REVIEW

concerning a competition for the academic position of Professor in the field of higher education 5. Technical sciences, professional field 5.2. Electrical engineering, electronics and automatics, subject area "Magnetic field sensors" for the needs of the section "Sensors and Measurement Technologies in Robotics and Mechatronics" of the Institute of Robotics-BAS

Reviewer: Prof. DSc. Velislava Noreva Lyubenova, Institute of Robotics-BAS

1. General and biographical data

By Order No. 70/31.05.2023 of the Deputy Director of Institute of Robotics BAS- Assoc. Prof. Dr. Alexander Krastev, I am included in the Scientific Jury of the above mentioned competition, announced in the State Gazette № 26/21.03.2023 with the only candidate **Assoc. Prof. Dr. August Yordanov Ivanov** from the Section "Sensors and Measurement Technologies in Robotics and Mechatronics" at the Institute of Robotics.

From the presented CV one can trace the professional development of the candidate - Assoc. Prof. Dr. August Ivanov. He was born on 9 August 1958 in Sofia. He received higher education at the Technical University - Sofia in 1983 with the qualification of Master Engineer in Hydraulics and Pneumatics. From 1983 to 1984 he obtained a postgraduate qualification in Mechanical Systems in Robotics. In the period 1985-1992 he worked as a design engineer at the Institute of Technical Cybernetics and Robotics at the Bulgarian Academy of Sciences in the field of Robots and Manipulators - hydraulic actuation of industrial robots. In the same position he worked at the Institute of Informatics at BAS for the period 1992 - 1994, his main duties were related to pneumatic and hydraulic actuation and control of robots and manipulators, as well as administration of local computer networks. From 1994 to 2000, he was an Assistant at the Institute of Control and Systems Research at BAS, from 2000 to 2016 he was a Chief Assistant at the Institute of Systems Engineering and Robotics at BAS, and from 2017 to present he is an Associate Professor at the Institute of Robotics at BAS. Assoc. Prof. Ivanov holds a Ph.D. in Elements and Devices of Automation and Computing, and his dissertation topic is "New varieties of magnetic field microsensors using Hall effect".

His research and inventive activities have taken place entirely at the Bulgarian Academy of Sciences and are in the fields of sensors, micro- and nano-electronics, power engineering, control and measurement technology, actuators and peripherals, robotics and mechatronics, atomic force microscopy. Assoc. Prof. Dr. Ivanov is the Deputy Head of the Centre of Competence "Quantum Communication, Intelligent Security Systems and Risk Management", Head of the Package in the Centre of Competence "Personalized Medicine, 3D and Telemedicine, Robotic and Minimally Invasive Surgery", carries out administrative management of the Centre of Competence "Intelligent Mechatronic, Eco- and Energy-Saving Systems and Technologies". He is Director of the Institute of Robotics at the Bulgarian Academy of Sciences since 2018, and the head of the thematic group "Integrated and Robotic Mechatronic Systems" at the Department "Sensors and measurement technologies in robotics and mechatronics" at IR-BAS, Sofia.

The copies of the competition documents provided to me contain:
1.1. Application for participation in the competition for Professor at IR-BAS-SITRM.
1.2. Declaration Annex 1 for participation in the competition.
1.3. Declaration Annex 2 for participation in the competition.
2.1. List of publications.
2.2. List of inventions.
3.1 Author's reference of scientific and applied contributions.

3.2. Publications equivalent to a monographic work, according to Art. 29, para. 1, item 3 of the Law on the development of the academic staff of the Republic of Bulgaria (LDASRB) and Art. 60, para. 1, item 3 of Regulations for the application of the Law on the Development of the Academic Staff of the Republic of Bulgaria (RALDASRB) on the topic: New generation of multi-functional sensor elements.
4. List of projects.
5. List of citations.
6. Diplomas for higher education, for the scientific-educational degree "Doctor" and for holding the academic position of Associate Professor.
7. Detailed CV based on European template.
8. A copy of the competition notice in the State Gazette.
9. Awards and participation in national and international forums.
10. Minimum required points by groups of indicators from National Center for Information and Documentation (NACID) and LDASRB Article 2b, paragraphs 2 and 3.
11.An electronic version of all the competition documents.

These documents are presented in two folders, one containing the documents and materials listed in the Application of Assos. Prof. Ivanov in I (1-11), copies of the publications and inventions for the competition, and the other containing copies of the publications and inventions for points 3.1. and 3.2.

