Event-Driven Message Passing and Parallel Simulation of Global Illumination

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Abstract

The contemporary message passing standards do not allow for an efficient and at the same time portable implementation of the parallel simulation of global illumination. Poling cannot be avoided if PVM or MPI is used as the underlying middleware. Other important parallel applications also suffer from this problem. These applications form a subclass of irregular applications which can be well characterised and which we call "non-trivial applications". We propose a formal framework for message passing and show how non-trivial applications can be implemented without polling (event-driven) in our framework. Using a non-trivial benchmark on a commodity computing cluster we measure an improvement factor of over 300 against polling PVM and MPI implementations.

We present a demand-driven parallelisation of ray tracing which uses a novel load balancing algorithm for process farms. This algorithm solves the problem of placement of a constant number of independent tasks with given, but unknown, complexity onto a homogeneous network of processors with given (known) communication latency. Efficiency of over 94% is measured for 128 workers for a practice-relevant ray tracing setting. Another set of experiments compares the efficiency of an event-driven implementation against a polling implementation for a ray tracing setting with a distributed object database. The event-driven implementation outperforms the polling one by factor 12.

We introduce a shooting radiosity algorithm which uses the ray tracing shader in order to perform the form factor computation and the energy transfer in a single step. Emphasis is put on simplicity and robustness of the resulting algorithm. We carefully choose an unbiased Monte Carlo estimator with finite variance for the form factor computation. Our implementation of the two-pass rendering method in POV-Ray correctly handles complex materials during the radiosity pass and seamlessly connects the radiosity and ray tracing passes.