OPINION

от Prof. Evdokia Nikolaeva Sotirova, PhD,

Burgas State University "Prof. Dr. Asen Zlatarov"

of a dissertation thesis for awarding the educational and scientific degree of "Doctor"

in the field of higher education: 4. Natural Sciences, Mathematics and Informatics,
Professional field 4.6. "Informatics and Computer Science",
Doctoral Program "Informatics"

PhD student: Evgeny Vladimirov Valchev

Topic: IoT environment for intelligent livestock

Scientific supervisor: Prof. Stanimir Stoyanov, Phd
prof. Todorka Glushkova, PhD

1. General presentation of the procedure and PhD student

The opinion was drawn up on the basis of order No. RD-22-772 от 27.03.2025 of the Plovdiv University „Paisii Hilendarski" Prof. Rumen Mladenov, PhD and Protocol 1, by which I have been appointed as a member of the scientific jury and entrusted with the task of preparing an opinion within the procedure for the defense of a dissertation entitled: „IoT environment for intelligent livestock" with author Evgeny Vladimirov Valchev, for the acquisition of the educational and scientific degree "Doctor" in the field of higher education 4. Natural Sciences, Mathematics and Informatics, Professional field 4.6. Informatics and Computer Science, Doctoral program "Informatics" at the Department of Computer Systems, Faculty of Mathematics and Informatics (FMI).

The materials presented by Evgeny Vladimirov Valchev are in accordance with the Regulations for the Development of the Academic Staff of Plovdiv University "Paisii Hilendarski".

Evgeny Vladimirov Valchev was born on 10.10.1984. In 2016, with a Bachelor's degree in „Business Information Technologies", from Plovdiv University "Paisii Hilendarski". In 2021 he was enrolled in full-time doctoral studies in the doctoral program "Informatics" at Plovdiv University "P. Hilendarski". Since 2024, he has held the position of Assistant at Plovdiv University. By decision of the Departmental Council of the Department of Computer Informatics (Protocol No. 7/14.02.2025), he was discharged with the right to defend his dissertation.

2. General assessment of the dissertation research

Actuality of the topic

The dissertation thesis is dedicated to a highly relevant area, namely the application of modern digital technologies and artificial intelligence algorithms in the field of agriculture, with a focus on intelligent livestock farming. The research is aligned with both the European Green Policies and national strategic documents, including the Concept for the Digital Transformation of

Bulgarian Industry and the National Scientific Program “Intelligent Livestock Farming”. The topic is interdisciplinary in nature, intersecting fields such as informatics, automation, agricultural sciences, and artificial intelligence, which further emphasizes its relevance and scientific significance.

Knowing the problem

The presented dissertation thesis demonstrates an in-depth understanding of the issues related to the implementation of IoT technologies in the field of intelligent livestock farming. Evgeny Vladimirov Valchev displays competence and strong knowledge of the evolution of the concept of cyber-physical systems and their application in agriculture. I believe that the doctoral candidate has very good knowledge of key aspects of the current state of IoT ecosystems, architectural models, and the specific characteristics of sensor networks. His solid awareness and thorough understanding of the subject matter form a strong basis for the competent realization of the dissertation’s objectives and tasks, as well as for the presentation and substantiation of the conducted research, analyses, and obtained results.

Research methodology

I find the methodology used by the doctoral candidate appropriate and logically aligned with the objectives and tasks of the research. The author applies an iterative, step-by-step approach, which enables an in-depth and consistent progression through the various phases of the development process - from problem analysis and architectural design to prototype development, testing, validation, and evaluation. The methodology integrates theoretical analysis with experimental work, based on the construction of real IoT components (sensor network, data collection devices, and software modules for data processing and visualization). Modern data analysis approaches have been employed, including algorithms from machine learning and deep learning, which further enrich the research process. This contributes to the reliability and practical value of the obtained results.

Characterization and evaluation of the dissertation thesis

The dissertation thesis of Evgeny Vladimirov Valchev consists of 133 pages. It includes a list of figures, a list of tables, an introduction, three chapters, a conclusion, a declaration, a list of the author's publications, a glossary of terms, acknowledgements, and a bibliography. The bibliography comprises 111 references, all presented in Latin script.

