R E V I E W

of dissertation work
for acquiring the educational and scientific degree "Doctor"
in the field of higher education – 5. Technical sciences
professional field – 5.2. Electrical engineering, electronics and automation
in the PhD program 'Automated Systems for Information Processing and
Control'

Author: Mag.Eng. Kristiyan Simeonov Dimitrov
Topic: Cyber-physical systems for intelligent management of animal
husbandry complexes

Reviewer: Assoc. Prof. Eng. Stefan Savov Biliderov, PhD ,
Air force Academy 'Georgi Benkovski' - Dolna Mitropolia town,
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Technologies

*The review was prepared on the basis of the Order for Approval of the
Scientific Jury № 231/01.10.2025 of the Director of IICT and in accordance with
the decisions of the jury taken at its first meeting on 10.10.2025.*

1. General information about the procedure and the materials submitted

Mag. Eng. Kristiyan Simeonov Dimitrov has been dismissed from the full-time form of doctoral studies with the right to defend on 01.01.2025. The dismissal is in accordance with the order of the Director of IICT № 329/20.12.2024. The doctoral student's scientific supervisor is Prof. Eng. Naiden Shivarovp PhD.

The dissertation work was admitted to defense by a decision of the Cyber-Physical Systems Section dated 16.09.2025. On this basis, an application was submitted by the candidate to the head of the section, together with the necessary documents for conducting the defense:

- copies of the dissertation with a signed declaration of originality;
- copies of the abstract in Bulgarian and English;
- list of publications of Eng. Kristiyan_Dimitrov ;
- reference for the minimum requirements of IICT;
- reference to the minimum requirements of NACID;
- Plagiarism report – Report;
- electronic medium according to the requirements of IICT;
- and various other required administrative documents;

The documentation provided is in accordance with the requirements of the IICT and is in line with the minimum national requirements.

2. General characteristics and relevance of the dissertation work

The text part of the dissertation consists of 155 pages, and together with the Bibliography, References, Declaration of Originality and References to

Publications on the topic of the dissertation, it increases to 169 pages. The structure of the dissertation is composed of an Introduction, Seven Chapters, Conclusion, Bibliography and the references described above.

In **the Introduction** of the dissertation work, its relevance is shown, the goal of its development is presented and the object and subject of the research are defined. The general goal of this work is to develop a Cyber-Physical System (CPS) for microclimate management in animal husbandry complexes and for environmental management in fish farming based on openHAB technology. To achieve the goal thus set, specific tasks are solved through the proposed structure of the work.

Chapter one (8 pages) *'Overview, analysis and systematization of existing research and practices on the topic'* introduces the topic of the problem, after which it is defined. The consumption of meat and dairy products worldwide over time and trends in their purchase prices are analyzed. The influence of the environment and microclimate on productivity and yield in dairy farms, pig farms, poultry farms and aquaponic systems is examined.

After a detailed analysis and taking into account the established facts about the influence of the environment and microclimate on the animals raised, it has been shown that the implementation of control over certain parameters of the animals' living environment is of essential importance for their well-being in increasing productivity and improving their health. Last but not least, it also ensures humane treatment of the animals themselves.

In order to analyze a number of possible gaps and weaknesses in the breeding of animal species, existing methods and means for controlling the environment and microclimate in livestock farms and in aquaponic systems are examined and compared. On this basis, new methods or more accessible ways of management are proposed.

Chapter Two (22 pages) *'Research on Existing Methods and Tools'* examines existing methods and tools for managing the environment of various animal species. The actuators, sensors and computers for managing the microclimate in livestock farms and aquaponic systems are described in detail.

A comparative analysis of the capabilities and shortcomings of the control systems of different manufacturers, as well as some applied scientific developments, has been made. The great variety of devices offered on the market has been established, as well as the high prices of specialized devices in the absence of opportunities for further expansion in the future. For aquaponic systems, there are no such ones on the market that provide full control, but systems are used to monitor only some of the necessary parameters.

One of the appropriate solutions is to develop more environmental management systems that are modular, can be easily upgraded, both by expanding the number and type of controlled parameters, and with the possibility of changing control logic.

Chapter Three (total volume of 7 pages) *'Development of a concept with requirements for creating a Cyber Physical System (CPS) for intelligent management of animal husbandry complexes'* based on a definition of a Cyber Physical System (CPS) shows the requirements that are imposed on it. Steps have been taken to synthesize such a system based on parameters that can be controlled automatically, measured directly or it is only necessary to know their values.

