OPINION

for a competition for the acquiring academic position "Professor"

in a professional field 4.6. Informatics and Computer Sciences (Computer Modelling through CAD Systems with Application in Mechatronics and Robotics),

for the needs of Sofia University "St. Kliment Ohridski" (SU),

Faculty of Mathematics and Informatics (FMI),

announced in SG no. 20 of 08.03.2024 and on the FMI and SU websites

The opinion was prepared by: Assoc. Prof. PhD Krasimira Minkova Ivanova, Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences, professional field 4.6. Informatics and Computer Sciences, as a member of the scientific jury for the competition according to Order No. RD-38-203/30.04.2024 of the Rector of Sofia University.

Only one candidate has submitted documents for participation in the announced competition:

Ivan Nikolov Chavdarov, PhD

Associate Professor at SU, FMI, Department "Mechatronics, Robotics and Mechanics".

I. GENERAL DESCRIPTION OF SUBMITTED MATERIALS

1. <u>Application details</u>

The documents submitted by the candidate in the competition correspond to the requirements of the Act on development of the academic staff in the Republic of Bulgaria (ADASRB), the Regulations on the implementation of ADASRB, and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski".

For participation in the competition, candidate Ivan Nikolov Chavdarov submitted a list of a total of 14 articles and 2 patents. The publications fall into the following groups – 2 in Q2, 4 in Q4, the remaining 8 are with SJR. One of the patents is independent, and in the second he is the first author.

Among the presented documents are a list of all publications (total 90) and patents (total 10); list of all citations (62 indexed in WoS / Scopus and 86 not indexed); copies of the master's and PhD's diplomas and of the academic positions "Associate Professor" in professional fields 5.1 (former specialty 02.01.52 "Robots and manipulators") and 4.6; certificate of academic and other activities and awards; sample from the Authors system, showing participation in scientific projects (14 items), scientific guidance (6 graduates and 2 doctoral students), participation in conferences and issued teaching materials (2 items).

The submitted documents are complete. There is only one error in reporting the scientometrics of an article published in LNCS, which is only with SJR. The lists are conveniently cross-referenced to the texts of the publications and indexing in the scientometric databases.

2. Applicant data

Ivan Chavdarov graduated with a master's degree in mechanical engineering at TU – Sofia with a subsequent specialization in robotics. He worked in the Central Laboratory of Mechatronics and Instrumentation, and subsequently in the Institute of Systems Engineering and Robotics at the BAS – from Research Assistant to Associate Professor (PN 5.1. Mechanical Engineering), and in recent years he was also the Institute's scientific secretary. In 2006, he defended his doctoral thesis on the specialty "Robots and Manipulators". Since 2017, he has been an Associate Professor at the Sofia University "St. Kliment Ohridski", Department "Mechatronics, Robotics and Mechanics" (PF 4.6. Informatics and Computer Sciences). He is a member of the Bulgarian Robotics Society.

3. General characteristics of the scientific works and achievements of the candidate

The submitted scientific publications and citations for participation in the competition meet the minimum national requirements (according to Art. 2b, paras. 2 and 3 of ADASRB) and, respectively, the additional requirements of SU and FMI for occupying the academic position "Professor" in PF 4.6. They do not repeat publications included in the candidate's PhD dissertation (reference – the registration of Ivan Chavdarov in the Register of academic staff and the protected dissertation works of NACID). There is no evidence of plagiarism in the scientific works submitted for the competition.

The scientific interests of Ivan Nikolov Chavdarov are mainly in the field of computer modelling of robots and their application in mechatronics and medicine. The field is modern and rapidly developing. He knows in detail the current state of the problems and the proposed solutions now. The candidate has extensive publication activity in established journals and series. The citation of the results is a sign of the relevance and novelty of the proposed methods and solutions.

4. Characteristics and assessment of the candidate's teaching activity

Since his appointment in 2017 at FMI, Ivan Chavdarov has been leading lectures and exercises for Bachelor students in "3D modelling, printing and applications in robotics" and for Master students in the disciplines "Kinematics", "Modelling robots with a 3D printer", "Motion planning in a complex environment" and "Designing mechanical components of robots with CAD systems".

He is the supervisor of 4 doctoral students (three of them from the Institute of Robotics and one from SU-FMI), two of them have successfully defended, and the other two are in the process of learning.

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

The contributions of candidate Ivan Chavdarov are well structured and described in the Reference for Original Scientific Contributions.

