Master Thesis –

SIMD Optimized Bounding Volume Hierarchies for Proximity Queries

Proximity queries are fundamental to many computer based applications, including computer games, physically based simulations (such as computer animation), robotics, virtual prototyping, and engineering simulations, etc. In order to do this one requires some type of geometric data structure to massively accelerate proximity queries. One of the most tested and successful such geometric data structures are bounding volume hierarchies (BVHs). Bounding volume hierarchies consist of a hierarchy of simple geometric shapes enclosing the object that one wishes to carry out proximity queries on and allow for fast proximity queries such as collision detection, distance measurement and penetration depth computation. Researchers have optimized and improved BVHs over the last twenty years but one of the major challenges has always been to adapt them to improving hardware. In recent years there have been numerous publications on GPU optimized BVHs but the majority of results deal with speeding up existing structures. The goal of this master thesis is to analyze the BVH paradigm from a new perspective and utilize new SIMD (single-instruction-multiple-data) instructions to take proximity queries to a new level. The new AVX (and SSE) instruction sets in modern computers open up numerous possibilities for optimizing bounding volume hierarchies and in this thesis, the goal is to investigate some of them in particular to redefine the BVH structure.

Objectives:
- To investigate the use of AVX (and SSE) instructions for general geometric primitive proximity queries.
- To investigate design choices for BVHs optimized for AVX (and SSE) instructions.
- Compare the performance of SIMD optimized BVHs with traditional BVHs

Prior Knowledge:
Working knowledge of C++ is required although the student will acquire the necessary SIMD skills during the thesis

Expected Outcome:
A new paradigm based on SIMD optimization for BVHs as well as the goal to publish the results in a peer reviewed journal.

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