

REVIEW

concerning a competition for the academic position of Associate Professor in the field of higher education 5. Technical sciences, professional field 5.2. Electrical Engineering, Electronics and Automatics, subject area "Automated Information Processing and Control Systems" (Integration of data from sensor networks) for the needs of the "Unmanned Robotic Systems" laboratory of the Institute of Robotics-BAS

with the only candidate **Chief Assistant Dr Aleksandar Kirilov Alexandrov**

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

(The present review was prepared on the basis of Order № 153/13.12.2023 of the Director of IR-BAN on determining the composition of the scientific jury.)

1. General and biographical data

In the announced in the State Gazette № 85/10.10.2023 competition for Associate Professor in the field of higher education 5.2. Electrical Engineering, Electronics and Automation, scientific specialty "Automated Systems for Information Processing and Control" (Integration of data from sensor networks), the only candidate is Ch. Assistant Dr. Alexander Kirilov Alexandrov from the "Unmanned Robotic Systems" Laboratory at the Institute of Robotics - BAS, for whose needs the competition has been announced.

Dr. Alexandrov completed his higher education at the Technical University, Varna with a Master's degree in Electrical Engineering in 1986. He also holds a Master's degree in Business Administration from University of National and World Economy, Sofia in 2006. In the period 2018–2023, he worked as a Chief Assistant in Informatics and Computer Science at the Institute of Information and Communication Technologies (IICT) – BAS. From 2023 to the present, he is the Ch. Assistant at the Institute of Robotics – BAS.

In 2017, he received the educational and scientific degree "Doctor" in Informatics and Computer Sciences at IICT-BAS. The main area and sub-areas of his scientific research are: mechatronics, wireless sensor networks, neural networks, generalized networks and mathematical modeling.

2. General description of the submitted materials

As a member of the jury I received:

1. Copy of higher education diploma. 2. Copy of diploma for educational and scientific degree "Doctor". 3. Copy of a certificate for a scientific title "Ch. Assistant". 4. Model declaration (Appendix 1). 5. Model declaration (Appendix 2). 6. Professional curriculum vitae according to the European model. 7. List of scientific works for participation in the competition, which do not repeat those submitted for the acquisition of the educational and scientific degree "Doctor". 8. Certified copies of scientific contribution protocols between the authors of each scientific publication. 9. List of

citations of scientific publications for participation in the competition. 10. Summaries of the publications for participation in the competition in Bulgarian and in English. 11. Reference for the original scientific and scientific-applied contributions - in Bulgarian and English. 12. Certificate of fulfillment of the minimum national requirements at the Institute of Robotics at the BAS for the academic position "Associate Professor". 13. Copies of scientific publications for participation in the competition. 14. Document for the fee paid by bank transfer to the Institute of Robotics - BAS, for the procedure for reviewing the documents and accompanying administrative services and activities. 15. Copy of the announcement from the State Gazette. 16. Copies of documents on electronic media with information, as required by IR-BAS.

I have no objections to the required documents for participation in the competition and their content, according to the normative basis of the the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), the the Regulations for its Implementation, and the Internal Regulations of the IR-BAS, on the conditions and procedure for holding the academic position "Assoc. 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 requirements of LDASRB and the Regulations for its Implementation, candidates for the academic position of "Associate Professor" must meet the following requirements, regulated in Art. 24(1):

1. To have acquired the educational and scientific degree "Doctor";
2. For not less than two years they have held the academic position of "Assistant", "Ch. Assistant";
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 and scientific degree "Doctor" and for the acquisition of the scientific degree "Doctor of Science";
4. To meet the minimum national requirements under Art. 2b, para. 2 and para. 3, according to the requirements under Art. 2b, paragraph 5.
5. Not to have proven plagiarism in scientific works in accordance with the law.

According to the submitted documents for participation in the competition, Ch. Assistant Dr. Eng. Alexandrov meets the requirements of Art. 24(1) item 1 (Diploma № 000897/06.06.2017) and meets the requirements of Art. 24(1) item 2 (Certificate № 001226/16.03.2018)

According to the submitted author's reference, the candidate participated in the competition with one monograph, 6 scientific publications in publications that are referenced and indexed in world-renowned databases with scientific information and 1 scientific publication in a non-refereed journal with scientific review.

