

REVIEW

of the competition for the academic position of PROFESSOR

Field of Higher Education 5. Engineering Sciences

Professional Field 5.1. Mechanical Engineering

Scientific Specialty "Robots and Manipulators"

Competition: announced in the State Gazette, Issue No. 51 of 5 June 2026, for the needs of the "Robotic and Mechatronic Intelligent Systems" (RMIS) Department at the Institute of Robotics, Bulgarian Academy of Sciences (BAS).

Topic: "Metrology of Mobile Robots – Methods, Models, Evaluation and Optimization of Mobile Collaborative Service Robots".

Candidate: Assoc. Prof. Nina Foteva Valchkova, PhD, Eng.

Reviewer: Academician Chavdar Roumenin, Institute of Robotics – BAS

1. General Overview of the Competition and the Submitted Materials

Assoc. Prof. Nina Foteva Valchkova, PhD, Eng., is the candidate in this competition. The submitted documentation contains the materials required to assess her academic and research development: a curriculum vitae; documents certifying the award of the doctoral degree and appointment to the academic position of Associate Professor; publication lists; a habilitation monograph; abstracts of scientific works; a statement of original scientific, scientific-applied and applied contributions; a citation list; bibliometric reports; and tables demonstrating compliance with the minimum national requirements.

The research output is directly related to the subject of the competition. Its principal areas include mobile and collaborative robotics, healthcare service robots, intelligent control and sensor fusion, high-mobility robotic platforms, hydrogen fuel-cell energy systems, autonomous field medical stations, and metrological evaluation and verification of robotic systems.

2. Professional and Academic Development

Assoc. Prof. Nina Foteva Valchkova has extensive professional and research experience within the Bulgarian Academy of Sciences in robotics, mechatronics, instrumentation and intelligent systems. She has held the academic position of Associate Professor at the Institute of Robotics – BAS since 18 March 2018.

The candidate also undertakes organizational and research-supervisory responsibilities: she performs managerial functions in the RMIS Department at the Institute of Robotics – BAS, chairs the Institute's General Assembly of Scientists, and participates in BAS governing bodies as a member of the BAS General Assembly of Scientists and its Credentials Committee. She leads research projects and supervises doctoral students. The submitted materials document her supervision of Vasil Georgiev

Tsvetkov, who successfully defended his dissertation in 2025, as well as her work with other doctoral students and early-career researchers.

3. Compliance with the Minimum National Requirements

The submitted tables prepared under the Bulgarian Act on the Development of the Academic Staff in the Republic of Bulgaria indicate that the candidate meets or exceeds the minimum national requirements for the academic position of Professor in Field 5, Engineering Sciences. The comparison is as follows:

Indicator group	Minimum	Candidate's points	Excess
A	50	50	0
B	100	100	0
G	200	225.33	25.33
D	100	158 – after exclusion*	58
E	150	214.53 – after adjustment**	64.53

* In calculating the score for Group D, citations appearing in Vasil Tsvetkov's doctoral dissertation have been excluded.

** For Group E, a 20-point adjustment has been applied following the reclassification of the project under the National Recovery and Resilience Plan (NRRP) from an international to a national project.

Group A is fulfilled with 50 points through the dissertation for the award of the doctoral degree. Group B is fulfilled with 100 points through the habilitation monograph “Metrology of Mobile Robots in Healthcare: Methods, Models, Evaluation and Optimization of Mobile Collaborative Service Robots”.

For Group G, the candidate reports 225.33 points against a required minimum of 200. These include publications in refereed and indexed outlets, peer-reviewed scientific journals and proceedings of international conferences.

When determining the score for Group D, only citations eligible under the applicable indicators of the Act and supported by the submitted evidence should be counted. Citations in the doctoral dissertation of Vasil Georgiev Tsvetkov are not included in the score awarded in this review.

