

REVIEW

by **Prof. Dr. Rositsa Zhelyazkova Doneva** – professor at Plovdiv University “Paisii Hilendarski”

(professor, first name, last name, family name – academic title at the higher education institution or scientific organization)

of a dissertation for the award of the educational and scientific degree "**Doctor**"

in field of higher education 5. Technical sciences

professional field 5.3. Communication and computer technology

Doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)"

Author: *Anatoliy Rosenov Parushev*

Topic: *AUTOMATION OF A LABORATORY FOR ECO-ENERGY TECHNOLOGIES*

Scientific supervisor: *Prof. Dr. Rumen Kostadinov Popov - Paisii Hilendarski University*

(academic title, senior lecturer, first name, last name, family name - higher education institution or scientific organization)

1. General description of the materials presented

By order No. PD-22-2023 of 22.10.2025 of the Rector of Plovdiv University "Paisii Hilendarski" I have been appointed as a member of the scientific jury in the procedure for the defence of a dissertation on the topic "Automation of a laboratory in eco-energy technologies" for the acquisition of the educational and scientific degree "doctor" in the field of higher education: 5. Technical sciences, professional field 5.3. Communication and computer technology, doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.). The set of materials on paper submitted by the doctoral student is in accordance with Art. 36 (1) of the Regulations for the Development of the Academic Staff of the University of Sofia and the Regulations for the Implementation of the ADAS in the Republic of Bulgaria.

The author of the dissertation is Anatoliy Rosenov Parushev, M.Eng. - a full-time doctoral student at the Department of Computer Science and Engineering with scientific supervisor Prof. Rumen Kostadinov Popov from Paisii Hilendarski University.

The set of materials on paper presented by Anatoliy Rosenov Parushev is in accordance with Art. 36 (1) of the Regulations for the Development of the Academic Staff of the University of Plovdiv, and includes the following documents:

- a request to the Rector of the University of Plovdiv to disclose the procedure for defending a dissertation;
- CV in European format;
- minutes from the department council, related to reporting the readiness to open the procedure and preliminary discussion of the dissertation work;
- dissertation;
- abstract;
- a list of scientific publications on the topic of the dissertation;
- copies of scientific publications;
- declaration of originality and authenticity of the attached documents;
- a certificate of compliance with minimum national requirements;

The doctoral student has submitted six publications on the topic of the dissertation.

2. Brief biographical data about the doctoral student

The doctoral student, M.Eng. Anatoliy Rosenov Parushev, was born in 1997 in the city of Zlatograd, Smolyan region. He graduated from secondary education at the Karl Marx Vocational High School of Economics - Smolyan in 2016. He received a bachelor's degree in "Computer and Communication Systems" at the Plovdiv University "Paisiy Hilendarski", Faculty of Physics and Technology in 2020, where he also obtained his master's degree in "Information Security" in 2021. In the period from 2017 to 2020, he worked as a technical manager at the company Digital Systems EOOD, Varna. From October 2020 to November 2021, he held the position of "Key Account Manager" at "Eco-Spa-Agarti", Devin, whose subject of activity is the trade in mobile devices and accessories. From November 2021 to the present, he is an assistant professor in the Department of Computer Science at the Faculty of Physics and Technology of Paisii Hilendarski University, where he leads laboratory exercises in the disciplines: "Computer Networks", "Software Development Practicum", "Computer Periphery", "Informatics", "Sensors and Actuators", "Operating Systems" and others.

3. Relevance of the topic and appropriateness of the set goals and objectives

The presented text of the dissertation is on a topic that is undoubtedly very relevant since in recent years conducting remote laboratory experiments with the possibility of real access to laboratory equipment has become an increasingly necessary method of learning, especially in technical sciences. Another reason for this is the possibility of providing access to expensive experimental equipment from anywhere in the world, which also implies the possibility of sharing laboratories. Students acquire practical knowledge by having the opportunity to conduct real experiments at any time and from any place. A large part of the latest research related to the problems in education indicates that remote access laboratories significantly increase the efficiency of the educational process in distance learning mode. This determines the increased interest in the introduction of remote access education

in the field of technical sciences and, accordingly, determines the relevance of the topic of the dissertation.

The main goal of the dissertation is the development, construction and experimental validation of an automated laboratory stand SR1162E with remote control capabilities, intended for training and research of thermal processes. To achieve the set goal, the doctoral student has formulated eight research tasks that fully meet the requirements for conducting the relevant scientific research. On this basis, I assess the topic as very relevant for ensuring adequate and modern engineering training in the field of eco-energy technologies in the distance learning mode. I accept the main goal and tasks as adequately formulated.

