REVIEW

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of the materials submitted for participation in a competition for the academic position of "Professor" at the Institute of Robotics "St. Matthew the Apostle and Evangelist" at the Bulgarian Academy of Sciences

Field of higher education: 5. "Technical Sciences"
Professional field: 5.2 "Electrical Engineering, Electronics and Automation"
Scientific specialty: "Interactive Robotics and Control Systems"
Scientific organization: Institute of Robotics "St. Matthew the Apostle and Evangelist" at the Bulgarian Academy of Sciences
Research unit: Department of Interactive Robotics and Control Systems
Announcement in the State Gazette: No. 44 of 21 May 2024, p. 18

1. Details of the procedure

In the competition for the academic position of "Professor", announced in the State Gazette, No. 44 of 21 May 2024, p. 18, and on the website of the Institute of Robotics "St. Matthew the Apostle and Evangelist" at the Bulgarian Academy of Sciences, for the needs of the Department of Interactive Robotics and Control Systems at the Institute, as the only candidate documents has been submitted by Assoc. Dr. Eng. Snezhanka Petrova Kostova. Currently, the candidate is an Associate Professor in the mentioned section of the Institute. The competition was announced on the basis of a decision of the Scientific Council of the Institute of Robotics "St. Matthew the Apostle and Evangelist" according to protocol number 5 of May 31, 2024.

By Order No. 62 of July 23, 2024 of the Director Prof. Dr. August Ivanov of the Institute of Robotics "St. Apostle and Evangelist Matthew" I was appointed as a member of the Scientific Jury of the competition. At the first meeting of the Scientific Jury on July 24, 2024, held online, I was selected to prepare a review of the competition.

For the competition, the candidate Assoc. Dr. Snezhanka Petrova Kostova has presented materials required by the regulatory documents, which were provided to me in electronic form. Subsequently, these materials were supplemented. I have not found any formal violations of the competition procedure at this stage, as well as illegally used foreign results (plagiarism) in the candidate's scientific papers submitted to me.

2. Scientific biography of the candidate

The candidate Assoc. Dr. Snezhanka Petrova Kostova was born in 1959 in the region of Ruse. She graduated from the University of Ruse "Angel Kanchev", majoring in Mechanical Engineering, in 1982 and has a specialization in "Applied Mathematics and Informatics" (blocks B and C) from the Faculty of Applied Mathematics and Informatics at the Technical University of Sofia.

In 2002 she defended her dissertation on "Analysis and Synthesis of Positive Linear Discrete Systems" (supervised by Prof. Ventseslav Rumchev, DSc and Prof. Petko Petkov, DSc) for awarding the educational and scientific degree of "Doctor" in the scientific specialty 02.21.01 "Theory of Automatic Control". The dissertation proposes new methods and algorithms for analysis and synthesis by linear feedback on the state of positive linear discrete systems. The problems for maintaining and stabilizing the state of the system and for synthesis with predetermined spectrum of the closed system (synthesis according to specified poles) are solved. The results of the dissertation are applied to objects in the field of energy and environmental protection.

The candidate has worked as an assistant professor of mathematics at the Department of Mathematics and Statistics at the Academy of Economics "A.D. Tsenov" in Svishtov and as an Assistant Professor in mathematics at the Institute for Foreign Students, Sofia. She was a research associate of the third, second and first degree respectively at the Institute of Economics and Economics – BAS. Since 2007 she has been an Associate Professor at the Institute of Robotics at the Bulgarian Academy of Sciences (former ISUSI-BAS and ISIR-BAS). Since 2010 she has been Head of the Systems Engineering Department at the Institute.

Ass. Prof. Dr. Snezhanka Kostova has led a PhD course in Linear-Quadratic Differential Games and Applications at the Faculty of Economics of Sofia University "St. Kliment Ohridski". She has delivered lectures under a program for exchange of lecturers in scientific institutions in Valencia (Spain), Grenoble (France), Kavala (Greece), Portsmouth (Great Britain) and others.

The research interests of the candidate are in the field of interactive robotics, the application of innovative technologies in education, the analysis and synthesis of control systems, positive control systems, mathematical modeling and modeling and management of processes in the field of the environment. In particular, she is engaged in the application of robotics for the training of people with special educational needs (SEN) and neurological problems. This is an important area of the social activity of the modern humanitarian state, which I personally appreciate very highly.

