REVIEW

concerning a competition for the academic position of Professor in the field of higher education 5. Technical sciences, professional field 5.2. Electrical engineering, electronics and automatics, (Interactive Robotics in Education) for the needs of the section "Interactive Robotics and Control Systems" of the Institute of Robotics-BAS

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

1. General and biographical data

By Order № 62/23.07.2024 of the Director of Institute of Robotics BAS, I am included in the Scientific Jury of the above mentioned competition, announced in the State Gazette № 44/21.05.2024 with the only candidate Assoc. Prof. Dr. Snezhanka Petrova Kostova from the Section "Interactive Robotics and Control Systems" of the Institute of Robotics-BAS.

From the presented CV one can trace the professional development of the candidate - Assoc. Prof. Kostova. She received higher education at University of Ruse "Angel Kanchev" in 1982 with the qualification of mechanical engineer. During the period 1982–1984, she specialized in "Applied Mathematics and Informatics" (Block B and Block C) at the Faculty of Applied Mathematics and Informatics of TU Sofia. She received the scientific and educational degree "Doctor" at the Institute of Control and System Research (ICSR) – Bulgarian Academy of Science (BAS) (now the Institute of Robotics - BAS) in the scientific specialty 02.21.01 "Theory of automatic control". She works as an assistant in mathematics in the Department of "Mathematics and Statistics", Academy of Economics "D.A. Tsenov", Svishtov in the period 1984-1987, in 1987-1988 she was a part-time assistant in Mathematics at Institute for Foreign Students, Sofia. During the period 1995–2007, she was a research assistant III, II, I degree at ICSR - BAS, and since 2007 she has been an Associate Professor at IR - BAS (former Institute of Control and System Research (ICSR)-BAS and Institute of System Investigations and Robotics (ISIR)-BAS.

The scientific and research activities of Associate Professor Dr. Kostova took place almost entirely in the Bulgarian Academy of Sciences and are in the field of Interactive robotics, Application of innovative technologies in education, Analysis and synthesis of control systems, Control of positive systems, Mathematical modeling , Modeling and control of environmental processes.

The copies of the documents provided to me contain:

- Application for participation in a competition for a professor at IR-BAS-IRSU;
- Declarations Appendix 1 and Appendix 2 for participation in a competition for a Professor at IR-BAS;
- A complete list of the candidate's publications, divided into a list of publications in specialized scientific publications equivalent to a monograph and a list of other publications submitted for participation in the competition;
- Reference to the applicant's contributions;
- Certificates for participation and project management and for attracted funds;
- List of citations of the candidate's works;
- Diplomas of the candidate - copies;
- Detailed CV of the candidate;
- Announcement of competition in the State Gazette and invoice for paid fee;
- Certificate of fulfillment of the minimum national requirements for occupying the academic position "Professor" according to National Center for Information and Documentation (NACID) and the Law on the development of the academic staff of the Republic of Bulgaria (LDASRB) indicator groups, art. 2b, paragraphs 2 and 3;
- Copies of the applicant's publications.

I have no objections to the required documents for participation in the competition and their content, according to the normative basis of the LDASRB, the RALDASRB and the Internal Regulations of the IR-BAS, on the conditions and procedure for holding the academic position "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 LDASRB, candidates for the academic position of professor must meet the requirements of Article 29(1):

1. To have acquired the educational and scientific degree "doctor".
2. To have held the academic position of "associate professor" in the same or in another higher school or scientific organization for no less than two academic years or...
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-scientific degree "Doctor" and for occupying the academic position of "Associate Professor".
4. To have presented other original scientific research works, publications, inventions and other scientific and scientific-applied developments or artistic achievements, which are evaluated as a whole;
5. To meet the minimum national requirements under Art. 2b, para. 2 and 3, respectively, to the requirements under Art. 2b, para. 5;
6. Not to have plagiarism or unreliability of the presented scientific data in the scientific works proven in accordance with the law.

The requirements under Article 29(1), item 1 are fully fulfilled, since with diploma № 28143/30.09.2002, the Higher Attestation Commission confirmed the educational and scientific degree "Doctor" awarded to Snezhanka Petrova Kostova for successfully defended dissertation for a successfully defended dissertation on the topic "Analysis and synthesis of positive linear discrete systems" in the scientific specialty "Theory of automatic control".

The candidate meets the requirement under Art. 29(1), item 2, as the Higher Attestation Commission awarded Snezhanka Petrova Kostova the scientific title "Associate Professor" (ranking of the second degree) with certificate No. 24540/30.08.2007 in the scientific specialty "Application of the principles and methods of cybernetics in the field of technical sciences'.

