Review

of a competition for the academic position of

"Associate professor"

in the field of higher education: 5. Technical Sciences, to the section:

"URSM", in the

professional field 5.2. Electrical Engineering, Electronics and Automation,

scientific specialty

"Elements and Devices of Automation and Computing", for the needs of the

Institute of

Robotics - BAS, announced in SG No. 39 of May 13, 2025.

The review was prepared by: **Prof. Dr. Ivan Nikolov Chavdarov**, Sofia University "St. Kliment Ohridski", 4.6. Informatics and Computer Sciences, in my capacity as a member of the scientific jury for the competition according to Order No. 79/17.07.2025 of the Director of the Institute of Robotics - BAS.

Only one candidate has submitted documents for participation in the announced competition: Senior Assistant Professor Dr. Vanya Dimitrova Markova, Institute of Robotics - BAS, Section "URSM".

I. General description of the materials presented

II.

1. Application details

The documents submitted by the candidate in the competition comply with the requirements of the Act on the Acquisition of Scientific Degrees and Academic Positions at the Institute of Robotics - Bulgarian Academy of Sciences.

To participate in the competition, the candidate Vanya Markova has submitted a list of a total of 18 titles, in Bulgarian and foreign scientific publications and scientific forums, 0 studies, 0 monographs, 0 books, 0 certificates and patents, 0 textbooks and teaching aids. Ten of the submitted publications are separated as refereed publications according to criteria B4 of the

PPZRAS. Other documents (in the form of official notes and certificates from an employer, project manager, funding organization or project assignor, references and reviews, awards and other appropriate evidence) supporting the candidate's achievements that have been submitted are 0. The total number of points of the candidate in relation to the Regulations for the Implementation of the Act on the Development of the Academic Staff in the Republic of Bulgaria is **330 for indicator B** (out of 100 required), **240 for indicator D7** (out of 200 required) and **260 for indicator D** (out of 50 required), which satisfies the requirements for the position held.

Notes and comments on documents.

All submitted documents meet the requirements and regulations of the Institute of Robotics - BAS.

2. Candidate details

Senior Assistant Professor Dr. Vanya Markova graduated from the University of Plovdiv with a degree in Mathematics, qualification "Mathematician with specialization in Informatics". The thesis is on "Indirect command files for PDP 11. Development and Application". She defended her doctoral dissertation at the Institute of Systems Engineering and Robotics with the title "Methods and algorithms for describing the behavior of an autonomous mobile sensor agent" in 2013. Since 2008 she has been working as a researcher, since 2013 - assistant, and since 2014 - chief assistant, at the Institute of Robotics - BAS.

3. General description of the candidate's scientific works and achievements

The scientific work and results of Vanya Markova can be defined in three main areas:

- Control of collectives of autonomous agents and robots. A method for autonomous formation of stable formations, represented by geometric graphs, has been developed. The obstacle avoidance problem focuses on a combination of the Artificial Potential Fields method and Refined Particle Filters, which is believed to increase the security of navigation.

- Cooperative learning and strategy of agents through supported learning and knowledge transfer. A strategy is presented for integrating the management of formations of agents for supported learning, which allows for the automation of behavior. The approach increases the intelligence and adaptability of multi-agent systems.

- An approach to predicting behavior of autonomous agents using deep machine learning methods. An approach has been developed to create behavior of autonomous agents solving tasks in a two-dimensional (2D) environment. Simulations have been conducted to assess the efficiency in reaching target positions, the environment is modeled as a

sequential discrete structure, typical of mathematical games. Algorithms have been developed for describing and predicting chaotic behaviors, based on deep recurrent neural networks (Deep Recurrent Neural Networks). They allow identification of complex time dependencies and prediction of future behavior under conditions of uncertainty.

The results of the candidate's activities have been presented at international scientific forums. Ten articles have been published in SCOPUS and 8 in conference proceedings. All submitted papers have been peer-reviewed. The papers fully meet the minimum national requirements (under Art. 2b, para. 2 and 3 of the Law on the Promotion of Research and Development of the Republic of Bulgaria) and, respectively, the additional requirements of the Institute of Robotics-BAS for holding the academic position of "associate professor" in the scientific field and professional direction of the competition. The scientific papers submitted by the candidate do not repeat those from the previous procedures for doctor and chief assistant. There is no plagiarism proven in accordance with the statutory procedure in the scientific papers submitted for the competition.

4. Characteristics and evaluation of the candidate's teaching activities

The candidate's teaching activity is presented in an additionally requested reference. Senior Assistant Professor Dr. Vanya Markova participation in the preparation and conduct of the following academic disciplines at the Faculty of Electronics and Automation (FEA) and the Faculty of German Engineering Training and Industrial Management (FagIOPM) at the Technical University of Sofia and the branch in Plovdiv:

Systems Analysis, lectures and exercises for masters, FEA, Technical University of Sofia. Plovdiv branch 2024/2025;

XML technologies, exercises for bachelors, FEA, Technical University of Sofia, Plovdiv Branch 2021/2022, 2022/2023;

Artificial Intelligence and Robotics, lectures and exercises for bachelors, FEA, TU-Sofia Plovdiv Branch 2018/2019, 2019/2020, 2020/2021, 2021/2022;

Machine Learning, lectures and exercises for bachelors, FaGIOPM, TU-Sofia, 2018/2019 2019/2020, 2020/2021;

Advanced Machine Learning, lectures and exercises for masters, FaGIOPM, TU-Sofia. 2018/2019, 2019/2020, 2020/2021, 2021/2022;

Introduction to Deep Learning, lectures and exercises for bachelors, FaGIOPM, TU-Sofia, 2023/2024, 2024/2025;

Applied Deep Learning, lectures and exercises for bachelors, FaGIOPM, TU-Sofia, 2023/2024, 2024/2025.

