

OPINION

by Assoc. Prof. Dr. Irina A. Radeva
Institute of Information and Communication Technologies - BAS
for the PhD thesis for 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 programme "Informatics"
"Research on the creation of a virtual operator in smart agriculture infrastructure"
by **Ivan Stanimirov Stoyanov**

By Order No. RD-21-1093/19.05.2023 of the Rector of the Plovdiv University "Paisii Hilendarski" Prof. Rumen Dr. Mladenov in connection with an open procedure 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 programme "Informatics" by Ivan Stanimirov Stoyanov - regular Doctoral student at the Department of Computer Systems with scientific supervisor Prof. Dr. Asya Georgieva Stoyanova-Doycheva, report No. RD-20-959/18.05.2023 by Prof. Dr. Angel Atanasov Golev - Dean of the Faculty of Mathematics and Informatics and in accordance with Art. 4 of the Act of the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), Art. 2. (2), Art. 30. (3) of the Regulation on the Implementation of the Development of Academic Staff in Republic Act (RIDASRBA) and Art. 37.(1) of the Regulations for the Development of the Academic Staff of Plovdiv University (RDASPU) I have been appointed as an external member of the Scientific Jury, approved by the decision of the Faculty of Mathematics and Informatics, Minutes No. 43/17.05. 2023.

As a member of the scientific jury, I have received:

1. Order No. RD-21-1093/19.05.2023 of the Rector of Plovdiv University „Paisii Hilendarski“ Prof. Dr. Rumen Mladenov.
2. Dissertation.
3. Abstract in Bulgarian and English.
4. Application to the Rector of Plovdiv University „Paisii Hilendarski“.
5. Curriculum vitae.
6. Protocol № 8-22/23.
7. Complete list of publications.
8. List of publications on the topic of the dissertation and full texts.
9. Declaration of originality and reliability.
10. Reference for compliance with minimum national requirements.
11. Two official notes for participation in research projects.
12. Statement on the fulfilment of the minimum national requirements for the acquisition of the educational and scientific degree "Doctor" in 4.6. Computer Science.

During the evaluation of the dissertation, the requirements of the ADASRB, the RIDASRBA, the Regulations for the DAS of Plovdiv University and the additional faculty requirements of the Faculty of Mathematics and Informatics for RDAS at PU “P. Hilendarski”.

1. Pursuant to Art. 6 (3) of the ADASRB “The dissertation must contain scientific and applied science results being and original contribution to science. The dissertation must show that the applicant got deep theoretical knowledge in the respective speciality and the capacity for independent scientific research”.
2. According to Art. 27 (2) of the RIDASRBA “The dissertation must be presented in a form and volume corresponding to the specific requirements of the primary unit. The dissertation paper must contain: a title page, contents, introduction, presentation, conclusion – summary of the obtained results with declaration for originality, bibliography.

3. According to the RIDASRBA, the minimum required number of points for the groups of indicators for the degree "Doctor" in 4.6. "Informatics and Computer Science" are:

| A group of indicators | Content | Number of points |
|-----------------------|--------------------------------|------------------|
| A | Indicator 1 | 50 |
| D | Sum of indicators from 5 to 10 | 30 |

The dissertation contains 120 pages and includes: an introduction, five chapters, a conclusion, a complete list of publications, a list of publications cited in the dissertation, a complete list of projects, noted citations, acknowledgements, a reference list with 164 references, a declaration of originality and authenticity, and a list of 20 figures.

The aim of the dissertation is formulated as "to develop a personal assistant (PA) to support farmers and agricultural professionals working in smart agriculture. The PA should operate as the core of the ZEMELA platform that is under construction."

To achieve the objective, four tasks have been formulated:

- To update the event model and propose a new version.
- To update the architecture of the ZEMELA platform.
- Create a concept, model, reference architecture and life cycle of a personal assistant for farmers.
- Prototype implementation of the personal assistant.