4. Knowing the problem

The dissertation submitted for review has a total volume of 224 pages, contains two appendices. The doctoral student Anatoliy Rosenov Parushev cited 139 literary sources, most of which were published in the last 5 years and reflect modern trends in the field of automation, microcontroller systems and remote laboratory platforms. The literature review is precisely structured and focuses on laboratory bench automation systems, energy and air flow measurement devices, as well as on current technologies for implementing remote laboratories - both industrial and educational. Existing technical solutions, communication protocols, controller types and software SCADA and IoT platforms are examined in detail, and a critical assessment of their capabilities and limitations is made. It should be emphasized that the review is sufficiently broad and in-depth, and the analysis is methodically justified. This gives definite reason to note that the doctoral student formulated the purpose of the research and the tasks arising from it, after becoming thoroughly familiar with the current state of the problem and the most current developments in the field of automation systems and remote access to laboratory and training resources.

5. Research methodology

The chosen methodology in the dissertation fully corresponds to the set goal and the specifics of the developed automated laboratory system. The Node-RED platform, running on a local server, was used to implement the software part of the laboratory. Algorithms for two-way communication with measuring instruments and actuators have been developed, including processing of input parameters, synchronization of exchange and visualization of results.

The hardware part of the system is implemented based on a microcontroller STM32F103ZE, for which the doctoral student has developed specialized firmware, providing sensor control, processing of measured values and communication via Modbus RTU, USART and RS485. The use of this controller allows for reliable connection to the frequency drive and other components of the laboratory stand, as well as accurate registration of air and heat flow parameters.

The methodology also includes conducting a wide range of experimental measurements of the real laboratory setup under different operating modes. Through systematic recording and analysis of the data, key dependencies have been derived, which allow assessing the behaviour of the system and

its stability under changing frequency, load and operating conditions. The presented graphs and summarized results demonstrate that the developed automated platform functions stably, provides reliable data and is suitable for use in educational and laboratory settings.

6. Characteristics and evaluation of the dissertation work

The dissertation has a total volume of 224 pages – it consists of an introduction, five chapters, a conclusion, a declaration of originality of the results obtained, a list of publications on the topic and a bibliography, which includes 139 sources. The introduction aims to justify the relevance of the problem addressed in the dissertation, outlining the need for automation of laboratory systems for eco-energy technologies and the need to implement modern means of control and measurement.

The first chapter provides an overview and analysis of existing solutions in the field of automated and remote laboratory systems, as well as the hardware and software technologies used for their implementation. Different approaches to measurement, control and visualization of processes characteristic of eco-energy technologies are compared. At the end of the chapter, the purpose of the study and the resulting tasks, formed based on the conducted analytical study, are defined.

The second chapter presents the methodology for the design and development of the automated laboratory system. The theoretical models and methodologies used to determine the air flow velocity profile in a rectangular pipe, the air flow rate and the mass specific heat capacity of air at constant pressure are described. The logical sequence of the used computational dependencies is shown, which serve as the basis for implementing the measurement algorithms in the system.

The third chapter is dedicated to the development of the automated laboratory bench and the associated software infrastructure. This chapter describes the hardware architecture, including the STM32F103ZE microcontroller, the sensors and actuators used, as well as the circuit solutions for communication via Modbus RTU, RS485 and USART. The software architecture of the system, implemented on a local Node-RED server, is also presented, considering the individual functional blocks, data processing modules and real-time parameter visualization. The interaction between software and hardware and the mechanisms that ensure reliable operation of the system are described in detail.

The fourth chapter includes a description of the experimental studies conducted on the real laboratory stand. The measurements in different operating modes, graphical and tabular summaries of the results, as well as an analysis of the relationships between the set parameters of the frequency drive and the obtained speed, temperature and energy characteristics are presented. The results demonstrate the correctness of the developed methodology and confirm the functionality of the system in real operating conditions.

Chapter Five contains the conclusions and contributions of the dissertation work. The main achievements obtained in the course of theoretical work, engineering implementation and

experimental research are formulated. The scientific-applied and applied contributions are distinguished, which clearly show the significance of the developed automated laboratory system both for the scientific field and for practical training in eco-energy technologies.

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

In the presented dissertation there is a correspondence between the goal, the tasks set for its implementation, the presented results of the theoretical and experimental developments. The dissertation contains results from which the doctoral student has defined scientific-applied and applied contributions.

I agree with the contributions described by Anatoliy Rosenov Parushev in the dissertation work and accept them as such.

The applied contributions are as follows:

- Based on an existing stand, model SR1162E, the hardware and software of a modernized laboratory stand were designed and tested, providing the possibility of remote access and control.
- A communication controller has been developed - a key element in the construction of the automated system, acting as an interface between the physical measuring/executing devices and the application software (server) implemented in Node-RED.
- An application server is designed in Node-RED and is installed on a personal computer (server). It provides a logical connection to the task of communication between the hardware part (the microcontroller of the stand) and the external interface and performs several key functions.
- Experimental validation of the functioning of the stand in remote mode has been carried out.
- Two sets of methodological instructions for students have been developed: for measuring the air flow velocity profile and for measuring the specific heat capacity of air at constant pressure. They consider the specifics of distance learning in an Internet environment and the possibilities for distance teaching and control by the teacher.

