REVIEW

by competition for the academic position of associate professor of 5.2 "Electrical engineering, Electronics and Automation" (Additive and inhomogeneous structures in sensors), announced in the State Gazette, no. 64 of July 30, 2024,
with candidate: Dr. Martin Lachezarov Ralchev
Reviewer: Petko Hristov Petkov, DSc, Professor

1. General and biographical data

In the competition for "Associate professor" in 5.2 "Electrical engineering, Electronics and Automation" (Additive and inhomogeneous structures in sensors) at the Institute of Robotics - BAS, only one candidate submitted documents: Dr. Martin Lachezarov Ralchev, engineer at the section "Sensors and measuring technologies in robotics and mechatronics" at IR. The candidate acquired the qualification "Electrical Engineer" at the Technical University - Sofia with an educational and qualification degree "Bachelor" in 2018. In 2016 and 2017, he underwent training at IR and the SIEMENS company, related to sustainable energy and the implementation of innovative systems, and in 2020, he graduated from the "Electric Power Engineering and Electrical Furnishings" major at TU-Sofia with educational and qualification degree "master". In the period 2020-2024, he was an assistant at the Institute of Robotics and participated in the institute's research activities, and in 2024 he received the educational and scientific degree "doctor" with a dissertation on the topic “Emission and sensor registration of microparticles in inhomogeneous structures under uniaxial deformations”. He was awarded by the Lachezar Tsotsorkov Foundation with first place in the National Competition in 2021, received the "Ivan Evstratiev Geshov" award for the youngest scientists in 2023 (awarded with first place), as well as the Young Inventor Award from the Eureka Foundation for 2023 (honored with first place). He speaks English.

The competition was announced in the State Gazette, no. 64 of July 30, 2024, based on a decision of the Scientific Council of IR. The formal requirements in connection with the procedure have been fulfilled within the necessary time limits.

2. General description of the presented materials

The candidate participates in the competition with a total of 33 works, which do not repeat those presented for the acquisition of the educational and scientific degree "doctor" and were published in the period 2019-2024. All submitted works are reviewed. Ten of the works are reasonably proposed as equivalent to a monographic work. Sixteen of the remaining papers are referenced and indexed in SCOPUS, with 4 of them published in journals or book chapters and having an impact factor or SJR index, and the remaining 12 published in conference proceedings (three of them with an SJR index). Seven of the papers are publications in peer-reviewed journals or conference proceedings. In 9 of the works, the candidate is in first place in the team, in 18 - in second place

and in 5 - in third place. One of the works is an independent publication of the candidate. A detailed reference for 28 citations of the candidate's works reflected in SCOPUS is attached. In addition to scientific works, Dr. Ralchev participated in 4 recognized patents for inventions, as well as in 4 published patent applications. Information on 4 honors received by the candidate related to his research work is presented. Documents have been submitted for the candidate's participation in 3 projects with a total value of 57 million BGN, two of which are implemented in National Centers of Competence, and one is within the framework of a European initiative. There is no information presented on participation in organizational or program committees of scientific events or on reviewing scientific publications.

3. General characteristics of the applicant's research and scientific applied activity

The candidate has a significant research output in the field of sensor systems and their application in various fields of science and technology during the period 2019-2024. Dr. Ralchev has a number of scientific and applied contributions in the field of identification and correction of harmonic distortions in sensors signals, the creation and research of a three-component silicon magnetic field multisensor, as well as in the development and verification of innovative Hall methods for measuring the mobility of current carriers in semiconductor wafers with application in microelectronics. The obtained results have been published in a number of articles and reports at home and abroad. There is a sufficient number of citations of his works by Bulgarian and foreign authors. This characterizes Dr. Ralchev as a promising scientist with significant research and scientific-applied activity.

4. Basic scientific and scientific-applied contributions

A. Contributions of the candidate in the works proposed as equivalent to a monographic work entitled "Additive sensor systems with application in electrical engineering"

1. **Scientific and applied contributions**

- A method for filtering the harmonic spectrum of current additive sensors has been developed and improved, which significantly improves the accuracy of measurements by identifying and correcting harmonic distortions. This makes it possible to generate more reliable and accurate data used in the analysis, management and monitoring of electrical systems (papers [B4-1, B4-2, B4-3]);
- An additive silicon sensor (multisensor) measuring simultaneously and independently the three orthogonal components of the magnetic field was created and investigated. This expands the possibilities of increasing the accuracy when studying magnetic fields with complex topology in different configurations and devices. (paper [B4-6]).

2. **Applied Contributions**

- A system for remote monitoring of transformer switching processes, based on additive acoustic sensors, was designed, constructed and tested, which allows monitoring the state of transformers in real time, increasing the reliability of power distribution networks (paper [B4-5]).
- A new technology for rapid prototyping of rotary flux modulator systems is proposed and experimented. This technology enables an accelerated process of design, testing and implementation of new control systems for electric motors and generators (paper [B4-4]).
- Innovative Hall methods for measuring the mobility of current carriers in semiconductor wafers for microelectronics purposes have been designed, constructed and verified. The use of these methods improves the possibilities of analysis and control in electrical engineering and the semiconductor industry (papers [B4-8, B4-9, B4-10]).

