

REVIEW

of the official reviewer for dissertation work

Abylkassymova Aizhan Bolatovna on the theme «Potential of hybrid OpenMP/MPI parallelization strategies for HPC software»
presented for the degree of Doctor of Philosophy (PhD) in the specialty «6D060200 – Computer Science».

№	Criteria	Eligibility (one of the options must be checked)	Justification of the position of the official reviewer
1.	The topic of the thesis (as of the date of its approval) corresponds to the directions of development of science and/or state programs	<p>1.1 Compliance with priority areas of science development or government programs:</p> <p>1) The thesis was completed within the framework of a project or target program financed from the state budget (indicate the name and number of the project or program)</p> <p>2) The thesis was completed within the framework of another state program (indicate the name of the program)</p> <p>3) The dissertation corresponds to the priority direction of the development of science, approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan (indicate the direction)</p>	<p>The dissertation work is devoted to the actual problem of studying the dynamic load balancing scheme, which allows increasing the efficiency of complex coupled simulations with non-trivial expansions in the domain.</p> <p>The dissertation work was carried out within the framework of the grant funding program of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan, AP08857306 "Development of efficient parallel computational algorithms for mathematical modeling of air movement in the nasal cavity on high-performance computing systems"</p>
2.	Importance for science	The work <u>makes</u> /does not make a significant contribution to science, and its importance is well disclosed/not disclosed	This dissertation makes a significant contribution to science. The developed schemes and numerical algorithms make a direct contribution to the development of science in distributed computing and

			in the field of information technology in the country.
3.	The principle of independence	Self-reliance level: 1) <u>High</u> ; 2) Medium; 3) Low; 4) No independence	The dissertation work has a complex research character. I consider the level of independence of this work to be high.
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) <u>Justified</u> ; 2) Partially justified; 3) Not justified.	The author substantiates the relevance of the dissertation. The practical value of the work lies in the fact that the developed dynamic load balancing (DLB) scheme on high-performance systems of great practical importance allows not only to obtain significantly "fast" results compared to sequential calculations, but also expands the possibilities for implementing labor-intensive methods and algorithms. for solving important applied and fundamental problems.
		4.2 The content of the thesis reflects the topic of the thesis: 1) <u>Reflects</u> ; 2) Partially reflects; 3) Does not reflect	The content of the dissertation fully reflects the purpose, objectives and topic of the study.
		4.3. The purpose and objectives correspond to the topic of the thesis: 1) <u>correspond</u> ; 2) partially correspond; 3) do not correspond	The dissertation clearly articulates the purpose and objectives of the study, which are fully consistent with the topic of the dissertation.
		4.4 All sections and provisions of the thesis are logically interconnected: 1) <u>completely interconnected</u> ; 2) the interconnection is partial; 3) there is no interconnection	The dissertation has an internal unity. All sections and scientific provisions in this work are logically interconnected.

		<p>4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions:</p> <p>1) <u>there is a critical analysis;</u></p> <p>2) partial analysis;</p> <p>3) the analysis does not represent one's own opinions, but quotes from other authors</p>	<p>The methods and solutions tested by the author are fully substantiated by the obtained reliable results. A complete analysis of the obtained results was also carried out.</p>
5.	Scientific novelty principle	<p>5.1 Are the scientific results and provisions new?</p> <p>1) <u>completely new;</u></p> <p>2) partially new (25-75% are new);</p> <p>3) not new (less than 25% are new)</p>	<p>Scientific results and provisions are completely new, which is confirmed by the results obtained:</p> <p>1. Исахов А.А., Абылкасымова А.Б., Мансурова М.Е. Применение метода балансировки нагрузки на высокопараллельных вычислительных кластерных системах // Вестник КБТУ. – 2021, – № 1 (18) – С.117-125</p> <p>2. Issakhov A.A., Abylkassymova A., Application of Parallel Computing Technologies for Numerical Simulation of Air Transport in the Human Nasal Cavity. Innovative Computing, Optimization and Its Applications // Studies in Computational Intelligence. - vol 741. Springer, Cham. – P.131-149 In: Zelinka I., Vasant P., Duy V., Dao T. (eds).</p> <p>3. Issakhov A.A., Zhandaulet Y., Abylkassymova A., Issakhov As. A numerical simulation of air flow in the human respiratory system for</p>

