REVIEW

by. Nevena Stoyanova Mileva, Eng, PhD - Professor at Plovdiv University "Paisii Hilendarski"

dissertation for the award of the educational and scientific degree **"PhD"**

by: field of higher education 5 *Technical sciences*

Professional field *5.3. Communication and computer engineering*

Doctoral programme *"Automation of areas of the intangible sphere (medicine, education, science, administration, etc.)"*

Author: *Mag. Sezgin Fakhri Ismail*

Topic: *"Parametric and structural optimization of telecommunication models"*

Scientific supervisor. *Prof. Dr. Slavi Yasenov Lyubomirov - Paisii Hilendarski PU*

1. General description of the submitted materials

By Order No. RD-21-668/24.03.2023 of the Rector of the University of Plovdiv "Paisii Hilendarski" I have been appointed as a member of the scientific jury in the procedure for the defence of the dissertation on **"Parametric and structural optimization of telecommunication models"** for the acquisition of the educational and scientific degree "Doctor" in the field of higher education. Technical sciences, professional field 5.3. Communication and computer engineering, doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.) with the author of the dissertation. The set of paper materials submitted by the PhD student is in accordance with Article 36 (1) of the Regulations for the Development of the Academic Staff of PU and PP of ZPAS in the Republic of Bulgaria. The doctoral candidate has attached 5 publications on the topic of the dissertation.

The set of hard copy materials submitted by Mag. Sezgin Fakhri Ismail is in accordance with Article 36 (1) of the PU Academic Staff Development Regulations. It includes the following documents: an application to the Rector of PU for the opening of the dissertation defence procedure, a curriculum vitae in European format, the minutes of the departmental council related to the reporting of the readiness for the opening of the procedure and to the preliminary discussion of the dissertation, a 161-page dissertation and two 22-page appendices, a 32-page abstract, a list of scientific publications on the dissertation topic, copies of the 5 scientific publications submitted under the procedure, a declaration of originality and

credible declaration of originality and authenticity of the attached documents, as well as certificate of compliance with the minimum national requirements. The doctoral candidate has attached 5 copies of his publications on the topic of the dissertation. A list of noted citations has not been submitted.

2. Brief biographical data about the PhD student

According to the submitted CV, PhD student mag. Sezgin Fakhri Ismail was born in 1974 in. Fotinovo, Kurdzali. He graduated from secondary education in 1992 at the Secondary Primary School "Dr. Petar Beron", Momchilgrad. In 1997 he graduated from Plovdiv University "Paisii Hilendarski", Faculty of Mathematics and Informatics, specialty "Mathematics and Informatics". In 1999 he started working at the Secondary General Education School "Nikola Yonkov Vaptsarov", in the town of Bishkek. He graduated from the school in 1999 in Momchilgrad as a teacher of Computer Science and Information Technologies. In 2019 he graduated from the Department of Information and Teacher Development at Sofia University "St. Kliment Ohridski", Sofia, second professional qualification degree. He has technical skills and competences in the field of installation, configuration and maintenance of Windows, ms office and other software products. He is proficient and teaches information technology programming languages - c#, python, html, css, sql, etc.

3. Relevance of the subject matter and appropriateness of the set goals and objectives

Developments in telecommunications technology are changing the approach to designing, building and upgrading most enterprise systems and networks, which are becoming increasingly complex and large in terms of their infrastructure, functionality and services used. It is known to include advanced telecommunication models whose software and hardware implementation is based on modern information and telecommunication technologies. The quality and efficiency of systems in this class is largely determined by both their hardware reliability and the reliability of the software. The problem of ensuring the reliability of telecommunications systems and networks, which are the core of the systems, remains a topical one. Methods for assessing the reliability of devices, which are critical to the results of computations, require further investigation and development.

The development of new versions of stochastic evolutionary algorithms is a current and active direction in modern scientific research worldwide.

The presence of unsolved problems requires the development of new versions of stochastic evolutionary algorithms that give better results under certain conditions.

From the above and from the presented work it is concluded that the reviewed dissertation is related to a topical problem in scientific and applied terms.

The main objective of the research formulated in the thesis is to "explore the capabilities of genetic algorithm and optimization methods, using particle swarm, in automating the process of determining the structure and parameters of mathematical models of devices specific to telecommunications".

In order to achieve the set goal, the PhD student has formulated six tasks corresponding to the main tasks in any scientific research - problem analysis, solution proposal, experimental justification and feasibility analysis of the proposed solutions.

