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Legal Aspects of Production and Operation of Autonomous Combat Robots

Michał SIWEK*, Kamil WACŁAWIK

Military University of Technology, Faculty of Mechatronics and Aerospace,
2 gen. Sylwestra Kaliskiego Str., 00-908 Warsaw, Poland
**Corresponding author's e-mail address and ORCID:*
michal.siwek@wat.edu.pl; https://orcid.org/0000-0003-2818-9725

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Abstract. Mobile robots are increasingly replacing people in particularly dangerous situations and those at risk of losing their lives or health. One of such applications are military and preventive activities, where mobile robots are not only used for reconnaissance and patrol operations and the development trend is focused on the increasing use of mobile robots on the battlefield. Therefore, this type of equipment must meet the requirements and standards guaranteeing safety for the user and the environment. The paper presents a set of requirements for the production and use of autonomous combat vehicles put up by organizations such as the Defence Department, the European Union and NATO.
Keywords: combat mobile robot, robot on the battlefield, robot with a weapon module, military robot

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1. INTRODUCTION

Technological progress means that soon military operations will be strongly supported by autonomous combat systems, and ultimately the role of soldiers in the battlefield will be taken over by robots. The special application now is directed to the fight against terrorism, where robots are used to disarm bombs and reconnaissance and patrol tasks [1]. The development trend, however, seeks to use robots to carry out combat tasks on the battlefield. It is anticipated that the first fully autonomous combat robots will be used in such army actions as rescue missions, activities in areas contaminated by biological or chemical weapons and irradiated as a result of a nuclear attack, conducting reconnaissance in an unknown area patrolling military bases in peacekeeping missions. Robotization of the army clearly reduces the risk of casualties among soldiers, but the use of robots on the battlefield still raises a lot of controversy [2].

Special interest in autonomous combat vehicles is demonstrated by the Russian and American armies. The Russian arms industry is working on a series of terrestrial battle platforms, what confirms that the support of soldiers on the battlefield by robots will be one of the most important elements of conducting combat operations [3]. One of the examples of robots deployed in the Russian army is the Platform-M robot (Figure 1), which was tested in Syria and Kaliningrad, and its goal is to protect the naval base in the far north.

Fig. 1. A prototype of a heavy, autonomous combat platform Platform-M [Source: https://sputniknews.com/military/201507241025004070/]

An example of an American combat robot is Foster-Miller TALON [4]. It is a small, weighing about 45kg robot on a tracked chassis with the possibility of being equipped with an armament module in the TALON SWORDS version (Figure 2). The use of TALON SWORDS robots in military missions was tested in Iraq.

Fig. 2. American battle platform TALON SWORDS
[Source: http://www.asimo.pl/modele/talon.php]

The analysis of the literature shows that the use of military robots is not limited only to guarding military bases. The use of military robots on the battlefield is increasingly frequent, which is a very difficult task from the point of view of legal conditions due to the need to quickly take much more decisions by the autonomous platform control system than in the case of driving along fences of military bases. The article presents a set of principles and legal regulations that should be considered when building an autonomous robot, intended for military and civilian applications.

2. LEGAL CONDITIONS FOR THE USE OF COMBAT ROBOTS FOR CIVIL AND MILITARY TASKS

When considering an autonomous wheeled vehicle with an armament module for reconnaissance and combat tasks, both legal conditions concerning civil and military equipment should be considered. In this paper, the legal considerations imposed on military works by such organizations as the European Union, NATO and the consideration of Polish Defence Standards were considered.

2.1. General laws of robotics

The task of the laws of robotics is to consider all aspects of the robotic capabilities increase. Due to the development of robotics and microtechnology, the set of robotics laws requires constant updating [5].
The first canons of robotics were formulated by Isaac Asimov:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence if such protection does not conflict with the First or Second Law.

Later, the so-called the zero law, which has become the overriding law that a robot cannot harm humanity or lead to damage to human beings by stopping action. The analysis of the global state of knowledge shows that the EU has proposed that rules be created based on the existing laws of robotics. When creating the algorithm for controlling autonomous machines, the principle of code flexibility should be considered. For this purpose, in the case of implementing moral principles, blockades should be used to prevent the robot from changing these rules.

