

REVIEW
of a dissertation
for awarding an educational and scientific degree of "Doctor" in

in the field of higher education – 5. Technical Sciences
the professional field 5.3 “Communication and Computer Engineering”
the scientific specialty "Communication Networks and Systems"

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Thesis: DETECTION AND ANALYSIS THROUGH COMMUNICATION CHANNELS OF THE PHYSICAL CHARACTERISTICS OF METALS BY USING OF ULTRASONIC SENSORS

Reviewer: Prof. Valentina Ilieva Markova, PhD

1. Topic and relevance of the dissertation

The development of communication and computer technologies and the massive implementation of sensor systems have changed the daily life of modern humans. The main purpose of data acquisition systems is to reliably collect, process, analyze and visualize data. In this context, the connection between signals, data, and communication channel is important, because the main task of a sensor system is to achieve knowledge through data collection and processing to support informed decision-making.

Provision of the communication channel by reducing the impact of various interferences and noise signals is essential for the quality of recorded measurement information. For this purpose, it is necessary to use appropriate mathematical models and software to determine and suppress disturbances.

The use of modern approaches for research and modeling of various disturbances and evaluation of the functionality of a complete system for measuring the impact of applied forces on metal parts and objects determines the actuality of the dissertation.

The achieved research and applied results are significant in scientific and applied aspects and can find many applications in modern industry.

2. Review of cited literature

In the present dissertation a detailed literature review of 123 sources is made. Basic concepts related to sensor systems are considered, as well as modern approaches for modelling and analysis of communication channels. An overview of communication interfaces and standards for transmission of sensory information, as well as known technical approaches for digital signal processing and noise reduction in communication channels.

An analysis of the existing methods for measuring force impacts and of basic technical measuring instruments for registration of force loads measurements on metal parts and structures and sensor systems for load measurements in various fields of industry has been made. Specific approaches for application of elements of artificial intelligence as a tool for predictive analysis in telecommunication systems in relation to users of communication services and processed traffic are presented.

The good interpretation of the literature, the in-depth analysis and the conclusions made prove a high degree of knowledge of the state of the problem by the doctoral student.

As a result, the purpose of the dissertation and the specific research tasks are defined.

3. Research methodology

The results presented in the dissertation are obtained on the basis of a theoretical overview, developed methodology for modeling, forecasting and analysis of data through programs among Matlab and LabVIEW. A number of experimental studies have been performed to assess the significance and comparability of developed algorithms for the identification of simulated random noise and interference, as well as models for predictive analysis of load forces.

Objective analysis has been made with regard to the combinations of working transducers used in the monitoring of loads on test parts, as well as the forecast determination of the quantitative changes of the applied forces of influence. In addition, a forecast analysis of the potential amount of processed user requests for transmitted measurement sensor information in a simulated traffic transmission environment is made in connection with the planning of the capacity of the served traffic system.

4. Contributions to the dissertation

The main contributions are related to the proposed concept for research and measurement of the impact on the applied forces of metal parts and objects of the system of strain gauges. A total of five scientific and three applied contributions have been defined.

Scientific contributions:

- ✓ developed a methodology for 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 and Periodic 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 communication units with the help of Generalized Regression Neural Networks, Feed-Forward Neural Networks and Cascade-forward Neural Networks at LM, SCG and BR training algorithms with confirmed advantages over the classical regression analysis.

Applied contributions:

- ✓ a conceptual system for studying the characteristics of strain gage sensor elements in measuring forces on metals with introduced modules for digital filtration in connection with noise reduction and descriptive analysis for data processing is proposed;
- ✓ linear regression models are derived when switching on one and two working strain gauge transducers for predictive analysis of the change of applied force loads when testing metal samples;
- ✓ 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 main contributions and results of the dissertation are presented in two publications in journals and four papers presented at conferences and published in conference proceedings. Three of the publications are indexed in Scopus. The doctoral student has a separate publication. I am not aware of any citations to the publications.

The publications on the dissertation in quantitative and qualitative terms fully meet the requirements for obtaining the educational and scientific degree "Doctor".

6. Authorship of the obtained results

From the presented publications it is clear that the doctoral student worked in a team together with her supervisor and other researchers working in the field of dissertation. The results of the research have been reported in established conferences and journals. There are no separation protocols attached, which gives me reason to assume that the degree of personal involvement of Dionisia Daskalaki is significant for achieving the results.

7. Summary and author's reference

The author's presentation was received in a volume of 51 pages in accordance with the requirements. The abstract is fully feasible highlights of the dissertation and achievements. Research and applied contributions are indicated. Attached is a list of publications, as well as an abstract in English. The doctoral student has attached a declaration of authorship.

8. Opinions, recommendations and remarks on the dissertation

The dissertation is designed according to the requirements. The conclusions correctly reflect the results obtained, as a significant part of them are interpreted with a large number of figures and tables.

Thanks to the doctoral student for complying with the recommendations made in the preliminary review and for removing all remarks.

I recommend to the Dionisia Daskalaki will continue to work hard and publish in scientific journals with an influential factor.

9. Conclusion

I believe that the presented dissertation meets the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria. The achieved results give me grounds to propose to obtain the educational and scientific degree of "Doctor" from Dionisia Daskalaki in the field of higher education – 5. Technical sciences, professional field - 5.3 "Communication and computer engineering", doctoral program - Communication networks and systems

17.06.2022г.

**Reviewer: /signature/
/Prof. V. Markova, PhD/**