ABSTRACT

A NEW ACCELERATING TECHNIQUE FOR RAY TRACING OF COMPLEX SCENES

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Ray tracing has proven itself to be a highly effective method for producing photo-realistic images of three-dimensional scenes. The basic problem with ray tracing is the enormous amount of computation required for tracking a large number of rays through the scene. Traditionally, each tracked ray has to be checked for intersection with every object in the scene in order to render the image. Many researchers report that more than 95% of the image creation computation time is consumed by object-ray calculation. Various accelerating techniques have been proposed in recent years to reduce the number of ray-object intersection checks, such as bounding volume hierarchies, spatial subdivision, and directional cube methods. Among them, the spatial subdivision technique is the most widely discussed method.

While most researchers have concentrated on directly extracting information from the three-dimensional space to accelerate the ray tracing process, information about relationships between objects that also exists on various two-dimensional projection planes has been overlooked. This dissertation presents a technique to track the rays in three-dimensional space by a two-dimensional approach -- using multiple projection planes. Although extra projection planes are widely used for building and displaying models and scenes, no previous work has been done to use extra projection planes for accelerating ray tracing.

The approach used in this work is as follows. In addition to the projection plane which is used to observe the scene and generate the picture, k additional projection planes are judiciously positioned in the scene. The objects in the scene are projected onto each projection plane and their projected bounding rectangles are collected and properly manipulated. During the ray tracking process, the path of the ray inside the scene is monitored by each of the additional projection planes with the aid of the projected bounding rectangles of the objects. This additional information is consulted to build list of candidate objects which could be intersected by the ray. In order to maintain the accuracy of the information from each additional projection plane, a method is used to coordinate the movement of the ray across these additional projection planes.

Several variations of this method were implemented and are discussed in this dissertation along with a series of experiments. Statistics on the execution time and the total number of ray-object intersection tests are reported.