			<p>various environmental conditions // Theoretical Biology and Medical Modelling. - 2021. – 18. - Article number: 2, doi.org/10.1186/s12976-020-00133-8 (Impact Factor: 1.68)</p> <p>4. Issakhov A.A., Mardieyeva A., Zhandaulet Y., Abylkassymova A. Numerical study of air flow in the human respiratory system with rhinitis // Case Studies Thermal Engineering. Available online. - 19 May 2021. - 101079, 10.1016/j.csite.2021.101079.</p>
		<p>5.2 Are the dissertation findings new? <u>1) completely new;</u> 2) partially new (25-75% are new); 3) not new (less than 25% are new)</p>	<p>The conclusions are completely new, made on the basis of the obtained numerical experiments, are scientifically substantiated and do not raise doubts about their reliability.</p>
		<p>5.3 Technical, technological, economic or management decisions are new and reasonable: <u>1) completely new;</u> 2) partially new (25-75% are new); 3) not new (less than 25% are new)</p>	<p>The technical solutions proposed in the dissertation to obtain an effective approach to reduce the load imbalance between processors can be considered new.</p>
6.	The validity of the main findings	All main conclusions <u>are</u> /are not based on scientifically significant evidence or well-grounded (for qualitative research and areas of training in the arts and humanities)	All main conclusions are based on scientifically sound results in accordance with modern literary sources.
7.	The main provisions for the defense	<p>It is necessary to answer the following questions for each provision separately: 7.1 Is the provision proven? <u>1) proven;</u> 2) rather proven; 3) rather not proven;</p>	<p>The following provisions have been defended: 1. Results of a numerical study of the efficiency of high-performance computations for problems of flow</p>

		<p>4) not proven</p> <p>7.2 Is it trivial?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u></p> <p>7.3 Is it new?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u></p> <p>7.4 Application level:</p> <p>1) narrow;</p> <p>2) medium;</p> <p>3) <u>wide</u></p> <p>7.5 Is it proven in the article?</p> <p>1) <u>yes</u>;</p> <p>2) <u>no</u></p>	<p>behind a backward step</p> <p>7.1 proven</p> <p>7.2 no</p> <p>7.3 yes</p> <p>7.4 wide</p> <p>7.5 yes</p> <p>1. Исахов А.А., Абылкасымова А., Сақыпбекова М. Применение параллельных вычислительных технологий для моделирования процесса отрыва течения за обратным уступом в канале с учетом сил плавучести // Вестник КазНУ. - 2018. - № 1 (97) – С.143 – 158.</p> <p>2. Issakhov A.A., Abylkassymova A., M. Sakypbekova Applications of parallel computing technologies for modeling the mixed convection in backward-facing step flows with the vertical buoyancy forces // International Journal of Mathematics and Physics. – 2017. - Volume 8. Number 2 (4). - P. 43-50.</p> <p>2. Results of a numerical study of the efficiency of high-performance computing using hybrid parallel algorithms for problems of air flow in a complex nasal region</p> <p>7.1 proven</p> <p>7.2 no</p> <p>7.3 yes</p> <p>7.4 wide</p>
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			<p>7.5 yes</p> <p>1. Issakhov A.A., Abylkassymova A., Application of Parallel Computing Technologies for Numerical Simulation of Air Transport in the Human Nasal Cavity. Innovative Computing, Optimization and Its Applications // Studies in Computational Intelligence. - vol 741. Springer, Cham. – P.131-149 In: Zelinka I., Vasant P., Duy V., Dao T. (eds).</p> <p>2. Issakhov A., Abylkassymova A. Numerical study of identification of the main characteristics of air transport in the human nasal cavity // International journal of biology and biomedical engineering. – 2017. - Volume 11. - P. 80-87 (Scopus).</p> <p>3. Исахов А.А., Абылкасымова А. Применения параллельных вычислительных технологий для численного моделирования переноса воздуха в респираторной системе человека // Вестник КазНПУ – 2017. – № 1(57). – С.219-229.</p> <p>3. Results of hybrid parallel numerical computation using various methods of domain decomposition</p> <p>7.1 proven</p> <p>7.2 no</p> <p>7.3 yes</p>
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			<p>7.4 wide 7.5 yes 1. Issakhov A.A., Abylkassymova A., M. Sakypbekova Applications of parallel computing technologies for modeling of the wind flow around the architectural obstacles with the vertical buoyancy forces // Известие НАН РК – 2018 Серия физ.-мат. – № 4(320) – С.48-57. 2. Issakhov A., Abylkassymova A. Numerical study of identification of the main characteristics of air transport in the human nasal cavity // International journal of biology and biomedical engineering. – 2017. - Volume 11. - P. 80-87 (Scopus). 3. Исахов А.А., Абылкасымова А. Применения параллельных вычислительных технологий для численного моделирования переноса воздуха в респираторной системе человека // Вестник КазНПУ – 2017. – № 1(57). – С.219-229. 4. Results of hybrid parallel numerical computation using dynamic load balancing method 7.1 proven 7.2 no 7.3 yes 7.4 wide</p>
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			<p>7.5 yes</p> <p>1. Исахов А.А., Абылкасымова А.Б., Мансурова М.Е. Применение метода балансировки нагрузки на высокопараллельных вычислительных кластерных системах // Вестник КБТУ. – 2021, – № 1 (18) – С.117-125</p> <p>5. Results of Evaluation of the Efficiency of Hybrid Parallel Numerical Computing Using Various Domain Decomposition Methods</p> <p>7.1 proven</p> <p>7.2 no</p> <p>7.3 yes</p> <p>7.4 wide</p> <p>7.5 yes</p> <p>1. Issakhov A.A., Zhandaulet Y., Abylkassymova A., Issakhov As. A numerical simulation of air flow in the human respiratory system for various environmental conditions // Theoretical Biology and Medical Modelling . - 2021. – 18. - Article number: 2, doi.org/10.1186/s12976-020-00133-8</p> <p>6. Results of evaluating the efficiency of a hybrid parallel numerical algorithm using the method of dynamic load balancing</p> <p>7.1 proven</p>
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			<p>7.2 no 7.3 yes 7.4 wide 7.5 yes</p> <p>1. Исахов А.А., Абылкасымова А.Б., Мансурова М.Е. Применение метода балансировки нагрузки на высокопараллельных вычислительных кластерных системах // Вестник КБТУ. – 2021, – № 1 (18) – С.117-125</p> <p>7. Results of the comparison of the obtained simulation results with numerical data and experimental data of other authors.</p> <p>7.1 proven 7.2 no 7.3 yes 7.4 wide 7.5 yes</p> <p>1. Исахов А.А., Абылкасымова А. Исследование движения воздуха в респираторной системе человека методами математического моделирования // Известия КГТУ им. И. Раззакова. - 2016, – № 3 (39) – С.116 – 121.</p> <p>2. Исахов А.А., Абылкасымова А. Свойства переноса воздуха в респираторной системе человека с помощью численного моделирования // Вестник КазНУ.</p>
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			<p>- 2017. – № 1 (93) – С.105 – 118.</p> <p>8. Results of the analysis of the obtained results of hybrid parallel numerical computing and hybrid parallel numerical computing using the method of dynamic load balancing</p> <p>7.1 proven</p> <p>7.2 no</p> <p>7.3 yes</p> <p>7.4 wide</p> <p>7.5 yes</p> <p>1. Исахов А.А., Абылкасымова А.Б., Мансурова М.Е. Применение метода балансировки нагрузки на высокопараллельных вычислительных кластерных системах // Вестник КБТУ. – 2021, – № 1 (18) – С.117-125</p> <p>2. Issakhov A.A., Mardieyeva A., Zhandaulet Y., Abylkassymova A. Numerical study of air flow in the human respiratory system with rhinitis // Case Studies Thermal Engineering. Available online. - 19 May 2021. - 101079, 10.1016/j.csite.2021.101079.</p>
8.	The principle of reliability Reliability of sources and	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail <u>1) yes;</u> 2) no	In her dissertation work, the author provides in detail the rationale for the choice of all the methods used to obtain a dynamic load balancing (DLB) scheme on high-performance