The formulated aims and objectives have scientific and scientific-applied potential. Research on approaches, methods and implementations of cyber-physical and cyber-physical-social systems to support smart agriculture, in part and as presented in this thesis, is very actual for a number of reasons. First, they are linked to the Strategy for the Development of Artificial Intelligence in Bulgaria until 2030 and to the two National Science Programmes "Smart Crop Production" and "Smart Animal Husbandry". Second, the continuous line in the multi-year developments of the Distributed eLearning Center (DeLC), Virtual Education Space (VES) and Virtual-Physical Space (ViPS) architectures implemented at Paisii Hilendarski University of Applied Sciences (PU "Paisii Hilendarski") is continued. Thirdly, they imply a search for new theoretical and specialized solutions in a specific applied area related to the implementation of digital technologies in agriculture. Fourthly, they imply an original software implementation of a prototype.

In the development of the dissertation, the Doctoral student has demonstrated a thorough knowledge of the state of the field.

The chosen research methodology allows achieving the set goal and obtaining an adequate answer to the problems solved in the dissertation.

The scientific and applied results presented in the thesis can be briefly systemized as follows:

1. A new version of an event model is presented, with refined definitions of the basic operations on events in terms of their algebraic properties and, as part of the event model, a new concept of an abstract event machine.
2. A new version of the architecture of the ZEMELA platform is presented.
3. A reference architecture of a specialized personal assistant adapted for smart agriculture is developed, which is based on a specific event model using a repository of specialized knowledge and data.
4. A prototype implementation of a personal assistant implemented with the JaCaMo development environment is presented.

I accept that the results are consistent with the scope and content of the aims and objectives and have potential for further development. The Doctoral student has demonstrated the necessary theoretical and practical knowledge of the field, developed skills and gained experience to conduct independent research.

I accept that the Doctoral student has undeniable participation and merit for the realization of the presented tasks, formulated contributions and obtained results.

2 publications on the PhD thesis have been presented in the proceedings of two refereed international conferences. The publications are co-authored, in English and are for the period 2021 - 2022.

The **scientific-metric indicators** for the completion of the requirements for the educational and scientific degree "Doctor" in Group D are 36 points with a minimum requirement of 30 points, which **fulfils the conditions of the RIDASRBA and the Regulations for the DAS of Plovdiv University**.

A list of 13 noted citations in 11 publications is provided.

As critical remarks, it can be pointed out that according to Art. 27 (2) of the RIDASRBA instead of "Conclusion" should be used "Conclusion - summary of the results obtained" and instead of referenced literature - bibliography. In the text there are typographical errors and stylistic inaccuracies.

I take the opportunity to make a recommendation for the implementation of future developments and projects related to the topic of the dissertation and the intensification of independent publishing activity.

The **abstracts** consist of 32 pages in Bulgarian and 30 pages in English and presents the dissertation work.

I have **no evidence of plagiarism or unreliability** of the scientific data presented in the dissertation.

CONCLUSION

The dissertation work contains scientifically applied results that represent an original contribution to science and meet all the requirements of the requirements of the ADASRB, the RIDASRBA, the Regulations for the DAS of Plovdiv University and the additional faculty requirements of the Faculty of Mathematics and Informatics for RDAS at P. Hilendarski".

The dissertation work demonstrates that the Doctoral student Ivan Stanimirov Stoyanov possesses in-depth theoretical knowledge and professional skills in the professional field 4.6 "Informatics and Computer Science", demonstrating qualities and skills for independent scientific research.

Due to the above, I confidently give my **positive assessment** of the presented dissertation, abstract and results, and **I propose the honourable scientific jury to award the degree of Doctor of Education and Science to Ivan Stanimirov Stoyanov in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.6 "Informatics and Computer Science", doctoral programme "Informatics"**.

10.05.2023

Signature:

Assoc. Prof. Dr. Irina Radeva