

OPINION

by **Prof. Maria Petkova Hristova, PhD**

of a doctoral dissertation for awarding educational and scientific degree Doctor (PhD)

Field of Higher Education: 4. Natural Sciences, Mathematics and Informatics

Professional field: 4.6. Informatics and Computer Science

Doctoral Programme: Informatics

Author: **Irina Krasimirova Krasteva**

Subject: **BLOCKCHAIN-BASED SYNCHRONIZATION OF PERSONAL ASSISTANTS**

General description of the the PhD student and submitted materials

The opinion is prepared in accordance with order № RD-21-236 of 29.01.2024 of the Rector of Plovdiv University "Paisii Hilendarski", by which I was appointed as a member of the scientific jury for providing a procedure for the defense of a dissertation with topic „BLOCKCHAIN-BASED SYNCHRONIZATION OF PERSONAL ASSISTANTS“ for awarding a Ph.D degree in professional field: 4.6. Informatics and Computer Science. Author of the dissertation is Irina Krasimirova Krasteva, a full-time PhD student at the Department of Computer Systems, with scientific supervisor Prof. Dr. Stanimir Stoyanov. The submitted set of materials is in accordance with Art. 36 (1) of the Regulations for Academic Staff Development of Paisii Hilendarski University of Plovdiv.

Irina Krasteva holds a Bachelor's degree in Computer Sciences and a Master's degree in Financial Management from Paisii Hilendarski University of Plovdiv. Since January 2019 she has been an assistant professor at PU, Faculty of Mathematics and Informatics. She is a member of John Atanasoff SAI. She has participated in a research project BG PLANTNET "Creation of a national information network Genbank - plant genetic resources", a competition for funding of scientific research projects, funded by the Scientific Research Fund at the Ministry of Education and in the National Program "Smart Agriculture", approved by Decision of the Council of Ministers № 866/26.11.2020.

Relevance, aim and objectives of the dissertation

The focus of this dissertation is on blockchain-based synchronization of personal assistants. Undoubtedly, the topic of the dissertation is relevant in computer science today and will remain so in the future, considering the increasingly significant role of Blockchain technologies, Internet of Things, cyber-physical systems and cyber-physical social systems. The significance of the topic is also determined by the fact that the reference architecture of Virtual Physical Space as an IoT ecosystem, which is being developed in the laboratory of the Distributed e-Learning Center (DeLC) of Paisii Hilendarski University, can be applied in various fields - smart agriculture, tourism, smart cities, education, etc. On the other hand, the use of Blockchain technologies and their integration into cyber-physical systems can provide higher security, concerning the minimization of the risk of data manipulation.

The main objective of this dissertation is formulated as: to analyze and conduct experiments on the reconciliation of intelligent personal assistants with block chains. An

additional goal is also set as: development and testing of blockchain-based models synchronized with personal assistants and their application to different adaptations of the virtual-physical space ViPS.

To achieve the main goal, two sub-goals are defined:

1. Development and testing of an "Electronic School Diary" model based on synchronization between intelligent agents and the use of blockchain technologies in the framework of an adaptation of the reference architecture in secondary education.

2. Development and testing of a model for application of the mentioned technology in the adaptation of the ViPS architecture in smart agriculture.

Three tasks are set:

1. After studying different aspects and approaches in the development of Blockchain technologies, to create a general concept for their use in synchronizing information so that personal assistants can use it.

2. To create models for the application of this concept in the adaptation of the ViPS reference architecture in the fields of education and smart agriculture.

3. To create prototypes and to test the application of these models.

Knowledge of the problem, style and language

Clearly defined main aim, well-motivated tasks for achieving the aim, logically coherent structuring of the dissertation text, as well as correctly cited in the text 150 literary sources (141 are in English and 11 - in Bulgarian), permits me to assume that the PhD student knows well the theoretical and applied aspect of the research subject. Rules of good language and scientific style of writing research papers have been observed. The text of the dissertation is clear, precise and analytical.

