O P I N I O N

about the dissertation for the award of educational and scientific degree "Doctor"
Author: Milena Filipova Grueva
Topic: **Group control of robotized vehicles for transport of goods**
Scientific area 5. "Technical sciences", Professional field 5.2. "Electrical Engineering, Electronics and Automation",
Doctoral program "Automated systems for information processing and control"
Member of the Jury: Prof. DSc Ivo Krastev Malakov, Technical University - Sofia,

The dissertation presented for my opinion is structured in 4 chapters and has a volume of 151 pages. The bibliography includes 101 literature sources, of which 14 in Cyrillic, 11 websites and the rest in Latin. In connection with the work are presented 9 publications (1 in a journal abroad, 6 in conference proceedings in Bulgaria and 2 in journals in English). All publications are co-authored, in 1 the candidate is the first author and in 7 – the second. No documents for protection of intellectual property have been submitted.

The work was developed at BAS under the scientific guidance of Prof. Dr. Dimitar Nedelchev Karastoyanov.

1. Relevance of the problem developed in the dissertation in scientific and scientific-applied terms

The dissertation is in a promising and relevant field of technology and control systems for robots in a formation that has been the subject of intensive research in recent years. The proposed approach for group control of non-holonomic mobile robots enriches and develops the knowledge and methods for solving problems in the field, increases the functions and capabilities of groups of robots and creates conditions for expanding their areas of application. All this determines the relevance and significance of the research in scientific and applied terms.

2. Degree of knowledge of the state of the problem and the literary material and creative interpretation of the literary material

The main types of mobile robots are systematized and an in-depth review and analysis of modern methods, tools and technologies for group control of these devices is performed. As a result, unsolved problems have been defined. On this basis, the doctoral student has correctly formulated the goal of the dissertation and the tasks for its achievement.

I believe that the candidate knows very well the current situation in the field and has the necessary capacity to obtain new results.

3. Correspondence of the chosen research methodology and the set goal and tasks with the achieved contributions

In accordance with the purpose of the dissertation, it analyzes the types of group control of mobile robots and proposes innovative approaches for group control of non-holonomic mobile robots with application in robotic means of transport of goods.

From the obtained results it can be concluded that the chosen research methodology is adequate to the set goal and tasks of the dissertation, which fully correspond to the achieved contributions.

4. Characteristics and evaluation of the dissertation

The doctoral student demonstrates the in-depth knowledge of the problems and the use of appropriate modern tools for solving the set tasks. A structure of a system for centralized (distributed) group control of non-holonomic mobile robots is proposed. An innovative approach to building a control system for group control based on the ROS operating system and the Webots simulation environment has been developed. A robotic vehicle for cargo transport with the possibility of application in various fields has been developed and researched. Experiments and simulations were conducted with the proposed approach and structure for group control of robotic means for transport of goods with one and several subordinate leaders in different modes. The obtained results are analyzed and the efficiency of the development is proved. The presentation of the obtained results is in a methodical sequence, as they are commented in detail and are supported by data and evidence. Based on them, the relevant conclusions have been drawn.

I appreciate the results of research and development.

5. Scientific and scientific-applied contributions of the dissertation work

I accept the contributions formulated by the author, which are scientifically-applied and applied.

The received scientific-applied and applied contributions can be referred to the groups: proving with new means of essential new sides of already existing scientific fields, problems, theories, hypotheses; creating new classifications, methods, constructions, technologies and obtaining confirmatory facts, constructions and methods and enriching the existing knowledge with practical application.

6. Assessment of the degree of personal participation of the dissertant in the contributions

The dissertation and its contributions are the personal work of the doctoral student under the competent guidance of his supervisor.

7. Evaluation of the dissertation publications

In connection with the dissertation 9 publications were made. I have no information about citations or the use of dissertation results in practice, but I am confident that they will be reflected in the scientific community.

The presented publications on the dissertation reflect sufficiently fully and accurately significant aspects of its content and promote the work done.

8. Significance of the results of the dissertation work in science and practice

The results of the dissertation can be relatively easily used in the activities of companies and organizations engaged in the design of robot control systems in formation.

9. Opinions, recommendations and remarks

The good literary awareness of the doctoral student, the used appropriate research methods, the proposed approaches and their research, the obtained experimental material, its processing, presentation and creative interpretation, speak about the high professional qualification of the doctoral student and give his dissertation qualities of methodically constructed, reliable and scientifically done theoretical-experimental research, which also has a certain practical orientation and significance.

I have no significant remarks to challenge the main scientific and applied contributions of the candidate. Notes may be made in respect of unresolved editorial, terminological and technical errors.

The actuality of the issue and the results obtained from the dissertation give me reason to recommend the candidate to look for opportunities to summarize the results in an appropriate form and publish them in indexed and refereed journals.

CONCLUSION

Based on my acquaintance with the dissertation and the materials on it, the completed educational goal of the doctoral dissertation, the actuality and significance of the achieved scientific and applied contributions, I confidently give a POSITIVE assessment of the dissertation. All requirements of the Academic Staff Development Act in RB, of the Regulation for its application, as well as the specific requirements for acquiring scientific degrees in IICT-BAS in terms of scope, volume and quality of the dissertation are fulfilled.

On these grounds, I propose to Mag. eng. Milena Filipova Grueva to be awarded the educational and scientific degree "Doctor" in field 5. Technical sciences, direction: 5.2. Electrical engineering, electronics and automation, scientific specialty Automated systems for information processing and control.

Sofia, June 30th, 2020

/Prof. DSc Ivo Malakov/