Feedback on dissertation work

"Potential of hybrid OPENMP/MPI parallelization strategies for HPC software"
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submitted for the degree of Doctor of Philosophy in the specialty 6D060200 - "Computer Science"

Ensuring high parallel computing efficiency for various large-scale problems is inherently difficult, since even a slight load imbalance can seriously affect the overall performance of massively parallel computing. So that dynamic load balancing (DLB) scheme has been presented in this work. It improves the efficiency of complex modeling with non-trivial domain decompositions. So this method with different numerical methods and different computational costs per subdivided cell has been obtained using the Hilbert Space Filling Curve (SFC) at a coarse level. On the other words, minimal intrusive method has been proposed for estimating computational weights based on performance measurements during simulation. The approach allows automatically determine the appropriate weight parameters that can be used to estimate the overall distribution of the workload. Due to the inability of this evaluation procedure to capture local workload changes, the overall SFC-based load balancing approach may not be optimal. Therefore, an incremental DLB diffusion algorithm based on SFC separation has been introduced, which allows customization of the domain decomposition.

This doctoral dissertation consists of 5 main chapters devoted to the study of mathematical models for various large-scale problems and parallel numerical algorithms that solve these equations.

Providing an overview of the major HPC technologies and overview of the main parallelization models and the idea of hybrid OpenMP/MPI technology has been considered first.

Then models of the main characteristics of high performance computing were presented. Moreover, the partial differential equations, which describe the basic laws of hydrodynamics were described. And also the procedure of non-dimensionalization and discretization of the obtained equations has been described in detail. So then numerical studies of the efficiency of high-performance computing for flow problems beyond the backward step was presented. The mathematical models used in combination with boundary conditions were also described in detail. A precise description of the parallel numerical algorithm and detailed evaluation of the efficiency of the parallel numerical algorithm have been also made.

Finally, numerical studies of the efficiency of HPC using hybrid parallel algorithms for airflow problems in a complex nose region using a dynamic load balancing scheme that improves the performance of complex coupled simulations with non-trivial domain expansions were described.

As a result three main problems have been considered in order to verify numerical algorithm, to compare results with experimental data, to identify better choice of hybrid parallel algorithm. The forth problem has been solved with an eye to the importance of humidity and temperature parameters for a given problems. And finally the fifth problem was considered with an application of new DLB schema, to highlight the impressively better results in efficiency. And obviously proposed new method tends to demonstrate very good results in increasing the speed up of previous problems.

The results of the dissertation were reported at various international conferences, and also published in leading scientific journals of Kazakhstan, countries of near and far abroad.

During her work on dissertation, Abylkassymova Aizhan showed broad knowledge in the field of computer science, the theory of high-performance computing, numerical methods, great diligence and the ability to further research activities.

The planned amount of work has been completed, and the dissertation work meets all the requirements for doctoral dissertations in the specialty 6D060200 – Computer Science, and its author deserves to be awarded the required degree of Doctor of Philosophy (Ph.D).

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