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CAMOUFLAGING IN MODERN COMBAT OPERATION CONDITIONS

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Abstract: *Resources camouflaging is ongoing task that is constantly being planned and implemented. It is achieved through concealment, imitation and false actions. It is undertaken to reduce own losses and to reduce the effects of enemy's actions and to increase the ability to protect own forces. The conducting of camouflaging is accomplished by applying acquired experience, acquiring and applying knowledge of the application of various means and techniques, as well as technologies. The development of modern acomplishments in various fields of science has found application in camouflage actions. In order to lead to wrong conclusions, armored combat vehicles are disguised by the application of technical-technological solutions that create the image of a passenger car on the screen of recconaisance devices. In order to improve the camouflage effects, experiments are carried out based on the natural characteristics of the plant and animal world. Efforts are being made to conquer the possibility of controlled application of their natural abilities in artificial conditions through the production of materials that will significantly help the integration of manpower and technology into the natural environment.*

Key words: *Camouflage, Digital reflection, Bionic camouflage, Dynamic cloaking, Adaptive materials*

1. CAMOUFLAGING

Looking through the history of war events, it is impossible not to notice the fact called camouflaging and the application of camouflage discipline measures. According to Rkman (Rkman, I., 1988) "camouflaging is a skill that is needed to be understood as a creative application of experiences from the past, which in new conditions (more perfect means for reconnaissance and observation, high mobility of combat equipment, characteristics of modern

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combat operations, etc.) seek original solutions, self-initiative and creative spirit". The same author points out that "camouflaging represents the key military skill that is applied in various situations, (in peace, as well as in war) which includes entire set of measures and techniques that make it possible to conceal the presence, activities and disposition of own forces, assets and facilities from the enemy. Aim is to create confusion and disrupting the enemy, which exerts a significant influence on the outcome of the conflict." (Rkman, I., 1988)

In the modern environment, the importance of camouflaging is recognized, and accordingly, the planning and execution of various combat actions cannot be imagined without the application of certain elements of force protection. Force protection, as a substantive (influential) factor of combat operations, "implies the preservation of the combat potential of deployed forces in the combat operations zone, the fight against all enemy threats, natural and technological disasters and the prevention of operations" (Serbian Army Doctrine, 2010). Depending on the situation, available time and type of operations, force protection is conducted through: camouflage, combat insurance, anti-electronic and anti-aircraft protection, fortification, nuclear-chemical-biological protection, dispersion, mobility, as well as threat detection and warning. (Serbian Army Doctrine, 2010). As such, it "represents an integral and essential part of every operation" (Doctrine of Operations of the Serbian Army, 2012).

Camouflage includes concealment, impersonation, and false actions. It is undertaken in order to reduce own losses, protect the secrecy of the deployment of forces and conceal the activities, real intentions, actions and other planned activities of the Army units. (Doctrine of operations of the Serbian Armed Forces, 2012) To the above should be added the fact that "it is undertaken to reduce the effects of the enemy's actions and increase the ability to protect own forces" (Doctrine of ViPVO, 2010). In addition to the use of hand-held and formation camouflage items, the creation of false fire and radar positions, false runways, and the placement of models of means contribute to deceiving the enemy and protecting own forces in the operation. (ViPVO Doctrine, 2010) It is organized and applied continuously at all levels and all structures of the Army and society. (Doctrine of ViPVO, 2010)

Camouflage, as a content of force protection (Serbian Army Doctrine, 2010), can be divided according to: purpose (individual, tactical, operational and strategic), conditions and material used for camouflage (using natural and weather conditions and materials and using artificial materials and means - physical and formation) and execution method (hiding, concealment and deception), each has the purpose of "making it impossible or difficult for the enemy to find and recognize our facilities, material and technical means and units and thereby make it impossible or difficult for the enemy to choose a profitable targets for attack" (Rkman, I., 1988).

