REVIEW

in a competition for the academic position of "Associate Professor"
Professional field **5.2 "Electrical Engineering, Electronics and Automation"**
Specialty: **"Application of the principles and methods of cybernetics in various fields of science"**
Announced by IICT-BAS, published in the State Gazette issue 57 of July 9, 2021

Candidate: Dr. Eng. Denis Safidinov Chikurtev
Member of the scientific jury: Prof. Dr. Todor Dimitrov Neshkov

1. General provisions and biographical data

Dr. Eng. Denis Safidinov Chikurtev participates in the competition with 37 scientific publications, apart from those used in other procedures. He was born on January 19, 1990. After completing a doctorate and obtaining an educational and scientific degree "Doctor" in one of the most prestigious scientific and technical institutions IICT of BAS, headed by famous scientist Prof. Dimitar Karastoyanov, he entered IICT of BAS. In 2017, he was elected assistant professor. He was a programmer at the IICT of BAS. A number of publications are related to research, simulation and control of the work of service robots for human support and relevant automated and robotic systems. The groups of indicators from group A give 50 points, group B 131.5 points, at required 100, group G 234/220 points, from group D and from group E the points are more than the required ones.

The analysis of the presented materials shows that the requirements of ZRASRB and the regulations for its application are covered, as well as the additional requirements of IICT-BAS.

2. General description of the submitted materials for participation in the competition

Most papers are published in: scientific collections in our country; scientific collections abroad; magazines in our country, magazines abroad. They are in the field of competition. There are 12 citations, mostly abroad and on prestigious forums.

Denis Safidinov Chikurtev has worked on research and development. He is the supervisor of some developments. All works are from the nomenclature scientific specialty of the announced competition. No

documents confirming the results of his work have been submitted. However, his participation is convincing and I am particularly pleased to note that the candidate's scientific and applied work is also directly linked to potential problems in the industry.

3. General characteristics of the research and scientific-applied activity of the candidate

I evaluate the research and pedagogical preparation of the candidate and his work as a researcher at the level of the requested scientific title in the conditions of BAS based on the following:

- After completing a doctorate and obtaining an educational and scientific degree "Doctor", the candidate continuously improves his qualification through successfully completed courses for various skills and work. The candidate is very fluent in English.
- He has actively participated in the conduct and organization of numerous conferences, seminars and forums with high-level international participation.

4. Main scientific and applied scientific contributions

I accept all the contributions presented in the applicant's report and evaluate them positively. They can be assessed as scientifically applied and applied as follows:

a. Applied scientific contributions

- A method has been developed to determine the most appropriate position of the mobile platform for object capture. This approach combines the data collected by the depth sensor and uses computer vision algorithms to find the correct projection of the object of interest on the two-dimensional map generated by the navigation system. It takes into account the parameters of both the mobile platform and the robotic manipulator [15];
- A model of a personalized communication system for remote control of service robots has been developed. The system is based on the Internet of Things, Web technologies, Wi-Fi and ROS. The structure of the system and the applied technologies used for system development are described. The system is applied in practice and its possibilities are presented [1].
- A method for controlling a service robot by voice commands via a web-based voice recognition user interface has been developed, which recognizes the set commands by the user and sends the control commands to the service robot, this method is based on

Google Cloud Speech API and uses HTML, Python Django and ROS [2, 28].

- Systems, methods and algorithms have been developed to ensure the safety and security of end users in the remote control of the ROBCO 20 robot. Methods for visual / facial recognition and voice verification of the speaker have been described and evaluated. A system for behavioral management and prioritization of users and their rights of access to the robot is proposed [5].
- A system consisting of the Kinect sensor, infrared and ultrasonic sensors is described. The Kinect sensor has a depth sensor with which the robot's navigation system does its job, with infrared and ultrasonic sensors located at the base of the service robot's mobile platform and making additional measurements to various objects that the Kinect sensor cannot register [21].
- Human-robot interfaces have been developed to provide user-friendly interaction between the elderly or disabled and the ROBCO 17 robot, presenting four possible robot control methods: joystick control, gesture control, voice control and remote control, through a web user interface and an open source speech recognition system - Julius - has been proposed as an alternative solution for local speech synthesis and recognition [7].
- RobCO18 robot control software has been developed, which allows the use of various interfaces and control methods, as the robot software system optimizes and distributes data from the robot's sensors and actuators, which allows the elderly and people with disabilities to be safe in work with the robot and can choose the most convenient for them method of robot control [8].
- A new approach to solving the problem of manipulator positioning has been developed, as the presented method combines computer vision and iterative learning control techniques to compensate for the inaccuracy of the kinematics and dynamics of the robot, which leads to an effective solution in accurate positioning near the desired object, even when there is very little knowledge of these mathematical models [4].
- A method has been developed to study the wear of lifters at mills. The aim of the method is to achieve remote imaging of the lifters by means of a robot and a 3D scanning device. The requirements to the parameters and characteristics of the robot are described, as well as the necessary properties of the 3D scanner. Methods for remote control of the robot and 3D scanner, as well as for transmission of the captured data of 3D models to a remote device have been studied [9].

