OPINION

by Assoc. Prof. Dr. Eng. Veselin Gerov Nachev,
University of Food Technology, Plovdiv

of dissertation for awarding 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 field (medicine, education, science, administrative activities, etc.)"*
Author: **phys. eng. Svetoslav Genchev Hadzhigenchev**
Topic: **"GEOELECTRICAL RESISTIVITY TELEMETRY SYSTEM IN SEISMOGENIC ZONES"**
Supervisor: **Assoc. Prof. Dr. Slavi Lubomirov - Paisii Hilendarski University of Plovdiv**

1. General presentation of the procedure and the doctoral student

Based on the order of the Rector of the Paisii Hilendarski University of Plovdiv (PU) № РД-21-123 from 19.01.2024 г., I have been appointed as a member of the scientific jury to ensure the procedure for defending the doctoral thesis on the topic **"GEOELECTRICAL RESISTIVITY TELEMETRY SYSTEM IN SEISMOGENIC ZONES"** for the acquisition of the educational and scientific degree "Doctor" in the field of higher education 5. Technical Sciences, professional direction 5.3. Communication and Computer Engineering, doctoral program "Automation of Areas in the Intangible Sphere (medicine, education, science, administrative activities, etc.)".

The author of the dissertation is **phys. eng. Svetoslav Genchev Hadzhigenchev,** with a supervisor **Assoc. Prof. Dr. Slavi Lubomirov**, PhD, from PU "Paisii Hilendarski".

The set of materials presented by the doctoral student complies with Article 36 (1) of the Regulations for the Development of the Academic Staff of PU and includes the following docu-ments:
- Application to the Rector of PU to initiate the procedure for defending the doctoral thesis from 11.01.2024;
- CV in European format;
- opinion from the doctoral student's supervisor;
- Protocol of preliminary discussion in the department;
- Doctoral thesis;
- Abstract in Bulgarian and English;
- List of scientific publications on the topic of the dissertation;
- Copies of scientific publications;
- Declaration of the originality and authenticity of the attached documents;
- Reference for meeting the minimum national requirements specified in the Regulations for the Development of the Academic Staff of PU for obtaining the educational-scientific degree "Doctor" in the professional direction 5.3 Communication and Computer Engineering.

All documents meet the requirements and based on this I determine the candidate's eligibility for further evaluation.

2. Relevance of the Topic

The dissertation work is related to the problem of monitoring and analysis of geophysical field anomalies preceding earthquakes, with the aim of their prediction. The subject of the study is the use of modern means for the implementation of geoelectrical resistance telemetry systems and other geo-physical information.

The topic of the dissertation is relevant and significant. It is related to the possibilities of early warning of earthquakes, which is a vital issue for every person, as well as for all elements of the social and economic system of a society.

The basis for the high degree of relevance of the dissertation stems from:

- The complexity of the task: multivariate, from the point of view of the nature of the parameter predicting the earthquake; the problem "the uncertainty of indicators"; non-triviality of the task, from the point of view of the region, presence of significant historical distances with different forecasting technologies and means of data collection, etc.;
- The aim to improve or create a new method based on modern means of automated, digitized data collection and modern communication networks.

In view of what has been said, I think that the topic of the dissertation work of Phys. Eng. Svetoslav Hadjigenchev is relevant and significant in a scientific and applied field, directly related to the scientific specialty of the doctoral program.

3. Understanding the Problem

During the development of the dissertation, 140 literary and electronic sources (15 Internet sites) were used.

With the exception of certain fundamental sources and excluding the presented datasheets, mainly publications from the last 15-20 years are present. In their main part, they are directly related to the topic of the dissertation.

In the overview part of the dissertation, a very good knowledge of the state of the problem and sufficient literary awareness with regard to conceptual solutions, technical systems and results of project development of external teams is shown. This has enabled the correct, accurate interpretation of information and definition of the purpose and tasks of the dissertation work.

The dissertation work shows accumulated experience and knowledge from the professional path of the doctoral student and it can also be accepted as the result of his long-term work in this field.

I believe that the dissertation student is familiar with the problem and has creatively evaluated and interpreted the literary material.

4. Research Methodology

The main part of the dissertation consists of four chapters. CHAPTER I („RESULTS FROM THE LITERATURE REVIEW ON THE DISSERTATION TOPIC") is an overview and it examines methods and tools for monitoring and forecasting earthquakes. The description includes conceptual models, methods, world experience in the subject area, etc. Applicability guidelines, advantages and disadvantages are presented. At the end of the first chapter, the purpose and tasks of the dissertation are defined.

The remaining chapters of the dissertation - "CHAPTER II. DESIGN OF APPARATUS FOR MEASURING VARIATIONS OF GEOELECTRICAL RESISTIVITY", "CHAPTER III. SOFTWARE CONTROL AND PRACTICAL IMPLEMENTATION OF INSTRUMENTATION FOR MEASURING VARIATIONS OF GEOELECTRICAL RESISTIVITY" and "CHAPTER IV. TRANSMISSION AND VISUALISATION OF MEASUREMENT DATA" follow clearly, precisely and logically connected objectives and correspond to the defined purpose.