	information provided		systems, as well as methods for conducting numerical simulation.
		8.2 The results of the thesis were obtained using modern methods of scientific research and methods of processing and interpreting data using computer technologies: <u>1) yes;</u> 2) no	All methods of analysis used in this work are considered to be fully sufficient for conducting this kind of research.
		8.3 Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research (for areas of training in pedagogical sciences, the results have been proven on the basis of a pedagogical experiment): <u>1) yes;</u> 2) no	All mathematical models and numerical methods used in this work were verified by experimental data and numerical data of other authors.
		8.4 Important statements are <u>confirmed</u> / partially confirmed / not confirmed by references to current and reliable scientific literature	Almost all important statements in the dissertation work are confirmed by references to modern literature.
		8.5 Used literature sources are <u>sufficient</u> /not sufficient for a literature review	The list of used literature includes 126 titles and is sufficient to achieve the goal of the dissertation work.
9	Practical value principle	9.1 The thesis has theoretical value: <u>1) yes;</u> 2) no	The dynamic load balancing (DLB) scheme proposed by the author with non-trivial domain expansions on high-performance systems can be considered new. In addition, a detailed performance analysis is justified by the need for dynamic load distribution, which is of great theoretical importance in the field of information technology.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice:	The implementation of tasks on high-performance systems, which are of

		<u>1) yes;</u> 2) no	great practical importance, allows not only to obtain a significantly “fast” result compared to sequential programming, but also expands the possibilities for implementing labor-intensive methods and algorithms to solve important applied and fundamental problems in the field of surgical rhinoplasty for practitioners doctors.
		9.3 Are the practice suggestions new? <u>1) completely new;</u> 2) partially new (25-75% are new); 3) not new (less than 25% are new)	All offerings are brand new, as evidenced by published scientific articles.
10.	The quality of writing and design	Academic writing quality: <u>1) high;</u> 2) average; 3) below average; 4) low.	High. Nevertheless, there are spelling and syntactic errors in the work, but this in no way reduces the quality of the dissertation work and does not affect the clarity of the conclusions drawn.

In reviews, official reviewers indicate one of the following solutions:

1) to award the degree of Doctor of Philosophy (PhD) in the speciality «6D060200 – Computer Science»;

Official Reviewer:

**Chairman of Board, Rector
of the International Information Technology University,
Candidate of physical and mathematical sciences**



Khikmetov A.K.