- An indoor navigation method based on a computer vision system has been developed. The method uses object recognition algorithms and a system of cameras to locate and navigate a mobile robot indoors [11, 20].
- A designed wearable architecture and its interoperability with the robot's operating system are presented in order to plan the robot's actions. A tele-controlled service robot for improving the quality of life of the elderly and people with disabilities Robco 19 is described. The communication aspects of interoperability are presented [12].
- A software architecture for multi-channel control of service mobile robots has been developed. The proposed system provides remote access to the robot and full remote control, diagnostics and control. At the same time, the software system collects all data and control signals and distributes them to each subsystem [13].
- A specialized intelligent robot control system has been developed. The system is made up of neural networks and algorithms for data analysis and decision-making. Through this system, robots can understand the definition of commands, self-learn and perform autonomous operations [14].
- Various algorithms have been proposed for the control of service robots - such as PID-based engine control and collision avoidance, which leads to very smooth and precise movement and control of tolerance to operator errors [10].
- Methods for distributed group control of mobile robots are considered. Types of management structures and existing control approaches are described. Attention is paid to the state of the problem. Approaches with a reference trajectory, described differential wheel mobile robot, adaptive control, use of neural networks are presented [22].
- The method of a leader-follower is studied. An algorithm for process implementation, mathematical model of non-holonomic mobile robot, navigation and communication methods are presented. The presented algorithm and control method contribute to the correct positioning and achievement of goals set by a group of mobile robots [25].
- Two models of a control system for a group of mobile robots have been developed. Centralized system model and distributed system model. The functions of the systems are to calculate the relevant equations, to ensure communication between agents, to collect data from sensors and to send control signals. An additional feature of the systems is that a web user interface is offered for remote access and user monitoring. A block diagram of the control systems, distribution

of software commands and communication system for data exchange is presented [22, 26].

b. Applied contributions

- Various designs of mobile and service robots have been developed, including ROBCO 12, ROBCO 17, ROBCO 18 and ROBCO 20.
- Software for control of mobile and service robots has been developed.
- Software based on ROS, RVIZ and MoveIt! Has been developed. ROS is an open source operating system for robots that provides various services for robots. RVIZ is a 3D visualizer for displaying sensory data and status information from ROS. MOVEit! is software for mobile manipulation, motion planning, kinematics, control and navigation [27].
- The usability of the tele-controlled service robot was studied by performing real tests of the robot with the elderly, as the robot control is based on a multi-channel system for data distribution from external devices, such as - joystick, virtual joystick, microphone [6].
- A computer simulation of MATLAB on LQR control of a quadcopter has been developed. The simulation allows tracking the deviation of a quadcopter from the desired flight path in turbulent conditions. The proposed experimental setup can be used to compare and evaluate other trajectory tracking methods [3].
- The methods for 3D modeling of objects by scanning are studied. 3D models are used to recognize objects in the field of service robotics. The methods are for manual scanning by hand and for manual scanning by a robot. [31].
- Experimental results from the research of mobile and service robots, which can be used in the scientific activity of IICT at BAS, are proposed.

The indicated scientific-applied contributions can be referred to the groups: proving with new means of significant new aspects of already existing scientific fields, problems, theories, hypotheses; creating new classifications, methods, constructions, technologies and obtaining confirmatory facts, constructions and methods and enriching the existing knowledge with practical application.

There are a large number of other unreported applied and methodological contributions in the presented works. According to the candidate, most of his works are cited in Scopus.

5. Significance of contributions to science and practice

I believe that in terms of volume and quality the research and scientific-applied activity of the candidate fully satisfies the requirements of ZRASRB and the regulations for its application. The quantitative indicators of BAS and IICT for holding the academic position "Associate Professor" are covered.

The scientific-applied and applied contributions contained in the works of the candidate are essential for the development and enrichment of the theory and practice of digitalization of the cultural-historical heritage, new materials and technologies and the automation of the discrete production. All this leads to the recognition of the authority of the candidate among the scientific circles at home and abroad.

6. Critical remarks and recommendations

I have no critical remarks with which to challenge the main scientific-applied and applied contributions of the candidate.

Critical remarks can be made regarding some omissions in the design of some of the publications - in some works certain Bulgarian literary sources are not cited and probably not used, when quoting websites the date of use is not indicated.

In general, the preparation of the documents does not suffer from significant omissions and incompleteness.

The importance of the issue and the results obtained in some studies give me reason to recommend the candidate to make publications in referenced foreign journals and I recommend that they be independent. I also recommend active participation in prestigious national and international projects related to industrial technologies and their application.

7. Personal impressions and opinion of the reviewer

I have known Dr. Denis Safidinov Chikurtev since he was a student. I have followed his growth as a researcher and I have personal impressions of his competence. He is a thorough and precise researcher, competent and responsible organizer and implementer with proven capabilities. He has the skills to work in a team and to create a creative environment for the transfer of experience and knowledge. I recommend active work in the Bulgarian Society of Robotics and Automation, as well as in IEEE, section Robotics and Automation and IFAC in the committees on Mechatronics, Low-cost automation and others.

CONCLUSION

Based on my acquaintance with the materials of the competition and my personal impressions of the research and pedagogical activities of the candidate, the relevance and significance of the achieved scientific-applied and applied contributions, I confidently recommend Dr. Eng. Denis Safidinov Chikurtev to take the academic position of "Associate Professor" in the scientific specialty "Application of the principles and methods of cybernetics in various fields of science" at the IICT of BAS.

10.10.2021

ЧЛЕН НА ЖУРИТО:

(проф. д-р Т. Нешков)