R E V I E W

from

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Department "Computer Systems and Technologies"

for obtaining the educational and scientific degree "Doctor" under the doctoral program "Communication Networks and Systems",

field of higher education - 5. "Technical Sciences",

Professional field 5.3 "Communication and Computer Engineering"

Author of the dissertation: Eng. Dionisia Antimos Daskalaki

Topic of the dissertation: "Detection and analysis of communication channels of physical characteristics of metals using ultrasonic sensors"

1. ***Relevance of the problem developed in the dissertation in scientific and scientific-applied terms***

The chosen topic is relevant and it allows for a combination of diverse statistical devices, means of information and communication technologies to ensure the transmission of sensor data and classical measurement settings with the inclusion of parametric transducers for monitoring non-electrical quantities. In the specific case the processes of research of forces on metals and basic characteristics, which are a consequence of the applied influences on the tested objects, are considered. Emphasis is placed on strengths and weaknesses, as well as existing shortcomings in ensuring the transfer, processing and analysis of sensory information. The areas of application of the research in the dissertation work are metallurgy, medicine, shipbuilding, construction activities, automobile construction, railway transport, agriculture, etc.

In fulfillment of the set goal and tasks, the text contains an introduction, four chapters, a conclusion with contributions to the dissertation and lists of abbreviations and symbols used, a list of publications on the dissertation and references, a total of 152 pages. The scientific content includes 116 figures and 30 tables.

As a result of the research within the dissertation scientific and applied contributions have been achieved with significance and usefulness in the detection and analysis of communication channels of physical characteristics of metals through the use of ultrasonic sensors and application of analytical, simulation and experimental methods and tools. All this is a proof that the issues considered in the dissertation are topical and significant, and the tasks solved in it are innovative, useful and related to the research topic.

2. Degree of knowledge of the state of the problem and creative evaluation of the literary material

The doctoral student has made a broad and contemporary literature review on the topic of the dissertation. In his literature he cited 132 sources, which according to the content of the note can be divided into the following areas:
• types of communication interfaces used for data transmission in sensor networks;
• general classification of types of sensor elements, intelligent sensor networks and systems;
• technical means and system solutions for monitoring and registration of power loads;
• technical approaches applied as tools for digital processing of measuring and specialized analog and digital signals;
• general characteristics of artificial intelligence as a method for tasks for recognition, predictive analysis and noise reduction in communication channels for communication in data transmission in information and communication systems.

The cited literature covers the period from 2006 to 2022 and in the interval from 2006 to 2012 a total of 26 sources or 21.14% of the total amount were analyzed. The significant number of contemporary sources covered from 2013 to 2022 is impressive. For the period between 2013 and 2017, the survey sample covers 45 sources or 36.59% of the presented report. In the last five years from 2018 to 2022, an assessment of the issue was made on 52 sources or 42.28% of the total.

The manner of presentation, terminology, style and level of the presented note speak of a good knowledge of the issue. The formulated tasks and the achieved results are a guarantee for an excellent preparation of the author. In the dissertation a good analysis of the methods and means for improving the quality of service in wireless communications is made. All this speaks of a creative depth and broad knowledge of the topic of the dissertation.

3. Correspondence of the chosen research methodology with the set goal and tasks of the dissertation

From what is stated in the first chapter, the author's desire for a comprehensive solution to the problem is evident. This determines not only the chosen research methodology, but also the structuring of the contributing chapters.

I believe that there is a correspondence of the chosen research methodology with the goals and objectives of the dissertation. The results of the theoretical research, as well as the logic of this research, determine the reliability of the material on which the doctoral student's contributions are based. He knows very well the situation and the problems in the research area.

The research methodology in the dissertation is focused on a sequence of applied procedures for qualitative and quantitative analysis, relating to the following categories of objects:
• Category №1: Disturbances in communication channels;
• Category №2: Strain gauge measurement data on applied load forces on experimental parts;
• Category №3: Impact forces on test metal specimens;

- Category №4: Processed volume of batch, measurement and specified parametric data.

The first and last category concern especially current problems in modern communications, related to limiting the influence of noise in communication channels and the ability to predict the volume of information processed. Here are the purpose selected software tools LabVIEW and Java Modeling Tool for simulation of experimental interference effects and signals with superimposed noise, as well as simulated traffic in telecommunications systems such as Markov chains.

Artificial neural networks with right signal propagation and error backpropagation with Levenberg-Marquardt, Scaled Conjugate Gradient and Bayesian Regularization training algorithms, and classical regression analysis have been selected as tools for qualitative and quantitative analysis based on the MATLAB and STATISTICA platforms. Also included are the devices of generalized regression neural networks and a modified version of the networks with right signal propagation and error back propagation.

4. Contributions to the dissertation

In view of the research work, two categories of contributions can be grouped, reflecting the qualities and new aspects in compiling the dissertation:

Scientific and applied contributions:
- a methodology has been developed for the identification of interference effects, analysis of strain gauge measurement data "and forecasting the capacity of the served traffic when applying forces on metals with compensation of the influence of noise and optimization of the processed user requests;
- Structures of artificial neural networks with backscatter based on Levenberg-Marquardt and Scaled Conjugate Gradient with different activation functions were selected with accepted quality indicators for identification of Gaussian constant noise and Periodic constant noise, as well as digital signals in the presence of these impacts, in communication channels;
- Neural models have been created for the right propagation of signals and back propagation of the error in various training algorithms for quantitative identification of applied working strain gauge transducers in monitoring and registration of forces on metals;
- neural structures with backpropagation of the error and generalized regression neural networks for forecasting the potential applied force loads on test metal samples in mechanical test procedures are derived;
- Synthetic intelligence models have been synthesized for predictive analysis of the served traffic in simulated information and communication units with the help of Generalized Regression Neural Networks, Feed-Forward Neural Networks and Cascade-forward Neural Networks with confirmed advantages over classical regression analysis.

