



МИНИСТЕРСТВО НА ОТБРАНАТА
ИНСТИТУТ ПО ОТБРАНА „ПРОФЕСОР ЦВЕТАН ЛАЗАРОВ
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OPINION

by Associate Professor Doctor Angel Dimitrov Genchev,
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for **Alexander Genchov Ranov's** dissertation

**on "A Model for Routing and Traffic Control of an Autonomous Combat
Platform"**

for the acquisition of the educational and scientific degree Ph.D.

in the scientific specialty "Automated systems for information processing and
management"

1. Relevance and significance of the developed scientific problem

The relevance of the problem is evident from the actions that not only militarily leading countries such as the USA, Great Britain, France, but also neighbors of the Republic of Bulgaria (Turkey, Serbia) are taking to promote development, testing and direct investment in the development of autonomous platforms with military application.

Modern wars such as the war in Ukraine and the war in the Gaza Strip have seen extensive use and testing of such platforms, both airborne and ground-based. Their application in the military sphere is aimed at assisting the own personnel in tasks such as transporting ammunition and wounded soldiers, working on minefields and as well as providing protection of certain combat positions and reconnaissance. From the above, we can conclude that the topic of the dissertation examines an actual problem related to the creation and use of a model for determining the routes and controlling the movement of an autonomous ground combat platform.

The main content of the dissertation is related to the presentation of a mathematical apparatus and algorithms for finding routes without using an existing road network and avoiding visibility from an enemy observation point, synthesis and validation of a model for processing information in routing, as well as an application of inertial navigation methods and motion control algorithms of an autonomous ground platform.

As a novelty I can classify the proposed algorithms for determining a route with hidden movement for avoiding mapped obstacles, as well as for detecting obstacles with the application of an inferred interpolation dependence. The model for controlling the speed of movement of the autonomous platform, the method for spatial compensation of deviations in the readings of a magnetometric sensor and the calculation procedure for optimizing the cutoff frequency of the digital filter of MEMS sensors are also novel.

2. Assessment of the scientific results and contributions of the dissertation work

In the first chapter, an analysis of the topicality of the problem, the existing achievements and the goal and tasks of the dissertation are set. The second chapter presents models, approaches, possible solutions and practical experiments in autonomous ground platform motion routing, unmapped obstacle detection and sensor calibration. The main scientific-applied and applied results and research are presented in the third chapter of the dissertation work, and the fourth chapter is dedicated to practical problems and solutions for the application of the autonomous platform, and experiments were conducted with a developed physical model of an autonomous platform.

I accept the contributions and results proposed by the author.

I believe that the developed methods and models for finding a route with a "hidden movement matrix" result and for controlling the speed of movement with the application of closed-loop feedback; the algorithms for drawing up a transport plan of a ground autonomous combat platform, without using an existing road network and in the conditions of stealth movement relative to a known enemy observation point and for compensation of deviations in the readings of a magnetometric sensor, as well as for the detection of unmapped obstacles using stereo-camera represent scientific-applied and applied contributions that build on existing knowledge.

As additional scientific-applied contributions, the presented approach for applying optimization of digital filter parameters in controlling the speed of an autonomous combat platform and the methodology for determining the possibilities of executing a given route and the presented architecture for routing and controlling the movement of autonomous combat platform.

The application of the scientific achievements in practice are the conducted studies of the possibilities of functioning of the proposed routing models by using

test software applications, the spatial graphic analysis on experimentally obtained data regarding the method of compensation of deviations in the readings of a magnetometric sensor, the created experimental setup for conducting research and recording of energy characteristics during movement of a physical model of an autonomous platform, etc.

There are four scientific publications on the subject presented. I believe that they reflect the ideas, the methods used, the research carried out and the results and conclusions obtained. I believe that these scientific publications sufficiently reflect the work done and inform the potential audience about the main results of the scientific activity in the course of developing the dissertation work.

The creation of a physical model of a self-propelled platform helps to prove in practice the applicability of the developed algorithms and locomotion models.

The author correctly cites the sources of basic concepts, theoretical and algorithmic foundations and software tools and components used in the dissertation work.

3. Critical remarks

I have no particular critical remarks about the presented dissertation work. My main complaint is that in places too much attention is paid to details irrelevant to the main topic of the work, for example how exactly the SD card of the physical model is formatted or exactly how the wireless connection is implemented.

I recommend that the PhD student continue his research in the field of autonomous combat platforms, paying more attention to presenting the results of implementing an improvement in the form of a comparison with and without its implementation, in isolation from other, subsequent improvements.

4. Conclusion

I believe that the presented dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its implementation for the acquisition of the scientific and

educational degree "DOCTOR".

The achieved results contain the necessary quantitative and qualitative contributions of a scientific-applied and applied nature. They can find practical application in the development of autonomous ground platforms for military purposes.

5. Assessment of the dissertation work

I positively evaluate the presented dissertation work, considering that the material includes theoretical and practical results in a volume that satisfies and exceeds the minimum requirements for awarding the educational and scientific degree "doctor" in the scientific specialty "Automated systems for information processing and management".

Date
19.02.2024 г.

Member of the jury