

## REVIEW

By Assoc. Prof. Eng. Martin Milenov Kambushev, Ph.D.

"GEORGI BENKOVSKI"

BULGARIAN AIR FORCE ACADEMY

of the thesis of mag. eng. PETKO IVANOV STOEV

on the topic „MULTIPURPOSE TELE-OPERATED SERVICE  
ROBOT”,

presented for the acquisition of the educational and scientific  
degree "doctor"

in a doctoral program

„Application of the principles and methods of cybernetics in various  
fields of science“

## **1. Relevance and significance of the developed scientific problem**

The topics covered in dissertation submitted for review cover mechatronics and in particular robotics, communication technologies, human-computer interaction with the resulting legal and ethical norms. The research and creation of a multi-purpose tele-controlled service robot is a complex task requiring in-depth knowledge in many scientific fields such as communication and information technologies, mechatronics, cyber-physical systems, artificial intelligence, etc.

The topicality of the topic is indisputable and is touched upon in the strategic policies and documents of the European Union and the United Nations for the development of the technological sector: "Society 5.0", "Industry 4.0", "Industry 5.0", PROGRAM 2030 of the United Nations, Strategic Program of the European Commission for period 2019-2024, "2030 Digital Compass: Europe's path to the Digital Decade", "European Digital Strategy", "Europe Fit for the Digital Age", Horizon Europe Programme, European Green Deal, EU Circular Economy Action Plan.

The creation of a multi-purpose tele-controlled service robot is a topical task that will help solve many tasks facing business and society.

## **2. General characteristics and structure of the dissertation work**

Engineer Petko Stoev has thoroughly researched the scientific problem. The solution proposed by him proves his knowledge in the field of technical sciences and the ability to solve scientific-applied and research tasks. When developing the dissertation work, based on the analysis, the author substantiated the object, subject, goal and tasks of the research. The research problems, their practical significance and applicability were investigated in the dissertation, and the set goals and objectives were fulfilled. The following methods were used in the dissertation work: 3D design, computer modeling and simulation using CAD/CAM products, processing of experimental data, etc.



The dissertation consists of an introduction, 3 chapters and a conclusion.

The introduction presents the topicality of the topic, the object of the research, the subject, the goal and the tasks that must be solved to achieve the goal.

The first chapter examines in detail the leading concepts and policies of the United Nations and the European Union and the corresponding plans and programs that guide and direct the development of the technological industry and in particular the development and application of robotics and service robots. In this chapter, the main specific features, mechanics and design of multi-purpose tele-operated service robots are given. The specifics of human-robot interaction are indicated.

In the second chapter, the design of the multi-purpose tele-controlled service robot developed by the doctoral student is presented. The mechanical system of the robot, its drive and executive mechanisms, its sensor system and the implemented design are described in detail.

The third chapter presents the control of the multi-purpose robot, and for each mode and selected module, the working algorithm, software and control hardware developed by the doctoral student are shown. The remote control of the remote controllable multifunctional mobile robot platform is considered. The simulations carried out in a computer environment, on the basis of which the control algorithms were verified, are described in detail.

### **3. Characteristics of the scientific and scientific-applied contributions in the dissertation work**

The scientific and applied contributions of the dissertation are expressed in:

1. For each of the robot's operating modes, depending on the module used, a control algorithm has been developed and the execution sequence of each of them is described.



**The applied contributions of the dissertation work are expressed in:**

1. 5 software are linked - Proteus 8.16, SolidWorks-CAD, Arduino IDE, HHD Software's Virtual Serial Port Tools and Blender 3D for synchronized data transfer between them.
2. On the basis of the joint and synchronized application of the five software (Proteus 8.16, SolidWorks-CAD, Arduino IDE, HHD Software's Virtual Serial Port Tools and Blender 3D) simulations were compiled and implemented, through which the work algorithms compiled by the doctoral student were verified the robot in its various modes.
3. A mobile robotic platform has been developed with the possibility of attaching modules of different construction and purpose.
4. Six separate modules have been developed, with different functions, design and purpose, through which the robot can work in heterogeneous environments and perform activities and operations that are completely different in nature and execution method.
5. Telecontrol of a multifunctional mobile robotic platform through a web-based graphical interface, using MQTT and web sockets, was developed.