For Group E, 214.53 points are reported against a minimum of 150. Major contributions to this score are the supervision of a successfully graduated doctoral student, participation in and leadership of national research projects, including projects under the National Recovery and Resilience Plan (NRRP), and funds attracted through projects led by the candidate. For the two specified projects alone, 84.13 points correspond to BGN 420,647.85 in attracted funding and 30.4 points to BGN 152,000.

Classification adjustment: project BG-RRP-2.017-0011-C02 under the NRRP is classified as a national project financed by European Union funds. Assuming that its leadership was initially credited with 40 points under Indicator 21 (international project), 20 points should instead be awarded under Indicator

20 (national project). Accordingly, the Group E total decreases by 20 points, from 234.53 to 214.53. Points under Indicator 22 for attracted funding remain unchanged.

Assessment: the candidate meets the minimum national requirements in all applicable indicator groups and exceeds them in Groups G, D and E.

4. Assessment of the Habilitation Monograph

The principal habilitation work is Nina Valchkova's monograph "Metrology of Mobile Robots in Healthcare: Methods, Models, Evaluation and Optimization of Mobile Collaborative Service Robots", Sofia, Prof. Marin Drinov Publishing House of BAS, 2026, ISBN 978-619-245-613-9. The monograph addresses a broad range of interconnected scientific and scientific-applied problems concerning the development, mathematical modeling, control, sensory and energy provision, and metrological evaluation of mobile collaborative service robots intended for healthcare applications. Its content follows a coherent logical sequence, beginning with the specific characteristics and functional capabilities of collaborative robotic systems in medical tasks and proceeding to the justification of design choices, selection and optimization of mobile platforms, mathematical models, and algorithms for integrated Whole-Body Control. The principles of sensor and energy subsystem design and the integration of robots into automated field medical stations are also considered.

Particularly noteworthy is the comprehensive systems approach, in which the mobile collaborative robot is investigated as an integrated cyber-physical system. Design parameters, kinematic and dynamic characteristics, sensing devices, control algorithms, energy resources and mechanisms of human-robot interaction are examined in their functional interdependence. This approach makes it possible to analyze how individual subsystems affect the overall performance, accuracy, reliability and efficiency of the robotic platform. Considerable attention is devoted to metrological assurance through the development and application of methods and procedures for measurement, quantitative assessment, testing and experimental validation of the functional characteristics of the robotic systems under study.

The concluding part of the monograph considers the proposed methodological approaches and technical solutions in the context of the development and operation of contemporary autonomous field medical stations. The main scientific and scientific-applied results are systematized, and conclusions are drawn regarding opportunities to improve mobile collaborative service robots. Thus, the monograph demonstrates thematic and methodological completeness, directly corresponds to the scientific specialty and subject of the competition, and synthesizes a substantial part of the candidate's research results achieved after her appointment as Associate Professor.

5. Analysis of the Publications Submitted for the Competition

Seventeen publications have been submitted for the competition and can be organized into several thematic areas. Seven are presented as publications in outlets refereed and indexed in internationally recognized databases, while the remainder appear in peer-reviewed scientific outlets and proceedings of international conferences.

5.1. Medical and Social Robotics – Metrological Aspects of Functional Reliability and Safety

The publications “Hybrid Intelligent Systems in Medicine – Automated Medical Station” and “Feasibility of the Cyber-Physical Nurse” address scientific and engineering issues relating to the integration of intelligent robotic systems into medical practice. From a metrological perspective, measurement, quantitative assessment and verification of the functional characteristics of robots operating in close proximity to healthcare professionals and patients are of particular importance.

In the first study, the integration of a mobile collaborative service robot into an automated medical station creates opportunities for comprehensive assessment of positioning accuracy, repeatability of operations, reliability of sensor information and safety of human–robot interaction. The second publication extends the discussion through the concept of a cyber-physical “nurse”, for which metrological assurance is essential to the trustworthiness of measurement information and the predictability of robotic actions.

This research area also includes studies on the use of collaborative robots in field medical stations, educational rehabilitation and special education. These applications impose specific requirements for accuracy, reproducibility and objective assessment of robotic systems’ functional behavior.

