Review

By Assoc. Prof. Emil Hristov Doychev, Ph.D, University of Plovdiv "Paisii Hilendarski"

on a dissertation for awarding the educational and scientific degree "Doctor",

Field of higher education: 4. Natural sciences, Mathematics, and Informatics,

Professional field: 4.6 Informatics and Computer Science,

Doctoral program: Informatics

Author: Ivan Stanimirov Stoyanov

Topic: Research on Creating a Virtual Operator in a Smart Agriculture Infrastructure

Scientific supervisor: Prof. Asya Stoyanova-Doycheva, Ph.D. University of Plovdiv.

General description of the submitted materials

By virtue of Order No. RD-21-1093/19.05.2023 issued by the Rector of the University of Plovdiv "Paisii Hilendarski" (PU), I have been appointed as a member of the Scientific Jury to participate in the defense procedure of a dissertation thesis titled "Research on Creating a Virtual Operator in a Smart Agriculture Infrastructure" for the acquisition of 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. The author of the dissertation is Ivan Stanimirov Stoyanov – a full-time Ph.D. student at the Department of Computer Systems, under the supervision of Prof. Asya Stoyanova-Doycheva, Ph.D. from the University of Plovdiv. The set of materials submitted to me by Ivan Stanimirov Stoyanov on electronic media is in accordance with Article 36 (1) of the Regulations for the Development of the Academic Staff of PU.

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

1. Order No. RD-21-1093/19.05.2023 of the Rector of University of Plovdiv "Paisii Hilendarski" Prof. Dr. Rumen Mladenov.

2. Dissertation.

3. Abstract in Bulgarian and English.

4. Request to the Rector of Plovdiv University "Paisii Hilendarski".

5. A Curriculum Vitae.

6. Protocol No. 8-22/23.

7. Full list of publications.

8. List of publications on the dissertation topic and full texts.

9. A Declaration of Originality and Authenticity.

10. Report to compliance with minimum national requirements.

11. Two letters for participation in research projects.

12. Report on the fulfillment of the minimum national requirements for the Acquisition of the educational and scientific degree "Doctor" in 4.6. Informatics and Computer Science.

Topic relevance

The development of personal assistants for smart farming is a highly significant and relevant topic. It holds a crucial role in the advancement of sustainable, efficient, and productive farming practices, which are essential for the economic prosperity of the industry. Personal assistants introduce a fresh approach to integrating data and technology into agricultural systems by combining sensors, the Internet of Things (IoT), cloud solutions, and analytical tools. They present opportunities to revolutionize how farmers gather, analyze, and utilize information to enhance their decision-making and achieve superior outcomes.

Knowledge of the problem

The Ph.D. student demonstrates a strong theoretical foundation and possesses practical skills and experience with the technologies necessary to achieve the objective of the thesis. Ivan Stoyanov exhibits extensive knowledge in the field related to the research problem, as evidenced by the substantial number of cited literature sources in the dissertation's bibliographic references, totaling 164 sources. Furthermore, in Chapter 1 "State of the Art" of the dissertation, the Ph.D. student consistently discusses topics such as cyber-physical and cyber-physical social systems, virtual physical space, smart farming environments, and personal assistants. These factors provide compelling evidence of the Ph.D. student's comprehensive understanding of the problem area addressed in the thesis.

Study methodology

The aim of the study, as clearly stated on page 10, is "to develop a personal assistant (PA) to support farmers and agricultural professionals working in smart farming," and the specified tasks align with this objective. The research methodology is described on page 11 of the thesis. A comprehensive analysis of the established smart farming platform ZEMELA is conducted. Additionally, a new version of the event model is developed, and a proposed architecture for the smart farming platform ZEMELA is presented. Furthermore, a reference architecture and prototype of a personal assistant for farmers, serving as the core of the ZEMELA platform, are developed, and the usability of the personal assistant is demonstrated.

Characteristics and evaluation of the thesis and the contributions.

The dissertation consists of 120 pages and comprises an introduction, five chapters, a conclusion, a declaration of the originality of results, a list of project participation, and a bibliography with 164 sources.

