

OPINION

on the Competition for the Academic Position "Professor" in the Professional Field 5.2. Electrical Engineering, Electronics and Automation (Interactive Robotics and Control Systems) for the needs of the IRSU Section of IR-BAS, announced in the State Gazette, issue 44/ 21.05.2024

Member of the scientific jury: Prof. Dr. Siya Lozanova, IR-BAS

In the competition for "Professor" has submitted regular documents within the statutory deadline only one candidate - Associate professor Dr. Eng. Snezhanka Petrova Kostova.

1. Thematic focus and competition materials

One of the priority scientific-applied directions in robotics, and in particular of the Institute of Robotics at BAS, is computer-based technologies with a focus on their intensive penetration into education and didactics. The role of this important topic is the development and application of devices and IoT systems with elements of artificial intelligence to support the learning process and increase its efficiency and quality. Within the competitive digital labour market, this trend finds its realisation in supporting STEM learning. Despite the positive results and trends, the analysis shows that there is a significant lag in the development of technology and the pace of the education system to follow. The more significant reasons for this are of an organisational and logistical nature. The insufficient training of teachers in the various disciplines to use robotic technologies in the educational process; the still high cost of many of the devices, in particular robots and specialised software; the unnecessary of their maintenance, etc. are a stagnating factor in this so important area. The delay of the necessary state protectionism is a restraining factor for the development. Another key issue is the establishment and testing of ethical regulations in the use of new technologies and ensuring safe operation. In their synergy, these technologies form interactive robotics. At its core is the interaction between children and robots as well as more complex cognitive configurations. The cooperation of the IR-BAS with worldwide scientific networks and laboratories, implemented within the framework of numerous scientific research projects, the participation and contacts with schools, educators, psychologists, parents and other interested groups are a guarantee for the progress and upgrading of this field. Also of particular importance is the support for the therapy and education of children with special educational

needs. The tendency is that all developed technological solutions, products, software, etc. will be implemented in real environments - schools and centres for children with special educational needs in compliance with all ethical standards. The modelling of this process can be described as a linear discrete control system with parameters that are non-negative in nature.

The peculiarities of the research activity of Assoc. prof. C. Kostova is determined by her professional activity in the field of interactive robotics and systems. I believe that this scientific and technological field is promising with the development of artificial intelligence. The transmission of information adequate to reality and the related architectures, algorithms, models and protocols is the key component in the projects developed by S. Kostova mechatronic platforms. The broad scientific style of the candidate stands out and is confirmed in a large part of her research activity, which is in line with the trends of development of hardware and software specialized for this purpose. This kind of complex solutions is an important trend underlying the management and application of the innovative devices developed by the candidate.

In the Report on the minimum points required for the academic position "Professor", Assoc. prof. C. Kostova has presented indicators by groups of indicators. The total number of points required is 600, while the candidate has declared evidence for 1223 points. She has submitted, in accordance with the requirements of the Law on Robotic Technologies in Education - Status and Prospects, thematically grouped and systematized 10 scientific works, defined as equivalent to a monograph with the title "Robotic Technologies in Education - Status and Prospects". In addition to these, the candidate includes 16 publications outside the subject of the monographic work. Dr. S. Kostova actively participates as a leader and lead contractor in numerous national and international projects of the IRSU - IR-BAS, of which 4 are funded by the European Commission and 5 - by Bulgarian sources. She is also a lead researcher in one Competence Centre with beneficiary TU-Gabrovo. The financial impact of these projects amounts to no less than BGN 304 518. She has submitted a list of 52 citations of her work in reputable international journals. Assoc. prof. C. Kostova has been a lecturer in the PhD course "Linear Quadratic Differential Games and Applications" and has delivered 3 lectures in English on the topic of the announced competition. The candidate is also the co-founder (from 2018 to date) and co-chair of the Symposium on: Robotic and ICT assisted wellbeing, organized within the IEEE: International Conference on Software, Telecommunications and Computer Networks (SoftCOM), within which she has reviewed numerous papers. Dr. Kostova has been a member of the jury in procedures for the academic positions of "Associate professor" and "chief assistant professor", and for the "PhD" degree.

In conclusion, I highly appreciate the quality and efficiency of the work carried out by S. Kostova's publications, projects, citations and cumulative data on her scholarship.

2. Main scientific and applied contributions and results, significance

The more significant and structurally defining results and contributions of the candidate I have summarized as follows:

2.1. A systematic review and a sequential analysis of the use of commercial service robots and mechatronic platforms with social purpose in education is performed, evaluating their effectiveness according to their technical characteristics. A reasoned assessment of their advantages, disadvantages and potential for multiplying activities in schools is given. A comparative analysis is made between certain classes of robots according to selected indicators.