Soon, the imagination of constructors may lead to the situation that the robot's appearance will make it impossible to distinguish it from a human being, which will cause many problems if legal regulations are not considered. To this end, the basic set of robotics rights has been extended by two more rights:

4. The robot must reveal its nature of the robot. In particular, the robot cannot pretend to be human.
5. The richer it is to equip the robot with sensor systems that ensure the perception of environmental conditions, and the possibility of autonomously determining actions by its control system, the poorer its design may be.

The existing laws of robotics were decided to modernize by the decision that fell during the robotics fairs in Fukuoka (Japan) in 2004. The alternative content of robotics has been formulated:

1. The next generation robots will be partners co-existing with human beings.
2. Next generation robots will help human beings both physically and psychologically.
3. The next generation of robots will participate in creating a safe and peaceful community.

The formulation of the current version of the laws of robotics was the beginning of the development by the European Robotics Research Network (EURON) of the documentary “Roboethics Roadmap”, announced in Geneva in 2006.

Specific recommendations of the Roboethics Roadmap include wording that should be specifically considered when developing a robot autonomous system. Recommendations for the construction of autonomous robot control systems resulting from Roboethics Roadmap:

1. The systems should be able to control and limit the autonomy of the robot by the human operator.
2. Hardware and software security and passwords should be used to limit unauthorized use of the robot.
3. The robot should have a built-in "black box" enabling it to track its activities and behaviours.
4. Like cars, autonomous robots should have a visible identification (registration or serial number).
5. To preserve privacy, the robot should be able to encrypt the information entrusted to him.

2.2. NATO requirements for combat robots

The role of robots in the army is referred to as supporting troops on the battlefield, and in the future eliminating human participation in the most dangerous to life and health tasks. Combat robots are particularly used in Special Forces, and hence, strict requirements on size, weight, as well as the functionality and speed of the control system are imposed on them. Due to the strategic tasks of the armed forces, specific legal conditions for the development and supply of military equipment are defined by NATO [6].

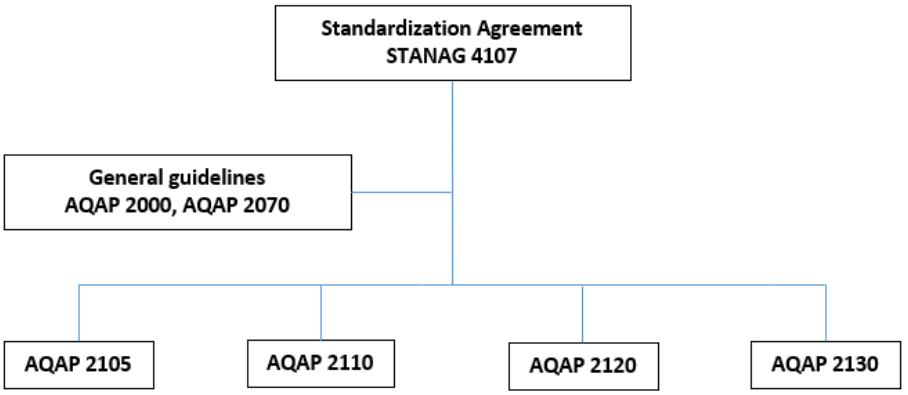

Fig. 3. Structure of the standardization agreement STANAG 4107 series AQAP 2000 [Source: own study]

In accordance with the NATO quality policy, defined in the standardization document AQAP 2000: 2003, all constructors, contractors, and users are responsible for its quality throughout the life cycle of arms and military equipment. To unify and specify the requirements for organizations providing defence supplies, including military devices and equipment, STANAG 4107 was established.

STANAG 4107 is a NATO standardization agreement recognized by NATO member states, including Poland. This agreement sets out the rules for ensuring the quality of delivery of products, subjected to international agreements as a part of the Government Quality Assurance process, and it introduces quality assurance requirements for organizations providing military supplies through appropriate AQAP quality assurance releases. Figure 3 presents a summary of the current AQAP 2000 series standards, which are described in detail below:

- AQAP 2105 - Quality plan requirements for the product being the subject of the order.