5.2. Mobile Platforms, Dynamics and Terrain Negotiation – Measurement and Assessment of Kinematic and Dynamic Characteristics

The publication “Parametric Analysis of a Collaborative Robotic Mobile Platform for Healthcare Application” is directly relevant to the metrological characterization of mobile robotic platforms. The investigation of velocities, accelerations, lateral displacements, deceleration and stopping provides a basis for quantitative assessment of dynamic behavior and identification of the parameters affecting movement accuracy and stability.

“An Approach to Developing an Optimal Model of the Mobile Platform of a Collaborative Robot” presents a methodological approach to selecting and optimizing the drive system according to stability, maneuverability, energy efficiency and intended function. From a metrological perspective, these criteria can be linked to measurable indicators enabling comparative assessment of different structural and kinematic solutions.

Studies of the high-mobility Roby1 robotic platform, featuring a triangular track configuration, complement this research direction. Movement in unstructured environments, obstacle negotiation and stair climbing require assessment of deviations from the prescribed trajectory, platform stability and the influence of external disturbances on motion parameters.

Taken together, these publications provide a basis for metrologically grounded analysis of the functional characteristics of mobile robotic platforms under different operating conditions.

5.3. Intelligent Control, Sensor Systems and Sensor Fusion – Metrological Assurance of Measurement Information

This research area is especially important for mobile robot metrology, as control accuracy and reliability depend directly on the quality of incoming measurement information.

The publication on intelligent control and sensor fusion for a tracked mobile collaborative robot presents an architecture integrating heterogeneous sensors in the ROS environment, together with a dedicated graphical interface. From a metrological standpoint, the joint processing of measurements obtained from sensors with different operating principles, accuracy, resolution and dynamic characteristics is particularly significant.

Combining sensor data offers opportunities to reduce the influence of individual measurement errors and improve the reliability of robot state estimates. Key issues include measurement-data alignment, temporal synchronization and evaluation of uncertainty when determining the robot's position and motion.

"Sensory System for Controlling Robot's Motion" presents a simulation model of a differentially driven mobile robot and a method for determining distance traveled. This approach is directly related to odometric measurement and assessment of cumulative errors in trajectory estimation.

In my assessment, these studies are important for the development of metrologically grounded methods for localization, navigation and autonomous mobile-robot control, including evaluation of the accuracy and reliability of sensor-fusion results.

5.4. Energy Systems and Green Hydrogen – Measurement, Monitoring and Optimization of Energy Characteristics

The publications devoted to powering collaborative service robots with hydrogen fuel cells address issues directly related to measuring and assessing the energy parameters of autonomous robotic systems.

"Methodology for Optimizing the Parameters of a Collaborative Service Robot Powered by a Hydrogen Fuel Cell" proposes an integrated approach combining a mobile platform, a seven-degree-of-freedom manipulator, sensor fusion and a hybrid energy architecture with a proton-exchange membrane fuel cell (PEMFC). It examines the principles of Whole-Body Control (WBC) and Energy Management Systems (EMS) in the context of multi-criteria optimization.

From a metrological perspective, measurement and monitoring of electrical and energy parameters, assessment of energy consumption, determination of energy efficiency, and identification of relationships between actuator loads and robot autonomy are especially important.

Comparative studies of different power-supply technologies complement this area through analyses of operating characteristics, environmental indicators and the applicability of hydrogen systems in medical settings.

The reported results provide a basis for establishing quantitative criteria for the metrological assessment of energy efficiency and operational autonomy in mobile collaborative robots.

5.5. Autonomous Field Medical Stations – Comprehensive Metrological Assurance of Integrated Robotic Systems

"Optimization of the Energy Subsystem in the Construction of Modern Field Medical Stations" presents a concept for modular medical stations combining renewable energy sources, telemedicine

technologies and robotic subsystems. Such complex systems require the coordinated operation of numerous technical devices, for which measurement accuracy, control reliability and traceability of operational parameters are of substantial importance. From a metrological perspective, the integration of robotic, energy and medical subsystems requires monitoring of functional parameters, performance assessment and reliable information about the status of individual modules.