The scientific and applied contributions are as follows:

- Developed and adapted for the specifics of remote sensing in real-time operation is a methodology for measuring the air flow velocity profile, based on a Pitot tube and a differential pressure sensor.
- Developed and adapted for the specifics of remote sensing in real-time operation is a methodology for measuring the specific heat capacity of air at constant pressure. It is

based on determining the mass flow rate of air in a pipe channel and measuring the heat transfer rate from a heating element and the temperature difference in the flow before and after the heater.

- An approach for remote switching on and control of stands and servers has been developed and tested, based on the Modbus over TCP/IP protocol, in combination with Remote Desktop remote access to the server by the teacher and granting access rights to the student, through popular video conferencing platforms such as Microsoft Teams, Google Meet, or Zoom.

8. Assessment of dissertation publications

The author has submitted a list of 6 publications, all of which are in English. The six articles are co-authored. One of the publications is indexed in the SCOPUS databases, the rest are presented in refereed international conferences, ICERI 2022 15th annual International Conference of Education, Research and Innovation and INTED 2023 17th annual International Technology Education and Development Conference Valencia. All publications are related to the topic of the dissertation.

The review of the publications shows that the necessary publicity has been provided for the results achieved from the scientific research carried out in the dissertation. Their number is sufficient and corresponds to the accepted requirements.

The publications are on the topic of the dissertation and demonstrate in-depth knowledge of the subject, including based on personal experience; knowledge of theory; structure, style, and language that demonstrate capabilities for academic work.

9. Personal participation of the doctoral student

Of the 6 publications presented on the dissertation work, essentially reflecting the results obtained from the development, in 3 the doctorate is in first place, in 2 of them he is the second author and in one he is the 4th in a row in the list of authors. The publication activity shows that during his studies as a doctoral student Anatoliy Rosenov Parushev has gained experience and confidence in independently solving scientific and practically oriented tasks.

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

10. Abstract

The review of the dissertation abstract shows full compliance with the requirements for its preparation. It is 32 pages long and faithfully reflects in a shorter form the content of the dissertation, containing a general description of the dissertation, goal and objectives, results of the literature review, the main highlights of the doctoral students work, and defined contributions contained in the dissertation.

The abstract is prepared in accordance with the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADSRB), the Regulations for the Implementation of the ADSRB and the relevant Regulations of the Paisii Hilendarski University and reflects the main results achieved in the dissertation.

11. Critical remarks and recommendations

The doctoral student has considered the remarks and recommendations made during the preliminary discussion procedure before the departmental council of the Department of ECIT at the University of Sofia. I have some rather recommendations for the dissertation work, which can be summarized as follows:

- a more detailed example of the influence of ambient conditions on measurements could be added, for example how a change in inlet air temperature affects the calculation of mass specific heat capacity or how fluctuations in flow rate affect the velocity profile.

- It is appropriate to present a brief comparison between the selected microcontroller STM32F103ZE and another modern platform, for example ESP32 or STM32F4, indicating why the current choice is most suitable for frequency drive and Modbus communication.

- A more detailed discussion of factors affecting the accuracy of Pitot tube measurements could be included, such as sensitivity to small fluctuations in static pressure, the influence of turbulence in the rectangular tube, or the need for precise positioning of the probe.

- On pages 82, 85, 97 and 133, there are some technical errors in terms of formulas and expression.

- a program fragment is noticed on page 140 in which a logical condition is missing.

12. Personal impressions

I know the PhD student as a colleague in the Department of Electrical Engineering and Communications. Extremely humble, focused and executive. He shows potential for research and creativity, which qualities I believe will improve with the acquisition of a PhD degree.

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

The developed automated laboratory system provides a reliable basis for expansion with new measurement modules and laboratory exercises. In future work, it is appropriate to explore the possibility of integrating additional aerodynamic and thermal processes that can be monitored through the existing architecture. The system allows easy adaptation to various engineering applications, which opens opportunities for upgrading in new thematic areas. It is recommended to gradually expand the functionality to increase its applicability in an educational and research environment. The

development can serve as a platform for future improvements aimed at modernizing and expanding the eco-energy technologies laboratory.

CONCLUSION

The dissertation work contains scientific-applied and applied results that represent an original contribution to science and meet all the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB), the Regulations for the Implementation of the ADASRB and the relevant Regulations of the Paisii Hilendarski University.

The dissertation shows that the doctoral student Anatoliy Rosenov Parushev possesses in-depth theoretical knowledge and professional skills in the scientific specialty "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)" by demonstrating qualities and skills for independent conduct of scientific research.

Due to the above, I confidently give my positive assessment of the conducted research, presented by the above-reviewed dissertation, abstract, achieved results and contributions, and I propose to the esteemed scientific jury to award the educational and scientific degree "doctor" to Anatoliy Rosenov Parushev in the field of higher education: 5. Technical sciences, professional field 5.3. Communication and computer technology, doctoral program "Automation of areas of the intangible sphere (medicine, education, science, administrative activities, etc.)".

17.11.2025

Reviewer:

(signature)

Prof. Dr. Rositsa Doneva

(ac. dl., n. st., name, surname)