In the *Introduction*, the relevance of the research problem is clearly and convincingly presented, the objective and the main tasks for its achievement are formulated, and the applied methodology is outlined. *Chapter 1* provides a competent and in-depth theoretical analysis and critical review of existing approaches and architectures in the field of IoT and cyber-physical systems, with a focus on their application in intelligent livestock farming. The reference architecture of the Virtual Physical Space (ViPS) is presented and used as a basis for modeling the target system. *Chapter 2* outlines the development of the IoT platform for intelligent livestock farming, from the hardware components and sensor network to the software modules for data collection, analysis, and visualization. Prototypes and technical solutions are presented, developed as a result of conducted tests and real-world experiments. The results and data analyses presented in *Chapter 3* are well justified. A particularly strong impression is made by the doctoral candidate’s well-structured directions for future development, including the enhancement of the IoT platform through personalized assistants, the development of economic models, and the application of multifactorial dispersion analysis for evaluating animal behavior and welfare. Of special interest is the proposal for the use of AI algorithms, including Deep Reinforcement Learning (DRL), for modeling herd behavior and decision-making in dynamic environments, which demonstrates

significant potential for future scientific and applied developments. The *Conclusion* provides a clear and accurate summary of the achieved results, with a tabular representation of the relationship between the tasks, results, structure of the dissertation, and the doctoral candidate's scientific publications, as well as the validation (approbation) of the research results.

The dissertation thesis is structured logically and consistently, in accordance with established academic standards. The research is well-argued and appropriately illustrated. I consider the studies to be conducted correctly and in line with the defined objectives and tasks. The results are well substantiated and presented at a high scientific and applied level.

3. Assessment of the publications and personal contribution of the PhD student

For the purposes of the current procedure, Evgeny Vladimirov Valchev has presented two publications containing results from his research, published in proceedings of international scientific conferences organized by IEEE and indexed in Scopus. In both publications, the doctoral candidate is listed as the first author, which clearly demonstrates his personal contribution. The publications are entirely focused on the topic of the dissertation.

In addition, Evgeny Valchev has participated in four international scientific conferences—two held in Varna, one in Pamporovo, and one in Munich—as well as in regular scientific seminars organized by the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences within the framework of the National Program "Intelligent Agriculture," where he presented reports on the current state of the IoT platform for intelligent livestock farming. He has also been a research associate in the project BG-RRP-2.004-0001-C01 "Digital Sustainable Ecosystems – Technological Solutions and Social Models for Ecosystem Sustainability (DUEcoS)."

The presented publications and scientific activity convincingly demonstrate the doctoral candidate's personal contribution and strong engagement with the research topic, as well as his active participation in the scientific community both in Bulgaria and abroad.

4. Contributions and significance of the development

I believe that the contributions in Evgeny Vladimirov Valchev dissertation thesis are scientific-but-applied and applied, and I summarize them as follows:

1) A well-founded general concept has been proposed for the development of an IoT ecosystem aimed at intelligent livestock farming, in the context of modern technological and environmental requirements;
2) Specific architectural and functional models have been developed, adapting the reference ViPS architecture to the needs of intelligent pasture-based cattle farming;
3) Functional prototypes of an IoT platform have been created, successfully demonstrating the applicability of the proposed concept in real-world conditions;
4) An effective approach has been proposed for processing and analyzing behavioral data, enabling the modeling of cattle behavior in pasture farming, with potential for future application of AI algorithms.

In support of the significance of the work are the possibilities and ideas for future applications presented by the doctoral candidate. The obtained scientific-applied and applied results are original, possess high scientific and practical value, and offer concrete solutions with

potential for real-world implementation. They fully correspond to the objective set in the dissertation thesis.

5. Abstract of dissertation thesis

The abstract of dissertation thesis contains 33 pages. It is well structured and correctly and fully reflects the structure of the dissertation work, the results obtained and the conclusions drawn from the study.

6. Critical remarks and questions

I have no critical remarks regarding the doctoral candidate. Some minor technical inaccuracies are present, but they do not diminish the value of the conducted research.

I would like to pose the following question:

What challenges do you foresee in the real-world implementation of the IoT platform you have developed?

7. Conclusion

My assessment of the dissertation thesis, the author's abstract, the publications, and the scientific activity of Evgeny Vladimirov Valchev is entirely positive. The dissertation contains scientific-applied and applied results that represent an original contribution to the field and demonstrate that the doctoral candidate possesses solid theoretical knowledge, the ability for critical analysis, and the capacity to conduct independent scientific research.

The dissertation thesis fully meets the requirements of the Law on the Development of the Academic Staff of the Republic of Belarus, the Rules for its Implementation, as well as the criteria of the Rules for the Development of the Academic Staff at Plovdiv University "Paisii Hilendarski" and the specific requirements of the Faculty of Mathematics and Informatics have been observed.

This gives me a reason to confidently recommend to the respected members of the Scientific Jury to award Evgeny Vladimirov Valchev the educational and scientific degree "Doctor" in professional field 4.6 "Informatics and computer sciences", Doctoral program "Informatics".

20.04.2025 Prepared the opinion:.....
Burgas (Prof. Evdokia Sotirova, PhD)