Abstract of PhD Thesis

Algorithms for solving selected types of narrow banded linear systems on computers with multicore processors

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The purpose of this PhD dissertation is to demonstrate the development of effective algorithms dedicated to solving selected numerical problems with the use of modern parallel and in particular heterogeneous computer architectures. We concern ourselves with problems that can be reduced to linear systems of equations with narrow banded matrices. High performance computing is obtained through the recently developed *divide and conquer* method, which can be effectively implemented on advanced multicore architectures.

The first of the most important results obtained in the dissertation is the design and implementation of parallel algorithm for solving piecewise cubic interpolation problems on machines with distributed memory system. The algorithm utilizes some of the available numerical software libraries optimized for modern hardware.

The next result presented here is the development of the effective numerical algorithm for solving a special kind of boundary value problem, which can be reduced to the problem of solving a tridiagonal system of linear equation with an almost Toeplitz structure. The implementation of the algorithm has been optimized for memory access to a graphics processing unit. The parallel algorithm proposed in this dissertation proved to be faster and more accurate than the sequential one in the carried out numerical tests. Moreover, numerical experiments showed that the use of mixed precision can improve the algorithm's accuracy without substantially compromising its speed.

Finally, fast parallel algorithms for linear congruential and lagged Fibonacci pseudo-random numbers generators has been developed with the employment of the *divide and conquer* metod for solving linear reccurence systems on GPU-accelerated heterogeneous architectures. In this setting a bidiagonal Toeplitz matrix arises from the reduction of the problem with the LCG and diagonally sparse lower triangular matrix for LFG generator. The *divide and conquer* approach allows to preserve all of the statistical properties of the aforementioned generators. Numerical experiments perfomed on a computer system with modern GPU using CUDA suggest that these algorithms can be a valuable addition to the cuRAND library. Parallel LCG rendered to be several dozen times faster than its sequential implementation. Parallel LFG also performed much better then its sequential version, however the speedup depends on the setting of the generator's parameters. In the dissertation there are also included optimal settings for the CUDA enviroment in order to achieve the best performance of discussed algorithms.

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