The concept itself focuses on the steps in determining the type of sensors, their number for measuring the same environmental parameter, their location in the various animal systems, as well as their communication with the CFS. The principles of selecting the control mechanisms and devices, the control computers and the necessary operating systems for them, which are carriers of the specialized software, are shown.

The concept thus developed for the implementation of the CFS provides guidance for the necessary steps for its implementation.

Chapter four (total volume of 18 pages) *'Research and analysis of software and systems for managing CFS. Development of a concept for a software system for managing CFS in an animal husbandry complex'* presents a concept for managing CFS in an animal husbandry complex. The requirements for the operating system and software with its specific functions for the implementation of such a CFS are shown. Various industrial protocols are considered and a choice of operating system and additional software is made.

The appropriate software is an important step for the implementation of the CFS and it is necessary to meet the requirements set out in the concept for building the system. It is also necessary to test the compatibility of the software with appropriately selected components and to correctly implement the various control algorithms. This leads to the next part of the dissertation - the selection of sensors and additional controllers.

Chapter Five (total volume of 18 pages) " *Research and selection of IoT executive devices and sensors with the necessary parameters for use in the Cyber-Physical Management System of an Animal Husbandry Complex* " emphasizes the selection and testing of the various components necessary for the implementation of the CPS - sensors and additional controllers. Most of them are based on IoT technology . A large range of sensors covering the necessary and required number of parameters in various systems have been studied. It should be noted that their selection was made on the basis of the price-oriented sensors offered on the market.

A large number of controllers have been investigated for applicability and to provide the necessary functionality. The selected additional controllers for connecting the sensors and end devices to the system server offer various communication options.

Chapter Six (total volume of 72 pages) *'Development of intelligent management of the CFS for animal husbandry based on OpenHAB'* solves the main task of the dissertation work - development of intelligent management for various animal ecosystems. The installation and configuration of the system are considered, after which a number of test experiments were conducted. The synthesized algorithms have a high level of autonomy and are able to manage the environment without personnel intervention. The personnel have the opportunity to intervene in the work of the CFS through a developed graphical interface, according to specific needs.

Chapter Seven (total volume of 12 pages) " *Research and development of graphical interfaces for CFS for intelligent management of animal husbandry complexes with the possibility of remote control via the Internet, based on openHAB* " is dedicated to the development of two types of user graphical interfaces for observation, monitoring and control through various physical devices. It relies on the technologies: Bacic UI and GUI based on HABPanel . The two types of developed GUI for CFS management can work simultaneously without interfering with each other. Each of them has its own advantages and disadvantages.

The topic of the presented work is extremely relevant and in view of the results obtained in the dissertation, along with the proposed solutions, the requirements for food self-sufficiency are met. From this point of view, the work acquires significance because it concerns almost the entire range of animal food resources that can be grown in a controlled environment. The complex use of theoretical research and experimental methods leads to the fulfillment of the set goals and objectives and to the formulation of the contributions of the dissertation.

3. Review of the cited literature

The bibliography presented at the end of the dissertation includes 167 literary sources, of which only 3 are in Bulgarian. These are mainly documents related to the necessary regulatory framework. The remaining sources are in English, which has recently become established as an international language for scientific and applied scientific publications. Many of the sources are scientific publications on the topic of the work, which shows that the candidate has obtained in-depth knowledge of the problem under consideration. The citation of the facts and data used in the work makes a good impression.

4. Contributions of the dissertation work

In essence, I agree with the proposed contributions in the dissertation work, which are classified by the doctoral student in the categories: scientific; scientific-applied and applied. These contributions can be attributed respectively to: Creation of new methods; Classification of existing ecosystems; Analysis of animal systems; Synthesis of appropriate management algorithms; Proving new aspects of existing problems with innovative means; Development of real systems.

The contributions can be summarized as follows:

Scientific contributions

- A new innovative method has been developed for managing the microclimate in a poultry farm, based on the temperature felt by the birds, which depends on the temperature, humidity and air speed, as well as the age of the chickens, and not on the temperature in the room.
- an aquaponic system based on the amount of food supplied to the automatic feeder is demonstrated .

Scientific and applied contributions

- A new concept for CFC has been developed for microclimate management in a cow farm, pig farm and poultry farm.
- An algorithm for fully autonomous control of a CFC for microclimate management in a poultry farm has been synthesized.
- A new concept of CFS has been developed for environmental management in an aquaponic system with autonomous control of a much wider range of parameters compared to existing similar systems.