**4. Evaluation of the scientific results and contributions of the dissertation work**

As a result of reviewing the dissertation work, I can confirm that Eng. Petko Stoev thoroughly knows the state of the problem and has creatively approached its development and solution. The author strictly adhered to the scheme of scientific research - object, subject, goal, formulation of tasks, analysis of the state of the problem, construction of a hypothesis, research and verification of the adequacy of the obtained results.



I appreciate that the contributions of the candidate Eng. Petko Stoev are his personal business. The scientific and applied contributions of the author enrich the existing knowledge. The realization of applied contributions by creating a multifunctional mobile robotic platform, the implementation in both practice and production and will lead to the creation of jobs and economic benefits for the state and society.

## **5. Evaluation of dissertation publications and authorship**

The author has presented 5 publications on the developed dissertation work. Three of them are at conferences referenced in Scopus, and the other two at national conferences with international participation. In one of them he is an independent author, and in the others he is a co-author. For the 5 publications presented, the author has one citation. The publications represent separate studies, correspond to the set topic of the scientific work and represent separate stages in the construction of the same. The author's published research prepares and enriches the scientific community for the researched problem. They demonstrate thoroughness in the preparation and execution of the research process by the doctoral student. The author's participation in the publications is indisputable, since the need for them is determined by the topic of the dissertation work.

Engineer Petko Stoev is the author or co-author of a total of 16 publications referenced in Scopus and Web of Science.

## **6. Literary awareness and competence of the doctoral student**

In the dissertation, a review of the available literature was carried out. There are 94 cited literary sources, mostly in English. A large part of the indicated sources are from the last five to ten years, which allows the doctoral student to obtain up-to-date information on the current state of the problem.

From the material provided, it can be argued that the doctoral student knows the state of the problem very well and has creatively interpreted the information from the analysis of the literary sources.

## **7. Evaluation of the abstract**

The abstract is prepared in accordance with the requirements, is well illustrated and fully reflects the scientific problem developed by the doctoral student. It reflects the scientific methods and approaches of the conducted research, as well as the obtained results.

## **8. Critical Notes**

The comments on my dissertation submitted for review are not essential and can be divided into two main groups:

1. Formatting errors: punctuation and grammar errors in the text, incorrect formatting, etc.;
2. The tasks set are repeated twice in the Introduction.

The mentioned remarks do not reduce the value of the dissertation work.

## **9. Personal impressions and other matters on which the reviewer considers it necessary to take a position**

I don't know the PhD student personally. Taking into account the presented dissertation work, the author's publications and his participation in several projects, one of which he is the leader of, I can claim that M.Sc. Eng. Petko Ivanov Stoev is a scientist with a taste for research work aimed at novelties in the field of robotics.

### **Recommendations:**

- I recommend the PhD student to form a team and further develop his project by creating a full-fledged multifunctional mobile service robot;



## 10. Conclusion

The dissertation submitted to me for review has volume, depth, and completeness. The author has obtained results with the necessary significance for the educational and scientific degree Doctor. The publications presented by mag. Eng. Petko Ivanov Stoev meet the minimum national requirements. The doctoral student has proven his competences for solving a scientific-practical problem. The work complies with the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its Implementation, and the dissertation work has significant contributions.

## 11. Evaluation of the dissertation work

Referring to what has been said so far, I give a positive assessment to my dissertation submitted for review. I propose to the members of the scientific jury to award the educational and scientific degree Doctor of Mag. Eng. Petko Ivanov Stoev for the developed dissertation on the topic "Multi-purpose tele-controlled service robot" in the scientific specialty " Application of the principles and methods of cybernetics in various fields of science ", field of higher education 5. "Technical sciences", professional direction 5.2. "Electrical engineering, electronics and automation".

10.03.2024.

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