Of the 6 publications in refereed editions in world-renowned databases, 1 is with Q3 quartile and 5 – with Q4. They are all with SJR and IF. The candidate presented 7 citations of 3 publications, 6 of which are in scientific publications, referenced and indexed in world-famous databases with scientific information, and 1 is a collective volume with scientific review.

The monograph submitted for the competition - "Wireless sensor systems. Architecture and Communication Protocols" was published in Academic Publishing House "About Letters", University of Library Science and Information Technology in 2023.

The presented publications did not participate in the procedures for acquiring the educational and scientific degree "Doctor", which satisfies the requirements of Art. 24 (1), item 3. All publications are in the area of competition. The contributions in the works with which Dr. Alexandrov participated in the competition were compiled correctly and the results have a scientific and scientific-applied nature.

According to the presented reference Dr. Alexandrov fulfills the requirement under Art. 24 (1) item 4 and he meets the minimum national requirements under Art. 2b, paragraph 2 and paragraph 3, according to the requirements under Art. 2b, paragraph 5, as well as the Specific requirements of the Institute of Robotics - BAS for occupying academic positions.

The submitted publications of the candidate for the competition are original and there is no known evidence of plagiarism, which is a requirement of Art. 24(1), item 5.

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

The candidate's research work is mainly in the field of wireless sensor networks and systems, but also related to mechatronics, neural networks (ANN), generalized networks, mathematical modeling and others.

Dr. Alexandrov's most significant results and contributions are in the current scientific field of Wireless Sensor Networks. The monograph presented for the competition has a volume of 190 standard pages, contains 6 chapters and 222 bibliographic sources. Problems from the theory and practice of wireless sensor networks and in particular their architecture and related communication protocols are discussed. The monograph was reviewed by two experts in the field. It gives a clear idea of the current state of research and achievements in the field of sensor networks and systems, outlines the current problems in this field and highlights the possibilities and prospects for using intelligent methods and artificial intelligence for the purpose of building and developing intelligent sensor systems.

Contribution protocols are presented for the seven publications for the competition, and in 6 of the publications Dr. Alexandrov's contribution is 88%, and in one - 82%. From this information it is clear that the contributions in these publications are almost entirely of the applicant. They are aimed at improving the functionalities of wireless sensor networks and systems by offering new methods and algorithms for optimization, control, etc.

Specifically, publications are about introducing new:

- ✓ parallel data processing model;
- ✓ model and approach for multicriteria optimization;
- ✓ wireless sensor node adaptive control method;
- ✓ a method based on the set of tools and techniques used to manage and improve network performance (Quality of Service) for energy optimization of the existing ZigBee communication protocol;

- ✓ an approach to improve the accuracy of the indoor positioning method for mobile devices;
- ✓ an approach based on a weighted clustering algorithm (Weighted Clustering Algorithm).
- ✓ Q-Learning based machine learning method and algorithm, for the optimization of the power control process of a node's transmission.

The candidate has defended a doctoral thesis on the topic: "Data integration of intelligent sensor systems", has many years of experience and significant results in the field of sensors and sensor networks. The publications he submitted for the competition not only analyze and summarize the results of his previous research activity, but undoubtedly continue, build on and develop these results.

4. Relevance of the topic

The topic on which Dr. Alexandrov works is undeniably current, considering the importance of information and communication technologies in the modern and future development of society, the wide range of applications of sensors and sensor networks in almost all aspects of social and economic life. In particular, wireless sensor networks have been the subject of intense research interest in recent decades due to their advantages of flexibility, robustness, and scalability, and their widespread use in commercial and industrial applications. This becomes possible on the basis of the rapid technological development of microprocessor technologies, incl. the development of specialized chips with low power consumption. In addition to their basic functionality for measuring physical, chemical and biological parameters, modern sensor modules also have intelligent functions based on embedded microprocessor controllers and software algorithms, which is in line with the increasingly large-scale penetration of smart devices and artificial intelligence in modern development of society.

5. Main scientific-applied and applied contributions

The presented monographic work thoroughly and systematically analyzes the main components, stages and problems related to the development of wireless sensor networks and systems, as well as the prospects for development in this area, which is a serious scientific and applied contribution of the candidate. Another important contribution of Dr. Alexandrov is the detailed description and analysis of the properties and application of a wide variety of wireless sensor devices, the in-depth study of methods and approaches for building their architecture and topologies, the precise analysis of modern communication standards and the protocols based on them from the point of view of wireless communication.