Applied contributions:
- a conceptual system for studying the characteristics of strain gauge sensor elements in measuring forces on metals with introduced modules for digital filtration in connection with noise reduction and descriptive analysis of the processed data is proposed;
- linear regression models for predictive analysis of the change of applied force loads in testing of metal samples are derived;

- analytical polynomial models are obtained on the basis of regression analysis for forecasting the potential served traffic with packet measuring and specified data with consideration and assessment of the influence of the controlled factors in simulated telecommunication systems.

5. Publications and citations of publications on the dissertation

The author has presented six publications at international conferences and scientific journals, fully meeting the minimum requirements for the criterion under consideration. One of the papers is independent (at the "UNITECH International Scientific Conference"), and the other five were prepared in co-authorship with the supervisor and the author's team. Two of the publications have been published in prestigious peer-reviewed international journals with indexing in Scopus with impact SJR rankings '0.190' and '0.184'. Scientific work from participation in the international scientific conference CIEES is also indexed in the international database Scopus. Two co-authored publications have been published in unreferred proceedings of the international scientific conference Unitech and TechCo.

A very positive aspect is the sufficient publishing activity in the publications with indexation in international databases. In this regard, I can recommend the PhD student to continue to publish her results, both in similar and in publications with Impact Factor. Many of the applied results have a high scientific value in this direction, allowing the implementation of implementation activities and participation in national and international projects under various operational programs.

6. Authorship of the obtained results

In the exposition of the dissertation work a significant volume of research and experimental activity has been realized by the doctoral student under the guidance of her research supervisor. I believe that a huge part of the research and analyzes conducted in connection with the summarization of the results are entirely personal contribution of Eng. Dionisia Daskalaki. The focus of the obtained results greatly builds on the current limitations in research related to the measurement of forces on metals. This is achieved by integrating the advantages of artificial intelligence technology in qualitative and quantitative analysis not only of measurement data, but also on factors influencing the integrity and quality of the processed information.

7. Abstract and author's reference

The abstract has a volume of 51 pages and contains a general description of the dissertation, a brief summary of the dissertation by chapters, conclusions, contributions and a list of publications. The abstract meets the requirements and reflects the nature of the results achieved by the doctoral student. It is well designed and illustrated, presents the full volume of work in a concentrated form, without compromising the ability to evaluate the results obtained.

8. Opinions, recommendations and remarks on the dissertation

I believe that methodical, in-depth and differently focused sets of research have been made in software and real experimental environment on the issues raised in the dissertation. In connection with the described research, analyzed results and synthesized models based on artificial intelligence, the following remarks and recommendations can be defined:
- It would be good to argue the choice of strain gauges as a selected type of sensor elements in monitoring the applied forces on metals given the type set

in the topic of the dissertation (for example, can be described relevant difficulties in conducting experimental work, established advantages or sensory advantages definition, features in the characteristics and others);

- The separate modules in the structured technical approaches for "identification of interference effects" on page 33, "qualitative and quantitative analysis of strain gauge data" on page 69 and "forecast analysis of the capacity of information and communication systems in traffic service units" on page 97, would be good to be more fully described in terms of clearly clarifying their functional purpose;
- In connection with a more complete assessment of the synthesized structures of artificial neural networks for the individual considered object tasks, additional indicators related to the quality of classification such as Precision, Specificity, Sensitivity, etc. can be analyzed;
- The complete systematic experimental data in tabular representation from simulation modeling of telegraphic systems of the Markov chain type may not be shown in the structure of the dissertation;
- It would be good to provide additional brief information on the specifics of each of the applied training algorithms Levenberg-Marquardt, Bayesian Regularization and Scaled Conjugate Gradient in connection with the synthesis of models for predictive analysis of processed application packets. With regard to the formulated contributions to the dissertation, it is good to make a clearer categorization and refinement of the applied and scientific-applied contributions.

In general, however, the activities performed in the dissertation have a completed form and include simulation and experimental research, presentation of the results, as well as formulation of analyzes and conclusions. Characteristic of the conducted research is the good scientific level. The dissertation is designed accurately and with good quality, and the style of the exhibition is technically sound.

In the future, I recommend the PhD student to continue his research work and have more independence in it, as the results will be presented and published in international conferences and peer-reviewed journals with "impact factor" (WoS) or Scopus rank. The remarks and recommendations given by me do not belittle the research carried out by Eng. Dionisia Antimos Daskalaki. I believe that the dissertation achieves the stated goal, and the defined tasks are performed at a high scientific level and the dissertation is complete.

9. Conclusion
The achieved results give me grounds **to propose to obtain** the educational and scientific degree "**Doctor**" from **Eng. Dionisia Antimos Daskalaki** in the field of higher education - 5. "Technical Sciences", professional field - 5.3. "Communication and Computer Engineering", doctoral program - "Communication Networks and Systems".

14.06.2022   **Reviewer: /signature/**
                                                      /Prof. D.Sc. Eng. Raycho T. Ilarionov/

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