The issue of camouflaging is not an area that is studied exclusively on the territory of the Republic of Serbia. Other armies have a similar approach to define camouflage. (Forbes, P., 2009, Abler, Th., 1999) Various papers have been published on issues related to camouflage. Holbrook A. W. (Houlbrook, A., W., 1999), in his work presents certain considerations about the need to develop capabilities, based on the development of technical means for image processing, in order to detect camouflaged objects and means in different terrain and environment. In order to better hide the personnel during the execution of tasks on different terrains, McNab Ch. (McNab, Ch., 2002) looks at the persistence and necessity of changing uniforms during the 20th century and the need to introduce a camouflage pattern. The question of the quality and persistence of the camouflage pattern was dealt with by Gramer G. and Onil T. R. (Cramer, G., & O'Neil T., R., 1999). Through the performed scientific analysis, they proved the need for the introduction of a digital pattern and its effects on cloacing. In addition to the issue of introducing camouflage patterns, Forbes P. (Forbes, P., 2009) indicates the need

for constant analysis of different camouflage patterns. Hartcup G. (Hartcup, G., 2008) indicates the importance of the application of concealment and deception (as the content of camouflaging) in war events. Mitchell K. D. and Staples C. R. (Mitchell, K., D. & Staples C., R., 1999) wrote about the application of camouflage colors, their harmonization with the surrounding color and their optimal relationship to form the necessary camouflage pattern. About camouflaging in modern combat conditions and the necessity of applying modern technologies in our professional literature wrote Milic, A., et. al. (Milic, A., Ranđelovic, A., Radovanovic, M., 2019).

2. THE ISSUE OF COMBAT OPERATIONS CAMOUFLAGE IN CONTEMPORARY CONDITIONS

Man's desire to improve various means is best reflected through the constant development of existing technologies and optoelectronic means. The development of means of reconnaissance deserves special attention. It was the development of the aforementioned means, during combat operations, that influenced the need to develop camoufalage assets aimed at specific techniques and technologies. The level of development of modern technological and electronic means for deception during the movement of military equipment is best explained by the report on the possibility of tank movement in space. It is a well-known fact that they are very difficult to mask. Therefore, the development of protection systems is no surprise, by applying camouflaging elements for tenks and other armoured vehiacles during combat operations (at the battle field and in approximity). One of the possible solutions is presented through the application of technological achievements that display the image of a passenger car on the screens of surveillance devices. (Wallace, J., 2011) The exsisteng camouflage pattern (uniform pattern and on camouflage items) is constantly checked and harmonized with the level of development of means of observation. Therefore, it is not surprising that in the literature you can find contents that perform different analyzes on the degree of compatibility of camouflaging effects with the environment (Winkelman, M., 2015, Bozanic, D., et. al., 2015). Not only the effects achieved by camouflage patterns (on uniforms or nets) are analyzed, but also the degree of camouflage of the vehicle by removing the shadow created by the vehicle during movement is considered, the work indicates (Yangping, W., et., al., 2017). The degree of masking achieved and the impact on the way the war is conducted is constantly and vigilantly monitored (Pomerleau, M., 2017) and certain assumptions are made about the possibility of applying modern technical innovations on the battlefield (Rayment, S., 2011). The existing possibilities of camouflage with standard assets are constantly analyzed with a tendency to improve them (Michalis, C., et., al., 2017), and an analysis of the capabilities of existing assets in relation to the influence of the environment and technical means is carried out (Fennell, J., G., et., al., 2018, Lin, C., J., et., al., 2019, Talas, L., et. al, 2018, Ershadi, N., Y., et., al., 2018).

The available published content indicates that the question of camouflaging is very studiously and constantly analyzed are carried out with the tendency of constant development and application of various means and techniques, in oreder to increase the level of protection for personel and weaponry during combat operations. In previous years, attention was focused on protection against means that conduct reconnaissance from space or very high altitudes. With the development of various technologies, the question of height from which reconnaissance is carried out is reduced, so airplanes and drones are included. Recent examples indicate that mini and micro drones equipped with high optoelectronic means for collecting information from air (Black Hornet Personal Reconnaissance System/FLIR Systems) are used for reconnaissance tasks. It was the use of drones that greatly influenced the (no) success of camouflage work during combat operations in Ukraine. (Milic, A.,et. al., 2023)

3. CAMOUFLAGE ACTIONS EXPERIENCES

Current practice indicates that the units for carrying out tasks from the content of camouflage depend to the greatest extent on the assigned (formation) camouflage assets as well as on the ingenuity of the command staff. The ingenuity of the command staff is based on the experiences gained from previous war conflicts or the knowledge gathered during the analysis of various combat conflicts (operations) in other countries. In order to better prepare for future combat operations, it is necessary, in addition to the previously mentioned experiences and knowledge, to monitor and gather knowledge about the level of development of modern means at opponent's disposal. As possible solutions, applied in practice so far is the application of appropriate measures of deception, concealment and cloaking. (Milic, A., etl. al, 2019)