The candidate has carried out a variety of scientific-organizational and scientific-administrative activities, being Chairman of the Scientific Council and Head

of the Department of Systems Engineering at the Institute of Robotics, Chairman of the Section of the Union of Scientists at the Institute of Robotics and others.

The candidate has a number of specializations and visits to foreign universities and other scientific organizations, including the University of Split (Croatia), the Norwegian University of Science and Technology in Trondheim (Norway), the Polytechnic of Valencia (Spain), the Technical University of Berlin, the European Institute for Energy Research in Karlsruhe (Germany), the University of Bremen (Germany) and the Curtin University in Perth (Australia).

In total, the candidate has over 70 scientific publications (journal articles and reports at conferences and congresses) in the field of Control Theory and its applications. These papers have been cited nearly 200 times, and she has an h-index equal to 7. According to SCOPUS, however, these indicators are lower (77 citations of 20 articles of the candidate in 75 citing documents and h = 4). This is probably due to the fact that SCOPUS does not monitor some of the editions in which the candidate has publications. There may also be duplicate names. Some of the candidate's publications are in prestigious publications with impact factor and SJR. Especially the publications on the competition are cited 52 times.

3. General description of the submitted materials

The candidate Assoc. Prof. Dr. Snezhanka Kostova participated in the competition with 26 scientific papers, 10 of which were presented as equivalent to a monograph. Some of these papers have been refereed in SCOPUS and Web of Science, and 11 are publications in non-refereed journals, which, however, are scientifically peer-reviewed. Data are presented for a total of 52 citations of the scientific works of the candidate for participation in the competition for professor. The candidate has participated in 12 scientific projects and contracts, some of which have a significant economic effect. On five of these projects, she was the leader.

4. Teaching activities

Brief information about the teaching activity of the candidate was presented above. In the materials of the competition, no information about the management of postgraduate and doctoral students was presented. Thus, in general, the teaching activity of the candidate is not particularly intensive, which is often observed in the candidates for the academic positions of "Associate Professor" and "Professor" in the institutes of the Bulgarian Academy of Sciences (unlike their colleagues at the universities).

5. Scientific and applied research

In the period after acquiring the academic position of Associate Professor, the candidate developed a sufficiently intensive scientific and applied scientific activity. Proof of this is the fact that data about the candidate are included in the NACID database for habilitated persons with proven scientometric indicators. This database provides information about 44 of her publications (articles and conference reports) for the period from 1994 to 2019. Initially, no information was provided about the candidate's participation in editorial boards and in the processes of reviewing scientific papers. In general, the candidate has a diverse scientific and applied scientific activity, and a relatively limited teaching activity. I positively assess the total activity of the candidate.

Data on the candidate's scientific activity are also published in the common databases Google Scholar and ResearchGate, in the specialized international databases Scopus, Web of Science, zbMATH, MathSciNet and others, as well as in the Bulgarian database of NACID for habilitated persons with proven scientometric indicators.

The materials submitted in the competition meet the minimum national requirements for occupying the academic position of "Professor" in the professional field 5. "Technical Sciences", scientific field 5.2 "Electrical Engineering, Electronics and Automation", as well as the specific requirements of the Institute of Robotics at the Bulgarian Academy of Sciences.

6. Contributions

26 scientific publications have been submitted for participation in the competition, 15 of which are refereed and indexed in world-renowned databases with scientific information (Scopus and Web of Science). Six of the publications are in impact factor journals and seven are in SJR journals. Four of the publications are independent, in eight publications the candidate is the first author, in two she is the second author, in four she is the third author, and in the remaining eight she is after third place in the list of authors. Some of the publications are related to the implementation of several successfully completed and three currently active research projects on the topic of the competition.

In the development of robotic systems to support the learning of children with SEN, linear discrete control systems with non-negative parameters were used. Thus, the candidate successfully applied her previous results in the analysis and synthesis of positive linear systems. In particular, a systematic review and analysis of the use of commercial social robots and platforms in education is made, evaluating their effectiveness in terms of their technical characteristics and their wider use in schools.

