

OPINION

from Idilia Alexandrova Batchkova, Professor, PhD, UCTM - Sofia, Dept. "Industrial Automation", idilia@uctm.edu,
member of the Scientific Jury

on the dissertation thesis for obtaining an educational and scientific degree "Doctor" in
the Doctoral Programme "Automated information processing and control systems",
Professional Area 5.2. "Electrical engineering, electronics and automation",
with author **Mag. Eng. Radoy Strezimirov Dukovski**
titled:

"Decision-making for process control of technological objects"

1. Relevance of the developed problem

The development presented in the dissertation is relevant, as it is in line with the conceptual framework of Industry 4.0 and addresses one of its key problems – intelligent decision-making in the control of complex technological objects in conditions of uncertainty, nonlinearity, and limited resources. The use of probabilistic and temporal models contributes to the development of the methodological and theoretical basis of modern control of technological systems, creating prerequisites for achieving autonomy, adaptability, and efficiency of cyber-physical systems. In this context, the dissertation is also relevant in terms of the construction of digital twins, which require the integration of behavioral models, state assessment and decision-making mechanisms.

2. Does the PhD student know the current state of the problem and creatively evaluate the references

The current state of the scientific problem considered in the dissertation is presented on the basis of an analysis of 146 references, of which 12 are by Bulgarian authors, 5 of which are published in English. This testifies to a broad and up-to-date awareness of international research in the field under consideration.

The doctoral student demonstrates very good knowledge of the current state of the research problem, as the dissertation presents a thorough and systematized analysis of both the main theoretical directions, models and methods for decision-making and the modeling and control of selected technological objects. Both classical deterministic approaches and modern probabilistic and time models are considered.

3. Can the chosen methodology give an answer to the set goal and tasks in the dissertation

The introduction to the dissertation formulates the goal of the dissertation, which is related to the development of models of real technological objects to support the decision-making process in their control. For this purpose, a methodology is proposed related to the solution of a sequence of 8 tasks, including: In-depth theoretical analysis of decision-making systems (1), Analysis, modeling and simulation of a heat energy object (steam generator) (2), Decision-making system for automatic regulation of the level of the steam-water mixture in the drum during real-time operation of an industrial steam generator (3), Design of a membrane bioreactor for yeast production and decision-making regarding the necessary aeration and stirring rates (4), Analysis, modeling and simulation of the operation of a cricket filter (5) and a double-layer heater (7), decision-making system during real-time operation of an industrial cricket filter (6) and a double-layer heater (8).

The chosen methodology is adequate and allows achieving the set goal and fulfilling the tasks formulated in the dissertation. The methodology combines theoretical analysis, formalization of decision-making models and their application to real technological objects, which ensures both conceptual correctness and practical verifiability of the results.

4. Contributions to the dissertation

The following scientific, scientifically-applied and applied contributions have been made in the dissertation:

- A conceptual and methodological framework for analyzing the control of complex dynamic technological objects under conditions of uncertainty has been formulated, based on the use of probabilistic and time models, and the need for their application in modern control systems has been justified.
- Consideration of decision-making models and modeling of technological objects in separate parts of the presentation, which provides a clear structural distinction between the theoretical and applied aspects of the study and creates a prerequisite for their subsequent connection.
- Mathematical and simulation models of real technological objects from the energy industry (steam generator) and the chemical industry (membrane bioreactor, cricket filter and double-layer heater) have been developed, which adequately describe their dynamic behavior and operational characteristics.
- Simulation verification of the developed models was performed, through which their behavior under different operating modes and disturbances was assessed, providing a valid environment for analysis and future upgrading with decision-making and control algorithms.
- A simulation and model basis was created, which creates a prerequisite for future implementation of formal decision-making models, without, however, these guidelines being explicitly formulated and detailed.

5. Publications on the dissertation thesis

5 publications are presented on the dissertation work, of which 4 are independent. All publications are in English, with one of the articles being in an internationally refereed and indexed journal included in the Web of Science (JCR-IF) and Scopus (SJR) databases, three are in a specialized scientific journal (Engineering Sciences), and one paper is in the proceedings of an international conference included in the IEEEExplore Digital Library and refereed in Scopus. I believe that the scientific publications are directly related to the topic, objectives and results obtained in the dissertation work, and the total number of points on indicators from 5 to 10 of the group of indicators D is 113.3 points, which significantly exceeds the requirements of 30 points, set out in the Regulations on the specific conditions for acquiring scientific degrees and for occupying academic positions in the IICT of the Bulgarian Academy of Sciences.

6. Opinions, recommendations and notes

Considering the relevance of the problem and the contributions achieved in the dissertation work, I positively assess the dissertation work presented to me for consideration. The author demonstrates a very good command of the modern theoretical apparatus, as well as the ability to apply the developed models and methods to real technological systems. The presentation is logically consistent, scientifically correct, and shows the independence of the research work, as the results obtained have both theoretical and practical value.

I recommend that the doctoral student, in the future, build on the research in the direction of integrating the developed models into full-fledged digital twins of technological objects, as well as conduct a comparative analysis with alternative methods, including methods from the field of machine learning, to more broadly assess the effectiveness of the developed methodology.

I have the following remarks regarding the presented dissertation:

1. In the dissertation, in places, there is an ambiguous use of terminology and notations for the same concepts, which may confuse the reader. For example, the terms "boiler" and "steam generator" are used to describe the same technological object, and different notations ("p" and "s") are found for the Laplace operator.

2. In equation (3.40) of the dissertation, there is a formally inaccurate representation of the inverse Laplace transform, which is probably the result of notational simplification. It is recommended that the notations for the operators L and L^{-1} be used in their strict mathematical sense.

7. CONCLUSION

My assessment of the dissertation, the abstract, the scientific publications, and contributions of M. Eng. Radoy Dukovski is POSITIVE. The presented dissertation fully meets the requirements outlined in the ZRASRB, the Regulations on the conditions for acquiring scientific degrees and occupying academic positions in the Bulgarian Academy of Sciences, as well as the Regulations on the specific conditions for acquiring scientific degrees and occupying academic positions in the IICT of the Bulgarian Academy of Sciences in terms of volume, quality, degree of novelty, scientific contributions and publications. In conclusion, I propose to the esteemed Scientific Jury to award M. Eng. Radoy Strezimirov Dukovski the educational and scientific degree "DOCTOR" in the scientific specialty "Automated information processing and control systems", professional field 5.2. "Electrical engineering, electronics, and automation".

Sofia, 28 January, 2026

Author of the Opin