The requirements of the AQAP 2105 standard include issues regarding the development of quality plans by units cooperating with the army. The development of a quality plan in the process of delivery of ordered military equipment makes it easier to supervise the contract and to eliminate inefficient, undesirable, or unfavourable activities. The quality plan defines the activities, processes, responsibility for the supplier's resources and indicates the way they are supervised. The quality plan should fulfil two compatible functions:

- describe all requirements for the system in relation to the contractual provisions set out in the delivery contract;
- present external activities with the planning of the product implementation in terms of product quality, possession of necessary resources and carrying out the indicated control activities, such as verification, validation, and monitoring.

The implementation of the AQAP 2105 standard limits the risk of disruption to the contract and eliminates unnecessary or inefficient activities.

- AQAP 2110 - Quality assurance requirements in design, development, and production.

Modern military units are complex organizations, have extensive technical and machine infrastructure. Undertaking all activities must take place regarding to specific rules of conduct. The AQAP 2110 standard sets the most extensive contractual requirements for product quality management. To introduce armaments and military equipment to the unit, the supplier should establish, document, implement, evaluate, and improve an effective and economical Quality Management System in accordance with ISO 9001: 2015. The scope of their System, documented by the Supplier, should contain records of internal audit, self-assessment, and other objective evidence that the system is compliant with AQAP 2110, effective, and easily accessible to the buyer.

In addition, the supplier will develop and maintain instructions on performing activities related to the control of production of materials, parts, components, subsystems, and the level of system advancement for the product delivered.

- AQAP 2120 - Quality assurance requirements in production.

NATO AQAP 2120 requirements extend the ISO 9001 standard in terms of responsibility, authority and communication with the provision concerning the tasks of a management representative, which should include maintaining proper communication with the ordering party. The AQAP 2120 standard extends the requirements for the disclosure of input and output data for the audit product. It also includes provisions regarding subcontracting of ordered military equipment. In the case of order fulfilment, the contractor is obliged to inform the customer about subcontractors with whom he cooperates. In addition, subcontractors have the same requirements for the quality of products as suppliers. The NATO standard AQAP 2120 requires the supplier to develop a procedure for classifying, supervising, and segregating all non-compliant products.

- AQAP 2130 - Quality assurance requirements for inspection and testing.

The production process is the initial phase of the product's life, and the activities constituting it have a significant impact on the quality of the product being created. The aim of AQAP 2130 is to ensure the maintenance of the highest level of quality in the process of product inspection and testing at subsequent stages of production, which determines the achievement of a final product that meets NATO requirements. The AQAP 2130 standard is largely based on the requirements of ISO 9001 and it introduces additional requirements based on:

- communication of the supplier with the armed forces at all stages of the production of the product;
- planning the entire production process, considering the requirements set out in the contract;
- providing military services with information on input and output data from periodic auditing;
- informing about the use, in the production process, of subcontractors' services and maintaining quality standards by them in the process of product testing and control;
- promptly inform the customer about the rejection or repair of the product delivered by the subcontractor, when this fact was identified as a risk factor;
- supervision of monitoring and measurement equipment, the standard of measurement and metrological confirmation systems should be in accordance with ISO 10012-1;
- supervision and measurement of the product, the supplier should demonstrate the Certificate of Conformity (COC) product declaration;

- supervision of an incompatible product.

The AQAP 2130 standard is used for contracts for the supply of machinery and equipment, the quality of which depends on the method of production. In practice, this applies to a very large range of defence and administrative products.

2.3. Civil law on robotics - European Parliament Directive

The European Parliament, bearing in mind the fact that the era of cooperation is close to the arm of the man with the robot, stated that it is extremely important to define legal provisions defining the admission of a machine to work among people [7]. The regulation of the European Parliament and the Council of the European Union 2016/679 specifies legal regulations concerning the protection of personal data and regulations ensuring privacy in the case of communication of applications and devices with each other and with databases without human intervention. In the process of designing autonomous algorithms, it is necessary to provide security and the ability to control and verify the decisions taken by the system. The more autonomous the robots are, the less they can be treated as ordinary tools in the hands of other entities (e.g. producers, operators, owners, users, etc.). It turns out that the ordinary rules on liability are not enough and it is necessary to introduce new rules and regulations to ensure clarity regarding legal responsibility. It was necessary to formulate a series of general principles regarding the development and use of autonomous robots for civilian purposes, and the most important of these is outlined below.