4. Knowledge of the problem

The dissertation submitted for review has a total length of 161 pages and contains two appendices. PhD student Mag. Sezgin Fakhri Ismail has cited 132 literature and information sources. Most of the works cited have been published in the last 10 years. From the list of cited references, it can be concluded that the PhD student has thorough insight into the current status and development trends of the problems addressed in the dissertation.

In the literature review, the PhD student has examined the current state of the topic and explored existing technologies and state-of-the-art methods. The overall theoretical and practical research reflected in the dissertation focuses on parametric and structural optimization of telecommunication models. The emphases are focused on current problems in the evaluation of systems with evolutionary algorithms. An analysis of the possibilities of applying the genetic algorithm and the particle swarm method has been made.

5. Research methodology

In connection with the fulfilment of the formulated aim of the dissertation, the doctoral candidate has used different theoretical and practical approaches and methodologies to solve the set tasks.

Methodologically, the Ph.D. student Sezgin Fakhri Ismail has structured his work correctly, following the stages typical for any research.

The PhD student has demonstrated the ability to deal with wide-ranging and complex tasks, which is evidence of thorough preparation. The methodology of work used has been properly selected in accordance with solving the set tasks and achieving the goal.

Therefore, from a methodological point of view, in his work the PhD student has demonstrated the necessary scientific training and professional skills.

6. Characteristics and evaluation of the dissertation

The dissertation submitted for review has a total length of 161 pages and contains two appendices.

Chapter I presents a definition of a telecommunications network and two important characteristics of that network: performance and reliability. It formulates basic problems in optimization theory, and discusses problems solved in the two branches of optimization theory: structural and parametric. A special emphasis is given to evolutionary algorithms for optimization of telecommunication models. An extensive survey of problems in the evaluation of systems modelled with evolutionary algorithms is given. The review is the basis for formulating several problems in modelling with evolutionary algorithms. The aim of the thesis is formulated: to investigate the possibilities of evolutionary algorithms - genetic and optimization, using particle swarm, to automate the process of determining the structure and parameters of mathematical models of telecommunication devices. Six tasks are posed to achieve this goal.

Chapter II describes the Monte Carlo method for conducting simulation with stochastic models and its variations. Artificial intelligence methods for system identification are discussed in detail. A special place is given to the use of Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) as methods for system parameter identification. A comparison between the two methods has been made.

Chapter III of this dissertation presents the use of artificial intelligence methods to assess the state of components of telecommunication systems. The creation of test models of basic telecommunication devices in the Matlab environment is discussed. The choice of a nonlinear structure that independently combines linear and nonlinear regressors and the nonlinearity structure itself, such as the binary splitting tree, is presented. The problem of determining the structure of an ARX-model is presented.

Chapter four focuses on experimental research. Tests of a linear system with and without noise are presented using a real coded GA and performing a planned Monte Carlo experiment. An analysis of the significance of the factors in testing the linear system is performed. A comparison of the evaluation of a linear system with GA and ORF is made. Testing of a frequency synthesiser model with PLL loop using GA and PSO using 3rd order filter by applying real coded GA and ORF and performing planned Monte Carlo experiment is

done. Testing of a frequency synthesiser model with PLL loop and 4th order low pass filter using ORF is presented.

The simulation results obtained are analysed and presented in tabular and graphical form. They confirm the mathematical relationships.

7. Contributions and significance of the development for science and practice

In the presented dissertation there is a correspondence between the aim, the set tasks for its realisation and the presented results of the conducted theoretical and experimental developments and essentially the work contains results that can be defined as scientific and applied contributions.

In each of the main chapters (second, third and fourth) a conclusion is drawn on the usefulness and effectiveness of the proposed solutions and the contributions of the developments in the specific section are formulated.

At the end of the dissertation, the contributions are combined in a common list, divided into two categories - scientific and applied.

Three scientific and applied contributions are formulated, which concern the following:

- Researched, systematised and analysed existing methods, techniques and tools of artificial intelligence for estimating the structure and parameters of basic components and nodes of telecommunication systems.
- Numerical experiment and Monte-Carlo simulation methods are applied to investigate the capabilities of GA and PSO algorithms for automated determination of the parameters and structure of specific classes of modules and devices in telecommunication systems.
- Procedures implementing the Genetic Algorithm (GA) and the Particle Swarm Optimization (PSO) method have been developed and the importance of factors affecting the qualities of the considered algorithms has been investigated and a comparative analysis has been conducted.

