POSITION

In the competition for the academic position of "associate professor" in professional field 5.2. Electrical engineering, electronics, and automation, scientific specialty "Automated information processing and control systems (data integration from sensor networks)" for the needs of the laboratory "Unmanned robotic systems", announced in the Official Gazette No. 85 of October 10, 2023, with candidate Alexander Kirilov Alexandrov, PhD, chief assistant.

Member of the scientific jury Avgust Yordanov Ivanov, PhD, professor (according to order No. 153/13.12.2023 of the director of the Robotics Institute at the Bulgarian Academy of Sciences, Prof. Avgust Ivanov).

1. Brief biographical data of the candidate and areas of scientific interests

From the attached documents and materials for the competition, it can be seen that the candidate completed his higher education - master's degree: in 1986 at the Technical University of Varna with a specialty in electrical power engineering; He defended his doctoral degree in 2017 at IICT - BAS. From 2018 to 2023, he was a senior assistant in "Informatics and Computer Science" at IICT-BAS, and from 2023 until now he has been a senior assistant in "Informatics and Computer Science" at IR-BAS.

Areas of scientific interest: Mechatronics; Wireless sensor networks; Artificial intelligence; Integration and processing of sensor data; Simulation modeling; Generalized networks; Modeling of climatic processes.

2. General characteristics of the candidate's scientific research and scientific-applied activities

Alexander Alexandrov, PhD, participates in the competition for the academic position of "associate professor" with nine scientific works, including: Indicator 1 - dissertation on the topic "Integration of data from intelligent sensor systems" 2017, Sofia, IICT-BAS, 165 pages; Indicator 3 - habilitation work - a monograph entitled "Wireless Sensor Systems. Architecture and Communication Protocols" ISBN 978-619-185-636-7, academic publisher "Za Bukvite", Sofia, 2023, 260 pages; 6 scientific publications (Indicator G7) (each accompanied by a Contribution Protocol between the co-authors) in publications, referenced and indexed in globally renowned databases with scientific information (Scopus, Web of Sciences). These publications have SJR and JCR-IF, one is in a Q3 journal, and the remaining five are Q4; one scientific publication (Indicator G8) in an unreferenced journal with scientific peer review or edited collective volumes (accompanied by a Contribution Protocol between the co-authors). In

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all publications, the candidate is the first author, and the monograph is his independent work. Abstracts of publications are presented in Bulgarian and English.

The candidate in the competition covers and, in certain indicators, exceeds the minimum national requirements. He defended a dissertation (Indicator A - 50 points). He presented a habilitation work - a monograph (Indicator B 3 - 100 points). Sum of indicators G (5-9) - 223.8 points, with Indicator G7 - 208.8 points and Indicator G8 - 15 points. Sum of indicators D (12-14) - 63 points, with Indicator D 12 - 60 points and Indicator D13 - 3 points.

According to an additional reference required by me, the candidate has participated in the following scientific-educational projects and programs:

- National Scientific Program "Information and Communication Technologies for a Unified Digital Market in Science, Education, and Security (ICTforUNOS)";
- EU Erasmus+ Program - lecturer at the University "Goce Delchev" - city of Stip, Republic of North Macedonia;
- Lecturer at the Rakovski Defense Academy. Academic discipline "Communication and Information Compatibility in Public and Corporate Networks and Systems".

3. Contributions Description

I accept the formulated contributions in the presented works. They have a scientific, scientific-applied, and applied character and are related to proving through new means substantial new aspects in existing scientific problems. Confirmatory facts have been obtained in the field of wireless sensor networks and the associated challenges in the development of communication protocols.

3.1. The monographic work of Alexander Alexandrov, PhD, consists of an introduction and six chapters:

The author provides an overview of the basic technologies related to the fundamental principles of sensor operation and sensor modules, as well as methods for sensor data exchange. In the second chapter, he examines the main characteristics of wireless sensors and the associated wireless and intelligent sensor networks. He analyzes the network architectures and topologies used in wireless sensor networks. Describes the main goals of network design and challenges in WSN implementation. Describes the communication standards used and the associated main communication protocols for wireless sensor networks. Their advantages and disadvantages are highlighted. A comparative analysis is made regarding their implementation. The main communication protocols in wireless sensor networks, grouped based on the Open System Interconnection modification for WSN, are discussed. An analysis of the specific features of OSI communication protocols serving WSN is made. The last chapter examines methods, protocols, and algorithms for managing and controlling wireless sensor modules. Emphasis is placed on new protocols and methods for clustering and localization of network

nodes developed by the author. New, more efficient protocols and algorithms for integrating sensor data, time synchronization in WSN, and localization in enclosed spaces are described.

