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# PEER REVIEW

on competition for occupation of the academic position "Associate Professor" in the professional field 5. Engineering sciences, scientific specialty 5.2 Electrical engineering, electronics and automation, specialty Robots and manipulators, declared in the Newspaper of State №. 41 of 21.05.2019 with the sole candidate Dr. Eng. Nayden Chivarov

Reviewer: *Prof. Dr. Dimcho Stoilkov Chakarski*,

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## 1. Background and biography

Dr. Nayden Chivarov was born on October 27, 1973. He graduated with a "Master's Degree" in Mechanical Engineering for the Forestry Industry at the Higher Forestry Institute - Sofia in 1997. In 2001 he successfully defended his doctorate at the Institute of Robotics. at the Technical University of Vienna. From 01.08.2007 to 30.06.2010 he works as a research associate at the Central Laboratory of Mechatronics and Instrumentation at BAS. From 01.07.2010 to 30.09.2014 he works at ISER - BAS. From 15.06.2015 - 30.07.2017 works as an expert in the Ministry of Health. Since 20.10.2015 he is Assoc. Professor at the European Polytechnic University - Pernik, and from 01.03.2019 he works at IICT - BAS.

The applicant submitted a total of 46 scientific works for review, of which 42 publications, 3 research developments and 1 utility model. I accept for review all the submitted scientific works that can be classified in the following groups:

The distribution of scientific works is as follows:

• 10 publications in indexed and refereed editions in world-renowned databases of scientific information;

• 3 publications in indexed and refereed editions;

• 29 scientific articles and reports presented at congresses, conferences and symposia with peer review;

• 3 research projects;

• 1 useful model;

According to the author's place in the published scientific works:

• 1st place – 22;

• 2nd place – 10;

• 3rd place – 8;

• 4th place – 1;

• 8 place – 1.

I do not review, but report on the evaluation of 3 research developments. I appreciate that most of the papers accepted for review are focused in the field of Robotics and Manipulators.

The survey shows that the national minimum requirements for occupying the academic position of associate professor have been exceeded.

The attached table shows that the national minimum requirements for all criteria are exceeded, with a 23.1% over-fulfilment.

Table: Minimum requirements for associate professor

| Criterion | National requirements | Applicant N. Shivarov |
|---|---|---|
| A | 50 | 50 |
| B | 100 | 106 |
| G | 200 | 224,4 |
| D | 50 | 62 |
| E | 0 | 50 |
| **Total** | **400** | **492,4** |

### 2. General characteristics of the applicant's research, applied and pedagogical activity.

A large part of the applicant's research and development activities are focused on problems and specific tasks in the field of the announced competition. The applicant has shown that in the field of robots and manipulators he is very knowledgeable, about current developments and is aware of existing problems.

The candidate defended his doctoral thesis in 2001 in the scientific specialty "Manipulators and Robots" on the topic: "Tool-kit for modular intelligent mobile robots" at the Institute of Robotics at TU - Vienna.

The presented scientific works show further development of the problems presented in the dissertation.

The problems that Dr. Nayden Chivarov is working on, are relevant to the industry both at national and international level. Participates in 3 research projects. He is known among the scientific community as a highly skilled and respected specialist active in the field of mobile robotics, as evidenced by his research and implementation activities, with an attached list of citations, most of which are abroad (62 points in total).

### 3. Basic scientific and applied scientific contributions.

The main scientific and applied contributions contained in the scientific papers are related to mobile and service robots.

The scientific and applied-scientific contributions contained in the applicant's scientific papers can be classified into the following groups:

• **Cost oriented robot "ROBCO 18";**

• **Web based user interface;**

• **Tele-controlled service robot "ROBCO 17";**

- **Intelligent modular service mobile robot controlled via Internet ROBCO 12**

- **Intelligent Modular Service Robot "ROBCO 11";**

- **Graphical user interface for multi-function shadow robot**

- **Robco Phoenix, Educational Articulated Robot**

- **Robco Mobile Mobile Mini Robot**

- **Robo Scara Educational Robot**

- **Mobile Assistance Technologies.**

## Scientific and applied scientific contributions

• The usability of the tele-controlled service robot was investigated by performing real-world robot tests with the elderly, the robot control being based on a multi-channel system for data dissemination from external devices, such as a joystick, virtual joystick, microphone;

• Human-robot interfaces have been developed to provide user-friendly interaction between the elderly or disabled and the ROBCO 17 robot, with four possible methods for robot control: joystick control, gesture control, voice control and telecontrol, 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.

• ROBCO 18 robot control software has been developed to allow the use of various interfaces and control methods, with the robot software system optimizing and distributing data from the sensors and actuators of the robot, allowing elderly and disabled people to be in robot safety and can choose the most convenient method for controlling the robot.

