

## REVIEW

Of PhD thesis for acquiring educational and scientific degree "PhD"

In scientific area **5. Technical sciences**,

By professional field **5.3. Communication and computer equipment**,

PhD program "**Computer Systems, Complexes and Networks**",

On the topic of: "**INTELLIGENT METHODS OF RESEARCH AND REALIZATION OF  
HARDWARE SOLUTIONS**"

Author of the PhD thesis: **Mag. Ing. KRASIMIR GEORGIEV MARKOV**,

Scientific lead: **Corr. Member of BAS D.Sc. LYUBKA ATANASOVA DUKOVSKA, DSc**

Reviewer: **Prof. Ivan Krumov Kurtev, PhD-Eng.**

Technical University - Sofia

By Order No. 328-1 of December 6, 2023. of the Director of the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences (further down IICT-BAS), on the basis of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB) and on the basis of Article 30, paragraph 3 of its Implementing Rules (IRLDASRB), I am appointed a member of a scientific jury in the procedure for acquiring the educational and scientific degree "Doctor" in the above-mentioned dissertation. At that meeting on December 15, 2023, the Scientific Jury selected me as a reviewer of this doctoral thesis.

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

1. Order No. 328-1 of December 6, 2023 to the Director of IICT at the Bulgarian Academy of Sciences, issued on the grounds of Article 4, paragraph 2 of LDASRB and a decision of the Scientific Jury of IICT at BAS, reflected in Protocol No. 12 of November 29, 2023;
2. PhD thesis for acquiring educational and scientific degree "PhD" in Bulgarian;
3. Abstract of the dissertation in Bulgarian and English;
4. Copies of publications on the topic of the PhD thesis;
5. Reference for the fulfillment of the minimum requirements of IICT at BAS for the educational and scientific degree "PhD";
6. CV of the author of the PhD thesis.

The review of the above documents showed that all of them fully comply with the requirements of the LDASRB, its IRLDASRB and Implementing Rules for the Terms and Conditions of Acquiring Scientific Degrees and Occupying Academic Positions in IICT-BAS.

All requirements under Article 3 of the Rules for the specific conditions for acquiring scientific degrees and for occupying academic positions in IICT-BAS in terms of the minimum number of points on indicators for professional field 5.3. Communication and computer equipment for acquiring the educational and scientific degree "PhD" are also met. By Group of indicators A the PhD student has the required number of 50 points, and by Group of indicators D with the required number of points at least 30, the PhD student has 120 points.

The PhD thesis in a volume of 133 pages has a structure: **Introduction, Three chapters, Conclusion-summary of the results obtained, Guidelines for future research, Publications**

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*"Intelligent methods of research and realization of hardware solutions"*



on the topic of the PhD thesis, Declaration of originality of the results, Annexes -3 (three) issues, Bibliography.

In the **Introduction** is indicated the topic of the PhD thesis submitted to me for review. The topic is extremely up-to-date and important with the application of intelligent methods for research and use of these methods in the design and development of modern technical means for intelligent computer systems for wireless collection, transfer and management of information flows, mainly in facilitating communication and data management in the different fields of science and technology: in computer science, in modern communication solutions, in the broad fields of electronics and automation. On the topic thus set, the purpose of this dissertation is synthesized: "... with the means of modern methods **in the field of intelligent systems**, to research and implement hardware solutions", while everywhere in this PhD thesis is indicated the design and development of technical means for **distributed systems**. Further in my review I consider the dissertation as a realization of its topic, namely the development of intelligent methods for research and implementation of hardware solutions by analyzing existing approaches and technologies to present new and innovative methods to improve the technical aspects of intelligent systems, or a specific implementation **such as intelligent computer systems**. These systems have been considered as a combination of different technologies, including radio frequency identification (RFID) and artificial neural networks, the latter as part of artificial intelligence. For the realization of a defined purpose of the dissertation, the following six (6) tasks are formulated:

1. To conduct a critical analysis of the possibility of applying intelligent methods for research and implementation of hardware solutions;
2. To analyze possible connections and interactions between two key technologies - radio frequency identification and neural networks;
3. To explore ways to integrate these technologies in order to achieve intelligent and effective solutions for collecting, processing and managing information flows;
4. To conduct an analysis of the opportunities and challenges those arise with the deployment of RFID and neural networks in distributed systems;
5. To analyze how the incorporation of wireless technologies can enhance the intelligence and functionality of a distributed system by adding additional communication and data analysis capabilities;
6. To present original hardware solutions for collecting, processing and managing information flows.

In **Chapter 1**, mainly theoretical, without defined specific contribution from the PhD student, reflected in his work and **in the Annexes 1, 2 and 3** are described and presented some theoretical concepts and dependencies used in the presented dissertation, related to systems for wireless collection, transfer and management of information flows. This Chapter 1 focuses on amplitude-pulse radio technology for frequency identification (RFID) and the means for its implementation, in which the amplitude of the carrier signal changes depending on the values of the modulating signal. The conclusion is made, known in the specialized literature presented in the bibliography of this dissertation, as a type of modulation that is used in communication systems for transmitting signals by radio waves and other means. A theoretical approach is also presented for finding the values of passive and active elements in an electronic circuit from the point of view of automatic control theory (ACT) for a specific study of an oscillating unit, which is also known in the specialized literature on this topic. A construction of a filter for high harmonics and white noise, also known in the bibliography used, was considered. With this chapter a solution is given to **Task 1**.