The five applied contributions presented in this dissertation can be summarised as:

- Tests of a linear system with and without noise, using a real coded GA and performing a Monte Carlo experiment are conducted and presented.
- Matlab codes for testing an analog bandpass filter using real coded GAs and ORFs, and performing Monte Carlo simulations were created and investigated. The significance factors in testing the filter model are conducted and analysed.

- Tests of a digital frequency synthesiser model using 3rd- and 4th-order filters using real-coded GA, Monte Carlo simulation and ORF are conducted and presented.

- A software tool in the Matlab environment has been developed and investigated to test a model of the cooling system of communication equipment in structure identification, using integer-coded GAs and ORFs and performing a planned Monte Carlo experiment. A significance analysis of the factors was carried out, and special functions implementing the procedures of integer-coded GAs and ORR-algorithms were written for this purpose. The values of the structural indices (na, nb and nk) of the ARX - polynomial model (idpoly) of the cooling system were determined.

- Testing was performed in the identification of the structure of a model of the cooling system of communication equipment using GA and ORF. Data taken from Feedback's PT326 laboratory experimental model is used as input.

8. Assessment of the publications on the dissertation

The author has submitted a list of 5 papers, two of which are in Bulgarian and three in English. He has one independent publication and four in co-authorship with his scientific supervisor. These 5 publications are related to the thesis topic.

Three of the publications are in scientific journals, refereed and indexed in the world-known databases Web of Science, one of them is presented in the 14th International Technology, Education and Development Conference, 2020, Valencia, Spain, two in the 13th annual International Conference on Education and New Learning Technologies, 2021, Spain. Two of the publications are in refereed journals - Scientific Proceedings of the Union of Scientists in Bulgaria in 2021. No reference for citations has been provided.

The data thus presented give me reason to conclude that the necessary publicity of the research in the dissertation has been provided.

9. Personal participation of the PhD student

Of the five publications submitted for the dissertation and reflecting in substance the results obtained from the development, in two the doctorate is in first place and in one is an independent author. They reflect the research in the dissertation and coincide in topic with it. This shows that the dissertant has acquired during his studies the skills to solve scientific and practice-oriented problems independently.

This testifies to the significant contribution of the PhD student to the results obtained.

10. Abstract

A review of the thesis abstract shows full compliance with the requirements for its preparation. It is 32 pages in length and faithfully reflects in a summarised form the content of the dissertation, containing a general description of the dissertation, aim and objectives, results of the literature study, the main highlights of the doctoral student's work presented in the second, third and fourth chapters, defined contributions contained in the dissertation.

11. Critical remarks and recommendations

The PhD student has taken into account the comments and recommendations during the preliminary discussion procedure before the extended departmental council at the Department of ECIT at PU and are reflected in the final version of the dissertation.

The work would only benefit from more detailed explanations of the determination of certain parameters, the specific conditions of the experiments and the motivations for the choices.

In Section 3.5 of the chapter, a description of the system parameter estimation function using the GA method is presented. The formal parameter of the function is given as the parameter err defined as the error tolerance. Its purpose and its importance for another important result, the averaged sum of absolute error (AvSAE), is not presented.

The remarks made in no way diminish the significant amount of research work carried out, but can only be seen as recommendations, especially for the future scientific activity of the PhD student.

12. Personal impressions

I don't know the PhD student Sezgin Fakhri Ismail personally.

13. Recommendations for future use of the dissertation contributions and results

Regarding the future use of the scientific and applied contributions of the dissertation research, no future directions are presented in the final part of the dissertation.

CONCLUSION

In this dissertation, an extended review of methods for the identification of structure and parameters of systems is carried out, the evolutionary methods GA and PSO are selected for their application in the identification of parameters and structure of telecommunication systems and their components, and the limits of applicability of both methods are outlined by

experimenting them on test models. A considerable amount of work has been done on creating computational procedures for implementing the methods in Matlab.

The dissertation contains *scientific and applied results that represent an original contribution to science* and meet all the requirements of 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 Paisii Hilendarski University.

The dissertation shows that the PhD student Sezgin Fakhri Ismail possesses in-depth theoretical knowledge and professional skills in scientific specialty 5.3 Communication and Computer Engineering, demonstrating qualities and skills to independently conduct scientific research.

Therefore, I confidently give my positive *evaluation of* the research presented by the above-reviewed dissertation, abstract, results and contributions, and *propose to the Honourable Scientific Jury to award the degree of Doctor of Education and Science* to Mgr. 5 Technical sciences, professional field 5.3 Communication and computer engineering, doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)".

30.05. 2023 г.

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Reviewer: ....

(*Prof. Nevena Mileva, Eng, PhD*)

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