I have no objections to the required documents for participation in the competition and their content, according to the normative basis of the LDASRB, the RALDASRB and the Internal Regulations of the IR-BAS, on the conditions and procedure for holding the academic position "Professor". All the materials are properly formatted and arranged. The procedural requirements for announcing and participating the candidate in the competition have been met.

According to the LDASRB, candidates for the academic position of professor must meet the requirements of Article 29(1):
1. To have acquired the educational and scientific degree "doctor".
2. To have held the academic position of "associate professor" in the same or in another higher school or scientific organization for no less than two academic years or...
3. To have submitted a published monographic work or equivalent publications in specialized scientific publications, which do not repeat those submitted for the acquisition of the educational-scientific degree "Doctor" and for occupying the academic position of "Associate Professor".
4. To have presented other original scientific research works, publications, inventions and other scientific and scientific-applied developments or artistic achievements, which are evaluated as a whole;
5. To meet the minimum national requirements under Art. 2b, para. 2 and 3, respectively, to the requirements under Art. 2b, para. 5;
6. Not to have plagiarism or unreliability of the presented scientific data in the scientific works proven in accordance with the law.

The requirements under Article 29(1), item 1 are fully fulfilled, since with diploma No 000872/06.04.2017 BAS confirmed the educational-scientific degree "Doctor" awarded to August Ivanov for successfully defended dissertation in the scientific specialty Elements and Devices of Automatics and Computing.

The candidate meets the requirement of Article 29(1), item 2, as by the decision of the Scientific Council of IR-BAS of 10.10.2017 he holds the academic position of "Associate Professor" and according to the submitted documents has held this position at IR-BAS for more than 5 years.

Assoc. Prof. Dr. August Ivanov fulfils the requirement of Article 29(1), item 3, as he has submitted 10 publications equivalent to a monographic work, which do not duplicate the publications for the academic position "Associate Professor" and for the educational-scientific degree "Doctor".

Assoc. Prof. Dr. Ivanov meets the requirement of Article 29(1)(4) as he has submitted other original research papers and publications, 34 in total.

The applicant has submitted a Reference of Fulfilment of National Minimum Requirements, supplemented by a list of his scientific output. He meets and exceeds the requirements of this Reference. Regarding the requirement of Art. 29(1), item 6, I am not aware of received reports under Art. 4 para. 11 of LDASRB and no plagiarism was found in the candidate's works. There is a declaration signed by Associate Professor Ivanov that the results and contributions in his scientific production are original and not borrowed.

Group	**Contents**	min. points for professor	**Evidential materials**	**Points for Assoc. Prof. A. Ivanov**
A	Indicator 1	**50**	*"New varieties of magnetic field microsensors using Hall effect"*	**50**
B	Indicator 4	**100**	3.2. Equivalent to a monograph thematically united and systematized scientific works	**154**
Г	Indicators 7 and 8	**200**	3.1. Reference for scientific and applied contributions	**221.62 in total**
Г	Indicator 7			*209.95*
Г	Indicator 8			*11.67*
Д	Indicators 12, 13, 14	**100**	5. List of citations of the candidate's works	**373 in total**
E	Indicators 18, 20, 22, 25, 26	**150**		**1360 in total**
E	Indicator 18. Participation in a national scientific or educational project		*4. List of research projects, contracts, topics* Ten projects x 10 p.	*100*
E	Indicator 20 Leadership of a national scientific or educational project		*4. List of research projects, contracts, topics* One project x 20 p.	*20*
E	Indicator 22 Funds raised for projects managed by the applicant		Project № 3 = 1 100 000 lv./5000=220	*220*
E	Indicator 25 Published patent or utility model application		03_ list of patents and copyright certificates	*140*
E	Indicator 26 A recognized application for a utility model, patent or copyright		03_ list of patents and copyright certificates	*880*

2. General description of the submitted materials

Associate Professor Dr August Ivanov has submitted 30 publications, 22 invention patents and 7 patent applications for his participation in the competition. They are distributed by the grouped indicators from the table above as follows:

- ✓ Thematically united and systematized scientific publications, equivalent to a monographic work with a reference to the contributions, according to Art. 29, para. 1, item 3 of the LDASRB and the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at the BAS. **The contributions are six** in number and cover 16 publications, patents and authorship certificates, 10 of which publications [B4 - 1÷10] are in journals with an impact factor or impact rank.
- ✓ **Original research works, 34 in number**, including publications and patents. Of these, group **Г7** includes **16 publications** with impact factor, impact rank or referenced and indexed in **WoS or Scopus. 7 contributions** related to these publications are presented.

