the user explores the scene using a virtual pinhole camera. The pinhole captures only a small fraction of the scene due to occlusions. One conventional solution is interactive navigation. However, such sequential visualization can be inadequate for dynamic scenes where the features of interest are transient and their visual saliency degrades by the time the camera reaches them. A second conventional solution is to visualize the scene in parallel with several stationary pinhole cameras. However, parallel visualization requires a large number of cameras for adequate scene coverage. Moreover, the individual images are discontinuous and redundant, which reduces the effectiveness of the visualization.

We introduce the graph camera, a non-pinhole camera with rays that circumvent occluders to create a single layer image that shows simultaneously all regions of interest in a complex 3-D scene. The graph camera enables comprehensive, continuous, and non-redundant visualization of dynamic 3-D scenes. Although a graph camera image does convey spatial proximity, it does not and is not intended for providing global spatial relationships. The graph camera is constructed from a planar pinhole camera through a series of view frustum bending, splitting, and merging operations. The resulting non-pinhole camera is literally a graph of planar pinhole camera frusta. Although there are tens or even hundreds of frusta, graph camera images are rendered at interactive rates leveraging a fast projection operation that allows rendering in feed-forward fashion. We explore the use of the graph camera as a summarization tool for 3-D scenes. Through an interactive editor the user constructs a graph camera that shows all features of interest making good use of image space. Finally we explore the use of the graph camera for the integration of multiple video feeds in a continuous and non-redundant visualization, enabling monitoring complex spaces with a single image.