Studies on the use of collaborative robots in field medical stations extend this concept to robotic logistics and operations under emergency conditions. In such applications, metrological assessment should encompass positioning accuracy, navigation reliability, task timing and operational robustness under changing environmental conditions.

These studies demonstrate the importance of comprehensive metrological assurance for autonomous medical systems in which robotics, energy infrastructure and medical technologies operate as interconnected components.

5.6. Manipulation Systems and Kinematic Sensitivity – Metrological Assessment of Positioning Accuracy

“Analysis of the Kinematic Sensitivity of a Gripper in Robotics” addresses a topic of direct metrological relevance: the effects of geometric deviations, changes in joint coordinates, inaccuracies at contact points and manufacturing tolerances on the functional characteristics of a robotic gripper.

The investigation of kinematic sensitivity makes it possible to analyze how small changes in input geometric and kinematic parameters affect the position and orientation of the end effector. This is particularly important for assessing positioning accuracy and identifying the factors responsible for deviations from a prescribed position.

The relationships considered with singular configurations, underactuation and mechanical compliance further develop the sensitivity analysis and provide a basis for assessing the influence of structural parameters on accuracy and force interaction.

I consider this publication to have a clear connection with the metrology of robotic manipulation systems, since it examines factors determining the accuracy, sensitivity and reproducibility of executed motions.

5.7. Ethical and Social Aspects – Measurable Criteria for Safety and Quality of Human–Robot Interaction

Research on ethical aspects of using collaborative robots in the education of disadvantaged individuals extends the technical discussion to the social and organizational conditions of deploying robotic systems.

In the context of metrological assurance, this area raises the need for objective and measurable criteria for assessing the safety, reliability and quality of human–robot interaction.

Particularly relevant parameters include motion accuracy and predictability, response time, repeatability of actions and compliance with permissible limits of physical interaction. Such indicators

may provide a technical basis for assessing robotic systems intended to work with vulnerable user groups.

Thus, this publication complements the engineering studies by highlighting the relationship between technical reliability, objective assessment of functional behavior and social acceptance of collaborative robots.

Overall Assessment of the Publication Record

The analysis of the submitted publications demonstrates the consistent development of the candidate's research in mobile and collaborative robotics, with metrological issues serving as a unifying element across the different thematic areas.

The studies encompass a wide range of measurable functional characteristics: kinematic and dynamic parameters, positioning accuracy, sensor-data reliability, autonomous navigation performance, energy efficiency, functional reliability and safety in human-robot interaction.

Of particular importance are studies on parametric analysis of mobile platforms, kinematic sensitivity of manipulation mechanisms, sensor fusion and assessment of energy characteristics. These are directly related to measurement, modeling and quantitative evaluation of robotic-system parameters.

In summary, I consider that the submitted publications demonstrate a systems approach to mobile collaborative robotics in which metrological assurance plays an important role in determining, evaluating and optimizing functional characteristics. The scientific results are thematically related to the habilitation monograph and correspond to the scientific specialty "Robots and Manipulators" and the subject of the competition for the academic position of Professor.

6. Scientific, Scientific-Applied and Applied Contributions

Based on my analysis of the submitted scientific publications and the statement of contributions, I consider that the candidate's principal achievements can be summarized in three interrelated areas:

- Scientific contributions: Methodological approaches have been developed for systems-based design, mathematical modeling, parametric synthesis and multi-criteria optimization of mobile collaborative robots. Methods for intelligent control, sensor fusion and energy optimization have been investigated, with particular emphasis on metrological assessment of functional characteristics, accuracy analysis and experimental verification of robotic systems.
- Scientific-applied contributions: Engineering methods and criteria have been proposed for selecting and optimizing mobile platforms, integrating heterogeneous sensor systems, and implementing autonomous navigation and safe human-robot interaction. Approaches have been developed for managing battery-based, hydrogen and hybrid energy systems, together with solutions for high-mobility robots and autonomous medical stations. The metrological aspect lies in the use of measurable indicators to assess accuracy, reliability, and dynamic and energy characteristics.
- Applied contributions: Experimental mobile collaborative platforms, multisensor localization and navigation systems, intelligent control systems and hybrid hydrogen fuel-cell power solutions have been implemented. Models of autonomous field medical stations, high-mobility robotic systems and

virtual experimental environments have been developed, providing opportunities for testing and quantitative assessment of functional parameters.