All the works of the candidate's production are entirely in the theme of the competition. Of the 30 publications presented, **13** are with impact factor, **7** with SJR and **6** - refereed and indexed in the world evaluation system (WoS or Scopus). Two of the publications that are in press are not included in the minimum requirements. Patents for inventions are not included also in these minimum requirements, although they have the status of articles referenced in world-renowned databases.

The scientific works of Assoc. Prof. Ivanov have been published in international and national journals and series with impact factor and SJR in "Sensors and Actuators" Elsevier; "Procedia Engineering", Elsevier; "Electronics Letters"; "Comptes Rendus de l'Academie Bulgare des Sciences"; "Solid-state Sensors and Actuators", "Proceedings at the Eurosensors", as well as in full-text reports at international and national forums, etc.

English was used as the main language of publication, only one publication was in Bulgarian.
Assoc. Prof. Dr. Ivanov has submitted a list certifying leadership or participation in more than **40 projects and contracts**.

3. Reflection of the candidate's scientific publications in the scientific community (known citations)

A reference to the scientific databases Scopus and Web of Science for the citation rate of the candidate's publications gives over 120 citations of a limited number of his works. In the reference on compliance with the minimum national requirements, Assoc. Prof. Dr. August Ivanov has provided data on 50 citations of his works. Citations indicate that the applicant's scientific results have gained wide popularity.

4. Overview of the content and results in the presented scientific production

The scientific output of Assoc. Prof. Dr. August Ivanov is directed in the above-mentioned areas, and especially in nano- and micro-sensorics and technologies, robotics and mechatronics, intelligent sensor-information systems and architectures.

The actuality and importance of these areas is undeniable. As will be highlighted in the contribution section, innovative developments in nano- and micro-sensorics are at the heart of today's cutting-edge communication technologies, artificial intelligence, robotics, and many other fields.

The results in thematically united and systematized scientific publications, equivalent to a monographic work, are presented under the title ***"New generation of sensor elements with multifunctional purpose"***. The presented researches is aimed at expanding existing knowledge in the field of sensorics and, above all, magnetometry and galvanomagnetism through new facts, mechanisms of operation and methods for their characterization and applicability. The created and researched sensor elements of a new generation - high-precision silicon 2-D and 3-D

magnetometers and a family of functional multisensors, registering simultaneously and independently with the same conversion zone the components of the magnetic field vector, are based on new principles and have no analogue in control and measurement technology. Their practical implementation is in innovative robotic platforms, sensor devices and new generation technologies.

The publications in group Г reflect results on the development of new three-component (3-D) vector magnetometers, a family of multidimensional silicon vector magnetometers containing a minimum number of contacts, a theoretical model interpreting experimental results of discovered regularities, new aspects of the Hall effect and phenomena in sensor electronics, etc.

Although the candidate's works are almost entirely co-authored, I believe that his contribution to the presented works is undoubted due to his overall scientific and applied activity in the field over the years.

5. General description of the applicant's activities

5.1 Scientific and applied activities

The applicant has submitted a list of a total of **42** research projects and technology transfer contracts in which he has participated or led. Of these, **2** are under the Operational Programme "Science and Education for Smart Growth" - Establishment and Development of a Center of Competence "Quantum Communication, Intelligent Systems for Security and Risk Management" (Quasar) and Establishment and Development of a Center of Competence on "Personal Medicine, PD and Telemedicine, Robotic and Minimally Invasive Surgery", **6** - funded by the European Commission, **5** - Structural Funds of the European Commission - Operational Programme "Innovation and Competitiveness", **4** - funded by Bulgarian sources, **5** - national projects, **2** - for the implementation and commercialization of scientific products, etc.

I believe that leadership and participation in projects is a significant contribution to the scientific research activity presented by the candidate.

The number of presented patents - **22** and patent applications - **7** is impressive. They are the result of many years of fruitful cooperation and work of the staff of Department "Sensors and measurement technologies in robotics and mechatronics" at IR-BAS on the patenting of results, in the field of sensorics, thanks to which IR-BAS has a leading role in this activity at the national level.

