REVIEW
of the official reviewer for dissertation work
of ARMAN IBRAYEVA on the theme «Synthesis of Leg Mechanism and Optimal Design of Walking Robot»
presented for the degree of Doctor of Philosophy (PhD) in the specialty «8D07117 – Robotic systems».

№	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:	
		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 was carried out as part of the following project, supported by state funding (AP09259589-OT-23 "Optimal Design of an Adaptive Walking Robot with an Intelligent Control System").
2.	Importance for science	The work makes/does not make a significant contribution to science, and its importance is well disclosed/not disclosed	The work makes a significant contribution to science, and its importance is well elucidated in the dissertation. The dissertation aligns with the priority areas of scientific and technological development and is aimed to the development of synthesis methods for the mechanisms of a walking robot and the optimization of its parameters based on the functional decomposition method.
3.	The principle of independence	Self-reliance level: 1) High; 2) Medium; 3) Low;	Level of independence: high. The main results of the research conducted in the dissertation were obtained independently by the author.

		4) No independence	
4.	The principle of inner unity	4.1 Justification of the relevance of the thesis: 1) Justified; 2) Partially justified; 3) Not justified.	Justification of the dissertation's relevance: fully substantiated.
		4.2 The content of the thesis reflects the topic of the thesis: 1) Reflects; 2) Partially reflects; 3) Does not reflect	The content of the dissertation fully covers the topic (see below).
		4.3. The purpose and objectives correspond to the topic of the thesis: 1) correspond; 2) partially correspond; 3) do not correspond	The purpose and objectives correspond to the topic of the thesis. The aim of the study is to develop synthesis methods and optimize robot parameters based on the functional decomposition method. This allows for simplifying the control system and ensuring movement across rugged terrain with minimal energy consumption.
		4.4 All sections and provisions of the thesis are logically interconnected: 1) completely interconnected; 2) the interconnection is partial; 3) there is no interconnection	All sections and provisions of the dissertation are logically interconnected. The main sections include a comparative analysis and substantiation of irrationalities and drawbacks in existing approaches, rational design of walking robots, development of synthesis methods, development of adaptation mechanism, optimization of turning, and experimental validation.
		4.5 The new solutions (principles, methods) proposed by the author are reasoned and evaluated in comparison with the known solutions: 1) there is a critical analysis; 2) partial analysis;	All conclusions are justified, and critical analysis is provided. The study demonstrates the irrationality of traditional biomorphic robots, including their structural redundancy, as well as the

		3) the analysis does not represent one's own opinions, but quotes from other authors	unreasonably low efficiency associated with motor operation in intensive acceleration-deceleration modes. The author proposes alternative solutions that addresses numerous shortcomings of existing designs.
5.	Scientific novelty principle	5.1 Are the scientific results and provisions new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	The scientific results exhibit complete novelty. While the concept of employing rectilinear-guiding mechanisms is not novel, the author has contributed novel synthesis methods. Moreover, the mechanisms synthesized by the author offer distinct advantages over existing iterations. Notably, the structural scheme, along with the turning mechanism, are approached uniquely, among other innovations (refer to details below).
		5.2 Are the dissertation findings new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	Dissertation findings are partially new. In the research, an alternative design principle for adaptive walking robots is developed, moving away from the traditional insectomorphic (insect-like) designs in favor of optimizing the robot's operational characteristics in terms of mechanics and control.
		5.3 Technical, technological, economic or management decisions are new and reasonable: 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	Technical, technological, economic or management decisions are new and reasonable.

6.	The validity of the main findings	All main conclusions are/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/are not based on scientifically significant evidence and well-grounded (see p.7 – 8)
7.	The main provisions for the defense	It is necessary to answer the following questions for each provision separately: 7.1 Is the provition proven? 1) proven; 2) rather proven; 3) rather not proven; 4) not proven 7.2 Is it trivial? 1) yes; 2) no 7.3 Is it new? 1) yes; 2) no 7.4 Application level: 1) narrow; 2) medium; 3) wide 7.5 Is it proven in the article? 1) yes; 2) no	Is the provision proven? - Yes. Is it trivial? - No. Is it new? - Partially (since linkage mechanisms have previously been applied as walking robot legs, but the PhD candidate proposes a radically new solution including novel optimization apprach). Level of applicability: wide application of walking robots. Is it proven in the article? - Yes. The candidate has authored 15 works on the dissertation topic, including 1 patent; 8 publications in highly indexed scientific journals and 5 proceedings of international conferences, 1 manuscript.
8.	The principle of reliability of sources and information provided	8.1 Choice of methodology - is justified or the methodology is described in sufficient detail 1) yes; 2) no	Yes, the reliability and validity of the scientific positions, conclusions, and results of the dissertation are confirmed by the correct formulation of the problem and the application of established mathematical methods, methods of theoretical mechanics, methods of mechanism and machine theory, and methods of experimental research.

		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: 1) yes; 2) no	Yes, theoretical investigations were conducted based on classical robot design methods, as well as analytical and numerical optimization and synthesis methods. Software tools such as Maple, Excel, and SolidWorks were utilized.
		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): 1) yes; 2) no	Theoretical conclusions, models, identified relationships and patterns have been proven and confirmed by experimental research.
		8.4 Important statements are confirmed / partially confirmed / not confirmed by references to current and reliable scientific literature	Yes, important statements are confirmed by references to current and reliable scientific literature.
		8.5 Used literature sources are sufficient/not sufficient for a literature review	Sufficient. 99 literature sources have been analyzed.
9	Practical value principle	9.1 The thesis has theoretical value: 1) yes; 2) no	Yes. Theoretical significance of the study includes optimization of the structural and kinematic parameters of a walking robot, development of a methodology and determination of the optimal structure and parameters of a walking robot and other contributions.
		9.2 The thesis is of practical importance and there is a high probability of applying the results obtained in practice: 1) yes; 2) no	Yes. Advantages of walking mobility over wheels and trucks are fully proven.
		9.3 Are the practice suggestions new? 1) completely new; 2) partially new (25-75% are new); 3) not new (less than 25% are new)	Majority of practical suggestions are new.

10.	The quality of writing and design	Academic writing quality: 1) high; 2) average; 3) below average; 4) low.	The level of academic writing is of high caliber.

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

1) to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization;

2) send the thesis for revision (except for cases of thesis defense in the form of a series of articles);

3) refuse to award the degree of Doctor of Philosophy (PhD) or Doctor of Specialization.

Copies of the reviews of the official reviewers are handed over to the doctoral student no later than 5 (five) working days before the defense of the thesis.

Official Reviewer:
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(signature)