Assoc. Prof. Dr. Snezhanka Kostova fulfils the requirement of Article 29(1), item 3, as she has submitted 10 publications equivalent to a monographic work, which do not duplicate the publications for the academic position "Associate Professor" and for the educational and scientific degree "Doctor".

Assoc. Prof. Dr. Kostova meets the requirement of Article 29(1)(4) as she has submitted other original research papers and publications, 16 in total.

The applicant has submitted a Reference of Fulfilment of National Minimum Requirements, supplemented by a list of his scientific output. She meets and exceeds the requirements of this Reference. Regarding the requirement of Art. 29(1), item 6, I am not aware of received reports under Art. 4 para. 11 of LDASRB and no plagiarism was found in the candidate's works.

2. General description of the submitted materials

Assoc. Prof. Dr. Snezhanka Kostova has submitted 26 scientific publications for her participation in the competition. Ten publications [4.1÷4.10] are in journals with an impact factor or impact rank and are thematically united and systematized in equivalent monographic work. The remaining original scientific research works are 16 in number, of which group Г7 includes 5 in number of publications with an impact factor, impact rank or referenced and indexed in the world assessment system (WoS or Scopus). The remaining 11 publications are included in group Г8. Two references of contributions are presented. One reference is in relation to the ten publications of group B mentioned above, and the other is related to the publications of groups Г7 and Г8. Most of the candidate's works are on the issues of the competition.

Group	Contents	min. points Prof	Evidential materials	Points for Assoc. Prof. Kostova
A	Indicator 1	**50**	"Analysis and synthesis of positive linear discrete systems"	**50**
B	Indicator 4 **Habilitation work** - scientific publications that are referenced and indexed in world- databases	**100**	Equivalent to a monograph thematically united and systematized scientific works: 4.1-4.10	**120**
Г	Indicators 7 и 8	**200**	3.1. Reference for scientific and applied contributions	**222 in total**
Г	Indicator 7		Publications Г7 – 7.1-7.5	*150*
Г	Indicator 8		Publications Г8 – 8.1-8.11	*72*
Д	Indicator 12	**100**	5. List of citations of the candidate's works	**520 in total**
E	Indicators 18, 19, 20, 21, 22	**150**	4. *List of research projects, contracts, topics*	**311 in total**
E	Indicator 18. Participation in a national scientific or educational project		Three projects x 10 p..	*30*
E	Indicator 19 Participation in a international scientific or educational project		Six projects x 20 p.	*120*
E	Indicator 20 Leadership of a national scientific or educational project		Three projects x 20 p.	*60*
E	Indicator 21 Leadership of a international scientific or educational project		One project x 40 p.	*40*
E	Indicator 22 Funds raised for projects managed by the applicant		Three projects with 10, 37 and 14 p.	*61*

Fifteen of them are referenced and indexed in world- databases of scientific information (Scopus and Web of Science). Six of the publications are with Impact Factor and another seven with SJR. Four of the publications are independent, in 8 publications she is the first author, in 2 she is the second author, in 4 she is the third author, and in the remaining 8 she is after third place in the list of authors.

Assoc. Prof. Kostova's scientific works have been published in international and national journals and series with an impact factor and SJR such as "International Journal of Technology and Design Education" (Q1), "The Scientific World Journal" (Q2), Comptes Rendus de l' Acade'mie Bulgare des Sciences (Q2, Q3), International Journal of Mechanics and Control (Q3), as well as full-text reports at international and national forums, etc. The main publication language is English, only one publication is in Bulgarian.

Associate Professor Dr. Kostova presented documents certifying leadership or participation in more than 20 projects and contracts, as well as funds raised for them.

She has presented data on 52 citations of her works, most of them in refereed editions, which show that the scientific results of Assoc. Prof. Kostova have gained wide popularity.

3. Overview of the content and results in the presented scientific production

The scientific output of Assoc. Prof. Dr. Snezhanka Kostova is directed in the field of robotic technologies in education, as well as the areas of analysis and synthesis of control of positive systems, modeling and control of processes in the field of the environment, etc.

The results in the thematically united and systematized scientific publications, equivalent to a monographic work, are presented under the title "Robotic technologies in education - status and prospects".

The use of technology in education has the potential to transform the way teaching and learning are done, making education more accessible, more effective, interactive and personalized. Robotics is emerging as an innovative teaching tool that is becoming increasingly important as children through recreational activities learn a variety of new concepts and develop abilities that will be useful to them in the future. It supports the understanding of abstract and complex concepts in science and technology courses, facilitates creative thinking, builds teamwork skills among children and young people.