General rules for the development and use of autonomous robots:

1. Within the current legal framework, robots cannot be held liable for acts or omissions of activities that result in third-party damage;
2. The cause of the cases of action or failure to act by robots can be traced and assigned to a specific entity, which is a human being;
3. Manufacturers, operators, owners, and users may be held responsible based on a risk for a robot to act or forfeit;
4. In the event of damage, caused by robots or artificial intelligence, the user of the product is liable for conduct leading to the damage;
5. The development of robotics-related technology should largely be based on complementing and not substituting human capabilities;
6. The robot should be equipped with a black box containing data on all operations performed by the machine, including logical operations that contributed to the decision, and should be able to present this information in a way that is understandable to humans;
7. The use of cameras and sensors in robots should be consistent with the principles of personal data protection, with emphasis on privacy and respect for private life;

8. The robots and software designers are responsible for the safety of certainty and functionality in achieving the goal of the placed machine.

The European Parliament's Directive also covers general principles for the design and use of automatic and autonomous vehicles. Engineers-designers of robotic systems should be responsible for the impact on society, the environment, people, and health that their designs may have now and in the future. Therefore, several rules have been developed for designers and users of robotic systems, which should be guided to meet all the requirements set in the European Parliament Directive in the process of developing new technologies. The design rules are summarized below. The design process should:

1. include privacy at the design stage to ensure that private information is securely stored and used only properly;
2. apply the obvious withdrawal mechanisms - emergency switches, which should be consistent with the reasonable objectives of the project;
3. ensure that the robot operates in a manner consistent with local, national, and international ethical and legal principles;
4. ensure that the robot's decision-making steps are traceable and reproducible;
5. guarantee the requirement of maximum transparency in the programming of robotic systems as well as predictability of robot behaviour;
6. analyse the predictability of the human-machine system by considering the uncertainty in interpretation and operation and possible failures on the side of robots and people;
7. develop tracking tools at the robot design stage that will facilitate the description and explanation of the robot's behaviour;
8. draw up design and evaluation protocols;
9. cooperate with potential users and stakeholders in assessing the benefits and risks associated with robotics;
10. ensure that robots are identified as robots during interaction with human beings;
11. ensure the safety and health of persons interacting with and being in contact with robots, as robots as products should be designed using processes that guarantee their safety and protection.

2.4. Defence standards imposed on combat robots

Based on a regulation of the Council of Ministers of 23 December 2002 on standardization activities related to defines and security, the state was approved and introduced for use in organizational units of the Defence Department and organizational units reporting to the Minister of National Defence or overseen by the Polish Defence Standards (NO) and Defence Normalization Textbooks (PDNO) [8].

An autonomous combat vehicle with an armament module should meet the requirements of the following eight Polish defence standards:

- NO-06-A101: Armament and military equipment - general technical requirements, inspection, and testing methods. General provisions.
  The subject of the standard are general provisions, purpose, scope, and validity of a set of standards, classification of apparatus, instruments, devices, and equipment for military use.
- NO-06-A102: Armament and military equipment - general technical requirements, methods of inspection and testing. Reliability requirements.
  The standard defines the general reliability requirements, the principles of selecting reliability indicators: apparatus, instruments, devices and equipment for military purposes and principles of ensuring reliability during design and production.
- NO-06-A103: Armament and military equipment - general technical requirements, methods of inspection and testing. Environmental requirements.
  The standard specifies general technical requirements regarding the impact of environmental factors (mechanical, climatic, biological, special environments, nuclear impact factors and other factors relevant to operating conditions) on equipment, instruments, devices, and equipment for military use.
- NO-06-A104: Utilities and military equipment - general technical requirements, methods of inspection and testing. Construction requirements.
  This standard defines structural and technical requirements, requirements for components, earthing, control and tuning bodies, depreciation, overall dimensions and weight, standardization and unification requirements, electromagnetic compatibility of interference immunity, radio masking, radio infrared, optical, hydroacoustic, vulnerability for control, metrological equipment of devices and built-in control measures, the use of radioelectric products, materials and coatings, electrical assembly, electrical insulation, hallmarking, maintenance and packaging, ergonomic and technical aesthetics, instruments, equipment and equipment for military use.
- NO-06-A105: Armament and military equipment - general technical requirements, methods of inspection and testing. General rules for testing and collection of prototypes and devices produced in series.
  The standard specifies the general principles of testing and receiving apparatus, devices, equipment and equipment produced in series as well as their prototypes, including checking compliance with the requirements regarding reliability and total resistance to environmental factors, as well as with construction and technical requirements given in tactical and technical assumptions, and technical conditions regarding devices.