• A new approach has also been developed to solve the manipulator positioning problem, with the presented method combining computer vision and iterative training control techniques to compensate for the inaccuracy of the kinematics and dynamics of the robot, leading to an effective solution in accurate positioning close to the desired object, even when there is very little knowledge of these mathematical models.

• Various algorithms for service robot control are proposed - such as PID-based motor control and collision avoidance, which results in very smooth and precise motion and control of operator error tolerance.

• The intelligent modular ROBCO 12 serviceable mobile robot designed via the Internet for the care of the elderly and / or the disabled is designed, which can "live" in the home of the elderly and / or disabled and help them 24/7, such as will be able to remind people to take medicines, serve food and drink, turn on / off electronic devices, alert when their health is deteriorating, and contact the doctor, family or emergency telephone 112.

• A project for personal assistive robots using ROS (Robotic Operating System) and Care-O-bot (COB) 3 has been developed as a demonstration platform, creating a semi-autonomous framework consisting of an autonomous control structure and user interfaces that support semi-autonomous operation.

• The "Intelligent Modular Service Mobile Robot Controlled via Internet" was developed, prototyped and tested using an open source / ROS meta-operating system that can be managed locally via a direct console or remotely (via the Internet) using remote terminal.

• A framework for improving the design of mobile assistive devices - MAT (Mobile Assistive Technology) has been developed by applying a modern engineering-generating method to develop architectural solutions for mobile assistive devices using the Rhapsody ™ tool, an MDD management environment. Real-time embedded systems based on the UML 2 standard.

• Examines iPad and Windows based user interfaces used to control a mobile robot for elderly care, describes specific areas such as robot control, object manipulation, task execution and real-time robot status processing, the robot uses the navigation map and manual control.

• Modern information and communication technologies have been proposed in the presentation and promotion of cultural heritage, with a system providing detailed information about museum exhibits through QR codes (Quick Response codes) and mobile devices.

• A robot with two active wheels and infrared sensors has been created, which follows a ball that emits modulated infrared light, with the robot having several infrared sensors ("eyes") that provide the necessary information to be able to detect not only the presence but and the direction of the ball.

• 3D object modelling methods that are used to identify objects in the field of service robotics are described, such as manual scanning and automatic scanning by a robot.

• A system consisting of a Kinect sensor, infrared and ultrasonic sensors is described. The Kinect sensor has a depth sensor for the robot's navigation system to do its work, with infrared and ultrasonic sensors located at the base of a mobile platform of the service robot and making additional measurements to various objects that the Kinect sensor cannot detect.

• A solution of the forward and invers kinematic problems for mobile robots with symmetric active wheels is proposed, and the results can be implemented in the control of such robots in the form of state feedback synthesized using linear quadratic optimization and / or stable techniques for management.

• 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 viewer for displaying sensor data and status information from ROS. MOVEit! is a software for mobile manipulation, motion planning, kinematics, control and navigation.

• A method for controling a voice-based service robot via a web-based voice recognition user interface has been developed that recognizes user-specified commands and sends commands for service robot management, using this method based on the Google Cloud Speech API and using HTML, Python Django and ROS.

• Some problems related to the kinematics, dynamics and control of a three-wheeled mobile robot are considered, the equations of motion are obtained using the Euler-Lagrange approach and the dynamics of the propulsion are taken into account.

• A mobile robot platform and its possible applications in different fields of education have been developed, based on modules suitable for different applications and easy to use. This article shows a robot with line tracking sensors, which presents the mechanical system, electronics, programming, and algorithm required to complete the task.

• Features of controlling mobile chain robotic platforms and implementing wireless communication to provide control and feedback between a robot and a computer are considered.

• A robot control and communication scheme are proposed, a block diagram of an algorithm for the operation of the entire robot system is described, a program is written in the C # programming language and the .net framework.

• The task of a circular mobile robot platform with two drive wheels, parallel to each other and at equal distance from the centre and two more passive wheels, is considered, with the aim to understand how it is possible to achieve the most accurate localization of a mobile robot caught in a previously unknown environment.

• Methods and means for controlling and driving DC motors driving mobile mini-robots have been reviewed and applied, with a broad pulse motor control selected and an algorithm used to perform this motor control in conjunction with an infrared sensor so as to achieve good overall system performance.

• The capabilities of the intelligent mobile service robot ROBCO 12 with limited capacity and six degrees of mobility, to transport compact loads along a predetermined trajectory in space, in this case determined by three trajectory points, such as the laws of motion at each degree of mobility is defined on the basis of the trajectory points and at a given trajectory travel time as third degree polynomials.