The research presented in the publications, equivalent to a monographic work, is related to the implementation of several successfully completed and three currently active research projects. It should be noted that the Institute of Robotics and, in particular, the "Interactive Robotics and Control Systems" section actively and successfully work in the field, having implemented numerous international collaborations with global scientific networks and contacts with schools, educators, psychologists, parents. These publications reflect research on the use of commercial social robots and platforms in education, creation of cyber-physical systems for interactive games with robots for inclusive education, as well as a developed system for speech therapy of children with special needs, creation of a brain-computer interface based of EEG signals, modeling of the game educational and therapeutic process based on the control theory of positive linear discrete systems.

Group Г publications reflect results related to the research of good practices in the use of social humanoid robots as assistive technology for people with autism spectrum disorders, with the integration of robotics and assistive technologies. Developments in modeling, control of environmental protection processes are also presented, theoretical aspects of the controllability of positive linear discrete systems, etc. have been studied.

The contribution of Assoc. Prof. Kostova in the presented works is beyond doubt given her overall scientific and applied activity in the field, as well as the fact that four of the publications are independent, and in 8 publications she is the first author.

4. General description of the applicant's activities

4.1 Scientific and applied activities

Associate Professor Dr. Kostova presented a list of a total of 13 scientific projects and contracts in which she participated or led. Of these, 1 is under the Operational Program "Science and Education for Intelligent Growth", 5 - financed by the European Commission, 2 - financed by the program of the financial mechanism of the European Economic Area, 5 - financed by Bulgarian sources.

I believe that the management and participation in projects is a significant contribution to the research activity presented by the candidate.

4.2 Expert activity

The candidate is a co-founder (from 2018 - until now) and co-chairman of the Symposium on: Robotic and ICT assisted well-being, organized within the IEEE, International Conference on Software, Telecommunications and Computer Networks (SoftCOM), within which she reviewed numerous reports. Assoc. Prof. Dr. Kostova was a member of the jury in procedures for filling the

academic positions of Associate Professor and Chief Assistant and for the educational and scientific degree "Doctor".

4.3 Scientific-organizational and scientific-administrative activity

From 2022 until now, Associate Professor Kostova is the Chairman of the Scientific Council of IR - BAS. She has been the head of the scientific direction "Systems Engineering" of IR-BAS since 2010, during which time she was a member of the scientific council of IR-BAS. From 2010 to 2022, she was the Chair of the General Assembly of IR-BAS Scientists, and from 2020 to now she is a member of the Steering Committee of COST Action CA19104 - advancing social inclusion through technology and EmPowerment (a–STEP) .

4.4 Teaching and lecturing activities abroad

Assoc. Prof. Kostova was an assistant in mathematics at the Academy of Economics "D. Tsenov" (1984-1988), Svishtov and Institute for Foreign Students, Sofia. Under Erasmus and Erasmus+ teaching exchange programs, she has lectured at UPV–Valencia, Laboratory G–SCOP, INPG-Grenoble, France, University of Kavala, Greece, University of Portsmouth, Great Britain, etc.

4.5 Scientific specializations and visits abroad

Assoc. Prof. Kostova has carried out specializations at Curtin University, Department of Mathematics and Statistics, Perth, Australia, at the University of Bremen, Center for Technomathematics, at the European Institute for Energy Research, (EIFER), Karlsruhe, Germany, at the Technical University, Berlin, Department in Mathematics, at the Polytechnic University in the city of Valencia, Spain, Institute of Applied Mathematics, etc.

5. Contributions

The candidate submitted two references for the scientific and scientific-applied contributions: 6 are based on the works united as a monographic work (group B) and 4 contributions are based on the works united in group Г. I accept the scientific, scientific-applied and applied contributions, considering that in this form they correspond to the results obtained by Assoc. Prof. Kostova.

