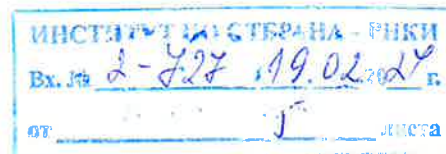




## **MINISTRY OF DEFENCE**

**DEFENCE INSTITUTE „PROFESSOR TSVETAN LAZAROV”**

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### **REVIEW**

**by professor Rosen St.Iliev, PhD,**

of the dissertation of  
**eng. Aleksander Genchov Ranov**

**on “Routing and Control Model of  
the movement of an autonomous combat platform”**

for the acquisition of an educational and scientific degree "doctor"  
in the doctoral program "Automated Systems for Information Processing and  
Control", professional management 5.2 "Electrical engineering, electronics and  
automation", field of higher education 5. "Technical sciences"

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

The creation of autonomous combat platforms in which a person does not directly participate in their management is an actual problem that is gaining more and more popularity, especially with the introduction of artificial intelligence in decision-making. From the point of view of military applications, such systems can be used to perform various combat tasks, for logistics, for reconnaissance, especially in conditions of probable adversary impact, in order to avoid unnecessary risk to the crew.

In the submitted dissertation, the research is focused on the issues of the military application of autonomous ground platforms with an emphasis on synthesizing a routing model when preparing a transport plan for the movement of a ground autonomous combat platform and to propose methods to control its movement taking into account the specifics when used for military purposes.

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

The dissertation consists of 170 pages (with the appendices), of which 147 pages are the main part, and the rest are 12 appendices. Its structure consists of an introduction, four chapters, a conclusion and a bibliography. In the main part of the dissertation, there are 62 figures and 11 tables. The bibliography includes 111 titles in Bulgarian and English.

In the *First chapter*, a study of modern achievements in theory and practice in the application of autonomous platforms is made, emphasizing their military application and the possibility of routing in a mode without using an existing road network, with tactical and technical requirements aimed at determining a route, using the protective properties of the terrain, not the shortest route. Restrictions have been placed on the development of the dissertation work, within the scope of the topic of the present scientific research and taking into account the available material provision. The goal of the dissertation research is defined and the tasks leading to the fulfillment of the goal thus set are set.

In the *Second chapter*, some problems and solutions in the routing of an autonomous combat platform are discussed, by considering a path planning approach hidden from a specific observation point of the likely adversary and according to the tactical-technical capabilities of the autonomous platform to overcome the slope. A model for processing the information during route determination is presented and the mathematical foundations for the localization of unmapped nearby obstacles with the application of computer vision methods through the use of a stereo camera are discussed.

In the *Third chapter*, methods and algorithms for controlling the movement of

an autonomous combat platform based on a mathematical model of the state vector are presented, and a movement speed control model based on an inertial navigation sensor (MEMS) is proposed and with the application of closed loop feedback; an innovative software approach is proposed with an adaptive digital filter for speed control and a method for spatial compensation of deviations in the readings of a magnetometric sensor for cases when it is physically separated from the sensor with accelerometric and gyroscopic action. The chapter presents the results of approbation of the method for spatial compensation of deviations in order to increase the accuracy.

The *Fourth chapter* presents an architecture for routing and conducting control of the movement of an autonomous combat platform, consistent with modern views on the use of autonomous devices in the preparation and conduct of combat operations; an experimental set-up is described for conducting model studies based on a specially created physical model (prototype) of an autonomous platform. As a result of the research, a methodology was proposed for determining the possibilities of executing a given route.

In the *conclusion*, the achieved scientific-applied and applied contributions in the dissertation work are formulated and a list of publications related to the dissertation is given.

### **3. Evaluation of the scientific results and contributions of the dissertation work**

The contributions of eng. Aleksander Ranov can be defined as scientific-applied and applied. They are a logical consequence of the scientific and applied research presented in the main part of the dissertation. I accept the results defined by the author as development and enrichment of existing knowledge and application of scientific achievements to solve important practical tasks related to the autonomous control of combat platforms in conditions of hidden movement from an enemy observer.

I consider that the dissertation work and the results obtained in it are credible and are the result of the conducted scientific research, studies, analyzes and experiments with the prototype of an autonomous platform developed specifically for this purpose.

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

In the attached list of publications related to the dissertation, four titles are indicated that present the achieved results of the work to the scientific community. In two of them, the candidate is the sole author, and in the third, he is the first

author. Two of the publications are in Bulgarian, and the other two are in English. One of the publications was presented at an authoritative international conference, referenced in the SCOPUS database.

All publications correspond to the topic of the dissertation work and reflect the results achieved in the research.

#### **5. Opinion on the presence or absence of plagiarism**

I have not noticed any plagiarism in the author's work. The content and manner of writing show a characteristic style of presentation of the text and emphasize its uniformity.

#### **6. Literary awareness and competence of the PhD-student**

In his work on the dissertation, the author used 111 literary sources. Of these, 14 are in Bulgarian and 97 are in English. Most of the cited publications are from the last 10 years. The indicated references are reflected in the main text of the dissertation work and are appropriately used by the author in the exposition.

#### **7. Evaluation of the autoreferat**

The presented autoreferat of the dissertation consists of 40 pages in Bulgarian. The autoreferat was developed in accordance with the dissertation work and adequately reflects the results achieved by the author during the research.

#### **8. Critical notes and recommendations**

The critical comments I made during the preliminary examination of the dissertation work were taken into account by the author and were reflected in the text.

I recommend eng. Aleksander Ranov to continue his scientific research in this, in my opinion, interesting topic on which he is working and to direct his efforts to present the achieved results in more publications included in world-renowned databases.

#### **9. Personal impressions**

I know engineer Aleksander Ranov as a long-time colleague from the Defence Institute. During conversations held with him on issues related to his work on the current dissertation, he demonstrates the necessary level of competence in the field of his scientific research. I consider that the candidate has the necessary potential for development as a young scientist in his chosen scientific specialty.

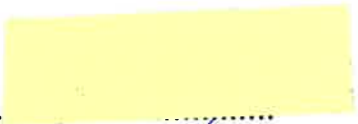
## 10. Conclusion

As a consequence of the above, I define the dissertation work of eng. Aleksander Ranov as meeting the content, volume and structure of the requirements for the acquisition of the educational and scientific degree "doctor", according to the "Regulations on the conditions and procedure for the acquisition of scientific degrees in Defence Institute "Professor Tsvetan Lazarov", the "Law on the Development of the Academic Staff in the Republic of Bulgaria" (LDASRB) and the regulations for its implementation (RLDASRB).

## 11. Evaluation of the dissertation work

From the content of the dissertation, the autoreferat, the fulfillment of the procedural requirements for compliance with the LDASRB and RLDASRB, as well as my personal impressions, gives me the reason to give a POSITIVE ASSESSMENT of the dissertation work "Model for routing and control of the movement of an autonomous combat platform" and **I offer to the author, eng. Aleksander Genchov Ranov, to be awarded the educational and scientific degree "Doctor", in the field of higher education 5 "Technical sciences", professional direction 5.2 "Electrical engineering, electronics and automation", doctoral program (scientific specialty) "Automated Systems for Information Processing and Control".**

02.02.2024

Reviewer:   
(Prof. Dr. Rosen Iliev)