

**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	1.1 Compliance with priority areas of science development or government programs:	The theme of the dissertation is relevant. The paper proposes a dynamic load balancing scheme to improve the efficiency of complex coupled simulations with nontrivial domain expansions.
		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) 2) The thesis was completed within the framework of another state program (indicate the name of the program) 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)	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"
2.	Importance for science	The work <u>makes</u> /does not make a significant contribution to science, and its importance is well <u>disclosed</u> /not disclosed	The proposed numerical algorithms and the scheme of dynamic load balancing are a significant contribution to science in distributed computing and in the field of information technology of the country.



3.	The principle of independence	Self-reliance level: 1) <u>High</u> ; 2) Medium; 3) Low; 4) No independence	I consider the level of independence of this dissertation to be high, since good results have been obtained and deep research activities have been carried out.
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. Since the resulting dynamic load balancing scheme can be used not only for the studied types of tasks, but also for any type where parallelization is used, which is an important criteria.
		4.2 The content of the thesis reflects the topic of the thesis: 1) <u>Reflects</u> ; 2) Partially reflects; 3) Does not reflect	I definitely could say, that 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 purpose and objectives correspond to the topic of the dissertation. Since tasks were considered using parallelization using hybrid methods, different types of domain decomposition, and tasks with a new load balancing scheme were also considered to increase the efficiency of the computational process.
		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 is logically interconnected. Since there is logic between sections.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) <u>there is a critical analysis</u> ;	The new solutions obtained by the author are fully substantiated. A comparative analysis with known



		<p>2) partial analysis;  3) the analysis does not represent one's own opinions, but quotes from other authors</p>	<p>solutions was also carried out. There are justifications for the uniqueness of the results obtained.</p>
5.	Scientific novelty principle	<p>5.1 Are the scientific results and provisions new?  1) <u>completely new</u>;  2) partially new (25-75% are new);  3) not new (less than 25% are new)</p>	<p>Scientific results and provisions are completely new, which is confirmed by the results obtained in following publications:</p> <ol style="list-style-type: none"> <li>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</li> <li>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).</li> <li>3. Issakhov A.A., Zhandalet 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</li> </ol>



			number: 2, doi.org/10.1186/s12976-020-00133-8 (Impact Factor: 1.68) 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.
		5.2 Are the dissertation findings new? 1) <u>completely new</u> ; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The conclusions are completely new and do not raise doubts about their reliability. Since numerical experiments and comparative analysis with the experimental data of well-known authors were carried out.
		5.3 Technical, technological, economic or management decisions are new and reasonable: 1) <u>completely new</u> ; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The technical solutions proposed in the dissertation work can be considered new. Since there are justifications for the novelty of the proposed dynamic load balancing scheme.
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)	The main conclusions made in the dissertation are based on adequate interpolation of results obtained during the research. All the conclusions made do not contradict modern views in the field of computer science.
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provision proven? 1) <u>proven</u> ;	The defenses include the following: 1. Results of a numerical study of the efficiency of high-performance



		<p>2) rather proven;  3) rather not proven;  4) not proven  7.2 Is it trivial?  1) yes;  2) <u>no</u>  7.3 Is it new?  1) <u>yes</u>;  2) no  7.4 Application level:  1) narrow;  2) medium;  3) <u>wide</u>  7.5 Is it proven in the article?  1) <u>yes</u>;  2) no</p>	<p>computations for problems of flow behind a backward step  7.1 proven  7.2 no  7.3 yes  7.4 wide  7.5 yes  1. 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.  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  7.1 proven  7.2 no  7.3 yes  7.4 wide  7.5 yes  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 //</p>
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			<p>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. Results of hybrid parallel numerical computation using various methods of domain decomposition</p> <p>7.1 proven 7.2 no 7.3 yes 7.4 wide 7.5 yes</p> <p>1. 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>2. Исахов А.А., Абылкасымова А. Применения параллельных вычислительных технологий для численного моделирования переноса воздуха в респираторной системе человека // Вестник КазНПУ – 2017. – № 1(57). –</p>
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			<p>C.219-229.</p> <p>4. Results of hybrid parallel numerical computation using dynamic load balancing method</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.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 7.2 no 7.3 yes 7.4 wide 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</p>
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			<p>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 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</p>
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			<p>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. - 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  7.1 proven  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>2. Issakhov A.A., Mardieyeva A., Zhandaulet Y., Abylkassymova A. Numerical study of air flow in the human respiratory system with</p>
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			<p>rhinitis // Case Studies Thermal Engineering. Available online. - 19 May 2021. - 101079, 10.1016/j.csite.2021.101079.</p> <p>However, here some remarks for dissertation:</p> <ol style="list-style-type: none"> <li>1. There are a number of small grammatical imprints in the text of the dissertation</li> <li>2. Comparison absence of the obtained numerical data for the problem of air movement in the nasal cavity, taking into account temperature and humidity, with experimental data</li> </ol>
8.	The principle of reliability Reliability of sources and information provided	<p>8.1 Choice of methodology - is justified or the methodology is described in sufficient detail</p> <ol style="list-style-type: none"> <li>1) <u>yes</u>;</li> <li>2) no</li> </ol>	<p>The methodology used in the dissertation work is common in conducting in this kind of research. Therefore, taken schema of dynamic load balancing was fully justified with modern methods of scientific research and methods of processing and interpreting data using computer technologies.</p>
		<p>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:</p> <ol style="list-style-type: none"> <li>1) <u>yes</u>;</li> <li>2) no</li> </ol>	<p>Modern methods of analysis, such as a smooth transition from one problem to another, while the introduction of innovations gradually gave a positive result in the work. All methods of processing and interpreting data using computer technology were observed.</p>



		<p>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):</p> <p><u>1) yes;</u> 2) no</p>	<p>All the results were obtained and can be reliable, since the author on each task carried out a comparative analysis with the experimental data of existing works of famous authors.</p>
		<p>8.4 Important statements are <u>confirmed</u> / partially confirmed / not confirmed by references to current and reliable scientific literature</p>	<p>All statements formulated in the dissertation work are consistent with the results of modern research in the field of parallel programming, published in the reputable scientific journals. All relevant references are available in the dissertation project.</p>
		<p>8.5 Used literature sources are <u>sufficient</u>/not sufficient for a literature review</p>	<p>All available references to the scientific literature are sufficient for a literature review. Out of 126 referenced used in the work, most of them are recent and have a good percentile.</p>
9	Practical value principle	<p>9.1 The thesis has theoretical value:</p> <p><u>1) yes;</u> 2) no</p>	<p>The thesis has a theoretical value. Because taken DLB schema was explained very well. And moreover it could be used for any kind of parallelization.</p>
		<p>9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice:</p> <p><u>1) yes;</u> 2) no</p>	<p>The developed schema of DLB could be applied to any kind of parallel problems not only in medicine, also in industry or anywhere where exists high performance calculations.</p>



		9.3 Are the practice suggestions new? 1) <u>completely new</u> ; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	Proposed schema is fully new. As the results were published in scientific articles.
10.	The quality of writing and design	Academic writing quality: 1) <u>high</u> ; 2) average; 3) below average; 4) low.	The writing quality is average. As there are some inaccuracies in the descriptions of terminologies.

The decision of the official reviewer:

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

**Official Reviewer:**

**PhD, Associate Professor of the Department of Mathematics,  
Sarsen Amanzholov East Kazakhstan University**



*D. Baigereyev*

**Baigereyev D.**

*Доктор Баигереева Д.П. ұсындырған  
сұрақтарға жауап*