The main contributions in the works of the candidate can generally be characterized as an enrichment of theory and practice in the field of robotic technologies in education as follows:

1. An in-depth analysis of the use of commercial social robots and platforms in education was carried out, evaluating their effectiveness in terms of their technical characteristics, advantages, disadvantages and their potential for wider use in schools. The possibilities and specifics for the introduction of new technologies in education were investigated in three directions - in mass education, in the so-called non-formal education with extracurricular activities and in education for children with special educational needs. A survey was conducted among teachers/experts and parents through questionnaires in four countries from about the attitudes of the target groups to the use of new technologies and robots in the educational process. [4.5, 7.4, 8.7 и 4.7]
2. Cyber-physical systems for interactive games with humanoid and non-humanoid robots have been created for the purpose of inclusive education of children with special educational needs. They make it possible to take into account the individual needs of children and, through personalization of the therapy, to increase its effectiveness. Pilot tests of the games were conducted in laboratory conditions with normal children, followed by real experiments conducted in day care centers for children with special educational needs. An analysis of the obtained results was made, which proves the advantages of the system. [4.8, 8.2, 8.4]
3. The psychosocial and psychophysical aspects of interaction with humanoid and non-humanoid robots are investigated. A formalization of the iterative game process of children's interaction with robots is proposed by using the apparatus of linear discrete control systems. [4.10]
4. A speech and language therapy (SLT) system for children with communication disorders has been developed and experimentally tested, which has the potential to work in the Internet of Things (IoT) for remote delivery of social services and speech therapy. The proposed system allows for flexible solutions and can be used for other types of educational and/or therapeutic

purposes. A model for natural language understanding in human-robot interaction is proposed by using Generative Pre-trained Transformers (GPT) models as a service in IoT. [4.9, 8.8 и 8.9]

5. A brain-computer interface (Brain Computer Interface – BCI) has been created, based on EEG signals, which are recorded in real time through a non-invasive, portable Emotiv EPOC+ device. The EEG data is used to control a robot, thus giving the child feedback on their level of concentration. The combination of BCI with programmable robots in a single framework enables predefined characteristics for the frequency bands to be translated into commands to the robot. This approach was used to navigate a 3D printed walking robot Big Foot, created at the IR-BAS for educational purposes and to analyze and evaluate the emotional state of children. Existing challenges related to ethical procedures are reported. [4.4, 4.6, 8.5 и 8.6]
6. Three problems of the control of positive linear discrete systems are solved, which are used to model the game educational and therapeutic process: stabilization of a positive linear discrete system (SISO and MIMO) by means of state feedback based on Brauer's theorem; solutions of Linear Quadratic Regulator (LQR) problem for discrete systems with state non-negativity constraint and using invariant set theory. [4.1, 4.2, 4.3 и 8.3]

Other contributions

7. A comparative analysis of the good practices available in the literature in the use of social humanoid robots as assistive technology for people with autism spectrum disorders (ASD) was made. [7.5]
8. The relationship between the controllability of a positive linear discrete system and the existence of a solution to the synthesis problem by given eigenvalues is investigated. Sufficient conditions imposed on the system matrices and the set of eigenvalues of the closed system are proved. [7.1]. The problem of maximizing the stability radius of a positive linear discrete system by means of state feedback in order to reduce the sensitivity of the system to external disturbances is solved. [7.3].
9. A model for describing the pollution of connected sea basins was proposed using the apparatus of positive linear discrete systems [7.2]. A methodology for calculating external environmental costs and existing information products for applying the methodology are described. [8.1]
10. A conceptual framework is proposed that integrates robotics and assistive technologies and is applicable in all stages of the rehabilitation process - preventive, restorative, supportive and palliative. [8.10]

6. Critical notes and recommendations

I have no critical remarks about the candidate. My recommendation is for a more active activity in terms of supervising doctoral students.

7. Personal impressions and opinion of the reviewer

I have known Assoc. Prof. Dr. Snezhanka Kostova since the first years after the establishment of the Institute of Control and System Research, the predecessor of the current Institute of Robotics. My personal impressions are entirely positive. Her research and organizational qualities are indisputable. Her activity as the Chairman of the General Assembly of scientists of IR-BAS, Chairman of the Scientific Council and Head of the "Systems Engineering" direction at the institute is very effective. She is always positive, shows collegiality and a desire to support.

Assoc. Prof. Kostova's scientific contributions correspond to the actually achieved results. The publications are on the issues of the competition, they have been approved in authoritative national and international publications and international scientific forums. The presented production, results and achievements confirm Assoc. Prof. Dr. Snezhanka Kostova as an erudite and respected scientist.

CONCLUSION

Bearing in mind the above, I consider that **Assoc. Prof. Dr. Snezhanka Petrova Kostova** fully meets the conditions, criteria and requirements for the selection of the academic position of "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 **Assoc. Prof. Dr. Snezhanka Petrova Kostova** to take the academic position of **"Professor"** in Department "Interactive Robotics and Control Systems" in the field of higher education 5. Technical sciences, professional field 5.2. Electrical engineering, electronics and automatics, in the specialty "Interactive Robotics in Education".

30.08.2024 .....

Sofia Reviewer: Prof. DSc. Velislava N. Lyubenova