2.2. Implemented cyber-physical systems for interactive games with educational focus through humanoid and non-humanoid robots with focus children with special educational needs. These innovative systems take into account the individual needs of the children and by personalizing the therapy increased psychomotor efficiency of the learning process is achieved. Pilot tests of the games have been conducted in laboratory settings for children without and those with special needs. An analysis of the obtained results was made, proving the advantages of the developed system.

2.3. Designed, constructed and tested a speech therapy system for children with communication disorders. It has been coordinated to work in the Internet of Things (IoT) for remote delivery of social services and speech therapy. Using a Node-RED platform, the system connects different applications, services and assistive technologies to support therapy and on-line evaluation of its effectiveness. The development has been validated with the French humanoid robot NAO, the emotional-expressive robot Emo-San (designed and developed at IR-BAS), the Emotiv EROS+ device for recording brain signals, Kinect-sensor and cloud services for natural language processing, among others. The proposed system provides flexible solutions and could be used for complex educational and/or therapeutic purposes.

2.4. A brain-computer interface based on EEG signals that are recorded in real time by a non-invasive portable device, Emotiv EROS+, has been created. Using the EEG information, the robot is controlled, and the child receives feedback on his or her concentration level. This approach has been used to navigate a 3D printed walking robot Big Foot, created, patented and validated at IR-BAS for educational purposes to analyse and assess children's emotional state. I believe this contribution

is one of the strongest of the candidate and has direct practical applicability.

2.5. The relationship between the controllability of a positive linear discrete system and the existence of a solution to the eigenvalue synthesis problem is investigated. For this purpose, existing results in the literature on the controllability criteria and the corresponding canonical forms are used. Sufficient conditions imposed on the system matrices and the set of eigenvalues of the closed system are proved. They guarantee the existence of a feedback matrix that provides the desired spectrum of the closed system while preserving its positivity. Based on this result, a substantial part of the speech therapy algorithms of the used interactive robots are developed.

2.6. A model is proposed to describe marine pollution using the apparatus of positive linear discrete systems. The parameters, states, control, dynamics and existing constraints are described. The compartmental nature of the system is specifically analyzed, which determines the structure of the matrices. A methodology for calculating the external environmental costs accompanying each eco-activity and existing information products for applying the methodology are formulated. It is illustrated by an example of the use of Eco-Sence to quantify external environmental costs.

2.7. A conceptual framework that integrates robotics and assistive technologies has been developed and validated. It is applicable in all stages of the rehabilitation process - preventive, restorative, supportive and palliative. The algorithms incorporate key aspects of the recovery process - physical, emotional and mental. Multiple solutions are given related to personalized patient care from diagnosis to the active recovery process. Included are physical, emotional and virtual systems and augmented reality, sensory transducers for motion capture, human-computer interface, configurations with artificial intelligence elements, and more.

More contributory elements and results can be initiated in the theses, but in my opinion the more significant ones are **2.1 – 2.7**.

The achieved scientific and applied results and contributions of Assoc. prof. C. Kostova generally consist in the formulation and substantiation of scientific problems in existing scientific fields and theories. This forms a promising range of practical models, algorithms and architectures in Big Data systems. Also important are the contributions and results contained in the monographic work. In concrete terms, the significance of the results and contributions for practice lies in the improvement of robotic networks and systems with applicability in the modern learning process. I commend her initiative in the preparation, organization and management of European and national projects.

3. Recommendations and others

My main recommendation to Assoc. prof. C. Kostova is related to the use of some of the publications from group G to those in group B, forming her monographic work. This makes it difficult to evaluate the data included in the scientometric Reference. It would be useful if the competition materials contained summaries in Bulgarian and English of the scientific publications.

I declare that I have no coincidental publications with the applicant, financial relationships or other aspects subject to conflict of interest.

FINAL CONCLUSION

On the basis of the presented works, their scientific content and originality, I consider that they correspond to the high requirements typical for IR-BAS for holding the academic position "Professor".

As a result of the foregoing, I propose to the Honorable Scientific Jury and the SC of the IR, **Assoc. prof. Snezhanka Petrova Kostova to occupy the academic position of Professor in the professional field 5.2. Electrical Engineering, Electronics and Automation (Interactive Robotics and Control Systems) for the needs of the IRSU Department at IR-BAS.**

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Sofia

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