Methodology of the study

The methodology used to complete the aim of the dissertation is adequate and appropriately chosen. Scientific methods have been applied: introduction to the subject; creation and testing of different approaches and models related to the application of blockchain technologies and their synchronization with personal assistants in different problem areas such as education, smart agriculture, etc. They contribute to the achievement of the main objective and the fulfillment of the set tasks of the research, which is evidenced by the presented results.

General description and evaluation of the thesis and its contributions

The dissertation contains 139 pages and consists of an introduction, four chapters, a conclusion, a list of publications on the dissertation, a list of papers presented at scientific conferences, sources cited, and a list of terms used. The graphical part of the thesis consists of 35 figures.

In the introduction the relevance and actuality of the subject is presented, the main aim and tasks for its achievement are defined, as well as the general approach and methodology of the scientific research. The state of the research problem is presented, advantages and disadvantages of Blockchain technologies are presented. It is concluded that synchronization between agents in cyber-physical and social environment with a system built on blockchain technology can be realized by using a specialized Oracle blockchain agent. Chapters two and three are devoted to the application of blockchain technology in a multi-agent system and the

adaptation of ViPS in secondary education and smart agriculture, respectively. Chapter four presents conceptual models of supply chains related to the national GenBank as well as blockchain-based supply chains in tourism.

Very good impression makes the finalization of the individual chapters, where the main conclusions, generalizations and analyses are synthesized, as well as the table used to present the relationship between the results, objectives, structure of the dissertation and the publications made.

The conclusion summarizes the results and achievements of the dissertation, which are original and in line with the aim and objectives. I accept the main three scientific and applied contributions summarized by the doctoral candidate at the end of the dissertation, which have been achieved by solving the tasks set in the work. I consider that original results have been obtained which are in line with the aim set in the thesis. The significance of the thesis consists of: a general concept of blockchain-synchronization of information and interaction with personal assistants within a cyber-physical multi-agent system; specific models for the application of the developed concept in the adaptation of the reference ViPS architecture in the fields of education and smart agriculture; prototypes to test the application of the developed models.

The contributions can be defined as enriching an existing scientific field with new knowledge and applied aspects. I consider that the aim of the PhD thesis has been achieved.

Assessment of dissertation publications and personal contribution of the PhD student

Irina Krasteva has submitted four publications on the dissertation work. Two of the publications are indexed in SCOPUS. One article is published in the journal "Informatics and Education". A list of 5 papers presented at scientific conferences in Bulgaria is presented. I accept that the results of the dissertation are well presented to the scientific community. I have no doubts that the dissertation and the results obtained are the personal work of the PhD student.

The minimum national requirements for obtaining the PhD degree in PhD 4.6 Computer Science and Computer Engineering have been met, as well as the specific FMI requirements adopted in conjunction with Plovdiv University Regulations for the application of the PhD Law according to which at least 30 points must be available for indicator group D, where the PhD student has 36 points.

Abstract

The abstract complies in length and content with the requirements of the Law on the Philosophy of Paisii Hilendarski University and its Regulations.

Recommendations

I recommend the PhD student to continue the research in the directions she has indicated in her intentions for the development, as the topic is of high applicability and broad prospects for development and to publish the results in indexed scientific journals in accordance with the requirements in the professional field 4.6 "Informatics and Computer Science".

CONCLUSION

My evaluation of Irina Krasimirova Krasteva's thesis, abstract and scientific publications is entirely positive. The doctoral candidate possesses thorough theoretical knowledge in the specialty of the PhD program "Informatics", a high level of proficiency in the terminology of the subject of the thesis and proven abilities for independent research.

Taking into account the original scientific and applied contributions obtained, I consider that the dissertation fully meets the requirements of the Law on Development of Academic Staff in Republic of Bulgaria, its Implementing Regulations, as well as the Regulations on the Development of Academic Staff of Paisii Hilendarski University of Plovdiv.

This gives me grounds to recommend the distinguished members of the scientific jury to award the educational and scientific degree "Doctor" to **Irina Krasimirova Krasteva** in the field of higher education: 4. Natural Sciences, Mathematics and Informatics, professional field 4.6 Informatics and Computer Science, doctoral programme "Informatics".

20.02.2024
Sofia

Opinion prepared by:
(Prof. Dr. Maria Hristova)