POSITION

from

Assoc. Prof. Daniela Dimitrova Parashkevova, Phd.
Institute of Robotics - BAS

for occupying an academic position "Associate Professor" in professional field 5.2. Electrical engineering, electronics and automation, announced in state newspaper no. 64/30.07.2024, p.74 with candidate Eng. Martin Lachezarov Ralchev, Phd.

1. General characteristics of the candidate's research and applied scientific activity

The activity of Eng. Martin Lachezarov Ralchev, Phd., represented by his scientific and applied scientific works, is mainly on the problems of micro-particles in inhomogeneous structures under uniaxial deformations and additive sensor systems with application in electrical engineering. This is confirmed by the attached 23 research papers, 16 publications in editions referenced and indexed in world-renowned databases with scientific information and 7 scientific publications in non-refereed peer-reviewed journals or in edited collective volumes.

The applicant has four published patent or utility model applications: #113474/25/01/2022, #113589/23/09/2022, #113625/06/12/2022 and #113641/10/01/2023, and four recognized applications for a utility model, patent or author's certificate - №67489B1/16.01.2023, №67551B1/17.07.2023, №67560B1/15.08.2023 and №67643B1/31.07.2024. The applicant is involved in 3 research project with European funding.

2. General characteristics of the applicant's activity

2.1. Participation in projects:

1. National Competence Center "Personalized Medicine, 3D and Telemedicine, Robotic and Minimally Invasive Surgery" (Da Vinci), No. BG05M2OP001-1.002-0010.
2. "Bulgarian National Plan for Quantum Communication Infrastructure - DIGITAL-2021-QCI-01" within the framework of the European initiative EuroQCI, No. 101091399.
3. National Competence Center "Quantum Communication, Intelligent Systems for Security and Risk Management" (QUAZAR), No. BG05M2OP001-1.002-0006.

2.2. Participation with publications in the following conferences of international importance:

1. International Scientific Symposium Metrology and Metrology Assurance (MMA), Sozopol, Bulgaria.
2. International Conference on Sensing Technology (ICST), Sydney, NSW, Australia.
3. Conference on Electrical Machines, Drives and Power Systems, ELMA.
4. Electrical Engineering Faculty Conference (BulEF), Varna, Bulgaria.
5. Seventh Junior Conference on Lighting (Lighting), Sozopol, Bulgaria.
6. Electrical Apparatus & Technologies (SIELA), Bourgas, Bulgaria.

3. Basic scientific and applied scientific contributions

I accept the contributions formulated in the presented works, namely:

3.1. Applied scientific contributions, equivalent to a monographic work

- New methods for monitoring and analysis of electrical discharges using acoustic spectra in inhomogeneous systems have been developed and verified. A typical example is the transient heating of lithium-ion batteries during discharge. The acoustic spectrum of electric arcs and the use of CNN to estimate the power of the electric discharge are analyzed. A study of the acoustic spectrum of direct current was carried out, and the possibility of integration of IoT technologies for monitoring electric discharges was developed.

- For the purposes of magnetic field metrology, new inhomogeneous sensor systems and technologies have been developed and researched, which expand the possibilities for measuring magnetic and electrical characteristics in complex conditions.Practically oriented examples are the results for bipolar transistors, obtaining information about inhomogeneous and highly divergent magnetic fields, as well as Hall micro-sensors for determining the in-plane X and Y components of the magnetic vector. Based on them, original modulator systems containing multi-purpose permanent magnets were constructed. The used Hall elements are suitable for weak-field, high-precision and multidimensional magnetometry, as their sensitivity increases sharply at cryogenic temperatures, especially the boiling temperature of liquid nitrogen T=77 K.

- This class of sensor systems and devices is based on the experimentally established previously unknown regularity in non-homogeneous systems - rocks and concretes, resulting in the generation of micro- and nano-particles under the influence of high uniaxial deformations. 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. The monitoring of the amount of generated particles is an integral parameter for early notification and prediction of pre-emergency and emergency processes in the infrastructure. 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. These studies are aimed at predicting earthquake processes.

3.2. Scientific applied contributions in publications equivalent to a habilitation thesis

- An additive method for filtering the harmonic spectrum of current sensors has been developed and improved. It significantly improves measurement accuracy by identifying and correcting harmonic distortions. This generates more reliable and accurate data, which is important for the analysis, management and monitoring of electrical systems.

- A new technology for rapid prototyping of rotary flux modulator systems was proposed and experimented. This enables an accelerated process of design, testing and implementation of new control systems for electric motors and generators, significantly shortening the time to achieve innovative solutions in electrical engineering.

- A system for remote monitoring of transformer switching processes based on additive acoustic sensors was designed, constructed and tested. This technology allows to monitor the condition of transformers in real time, increasing the reliability of power distribution networks and reducing the risk of malfunctions and accidents.

- An additive silicon sensor (multisensor) measuring simultaneously and independently the three components of the magnetic field (X, Y and Z) was created and investigated. This sensor expands the possibilities of increasing the accuracy in the investigation of magnetic fields with complex topology in different

configurations and devices, which is especially important for the optimization of many electromagnetic applications.

The publications have a scientific research and scientific applied nature in the field of:
- innovations - such as a paired Hall sensor;
- magnetotransistor sensor transducers;
- magnetic navigation systems in robotic surgery;
- improvement of measurement technologies based on additive sensing phenomena.

4. Critical notes and recommendations

As a recommendation for the future work of Eng. Martin Ralchev, Phd., it is to publish a textbook on additive sensor systems with application in electrical engineering.

5. Conclusion

The works of Eng. Martin Ralchev, Phd. are sufficient in number and have a high scientific research and applied scientific significance. The scientific work of the candidate, as well as his overall activity, meet the requirements. This gives me reason to propose that Dr. Martin Ralchev, Eng., be elected to the academic position of "Associate Professor" in professional direction 5.2. Electrical engineering, electronics and automation at the Institute of Robotics - BAS.

22.10.2024
Sofia

Jury member:

/Assoc. Prof. Daniela Parashkevova, Phd/