Dr. Alexandrov's contributions to publications can be presented as the development of:

1. A new model of parallel data processing of sensor nodes of large-scale wireless sensor networks (LWSN) with cluster topology based on generalized networks. The proposed new model covers all the aspects of the inter-node sensor data integration and the cluster-based parallel processes specific for large scale amounts of sensor data operations. (publication №1).
2. A new mathematical model and multicriteria optimization approaches by taking into account different performance and shelf life objectives. The

proposed model is aimed at developing an energy-efficient communication between sensor nodes and the cluster heads (CH) in the wireless sensor networks. (publication №2).

3. A new adaptive wireless sensor node control method using machine learning modeled based on multilayer perceptron (MLP). The new approach presented in the study uses the SARSA (State-Action-Reward-State-Action) algorithm, which is a form of reinforcement machine learning. The aim of the new method is to improve the sensor nodes Transmission Power Management (TPM) process. (publication №3).
4. A new method based on the set of tools and techniques used to manage and improve network performance (Quality of Service) for energy optimization of the existing ZigBee communication protocol. The algorithm proposed on this basis uses a combination of the Link Quality Indicator (LQI) embedded in ZigBee wireless modules and the Received Signal Strength Indicator (RSSI) as critical parameters. The results of laboratory experiments analyzing the transmission process from a wireless sensor module confirm the effectiveness of the proposed method and algorithm. (publication №4).
5. A new hybrid method for improving the accuracy of the indoor positioning approach for Bluetooth Low Energy (BLE) mobile devices, including an optimized combination of technologies based on the Angle of Arrival method and the received signal strength measurement. This method is implemented through a two-step data fusion process using an extended Kalman filter and the Fraser-Potter equation. Experimental results in laboratory conditions prove that the proposed method can achieve significantly better accuracy in a real environment compared to existing indoor localization methods and techniques. (publication №5).
6. A new approach based on an algorithm of weighted clustering by developing a modified method for ad-hoc clustering in wireless sensor networks (publication №6).
7. New method and algorithm for machine learning based on Q-Learning, which is a form of reinforcement machine learning for optimizing the transmission power management process of a node. (publication №7).

By applying these new methods and approaches, Dr. Alexandrov achieves results that reveal new knowledge and complement some aspects of existing knowledge in the field.

6. Significance of contributions for science and practice

The significance of the scientific and applied contributions in the scientific works of Dr. Alexandrov is expressed in the enrichment of the theory, research process and practice in the field of communication networks and systems.

More specifically, some of the proposed solutions maximize the use of resources and extend the life of wireless sensor modules, significantly reduce the risk of failure of cluster coordinators in wireless sensor networks, help the energy optimization of the implemented routing protocols, and others.

An important merit of the candidate is the fact that the results of theoretical studies are reduced to algorithms and software programs that can be used in educational and engineering applications, such as environmental monitoring, etc.

Last but not least, the monographic work of Dr. Alexandrov is addressed to a wide audience of readers in the field of technology and technical sciences. Although the nature of the scientific matter is specific, the style of the presentation is understandable on the one hand, and on the other hand, meaningful and thorough. This makes this work useful for students studying the discipline of communications and communication systems, for teachers when preparing lecture courses, as well as for professionals working on the construction and implementation of wireless sensor networks and systems.

7. Critical notes and recommendations

I have no critical remarks about the candidate. I would recommend that instead of some terms borrowed from the English "implementiram" the Bulgarian "прилагам" should be used. In addition, wherever there is an opportunity to use Bulgarian terms, the popular term in English should be written in parentheses.

8. Conclusion

Bearing in mind the above, I consider that Dr. Alexandrov fully meets the conditions, criteria and requirements for the selection of the academic position of "Associate 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 Chief Assistant Dr Alexandar Kirilov Alexandrov to take the academic position of "Associate Professor" in Professional field 5.2. Electrical engineering, electronics and automatics, subject area "Automated information processing and control systems" (Integration of data from sensor networks) for the needs of the "Unmanned Robotic Systems" laboratory of the Institute of Robotics-BAS.

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Sofia

/Prof. DSc Velislava Lyubenova/