To this end, the available forces and capacities (of the Army and civilian companies) can be engaged in the tasks of organized production of various types of models and decoys. Models that are made and placed according to the prepared plan can greatly influence the enemy to make wrong conclusions and enormous expences. Regardless of the quality of the models and decoys on fake firing positions, it is necessary to "revive" them by occasional simulated engagement of own forces. In order to realistically display the position, it is necessary to leave certain unmasking signs. Protection of more complex systems and facilities, e.g. airplanes, airports, bridges and other similar objects can be solved on a larger scale by decorative and scenographic painting (Milic, A., etl. al, 2019). For the purpose of protecting the assets of the air defense artillery-missile units and the artillery units, the firearms were placed under natural masks (in the forests) or within artificial structures (garages) and, if necessary, they went out to the firing positions. After the action, quickly place them in buses or trucks garages that are at a safe distance from the camouflaged shelters, and move the personnel away from the facilities to previously prepared shelters. After cooling the barrels and the system, the item, under the cover of darkness, returns to the camouflaged shelter.

Reducing the ability to spot combat vehicles and increasing resistance to the impact of certain missiles was conducted by using rubber conveyor belts, which were in simple fascion placed on combat vehicles and objects. By placing them on vehicles, the following is achieved: more difficult detection and detection of the actual dimensions of the items, reduction of signal transmission from the wheel hubs and from parts that can be hot (exhaust branch of engine gases, engine part of the tank) for the infrared spectrum of observation, a longer degree of protection because the material can survive field use.

4. TASK FOR IMPROVEMENT OF CAMOUFLAGE CONDITIONED BY EXPERIENCES FROM MODERN COMBAT OPERATIONS

The analyzes that were carried out after the NATO forces aggression on the Federal Republic of Yugoslavia in 1999 and the monitoring of the conflicts for the past 30 years imposed certain tasks that should be implemented with the aim of achieving the task of camouflaging in modern combat operations. One example is the analysis of the solution of the Army of FRY by the US Army (specifically, it refers to the application of rubber conveyor belts for tow) for vehicle camouflage. (Papa, J., W., & Fahlsing, G., A., 2004) The reports of pilots and reconnaissance agencies were checked through research on the impact of the mentioned means on the degree of camouflaging and protection of the assets that use them.

As a possible solution for the protection of personnel and assets, some countries have used the achieved effects of models of combat and radar systems, and continued to develop newer systems models whose production is simpler and profitable in the long term. They develop models of various devices that are the same dimensions as the real thing, but the shape and size is acquired by inflating them. In order to create a complete impression (in addition to the

visual one, a thermal reflection is also needed), they are equipped with engines that emit heat, in order to portray the image of the real vehicle as faithfully as possible. (Королёв, А.Ю., Королёва, А.А., Яковлев, А.Д., 2015). In order to overcome the negative indicators and apply positive solutions, some companies solved the problem of difficult camouflage of vehicles and military equipment in motion by making camouflage coverings (similar tarpaulins) for certain parts of combat and motor vehicles. The Barracuda Company from Sweden (SAAB Barracuda Advanced Multi-spectral Camouflage, 2018) has developed multi-purpose covers that provide multi-spectral protection against detection, identification, increase survivability, sustainability, facilitate logistics support and affect climate control for the vehicle and equipment.

