Efficient Collision Detection for Point and Polygon Based Models

Dissertation by Jan Klein
Paderborn, May 2005

Abstract

This work deals with the problem of efficient collision detection for point-based and polygon-based models. We have investigated the following three main areas:

1. We propose a technique that allows for increasing the speed of collision detection by decreasing its quality. The main idea of our average-case approach is to estimate the probability of an intersection of two sets of polygons (or other primitives) in order to guide the simultaneous traversal of two bounding volume hierarchies.
2. We give a new definition of an implicit surface over a noisy point cloud based on the weighted least squares approach. We use a different kernel function that approximates geodesic distances by shortest paths in a geometric proximity graph. Thus, artifacts are reduced and the bandwidth and boundaries can automatically be determined.
3. We propose a point cloud hierarchy for collision detection between point clouds. This hierarchy approximates the surface at inner nodes and allows for excluding parts where no collision can occur. Moreover, our interpolation search can be used to find intersection points efficiently by utilizing the proximity graph.

In all three areas, we have shown that algorithmic ideas of theoretical computer science lead to efficient, real time algorithms and allow for analyzing their quality and running time.