The indicated serious contributions show that the content of the presented 10 works fully meets the requirements for a habilitation work to obtain the title of "Associate professor".

B. Contributions of the candidate in the scientific works submitted for participation in the competition

The candidate's presented works relate to the development of new methods for monitoring and analysis of various processes characterizing the electromagnetic field, as well as new methods for registering seismic activity. The content of these works shows that Dr. Ralchev strives to expand the possible fields of application. In my opinion, the most significant scientific and scientific-applied contributions of the candidate can be noted:

1. Scientific and applied contributions

- New methods have been developed and verified for monitoring and analysis of electric discharges by using acoustic spectra in inhomogeneous systems such as e.g. the transient heating of lithium-ion batteries during discharge. The acoustic spectrum of electric arcs was analyzed and the use of a convolutional neural network to estimate the power of the electric discharge. A study of the acoustic spectrum of direct current was carried out, developing the possibility of integration of IoT (Internet of Things) technologies for monitoring electric discharges (papers [G7-1], [G7-3], [G7-4], [D7-5], [D7-10]);
- A new class of sensor systems and devices is proposed, based on the experimentally established previously unknown regularity in inhomogeneous systems - rocks and concretes, resulting in the generation of micro- and nano-particles under the influence of high uniaxial deformations. This regularity, the subject of the candidate's doctoral dissertation, is subject to upgrading, thematic development and expansion. Through additional research, it has been proven that the amounts of emitted particles and their distribution are reproducible for a specific type of rock and concrete. Through the new phenomenon, new methods and innovative robotic platforms have been developed for the purposes of anti-seismic engineering. Methodical and engineering solutions are patented as inventions. The proposed innovations allow early detection of the folding of tectonic plates and the dynamics of faults, the displacement of rock massifs, etc., which can be used to predict earthquake processes (papers [G7-9], [G7-11], [G8-2], [G8-4], [G8-6]).

2. Applied contributions

-For the purposes of magnetic field metrology, new inhomogeneous sensor systems and technologies have been developed and researched, which expand the possibilities of measuring magnetic and electrical characteristics in the given conditions. Based on Hall microsensors, original modulator systems containing multipurpose permanent magnets have been constructed (works [D7-2], [D8-2], [D8-4]), [D8-5]), [D83]);
-IoT technologies have been implemented for remote monitoring and control of various electrical parameters. A characteristic example is the study of electric discharges in real time, which significantly increases the efficiency and reliability of metrology in complex and inhomogeneous systems (works [D7-4], [D8-1]) ;
-Methods for control and optimization of processes in 3D printing have been developed and tested. The mechanisms of thread feeding and solidification of materials, which is important for the quality of 3D printing, have been investigated and analyzed. Gas diffusion monitoring chambers were developed and studied (paper [G7-6], [G7-7], [G7-8], [G7-13], [G7-12]).

The contributions reviewed above are the work of the candidate and show that there is a very good combination of scientific research and applied activity, the level of which fully meets the requirements for "Associate professor" in IR - BAS.

5. Significance of contributions for science and practice

The results in the field of monitoring and analysis of various processes represent a serious contribution in several scientific directions and find practical application. The applicant's efforts to implement scientific results into real products to be used in industry are evident. The candidate's works are cited enough abroad and in our country, which is why it can be considered that Dr. Ralchev's contributions have received the necessary recognition from the scientific community in our country and abroad.

6. Critical notes and recommendations

The analysis of the candidate's publications shows a certain diversity of the research carried out, which at the current stage of the candidate's development is useful in order to form a broad view of the engineering disciplines. In the future, however, some concentration of research will be necessary in order to obtain fundamental results. Of course, this does not exclude the possibility of creating a more general theoretical basis, which would allow the treatment of the obtained results in different areas from a unified point of view.

7. Implementation of scientometric tests

I declare the fulfillment of the normative requirements regarding the national and institute scientometric data for the field of "Technical Sciences" for occupying the position of "Associate professor" according to a group of indicators as follows: A = 50 points; B = 165 items; D = 262.8

t.; D = 280 items; E = 30 points. Since the required minimum number of points is 400, and the completed one is 1027.8 points, there is a significant excess of the normative requirements.

8. Personal impressions and opinion of the reviewer

My only personal impressions of the candidate are from my participation in the jury before which he defended his dissertation for receiving the educational and scientific degree "doctor". The impression of the jury was that Dr. Ralchev is a highly organized specialist with original ideas and in-depth knowledge in the engineering field. I believe that in his person the Institute of Work will receive a valuable collaborator who will actively contribute to the development of the relevant field.

Conclusion

The significant scientific-applied and applied contributions of the candidate, their publication in prestigious international and domestic publications, as well as the sufficient number of citations of the works, give me reason to confidently propose the assistant professor. Dr. Martin Lachezarov Ralchev to take the academic position of "Associate professor" in the professional direction 5.2 "Electrical engineering, Electronics and Automation" (Additive and inhomogeneous structures in sensors).

10/20/2024

Prepared the review:

/Prof. DSc Petko Petkov/