Assoc. Prof. Dr. Ivanov is the project leader of the National Plan for Recovery and Resilience, funded by the European Commission: Construction of a route for quantum communication by the Institute of Robotics at the Bulgarian Academy of Sciences for participation in the unified quantum communication system of the EU.

IR-BAS is the coordinator with the representative Associate Professor August Ivanov for the National Plan for the construction of QCI (quantum communication infrastructure) for Bulgaria. EuroQCI, (2022 – 2027) Digital Europe Program, which envisages that the Member States of the European Union will jointly build by 2027 ground and space communication infrastructure of a new (next) generation, which will aim to guarantee sovereignty and communication security of Europe.

Assoc. Prof. Dr. Ivanov is the leader of 8 researchers in the thematically related group "Integrated and Robotic Mechatronic Systems" at the Department "Sensors and Measurement Technologies in Robotics and Mechatronics" of the Institute of Robotics of IR-BAS. Of these, 1 professor, 1 chief assistant and 5 assistants.

He is the academic supervisor of one full-time doctoral student and one part-time doctoral student in the field of higher education: 5. Technical sciences, Professional direction: 5.2. Electrical Engineering, Electronics and Automation, Scientific specialty: Application of the principles and methods of cybernetics in technical sciences.

5.2 Expert activity

Assoc. Prof. Dr. Ivanov is a member of the Commission for Cooperation with CERN at the Ministry of Education and Science, the General Assembly of BAS, the Commission for Academic Property, the Council for Social Cooperation of BAS and others. He has administrative and managerial experience as the Director of the IR-BAS, as the organizer and head of the Laboratories of "Contactless Automation" and "Atomic Force Microscopy" at the IR-BAS, as the Vice-Chairman of the Innovation Council of the IR-BAS and others. He is Secretary of the Bulgarian Section of the International Network on Multifunctional Microsystems NEXUS Network of Excellence, Member of the Federation of Scientific and Technical Unions, Union of Scientists in Bulgaria, Member of the Bulgarian Society of Robotics, Union of Mathematicians in Bulgaria, Membership and leadership of the Organizing and Program Committees of international and national conferences, symposia, round tables, seminars, etc., such as EUROSENSORS, TRANSDUCERS, SENSORS, etc.

5.3 Awards

Assoc. Prof. Ivanov has received numerous awards such as the Diploma of the World Exhibition of Innovation, Research and New Technologies in Brussels - 2000, the Silver Medal for the patent for the invention "High Temperature Hall Sensor with Parallel Axis of Sensitivity" – 2001 and Gold Medal for the invention patent "Hall Sensor with Parallel Sensitivity Axis and Magnetodiode" from the International Exhibition-Salon for Inventions, Innovations and Trademarks "East - West Eurointelect" - 2004, Diploma "Genius Europe" from the European Exhibition for Inventions and Trademarks, 2004, Diploma for his participation in the creation of significant inventions in the field of sensors, microsystems and nanotechnology, highly appreciated with the prestigious 2004 EURICA Invention Award of the EURICA Foundation, as well as numerous diplomas for his contribution to the development of IR-BAS in the period 2015-2018.

6. Contributions

The candidate has submitted 13 contributions, of which 6 contributions are based on the works grouped as monographs (Group B) and 7 contributions are based on the works grouped in Group Г. I accept the scientific, scientific-applied and applied contributions, considering that in this form they are in line with the results obtained. The main contributions in the candidate's works can be broadly characterised as enrichment of the existing knowledge in the field of sensorics and, above all, magnetometry and galvanomagnetism by new facts, mechanisms of operation, methods of their characterisation and applicability. For each contribution, a brief annotation, significance for the development of sensorics and multidimensional magnetometry, practical importance, technology transfer, knowledge are presented.

In my opinion, all the contributions submitted for the competition could be systematized as follows:

1. New regularities were experimentally investigated and interpreted in:
   - ✓ sensorics, consisting of the occurrence of a linear potential from the magnetic field on one side of the Hall elements, and a non-linear one on the opposite surface.
   - ✓ the magnetoelectric properties of the surface of conducting materials, including semiconductors, consisting in controlling by the strength and direction of the magnetic field the scattering of current carriers by varying their concentration in the near-surface layers.
2. Experimentally are identified and/or investigated:
   - ✓ the occurrence in conducting structures, including semiconductors, over a wide temperature range of a magnetically controlled surface current when a supply current is passed through the structures and a magnetic field is applied perpendicular to it.