Scientific contributions in the monographic work:

- Original model and method for simulation research of the process of parallel processing of integrated sensor data in WSN. The developed model uses the apparatus of generalized networks and adequately reflects the researched process when using network protocols from the IEEE 802.15.4 standard.

- New method and algorithm for clustering sensor nodes based on link quality priority.

- New method and algorithm for dynamic adjustment of synchronization intervals in cluster and mesh-based wireless sensor networks. The method consists of a two-step process of prediction and evaluation through the Kalman filter and Central Limit Theorem. This reduces the communication traffic for timer synchronization and saves energy for battery-powered sensor devices.

- New method for localization of mobile objects in enclosed spaces using wireless sensor locators. Measurement results are statistically processed based on a first-level Kalman filter and extended Kalman filter.

3.2. The scientific and scientific-applied contributions of Alexander Alexandrov, PhD, in the scientific publications are as follows:

- New model of parallel data processing from sensor nodes in LWSN with clustered topology based on generalized networks (GN). The proposed model covers all aspects of sensor data integration between nodes and cluster-based parallel processes, specific to large amounts of sensor data operations. Publication No. 1.

- New mathematical model and approaches for multi-criteria optimization, taking into account various goals for efficiency and shelf life. The proposed model is aimed at developing energy-efficient communication between sensor nodes and cluster heads (CH) in wireless sensor networks. Publication No. 2.

- New adaptive method for managing wireless sensor nodes, using machine learning, modeled on a multilayer perceptron (MLP) basis. The new approach presented in the study uses the SARSA algorithm (State-Action-Reward-State-Action), which is a form of reinforcement machine learning. The method offers solutions that maximize resource utilization and extend the life of battery-powered sensor modules part of the network. Publication No. 3.

- New QoS (Quality of Service) based technique for energy optimization of the existing ZigBee communication protocol. Publication No. 4.

- New hybrid method to improve the accuracy of positioning approach for indoor mobile devices with Bluetooth Low Energy (BLE), based on an optimized combination of technologies based on Angle of Arrival (AoA) and Received Signal Strength (RSS) methods. This is a new hybrid optimization method for indoor positioning, implemented through a two-step process of data fusion using extended Kalman filter and Fraser-Potter equation. Publication No. 5.

- New approach, based on Weighted Clustering Algorithm - WCA, by developing a modified method for ad-hoc clustering in wireless sensor networks (WSN). The method significantly reduces the risk of cluster coordinator failures in wireless sensor networks and helps optimize the deployed routing protocols. Publication No. 6.

- New method and algorithm for machine learning, based on Q-Learning, which is a form of reinforcement machine learning for optimizing the process of transmitting power control in nodes. The implementation of the proposed method and algorithm enables the realization of solutions that maximize the use of resources of sensor modules and extend the life of battery-powered wireless sensor networks. Publication No. 7.

The achievements in publications 1, 5, and 6, from the candidate's list, support the presented monographic work, chapters 5 and 6.

4. Significance of Contributions to Science and Practice

The evaluation of the candidate's recognition in scientific circles relies on the citations provided in the competition documents. A list of 7 citations is presented, with 6 of them being from scientific publications referenced and indexed in globally renowned databases of scientific information. The cited scientific publications of Assoc. Prof. Alexandrov are not included in the list for participation in the current competition.

All of this gives me grounds to conclude that the candidate is a well-known author, having published in significant scientific forums in the field of the competition. The quantitative indicators for the academic position of "associate professor" according to national requirements and the Internal Rules for the development of the academic staff of the Robotics Institute at the Bulgarian Academy of Sciences have been met.

5. Critical Notes and Recommendations

I did not find any significant omissions in the candidate's work and have no remarks on the materials presented.

I would recommend that the candidate increase their participation in the project activities of the IR-BAS and in the training of doctoral students at IR.

6. CONCLUSION

In conclusion, I can give a positive assessment of the overall scientific-research and pedagogical activity of Alexander Alexandrov, PhD, chief assistant, who fully meets the requirements for the academic position of "associate professor". Significant contributions have been made.

Based on my review of the presented scientific works, their significance, and the contributions contained therein, I find it justified to propose Alexander Alexandrov, PhD, chief assistant, to occupy the academic position of "associate professor" in Professional Field 5.2. Electrical Engineering, Electronics, and Automation, Scientific Specialty "Automated Information Processing and Control Systems (integration of data from sensor networks)" for the needs of the Institute of Robotics at BAS.

Sofia
12.02.2024

Member of the scientific jury:

Avgust Yordanov Ivanov, PhD, Professor