• The design and implementation of Mixed Reality Server (MRS) is described and a communication design concept is proposed for the Care-o-Bot robot user interface using the rosbridge stack and the open source meta-OS, such as the open source work system (ROS) is capable of rapid integration of various types of robotic platforms, the availability of easily configurable navigation packages and a wide range of robotic hardware support.

• The status of the current tasks and the work done by ISER-BAS as part of the SRS consortium for the project "Multifunctional System for Independent living" is reviewed.

• Trigonometric polynomials have been investigated for the purpose of using mechanisms, machines and robots in the planning of the laws for the motion of the working parts of the work, with special attention being paid to movements in which one of the mandatory conditions is the zeroing of speeds and accelerations at the beginning and end of displacement of effectors.

• A graphical user interface has been developed for easy control of ROBCO SCARA, allowing both manual (via keyboard commands) and automated (by executing automated control scripts) user control and configuration.

• An application using the open source / ROS meta-operating system for a remote-controlled anthropomorphic robot is described, as a basis for the exploration and study of a remote-controlled articulated robot via ROS / Ubuntu, using the ROBCO multifunctional articulated training minibot.

• A concept for centralized control of multiple subordinates' mobile robots has been developed, which is the key to solving a large number of tasks ranging from amusement to industrial controls and allows flexibility and scalability of the entire system.

• A system for control and programming of all types and classes of Robco educational robots, allowing manual and automated control and configuration, is presented.

• A graphical user interface has been developed for easy control of all types of Robko educational robots, which allows both manual (through keyboard commands) and automated (by executing automated control scripts) user control and configuration.

• Straight and inverse kinematic problems are set and solved concerning the definition of functions according to which the input parameters are changed to control the motion of SCARA robots at a given path and their derivatives, synthesizing the parabolic laws of motion based on obtained normalized polynomial of given trajectories.

• The technical parameters and rules for competitions with soccer robots are described, a soccer robot is developed and the system for controlling a soccer robot is described.

**Applied contributions**

• Various designs of mobile and service robots have been developed, including, ROBCO PHOENIX, ROBCO SCARA, ROBCO 11, ROBCO 12, ROBCO 17, ROBCO 18.

• Software for controlling mobile and service robots has been developed.

• The results of the research of mobile and service robots can be used in the scientific activity of the IICT-BAS.

• Publication results can be used in the engineering practice of companies and organizations.

**4. Significance of contributions to science and practice**

The importance of the contributions in the candidate's scientific work is expressed in the enrichment of the theory and practice in the field of robotics and automation of production processes. In this field, Dr. N. Chivarov has received recognition not only here but also abroad. This is confirmed by the quotations of his scientific works.

He has the necessary skills and experience to work with a modern toolkit for designing, creating and researching mobile robots and systems in various fields of human activity for the purposes of industry and social activity.

**The evaluated works** are highly applicable in practice.

**5. Critical notes**

I did not find any fundamental inaccuracies and errors in scientific works. Nevertheless, there are some disadvantages, gaps, incompleteness, etc., of which are characteristic:

• The number of self-published publications is small (only one).

• Not all publications clearly disclose scientific and applied contributions.

• They are presented in a very summarized way in the contribution reference, and one contribution must be defined in a complex sentence.

• There are publications with overlap texts.

• I recommend more self-published publications in the future.

## 6. Personal impressions

I personally know the candidate from our joint contacts and participation in scientific conferences on robotics, mechatronics and automation. The materials presented in the competition are well designed and significant in content.

In general, the following summaries can be drawn from the materials submitted by the candidate, Dr. N. Chivarov, for participation in the competition:

• **Research and implementation** are targeted and deepened with a very high potential for implementation in a number of companies and organizations, with significant involvement in international projects.

• **A great deal of scientific work** is devoted to current problems in the design, creation and research of mobile robots and robotic systems.

• **The applicant's scientific and applied contributions** are significant and indisputable.

• **Dr. Nayden Shivarov is an established specialist** in the design, research and application of mobile and service robots in the manufacturing and social fields, which is respected among the robotics and automation guild.

### Conclusion:

*Based on my acquaintance with the presented materials on the competition, my personal impressions, the relevance and importance of the scientific and applied contributions contained in the developments, the achieved implementation in engineering practice, I strongly recommend that the distinguished scientific jury positively evaluate the scientific works of the competition and propose of the Scientific Council of the Institute of Information and Communication Technologies to elect Dr. Eng. Nayden Chivarov to take up the academic position Associate Professor, in scientific specialty 5.2 Electrical engineering, electronics and automation, specialty Robots and manipulators.*

Sofia, 21/08/2019 Reviewer:.................................

**(Prof. Dr. Eng. Dimcho Chakarski)**