- ✓ consisting of two summing additive components Hall voltage atmagnetically controllable surface current in Hall sensors with in-plane and orthogonal magnetosensitivity
- ✓ a new sensing mechanism in Hall microsystems that allows, by injecting non-core carriers with as little as 0.1% of the supply current, to increase the magnetosensitivity by more than 50%.
- ✓ substantially new aspects of the Hall effect, usefully increasing knowledge of this phenomenon.

3. The phenomenon "Emission of particles under uniaxial pressure of solid-state structures" was discovered and interpreted in the field of sensorics. A new regularity was experimentally established in the inhomogeneous systems - rocks and concretes, resulting in the generation of microparticles under the influence of high uniaxial deformations. The continuous particle monitoring serves for early notification and prediction of pre-accident and emergency events in critical infrastructure.
4. A model is derived that theoretically interprets the experimental results of the discovered regularities - magnetically controlled surface current in conducting materials and anomalies in the behavior of the potentials of semiconductor structures in a magnetic field.
5. A method for measuring more than one non-electric parameter - magnetic field and temperature - with the same zone in silicon structures has been developed and validated.
6. An innovative solution to the problem in the accumulator module of a real-time animal control and monitoring system based on the principle of electromagnetic induction is proposed.
7. Families have been developed:
   - ✓ multidimensional silicon vector magnetometers containing a minimum number of contacts, recording simultaneously and independently the 2D and 3D components of the magnetic field.
   - ✓ multidimensional silicon microsystems for magnetic field measurement without analogue in control and measurement technology.

The practical relevance of the contributions is the basis for their technological transfer to industry and is reflected in the application of the developed innovative solutions such as multifunctional sensor modules with improved performance and characteristics in robotics and robotic medicine, quantum communication, navigation, counter-terrorism, military case, electric and hybrid vehicles, security systems with artificial intelligence, including underwater, land and air surveillance and prevention, etc.
The obtained results related to the discovered and interpreted phenomenon "Particle emission under uniaxial pressure of solid structures" are essential for solving many problems in the mining industry - ore-, oil- and coal-mining, seismically active regions, construction, etc.

7. Critical comments and recommendations

I have no critical remarks to make about the candidate. My recommendation is to publish his results in a monograph.

8. Personal impressions and opinion of the reviewer

I have known Assoc. Prof. Dr. August Ivanov since the establishment of the Institute of Control and Systems Research in 1994, the predecessor of the current Institute of Robotics. My personal impressions are entirely positive. His competence, efficiency, modesty and collegiality over the years are unquestionable. As the director of IR-BAS, he is also a respected leader who builds on the successfully achieved successes and reputation of the institute. After my detailed acquaintance with the candidate's scientific production, I believe that his participation in the current competition for a professorship is proof of the positive development of his potential as a researcher.

Assoc. Prof. Ivanov's scientific contributions are substantiated and correspond to the actual results achieved. The candidate has serious scientific publications and patents on the issues of the competition, approved in authoritative national and international editions and international scientific forums. The presented production, results and achievements confirm Assoc. Prof. Dr. August Ivanov as a highly erudite and respected scientist.

CONCLUSION

Bearing in mind the above, I consider that Assoc. Prof. Dr. August Yordanov Ivanov fully meets the conditions, criteria and requirements for the selection of the academic position of "Professor" according to the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for the application of the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations on the terms and conditions for acquiring scientific degrees and holding academic positions at the Bulgarian Academy of Science and the internal rules for the development of the academic staff of the Institute of Robotics at the BAS. On this basis, I give my positive vote and propose to the members of the scientific jury to vote positively for the selection of the candidate, and to recommend to the members of the Scientific Council of the Institute of Robotics-BAS **Assoc. Prof. Dr. August Yordanov Ivanov** to take the academic position of **"Professor"** in Department "Sensors and Measurement Technologies in Robotics and Mechatronics"in the field of higher education 5. Electrical Engineering, Electronics and Automation in the subject area "Magnetic Field Sensors".

04.07.2023
Sofia

Reviewer: Prof. DSc. Velislava N. Lyubenova