In recent decades, the level of scientific achievements in the field of electronic means for reconnaissance has come to the fore in the segments of hyperspectral imaging, radar systems with special abbilities, as well as the application of drones equipped with artificial intelligence. The consequences of mastered and applied scientific achievements are reflected in the development of camouflage methods that include bionic camouflage, dynamic adjustment of color(s) and structure, as well as the use of more complex materials that can respond to changes in the environment. An example of such advances is the company "BAE systems" from Sweden. They developed a system for adaptive thermal signature management. By placing a "cloak" - a covering (made of electronic emitters) over the tank, it creates the impression that the tank is invisible, integrated into the environment or one of the images (text, object of smaller dimensions or a car). Bionic camouflage is one of the most innovative approaches that are inspired by nature, particularly the ability of some organisms, such as octopuses and chameleons, to change colors and textures to blend in with their surroundings. This technology allows military units to blend in almost inconspicuously with their surroundings, reducing the likelihood of being detected by the enemy. The conduction of bionic masking involves the use of advanced materials that can change their optical properties in real time in response to external stimuli, such as temperature and light. (Qiao, Y., et.al. 2021) The same author states that "systems using bionic camouflage typically rely on sensors that capture visual information from the environment and then use algorithms to determine the most optimal colors and patterns to fit into the environment." These systems allow real-time color and texture change, which is especially useful in dynamic and complex war environments. As an example of the mentioned technology, the actual results of the company Hyperstealth can be used, which presented its achievement through the application of an optical illusion in order to hide the user. Their Quantum Stealth material bends light around the object making it invisible to the human eye and detectors. The applied technology is inspired by natural camouflage abilities, such as those of sea creatures. (Cramer, B., 2019)

Another example is the achievement of the NIMBUS (Nature-Inspired Camouflage) project (Mole, B., 2014), which explores the possibilities of creating camouflage materials that mimic real-time color and texture changes, such as those used by octopuses and squids. (C. Yu et al., 2014, Mathger, L. M. & Hanlon, R. T., 2007) It is necessary to point out that this technology is still being developed in order to define suitable advanced materials that would be suitable in order to achieve dynamic camouflage.

Dynamic camouflage is a task that is imposed in the modern world due to the necessity of protection during combat operations. It is based on adaptive camouflage by changing color and pattern to adapt - to blend into different characteristics of the surrounding terrain (color) such as deserts, forests or urban areas. The materials used in these systems often include microstructures or pigments that respond to external stimuli, such as changes in temperature or pressure. Other materials use advanced nanotechnology or liquid crystal technology to change their reflective properties on demand. (Lagneau, L., 2021)

In the absence of the aforementioned technologies, the application of adaptive uniforms, which are designed to automatically change color and pattern in accordance with the environment, is being used. Built-in sensors in the uniforms analyze lighting conditions and adjust the texture of the material to ensure optimal camouflage. The ISN (Smart Textiles by MIT's Institute for Soldier Nanotechnologies) project involves the development of adaptive uniforms that can change color, texture and even shape depending on the environment. These “smart textiles” contain embedded sensors and nanomaterials that can react to changes in light, temperature and humidity, allowing soldiers to remain undetected and protected. (Zewe, A., 2022)

The reason for such commitment to camouflaging tasks should be found in the fact that the method of gathering information about the situation in environment - the area of operation for the last 20 years or so has been carried out by various unmanned aerial vehicles and drones equipped with modern technical means. The collected data is analyzed using advanced software that relies heavily on achievements of artificial intelligence. Because of all the above, the task of camouflage is very complicated. In order to overcome the problem, the use of drones began to be used for a preliminary check of the degree of performed work on camouflaging the position, with the aim of removing detection signs.

5. CONCLUSION

Camouflaging, as part of force protection, has proven its importance (during previous combat operations) and proves it every day. Information gathering tasks are carried out in boath peace and war. In accordance with this fact, it is not surprising that the requirements to carry out daily research on the degree of compatibility of certain colors, patterns and shapes (on camouflage elements) with the environment. Comprehensive research is carried out on the application of existing materials, with their improvement and combination with certain colors and coatings that reduce or prevent the original reflection of the asset on the screens.

In previous years, the emphasis on developing "overlays" that show the image directly behind the "overlay" was in the realm of science fiction (due to the high cost of development). However, the published achievements in the subject area indicate that the previously taken steps enabled a significant step forward in this field. Because of the above, it is expected that the necessary attention will be paid to this issue and its development will be accelerated. The situation is similar with the development of means that reduce the emission of temperature reflection into environment.

As a possible solution in reducing the possibility of revealing the position and assets, the application of the most modern technical achievements, which are used to analyze the degree of completed works, is presented. Cameras with different readings are used or different sensors are used that react to certain light spectrums. The published content indicates the tendency to collect data from the environment using electronic means, with special attention focused on the possibility of interfering with the same in order to protect assets and people. To this should be added the fact that in resolving these requirements, the animal world, with its characteristics, is not forgotten. (Barnett, J., B., et. al., 2018)

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