

REVIEW

by **Corresponding Member Lyubka Doukovska, DSc**
from the Institute of Information and Communication Technologies,
at the Bulgarian Academy of Sciences,
on the Thesis for awarding educational and scientific degree **PhD**,
under the Scientific Field: **4. Natural Sciences, Mathematics and Informatics**,
the Professional Area: **4.6. Informatics and Computer Sciences**,
the Scientific Specialty: **01.01.12. Informatics**

Author of the PhD Thesis: **Ivan Stanimirov Stoyanov**

Thesis Title: **Research on creating a virtual operator in smart agriculture
infrastructure**

In accordance with Order No. RD-21-1093 from 19.05.2023 of the Rector of the Plovdiv University “Paisii Hilendarski”, I have been appointed as a member of the Scientific Jury regarding the PhD thesis of **Ivan Stanimirov Stoyanov** for awarding the educational and scientific degree “Doctor of Philosophy” (PhD) in the Scientific Field **4. Natural Sciences, Mathematics and Informatics**, the Professional Area **4.6. Informatics and Computer Sciences**, the Scientific Specialty **01.01.12. Informatics**. The scientific advisor is Prof. Asya Stoyanova-Doycheva, PhD.

As a member of the Scientific Jury I have received:

1. Order No. RD-21-1093 from 19.05.2023 of the Rector of the Plovdiv University “Paisii Hilendarski”;
2. Application for opening a procedure for acquiring the educational and scientific degree PhD;
3. European Curriculum Vitae;

4. Protocol No. 8-22/23 from 28.04.2023 of the preliminary discussion of the PhD Thesis in the Computer systems department at the Plovdiv University “Paisii Hilendarski”;

5. Reference to the implementation of the minimum requirements of the of the Faculty of Mathematics and Informatics at the Plovdiv University “Paisii Hilendarski” for obtaining the educational and scientific degree PhD;

6. Official notes for participation in projects from the NPD at the Plovdiv University “Paisii Hilendarski”;

7. Abstract of the PhD Thesis;

8. PhD Thesis;

9. Declaration for the original scientific and applied scientific contributions;

10. List of the publications included in the PhD thesis;

11. Copies of the publications included in the PhD thesis.

In order to form the final evaluation of the dissertation, the requirements of the *Development of Academic Staff Act in the Republic of Bulgaria* are implemented the specific requirements in the Act’s Institutional Regulation shall be taken into consideration, where the respective norms are:

1. Pursuant to Art. 6 (3) of the *Development of Academic Staff Act in the Republic of Bulgaria*, PhD thesis should contain scientific or scientific-applied results, which represent an original contribution in science. The PhD thesis must indicate that the candidate has in-depth theoretical knowledge of the relevant specialty and ability for independent research.

2. According to Art. 27 (2) of the specific requirements in the Act’s Institutional Regulation, PhD thesis should be presented in a form and volume corresponding to the specific requirements of the primary unit. The PhD thesis should contain: a cover page; content; introduction; exhibition; conclusion - a summary of the results obtained with a declaration of originality; bibliography.

I. Actuality and significance of the PhD thesis.

The relevance of the PhD thesis is determined by the field of research presented, namely Artificial Intelligence. Artificial Intelligence is the science of the

concepts, methods and means of creating intelligent models for the study of natural intelligence.

The PhD thesis submitted for review is devoted to the application of artificial intelligence methods for modeling processes in intelligent agriculture.

The aim of the PhD thesis is „to develop a personal assistant supporting farmers and agricultural specialists working in the conditions of intelligent agriculture”.

To achieve the goal, the following tasks are defined:

1. To update the event model and propose a new version of it.
2. To update the architecture of the ZEMELA platform.
3. Create a concept, model, reference architecture and lifecycle of a personal assistant for farmers.
4. Prototype implementation of the personal assistant.

II. Summary of the PhD thesis.

The PhD thesis consists of 120 pages. Its structure includes an introduction, five chapters, a conclusion, a complete list of the author's publications, a complete list of the author's participation in projects, a list of citations, acknowledgments, a bibliography and a declaration for the original scientific and applied scientific contributions.

In the “Introduction” of the PhD thesis, the relevance of the topic is justified, the main goal is defined, and tasks for its achievement are formulated.

In the first chapter “State of the problem” an overview of the current state of scientific research in the field of the PhD thesis research is made. The current state of the ViPS reference architecture, which was chosen during the construction of the specialized platform for intelligent agriculture presented in the PhD thesis - ZEMELA, is presented.

In the second chapter “Event model”, the new version of the event model is presented. The proposed event model is a theoretical framework for operating the smart agriculture platform. A reference abstract event machine is proposed in the model. The platform supports different implementations of the abstract event engine, depending on the nature of the specific event domain and the required data sources.