The possibilities and specifics for the introduction of new technologies in education in several areas are studied: in mass education, in non-formal education with extracurricular activities and in the education of children with special needs. A survey was conducted among teachers and parents, including 231 parents and 197 teachers and experts, through questionnaires in four Balkan countries: Bulgaria, Greece, Croatia and Bosnia and Herzegovina on the attitudes of the target groups to the use of new technologies and robots in the educational process. The results of the study can be used to develop strategies and policies aimed at accelerating the process of implementing new technologies in the educational process. These studies are part of the activities within the framework of the international project "Increasing the well-being of the population through innovative education based on robotics and information technologies".

Another contribution is related to the creation of cyber-physical systems for interactive games with humanoid and non-humanoid robots for the purposes of inclusive education of children with special needs. The systems make it possible to take into account the individual needs of children. Pilot tests of games in laboratory conditions were carried out with children in normal conditions, followed by real experiments conducted in day care centers for children with SEN. These studies are part of the activities of an international project with the participation of the candidate.

A third contribution is related to research on the psychosocial and psychophysical aspects of interaction with humanoid and non-humanoid robots. Formalization of the iterative game process of interaction of children with robots through the use of the apparatus of linear discrete control systems is proposed.

A fourth contribution is the developed and experimentally tested system for speech therapy for children with communication disorders. The system has been validated with a humanoid robot, an emotionally expressive robot, and a brain signal recording device. This system has the potential to work in the Internet of Things (IoT) for remote delivery of social services and speech therapy.

A fifth contribution is the creation of a brain-computer interface based on EEG signals, which are recorded in real time through a non-invasive handheld device. EEG data is used to control a robot, thus the child receives feedback on his concentration level.

As a sixth scientific contribution, the solution of several tasks of the control of positive linear discrete systems, which are used to model the game educational and therapeutic process, can be evaluated. The first problem is to stabilize a positive linear discrete system by state feedback based on Brouwer's theorem. Sufficient conditions for the positivity and sustainability of the closed system have been proven. The results are illustrated with numerical examples. The second problem is related to the synthesis of a linear-quadratic regulator for discrete positive systems. The third problem is again the synthesis of a linear-quadratic regulator using the theory of invariant sets. Among the scientific contributions, the study of the relationship

between the controllability of positive linear discrete systems and the synthesis with prescribed poles using the corresponding canonical forms should be highlighted. Another interesting result is the maximization of the radius of stability of a positive linear system. A connection and comparison with other synthesis methods such as the H_2/H_inf synthesis of discrete systems can be sought here.

7. Valuation of personal contribution

The candidate's works are both individual and collective. Due to the lack of separation protocols, I assess the contributions of the co-authors to the collective publications as equivalent.

8. Critical remarks and recommendations

- I recommend the candidate to continue her active publication activity mainly in prestigious international journals with good scientometric indicators.
- I also recommend the candidate to strengthen her teaching activities and in particular the work with postgraduate and doctoral students. Here I also take into account the fact that the associates of the institutes at the Bulgarian Academy of Sciences have more limited opportunities to develop teaching activities compared to the lecturers at the universities.
- It would be useful for the candidate to summarize her main scientific and applied scientific achievements and publish them in a monograph in English in a prestigious international or Bulgarian publishing house.

9. Personal impressions

I personally know the candidate Assoc. Prof. Dr. Snezhanka Petrova Kostova, as I was a reviewer of her PhD thesis in 2002.

10.Conclusion

I positively assess the scientific, applied and teaching activities of the candidate. This activity meets the requirements of the Academic Staff Development Act in the Republic of Bulgaria, the Regulations for its implementation and the specific requirements of the Institute of Robotics at the Bulgarian Academy of Sciences regarding the awarding of scientific degrees and the granting of academic positions. Taking into account the above, I propose to the Honorable Scientific Jury to propose to the Scientific Council of the Institute of Robotics at the Bulgarian Academy of Sciences Assoc. Dr. Snezhanka Petrova Kostova to be elected to the academic

position of "Professor" in the field of higher education 5. "Technical Sciences", professional field 5.2 "Electrical Engineering, Electronics and Automation", scientific specialty "Interactive Robotics and Control Systems".

12.08.2024

Reviewer:

Prof. Dr. Mihail Konstantinov