When presenting his developments, the author follows an approach to justify his decision, taking into account the presence of limitations, unfavorable factors and considerations in order to best parameterize the systems. An analogous approach is used in the technical design of the relevant functional devices in the proposed system for measuring geoelectrical resistance variations (Chapter II), including: electronic field part, power supply control circuit, automated measurement module, additional sensors, calibration circuits, analog-digital conversion, measuring circuits, etc. In the development process, the proposed solutions have been researched and evaluated, including with means of simulation modeling.

Chapter III describes the software of the measuring station and the conducted field experiment with it. Based on the analysis of the obtained data, it was found that the volume of the obtained data is insufficient for deriving a relationship between the variations of the geoelectrical resistance and the realized earthquakes during the observation period. The influence of temperature and amount of precipitation was also investigated.

Chapter IV contains the design and development of algorithms in a monitoring and control system (ThingSpeak) using network environments (LoRaWAN). This choice is purposeful and suitable

for the application – monitoring with low power consumption technical means, at relatively long distances and a solid interface allowing data analysis to support decision making.

In conclusion, I believe that there is compliance of the chosen research methodology with the set goal and tasks of the dissertation work. An element for evaluating the effectiveness of these methodologies is the reaching of completed systems, the experimental activity with them and the possibility of analyzing the results.

5. Characterization and Evaluation of the Dissertation and its Contributions

The dissertation contains scientific and applied contributions. The achieved results are based both on known electronic platforms and means of communication, and also on the creation of purpose-fully modified and further developed hybrid structures. The created data collection systems, hardware architectures and communication modules can be considered as completed developments. Although an individual approach was applied to the designed technological equipment, tailored to the specific requirements and conditions, some of them have a multifunctional nature and can be used in other applications, for example, environmental monitoring, climate monitoring, etc.

I believe that in popularizing the results of the dissertation, there are real prerequisites for them to be used in other engineering applications. In this regard, I appreciate the highly developed and functioning platform available on the web.

As main contributions in the dissertation, the following can be noted:
- Expansion and deepening of knowledge about research on variations of apparent resistance in the process of earthquake preparation, from the point of view of factors - noise, contact resistance of electrodes, temperature, precipitation;
- Designed and implemented equipment for measuring the variations of geoelectrical resistance and meteorological parameters;
- Design of modules for calibration and verification of the equipment for measuring the variations of the geoelectrical resistance;
- A system has been developed for registration, transmission, processing, storage and visualization of the received sensor data in a cloud platform.

In support of his contribution claims, the author of the thesis has attached electronic schematics, photographic material and program codes of created software or basic fragments thereof.

I am of the opinion that there is no reason to emphasize the fact that the obtained field experimental data did not allow the derivation of a relationship between the variations of the geoelectrical resistance and the realized earthquakes during the test. The reasons for this are detailed in the dissertation.

I accept the achieved contributions of the doctoral student and consider that they are sufficient in number and importance for a dissertation work for the acquisition of the degree of "doctor".

6. Evaluation of Publications and the Doctoral Student's Personal Contribution

The doctoral student phys. eng. Svetoslav Genchev Hadzhigenchev has presented a list of 5 works. One of the publications is co-authored with the scientific supervisor, and in the others the doctoral student is the author himself.

The topics and content of the publications are directly related to the dissertation, reflecting all its parts. I believe that the degree of personal involvement of the dissertation student in the contributions is significant.

The approach of presenting the developments in the dissertation speaks of expert knowledge and competence on the subject.

There is no information that they have been cited by other authors.

7. Dissertation abstract

The abstract is presented in Bulgarian and English. It consists of 32 pages, including contributions and publications related to the dissertation work. The structure of the abstract follows the main structure of the dissertation and presents it correctly.

8. Recommendations for future use of dissertation contributions and results

The proposed methods and the obtained results have practical utility. In addition to the field of earthquake prediction, certain solutions can be implemented in the general case in: environmental monitoring systems and hazardous environments for humans, security equipment and systems, automation in production - industrial systems for data collection, monitoring and control of technological processes. The additional functionality for working over long distances with a network communication module greatly expands their potential for use.

Important prerequisites for the future use of the dissertation contributions and results, it is my opinion that the doctoral student should:
- develops his research by participating in research projects;
- directed its publication activity in international forums;
- established contacts for joint work with other researchers in his field.

I recommend the author to expand his knowledge in the field of intelligent data analysis ("*Data Mining*"), which significantly increases the possibilities of analysis and interpretation of time series.

CONCLUSION

It is my opinion that the dissertation meets the normative requirements for receiving the educational and scientific degree "doctor".

The dissertation shows that the Ph.D. student in **Phys. Eng. Svetoslav Hadjigenchev** possesses in-depth theoretical knowledge and professional skills in the scientific specialty "Automation of areas of the intangible field (medicine, education, science, administrative activities, etc."), demonstrating qualities and skills for independent implementation of scientific and applied research.

Due to the above, I give my positive assessment of the developed dissertation work, abstract, achieved results and contributions, and I propose to the members of the scientific jury to award the educational and scientific degree "doctor" to **Phys. Eng. Svetoslav Genchev Hadjigenchev** in scientific field 5. Technical sciences, Professional direction 5.3. Communication and computer technology, doctoral program "Automation of areas of the intangible field (medicine, education, science, administrative activities, etc.").

Date: 14.02.2024   **Author of the opinion**: ....

Assoc. Prof. Dr. Eng. Veselin Nachev