The publications and patents presented for the competition are thematically divided into three main groups:

(1) Computer modelling of mobile robots.

(2) Computer modelling of stationary robots.

(3) Applications in mechatronics and medicine.

The main **scientific contributions** are:

Gait control models of a walking robot: New methods and models have been created to control the gait of a robot "Big Foot" based on sensory information. A model and algorithms for the optimization of the walking cycle with different sensors have been developed, and two laws of motion – sinusoidal and polynomial – have been proposed and investigated. The goal is to find a balance between minimizing impact loads and maximizing walking speed at a given motor output. A method is proposed to combine motor control and sensor information to investigate terrain irregularities. [1][5]

Optimization of the main dimensions of a walking robot: A method was developed for the optimization of the dimensions of the robot in order to reduce the energy losses when moving on flat terrain and overcoming obstacles. A normed space for the basic dimensions is introduced, a domain of operation is defined and an approach to the study of dimensional proportions is proposed. The method is applicable to robots with the same structure but different sizes. [2][3][4]

A method for solving the inverse kinematics problem redundant robots: The algorithm allows finding solutions through a geometric approach in a polar coordinate system, defining the different types of solutions for planar robots with serial topology. [11][14]

Methods and algorithms for robot movement in obstacle environments: Methods and algorithms have been developed for motion planning of stationary robots in obstacle environments, taking into account joint constraints and different types of solutions to the inverse kinematics problem. Planning involves analysing the kinematics and defining zones in the workspace corresponding to different types of solutions. A numerical approach is proposed to identify specific points at which the robot can change its decision type to perform the desired motion. This also includes trajectory planning to change the orientation of the executive unit with minimal displacement from the current position. [11][13][14]

Like **scientific and applied contributions** stand out:

- *Prototype of a walking robot with a minimum number of motors and a small number of moving parts*: design, CAD modelling and creation of a model by 3D printing, simulation study of the static stability and the ability to overcome obstacles of the robot by CAD software, creation of control algorithms for optimization of the walking cycle of the robot. [2][3][4]

- *Algorithm for combining sensory information with motility:* Terrain irregularities scanned by tactile sensors are used to correct the robot's movement. [1]

- *Robot prototype with additional degrees of freedom*: its design proposes a new approach for deriving the equations of motion and determining the torques of the motors of a robotic arm with an arbitrary number of joints [11-14], a program running in a CAD environment was created to solve the inverse kinematics problem for this robot [11], software was created to control the prototype, and experiments were conducted demonstrating the robot's obstacle avoidance capabilities. [13][14]

3

- *Application of the walking robot "Big Foot" in the education and rehabilitation of children with special needs*: Educational scenarios with the walking robot "Big Foot" are proposed for working with children with autism. [8]

- *Creation of a 3D printed humanoid robotic arm built on a modular principle:* the novelty is in the creation of the 3D printed fingers as a single assembled component and the monolithic embedding of actuators and control elements. An algorithm was created to determine the main kinematic characteristics of a finger of a humanoid hand. [9][10]

The publications submitted for participation in the competition are collective, and in 7 of the articles the candidate is the first author. Separation protocols were not submitted, so I consider authorship in the collective articles to be equally shared.

6. Critical notes and recommendations

I have no critical remarks about the candidate's work.

7. Personal impressions of the candidate

I don't know the candidate, so I have no personal impressions.

8. Application conclusion

After observing the materials and scientific works presented in the competition and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, **I confirm** that the scientific achievements meet the requirements of ADASRB, the Regulations for its application and the relevant Regulations of SU "St. Kliment Ohridski" for the candidate to occupy the academic position "Professor" in professional field 4.6. Informatics and Computer Science. In particular, the candidate satisfies the minimum national requirements in the professional direction and no plagiarism has been found in the scientific works submitted for the competition.

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

II. GENERAL CONCLUSION

Based on the above, **I recommend** the Scientific Jury to propose to the competent authority for the selection of the Faculty of Mathematics and Informatics at SU "St. Kliment Ohridski" to elect **Assoc. Prof. Ivan Nikolov Chavdarov** to occupy the academic position "Professor" in professional field **4.6. Informatics and Computer Science (Computer Modelling through CAD Systems with Application in Mechatronics and Robotics)**.

June 20, 2024   Sign:

Assoc. Prof. PhD Krassimira Ivanova