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The author has dedicated **Chapter 2** to theoretical concepts and methods of artificial intelligence (AI), focusing on the implementation of an intelligent computer system for wireless collection, transfer and management of information flows with artificial neural networks. An analysis of a communication network with data feeding in one direction, from the input layer to the output, without feedbacks, as well as simulations in the MATLAB programming environment for wireless transmission of equipment through a noisy environment was conducted. HDL coder is used, a tool provided by MathWorks that automatically converts MATLAB and Simulink models into code for the VHDL or Verilog programming languages. The HDL encoder facilitates the design and development of digital systems by generating optimized HDL code that can be used to create integrated circuits with a high degree of integration by FPGA technology. This chapter provides solutions to tasks 2 and 3 of the PhD thesis. It generates contributions 1, 2 and 3 of the dissemination work, which I would suggest to be united in one **scientific contribution**, namely:

✦ Intelligent and effective solutions for collecting, processing and managing information flows have been achieved, through critical analysis of the possibility of applying intelligent methods for the analysis, and implementation of hardware solutions and analysis of possible links and interactions between two key technologies - radio frequency identification and artificial neural networks.

In **Chapter 3**, the author has presented and described the specific research tasks he has conducted in order to analyze and evaluate the proposed RFID technologies and artificial neural networks for their incorporation into the algorithms for the operation of intelligent computer systems. The results of the simulation studies which have been performed to investigate different aspects of such a type of system are presented. As a result of the conducted research, the PhD student has also presented original hardware solutions to devices for collecting, processing and managing information flows. This part of the dissertation is the strongest in it and solves problems 4, 5 and 6 in this work. With that chapter the following **scientific and applied contributions** have been achieved, for which I propose texts according to the achievements of PhD student:

✦ Approaches are proposed for the implementation of radio frequency identification and artificial neural networks in intelligent computer systems based on an analysis of the opportunities and challenges that have arisen in this implementation;

✦ Strengthening the intelligence and functionality of an intelligent computer system with the addition of additional capabilities for communication and data analysis through conducted inclusion analysis for wireless technologies;

as well as one **applied contribution**:

✦ Original hardware solutions for collecting, processing and managing information flows are provided.

The achieved **scientific, scientific-applied and applied contributions** complement each other and fully meet the requirements for acquiring the educational and scientific degree "Doctor".

The **Conclusion** of the dissertation summarizes the results achieved by the PhD student from the activities carried out by him, which with the means of modern methods in the field of intelligent systems are studied and implemented hardware solutions.

The **Guidelines for future research** state that the results obtained in the dissertation are applicable to the solution of a much wider range of tasks related to the design and development



of technical means for intelligent computer systems for wireless collection, transfer and management of information flows.

**Publications on the topic of the PhD thesis** present six publications all on the subject of dissertation research and are referenced in Scopus and Web of Science, one of which is co-authored and five are standalone.

The necessary **Declaration of originality of the results** is also presented, which I do not dispute and accept.

The literature used by the author is presented in the **Bibliography** to this work and contains 108 publications in the period 2000-2023 which I assess as thematic and very up-to-date.

The **Abstract** in a volume of 37 pages correctly and accurately reflects the essence and content of the presented material, including the purpose, the tasks of dissertation research and the ways of their realization.

On the dissertation I could make the following remarks and recommendations, some mentioned above in the review:

1. Throughout the material to observe the exact terminology in the stated purpose of this PhD thesis, namely by means of modern methods in the field of intelligent systems, to research and implement hardware solutions;
2. Reformulating the contributions of this dissertation would reinforce the suppressed results;
3. It would be good to present the relevant document in confirmation of the hardware solutions created by the PhD student as a whole or as part of each of them;
4. In many places in the text of the dissertation there are spelling and technical errors: e.g. on p. 19: "вискока" and "структорни", the second being used everywhere in the text; on page 50: "следствие"; on page 74: "С FPGA XC3S550A се постига...", where FPGA (Field Programmable Gate Array) is a modern technology for the production of VLIS (Very Large Integrated Circuits) and does not participate in the numbering of that integrated circuit that is in this case XC3S550A.

The above remarks and recommendations **do not cast doubt on or diminish** the results achieved by author, indicated in the contributions of his PhD thesis.

## CONCLUSION

Having in mind the contributions achieved in the PhD thesis I have reviewed, as well as the fact that all the requirements of the relevant national and specifically BAS normative documents for the **educational and scientific degree "PhD"** have been met, I dare to give my **positive assessment** and recommend to the honorable **Scientific Jury** to award to **Eng. Krasimir Georgiev Markov educational and scientific degree "PhD"**, in scientific area **5. Technical Sciences**, professional field **5.3. Communication and computer engineering**, PhD program **"Computer systems, complexes and networks"**.

15.01.2024.

Sofia

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