In the third chapter “Platform ZEMELA” the specialized platform for intelligent agriculture called ZEMELA (Agricultural Assistant) is discussed. The current architecture of the system is presented, with the ViPS architecture being built as a virtual physical space. The individual components and the mechanisms for their interaction are described in detail.

The fourth chapter “Reference personal assistant” gives a general description of a personal assistant designed to support farmers working in the conditions of intelligent agriculture. The life cycle, architecture and individual components of the assistant are presented. The personal assistant has been developed as a core component for the purposes of the ZEMELA platform.

The fifth chapter “Software implementation of a personal assistant prototype” presents the software implementation of a personal assistant prototype designed for users of intelligent agriculture applications. The JaCaMo development environment that was used in the development of the prototype is presented. The current version of the prototype has been adapted to detect anomalies in tomato vegetation. The data used are from the region of Plovdiv.

In the “Conclusion“, a summary of the obtained results of the PhD thesis research is presented. Future directions for continuing work on the subject are also discussed.

The relationship between the chapters is ensured by the logic of the exhibition and allows for a thorough understanding of the scientific research.

The cited sources are sufficiently diverse and for the most part they are written by foreign authors. The presence of Bulgarian authors in the literature used also makes a good impression.

III. Evaluation of the PhD thesis's contributions.

During the achievement of the main goal and solving the tasks related to it, the following main results were obtained, and in summary:

1. A new version of the event model has been introduced. It retains the main productions presented in the previous version. The new stuff is about refining the definitions of the basic event operations in terms of their algebraic properties. Their non-commutativity, as well as their left and right associativity, respectively, are

motivated. Distribution remains undetermined for the time being. A completely new concept of an abstract event machine has been introduced, now as part of the event model. It is proposed to formalize it as a cellular automaton. Further tasks related to the practical implementation of the abstract machine are forthcoming.

2. A new version of the ZEMELA platform architecture is presented. In the new version, a new structure of the specialized knowledge and data repository ADK (Agriculture Data and Knowledge) Center is proposed. Simplified structure of the specialized library for the models - AML (Agriculture Models Library). In the new version, it is proposed to use mainly the DEVS (Discrete Event Specification) approach.

3. A reference architecture of a personal assistant designed to support farmers working in the context of the intelligent agriculture has been developed. The personal assistant is specialized in purpose, based on a specific event model and using a repository of specialized knowledge and data. In the version presented in the PhD thesis, the personal assistant is adapted for intelligent agriculture. A prototype implementation of the assistant implemented using the JaCaMo development framework is also presented.

I accept that the contributions so formulated could be considered to have scientific and common application. This separation would allow detailing the results obtained in accordance with the specificity of their significance.

IV. Assessment of the submitted publications.

Sixteen publications are included in the presented complete list of publications of the PhD student, of which two publications are related to the PhD thesis, which are referenced in the world databases SCOPUS and Web of Science. The published results are original and I am not aware of any plagiarism.

The qualities of the presented papers have been proven by being published in papers at international conferences. A list of thirteen citations of the PhD student's works is presented. The data thus presented give me reason to conclude that the research has been provided with the necessary publicity among the scientific community.

V. Evaluation of the PhD abstract.

The PhD abstract is consisting of 32 pages. It reflects the essence and content of the dissertation, including the purpose, subject, object and tasks of dissertation research and the ways of their realization.

VI. Remarks and recommendations.

In order to form the final evaluation of the PhD thesis, the requirements of the *Development of Academic Staff Act in the Republic of Bulgaria* and its Implementation Rules are to be taken into account, according to which I have the following remarks and recommendations:

1. Style errors are noted in the text of the PhD thesis.
2. The formulation of the PhD thesis results does not allow emphasizing the individual contribution of the PhD student.
3. To comment on the possibility of verification of the developed models.

VII. Conclusion.

I accept that the requirements of the *Development of Academic Staff Act in the Republic of Bulgaria* and the specific requirements in the Act's Institutional Regulations for its implementation, the Rules for the conditions and the order for acquiring academic degrees and the Rules for the specific conditions for acquisition of academic degrees and occupation of academic positions at the Plovdiv University "Paisii Hilendarski" are accomplished.

After my introduction to the PhD thesis and its publications, an analysis of their significance and the contributions they make, I give my positive assessment and I recommend to the Honorable Jury to award the educational and scientific degree "Doctor of Philosophy" (PhD) to **Ivan Stanimirov Stoyanov** in the Scientific Field **4. Natural Sciences, Mathematics and Informatics**, the Professional Area **4.6. Informatics and Computer Sciences**, the Scientific Specialty **01.01.12. Informatics**.

06.06.2023

Sofia

Signature:

/Corr. Member Lyubka Doukovska/