Applied contributions

- CFCs have been developed for microclimate management in a cow farm, pig farm and poultry farm with price-oriented components, with the final price being significantly lower than existing solutions on the market.
- The developed CFC for microclimate management in a poultry farm has been implemented and tested in a poultry farm jointly with Thracian University in Stara Zagora.

It is commendable to note that the developed CFS have been verified through the results of tests and can be used as a basis for the implementation of the specific proposals made.

5. Publications on the dissertation

Four publications have been presented on the dissertation. in publications referenced and indexed in world-renowned databases (Web of Science, Scopus) and one publication in non-refereed journals with scientific review. The scientific

publications in the refereed and indexed editions are co-authored with the participation of the scientific supervisor, and the publication in the non-refereed edition is independent.

The results of the two main scientific contributions have been published in the journal Animals -IMPACT FACTOR - 2.7; CITISCORE – 4.9; SJR – Q1 and in AgriEngineering Magazine - IMPACT FACTOR - 3.0; CITISCORE – 4.7; SJR – Q1. This proves the high value of the dissertation work and the fulfillment of the relevant requirements for admission to defense. Two citations of the candidate's work by foreign authors were also noted.

The publications reflect the main results of the research in the dissertation and it can be considered that the necessary publicity has been achieved to the engineering community.

6. Authorship of the results obtained

Based on the presented research and developments, which combine theoretical work with activities on the selection of equipment, tests and implementation of the obtained results, I believe that the dissertation work has been developed to a significant extent by the doctoral student. The work on the dissertation has helped the candidate to orient himself towards a current and promising area of development. From what is shown in the explanatory note, I can conclude that the candidate is a well-established engineer-specialist who proves his ability to conduct independent scientific research.

On page 176 of the dissertation, a declaration of originality is presented, but the candidate has omitted to sign it. Also, according to the regulatory documents, its place is in the conclusion - a summary of the results obtained, before the bibliography.

7. Abstract and author reference

The abstract is structured in a total volume of 50 pages, with the text part of the dissertation being 40 pages. This is a sufficient sample of the dissertation work.

The abstract reflects the main part of the research, developments and results of the dissertation work. At the end of the abstract, a conclusion is given and the literature review, contributions and publications related to the dissertation are included.

In my opinion, I believe that the abstract satisfies the requirements for its development.

8. Opinions, recommendations and remarks on the dissertation

In essence, I have no objections to the correctness of the proposed explanatory memorandum. Most of the weaknesses identified are related to recommendations and remarks of a technical nature:

- some of the sources in the literature review are cited only with websites, which is inappropriate in a dissertation paper
- very large volume of the descriptive part;
- breaking down the work into small sections, the structure should be more precise;
- very detailed presentation of the technical descriptions of the various devices;
- a number of punctuation and spelling errors are noticeable;

All this somewhat obscures the results obtained. It would be good to emphasize more on the contributions of the work, which are not small at all. Despite the shortcomings of the work listed above, it achieves the set goal. These shortcomings in no way diminish the results obtained. Everything listed so far is a typical mistake for a doctoral student who wants to provide a lot of information in the limited space of a dissertation.

9. Personal impressions about the doctoral student

I do not know the candidate personally, nor his work from before the dissertation work provided to me for preliminary opinion. After getting acquainted with the work of Eng. Kristiyan Simeonov Dimitrov and his presentation at the preliminary discussion of the dissertation work before the extended council of the Cyber-Physical Systems Section at the IICT - BAS, I gained very good impressions. I believe that he has the abilities to conduct independent scientific research and to work actively towards implementing the results obtained, which would undoubtedly lead to achieving a significant economic effect.

10. Conclusion

Despite the recommendations and remarks made, the doctoral student possesses in-depth theoretical knowledge on the topic, as well as the ability to conduct independent scientific research and practical implementation of the achieved results. I believe that the development is relevant, the created methods, concepts and obtained results are widely used in the management of various biological ecosystems and would help humanity cope with food insecurity. The

presented dissertation meets the requirements of the Act on the Development of Academic Staff in the Republic of Bulgaria.

*The achieved results give me reason **to propose** to the scientific jury to award the educational and scientific degree 'DOCTOR' (PhD) to Mag. Eng. Kristiyan Simeonov Dimitrov in the field of higher education - 5. Technical Sciences, professional field - 5.2. Electrical Engineering, Electronics and Automation under the doctoral program 'Automated Systems for Information Processing and Control'.*

Date: **REVIEWER**   **Assoc. prof.**
19.11.2025

На основание
ЗЗЛД