The courses are in the field of Machine and Deep Learning with applications in computer vision, robotics, working with time series and automatic control.

5. Content analysis of the candidate's scientific and scientific-applied achievements contained in the materials for participation in the competition

From the presented works, the following more significant achievements can be formulated:

An experimental prototype of a neural architecture of the encoder-decoder type, based on long short-term memory (LSTM) models and the Bahdanau and Luong attention mechanism, has been developed. It has been implemented using the TensorFlow and Keras libraries, including embedding layers, LSTM cells, and decoding blocks. A comparative analysis has been conducted between different configurations of the architecture, in which the influence of different optimization algorithms has been studied.

A new cluster initialization method suitable for the task of forming collectives of autonomous robots is presented. In contrast to existing approaches that rely on random or uniform initial initialization, the author introduces a strategy based on the minimum local edges in the graph and the geometric proximity between nodes. This approach provides an answer to the question of how the initial configuration affects the efficiency and convergence of classical graph partitioning algorithms (such as KL and FM), without changing their basic logic. The process of knowledge transfer from one trained agent to another untrained agent in the Reinforcement Learning paradigm is studied. The research aims to reduce the training time and improve the process of knowledge accumulation. The knowledge transfer between RL agents is formalized by Markov decision processes (MDP).

A hypothesis is formulated and experimentally validated that a group of non-holonomic mobile agents, without a central leader or pre-informed elements, can reach a consensus in finite time. This is achieved through distributed control protocols based on local communication and graph interaction models.

A simulation of a realistic leader-follower scenario is implemented, in which the leading agent follows a predefined trajectory, and the others maintain the formation through behavior learned with DRL. Experiments with adding white noise to the sensor inputs are conducted, demonstrating the robustness of the algorithms to noise and uncertainties - a key requirement for real autonomous systems.

A system for off-line knowledge transfer between agents has been developed and implemented. An experimental protocol has been built in which a previously trained agent (teacher) transfers its knowledge (value function or policy) to a new agent (student), who is subsequently trained in a new task with a similar environment. Through empirical analysis, it has been proven that knowledge transfer is particularly effective with a small difference in the goals of the tasks, leading to significantly accelerated learning in the initial stage.

The articles have scientific and applied contributions related to the enrichment of existing knowledge. Some of them apply scientific achievements in practice.

The works are presented in articles published in journals and at international conferences, there are a total of 18 of them, ten of which are referenced in Scopus. Their distribution by scientific-metric indicators is as follows: Q1 – 1 article with IF 0.9; SJR without quartile – 2 articles; Refereed and indexed without SJR/IF – 8. One of the articles is independent and the remaining works are co-authored with other authors, assuming that the contribution of the authors is distributed equally. A list of 25 citations is presented, of which 3 are in journals referenced in SCOPUS, and 5 in IEEE. These indicators confirm the high value of the presented scientific works.

6. Critical remarks and recommendations

I recommend that in the candidate's future work, the quality of theoretical and practically oriented research be improved. Qualitative research be submitted for publication in international refereed journals with an impact factor. The manner and clarity of presentation of theoretical statements be improved, supporting them with more practical examples. To present the main ideas succinctly and comprehensibly in an accessible language without unnecessary use of abbreviations and terms. More attention be paid to the geometric and graphical interpretation of algorithms.

7. Personal impressions about the candidate

I have no personal impressions of the candidate.

8. Conclusion on the application

Having familiarized myself with the materials and scientific papers presented in the competition and based on the analysis of their significance and the scientific and applied scientific contributions contained therein, I **confirm** that the scientific achievements meet the requirements of the Law on Scientific and Applied Scientific Research, its Regulations for its implementation and the relevant Regulations of the Institute of Robotics-BAS for the candidate to occupy the academic position of "associate professor" in the scientific field and professional field of the competition. In particular, the candidate meets the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers presented in the competition.

I give my **positive** assessment of the application.

II. GENERAL CONCLUSION

Based on the above, I **recommend** that the scientific jury propose to the competent body for the selection of the Scientific Council of the Institute of Robotics-BAS to elect **Senior Assistant Professor Dr. Vanya Dimitrova Markova** to occupy the academic position of "Associate Professor" in the professional field 5.2. Electrical Engineering, Electronics and Automation, scientific specialty "Elements and Devices of Automation and Computing".

Sofia, 01.09. 2025 г.   Reviewer: Prof. Dr. Ivan Chavdarov