The introduction serves the purpose of justifying the relevance of the problem and defining the goals and objectives that the author aims to achieve during the development process.

The first chapter provides a concise overview of topics related to the thesis. In this context, the evolution of the ViPS reference architecture, which serves as the foundation for the specialized smart farming platform presented in the thesis, is discussed. Furthermore, other thematic areas pertaining to the thesis topic are examined, including cyber-physical and cyber-physical-social systems, precision and smart agriculture platforms, and personal assistants.

The second chapter delves into the new version of the event model, which serves as the theoretical framework for operating the smart farming platform. This chapter aims to provide a detailed explanation of the event model and its functioning within the specialized smart farming platform.

The third chapter is dedicated to the specialized platform for smart agriculture known as ZEMELA. Within this chapter, the actual system architecture is presented, along with a discussion of the different components and their interaction mechanisms. The architecture of ZEMELA is described in detail, outlining its specifications and functionalities.

The fourth chapter focuses on the development of a personal assistant specifically designed to support farmers in smart farming. The personal assistant plays a crucial role in the ZEMELA platform, and this chapter elucidates its lifecycle, architecture, and individual components. It

explains how the personal assistant operates and supports farmers in their activities.

The fifth chapter showcases the software implementation of a prototype personal assistant tailored for users of smart farming applications. This chapter provides details of the prototype's development, including the utilization of the JaCaMo development environment and the functionalities incorporated into it.

The conclusion of the thesis offers a concise summary of the research findings. It also discusses potential perspectives and future directions for further work on the topic. The main conclusions and recommendations for future projects and enhancements are discussed within the context of the research results and their potential applications.

Assessment of publications and personal contribution of the Ph.D. student.

The doctoral candidate has submitted a list of two publications related to the dissertation. Both publications have been presented at international conferences and have undergone refereeing in SCOPUS, fulfilling the minimum national requirements for a Ph.D. Additionally, a list of 13 notable citations in 11 publications has been provided.

I acknowledge and endorse the conclusions formulated in the thesis. The conclusions represent the independent work of the doctoral candidate and can be categorized as scientific, scientific-applied, and applied contributions, which are as follows:

- A new version of the event model is introduced.

- A novel concept of an abstract event machine is presented, now incorporated within the event model. It is proposed to formalize this concept as a cellular automaton.

- An updated architecture of the ZEMELA platform is presented.

- A reference architecture for a personal assistant designed to support farmers in smart agriculture is developed, along with a prototype implementation utilizing the JaCaMo development framework.

I confirm that these contributions comply with the statutory requirement of constituting an "original contribution to science" (s. 27(1) of the Regulations for the Application of the Act for the Development of the Academic Staff in the Republic of Bulgaria).

Abstract

The abstract, consisting of 32 pages, meets the requirements in both Bulgarian and English

languages. It adheres to the guidelines for providing accurate, comprehensive, and concise coverage of the dissertation.

Critical comments and recommendations

I have no critical comments to make about the Ph.D. However, I have the following questions:

- Has the personal assistant prototype been tested with real sensor network data?

- If such tests have been conducted, are there any analyses and conclusions that can be drawn regarding the implementation of the prototype and the proposed assistant architecture?

CONCLUSION

The dissertation encompasses scientific, scientific-applied, and applied outcomes that constitute an original contribution to the field of science. It aligns with the requirements stipulated in the Law for the Development of Academic Staff in the Republic of Bulgaria (LADAPB), the Regulations for the Implementation of the LADAPB, and the relevant regulations of the University of Plovdiv "Paisii Hilendarski".

Based on the comprehensive theoretical knowledge demonstrated by the Ph.D. student in the field of "Computer Science" and their proven ability for independent research, **I am confident in recommending a positive evaluation.** Therefore, I propose that the esteemed scientific jury confers upon Ivan Stanimirov Stoyanov 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.

11.06.2023   **Reviewer**: …………………………………

Plovdiv   / Assoc. Prof. Emil Doychev, Ph.D. /