- NO-06-A106: Utilities and military equipment - general technical requirements, methods of inspection and testing. Methods of reliability testing.
  This standard presents methods for assessing the conformity of apparatus, instruments, devices, and equipment for military use with reliability requirements set in tactical and technical assumptions and technical conditions.
- NO-06-A107: Armament and military equipment. General technical requirements, control methods and tests. Methods of testing total resistance to environmental factors.
  The subjects of the standard are methods for assessing the conformity of apparatus, instruments, devices and equipment for military use (hereinafter referred to as devices) with requirements, regarding total resistance to environmental factors determined in tactical and technical assumptions and in technical conditions.
- NO-06- A108: Utilities and military equipment - general technical requirements, methods of inspection and testing. Methods for assessing compliance with structural requirements.
  This standard contains methods for assessing compliance with structural and technical requirements given in tactical and technical assumptions and technical conditions.

3. SUMMARY

Technological progress is rapidly bringing the world closer to the times when the use of automatic machines in everyday tasks will become commonplace. Advanced robots, computers, androids, and other forms of artificial intelligence seem to give rise to a new industrial revolution that will not bypass any layer or social field. Demand for autonomous systems is observed in military technology. Considering the last 50 years, the use of robots in combat tasks has allowed for a huge reduction in civilian losses related to the possibility of more accurate execution of combat operations by robotic systems.

The activity of the armed forces - its character and scope - imposes on the combat works, the requirement to use the highest quality products. To ensure that the product provided by the manufacturer meets all the necessary requirements, all the standards and requirements for design (construction, control system, and decision making), manufacturing and use should be considered at the design stage.

In the long term, the current tendency to design intelligent and autonomous machines, that can be trained and that are able to make decisions on their own, indicates not only economic benefits, but also raises many concerns about their direct and indirect impact on the whole society.

Machine learning, by significantly improving the ability to analyse data, offers many economic benefits, considering the aspect of innovation, but it is associated with the need to ensure sound conduct, transparency, and intelligibility of decision-making processes. In the process of designing combat robots, it is imperative to adhere to the applicable laws and norms.

Compliance with the adopted regulations guarantees the speed and accuracy of decisions made in the conditions of life and health hazards for many people. Maintaining high quality of technical infrastructure and processes in military units can only be ensured by undertaking cooperation with reliable and reliable contractors who will guarantee the delivery of products compliant with the requirements included in the contract.

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Aspekty prawne wytwarzania i eksploatacji autonomicznych pojazdów bojowych

Michał SIWEK, Kamil WACŁAWIK

Wojskowa Akademia Techniczna, im. Jarosława Dąbrowskiego
Wydział Mechatroniki i Lotnictwa
ul. gen. Sylwestra Kaliskiego 2, 00-908 Warszawa

Streszczenie. Roboty mobilne coraz częściej zastępują człowieka w sytuacjach szczególnie niebezpiecznych i zagrożonych utratą życia lub zdrowia. Jednym z takich zastosowań są działania militarne i prewencyjne, gdzie roboty mobilne nie są wykorzystywane już tylko do prowadzenia działań zwiadowczo- patrolowych. Trend rozwojowy ukierunkowany jest na coraz częstsze zastosowanie robotów mobilnych na polu walki. W związku z tym wytwarzanie i późniejsze użytkowanie tego typu sprzętu musi spełniać szereg wymagań i norm gwarantujących bezpieczeństwo dla użytkownika i środowiska. W artykule przedstawiono zbiór wymagań jakie dla wytwarzania i eksploatacji autonomicznych pojazdów bojowych jakie stawiają organizacje takie jak Ministerstwo Obrony Narodowej, Unia Europejska i NATO.
Słowa kluczowe: bojowy robot mobilny, roboty na polu walki, roboty z modułem uzbrojenia, roboty wojskowe