Overall, I consider that these contributions demonstrate a comprehensive approach to the development and investigation of mobile collaborative robots, in which metrological assurance, measurement accuracy and objective assessment of operational characteristics are essential. They correspond to the subject of the competition and provide a basis for further research on intelligent robotic systems. The contributions are consistent with the scientific specialty “Robots and Manipulators” and focus on current challenges in mobile and collaborative robotics: autonomy, safety, intelligent control, measurement and assessment, energy efficiency, and operation in dynamic and unstructured environments.

7. Citations and Scientific Recognition

Citations to research across several thematic areas—including service and social robots, robotic systems for special education, control and applied engineering methods—indicate that some results have gained scientific recognition beyond the immediate group of co-authors.

8. Project Activities and Research Supervision

Project activity is a strong element of the candidate’s academic profile. The submitted materials document participation in national projects and leadership of national projects, including a project under the National Recovery and Resilience Plan (NRRP), financed by the European Union through the Recovery and Resilience Facility. Of particular relevance to the competition are project KP-06-N57/8, “Methodology for Determining the Functional Parameters of a Mobile Collaborative Service Robot Assistant in Healthcare”, and project BG-RRP-2.017-0011-C02, “Environmentally Friendly Collaborative Robots Powered by Green Hydrogen”.

Supervision of a doctoral student who successfully defended a dissertation, together with work involving other doctoral students and early-career researchers, demonstrates the candidate’s contribution to training researchers and ensuring continuity in mobile and collaborative robotics.

9. Critical Remarks and Recommendations

The critical remarks are primarily editorial and methodological and do not alter the overall assessment. It would be advisable to standardize the presentation of DOIs, indexing information, SJR indicators and journal quartiles in the bibliographies, while clearly distinguishing metrics pertaining to a specific publication venue from those of the relevant series.

In future presentations of the results, it is recommended to distinguish more explicitly between simulation results, laboratory tests and validation in a relevant real-world environment, and to specify quantitative criteria for accuracy, repeatability, reliability, autonomy and energy efficiency for the principal methods.

The contributions are numerous and thematically diverse; for greater clarity, future academic reports could consolidate them into a smaller number of principal contributions, each explicitly linked to particular publications, experimental results and the candidate’s individual contribution.

10. Conclusion and Overall Assessment

The submitted materials demonstrate sustained scientific and scientific-applied activity in mobile and collaborative robotics. The habilitation monograph is directly related to the competition topic and brings together methods for modeling, design, control, sensory and energy provision, and metrological evaluation of mobile robotic systems for healthcare.

The publication record shows development in several complementary areas: medical and social robotics, mobile platforms, intelligent control and sensor fusion, high-mobility robots, hydrogen energy systems and autonomous field medical stations. Project leadership and doctoral supervision complement the academic profile through organizational and educational activities.

Based on my review and assessment of the materials submitted for the competition, I give a **POSITIVE ASSESSMENT** of the scientific, scientific-applied, project and academic activities of Assoc. Prof. Nina Foteva Valchkova, PhD, Eng., and recommend that the esteemed Scientific jury and Scientific council of IR-BAS support her appointment to the academic position of **PROFESSOR** in Field of Higher Education 5, Engineering Sciences; Professional Field 5.1, Mechanical Engineering; Scientific Specialty "Robots and Manipulators".

Date: .07.10.2026

Sofia

Reviewer:

Signature:

/Academician Chavdar Roumenin/