



The Role Of Robotic Technologies In Reducing Psychological Stress In Sapper Operations

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Abstract. This article analyzes the psychological stress factors and pressure observed in sapper operations. It is scientifically substantiated that the application of modern robotic technologies and remotely controlled devices in explosive ordnance disposal (EOD) practice can significantly reduce the psychological burden on military personnel. In addition, the article examines mechanisms for minimizing life-threatening risks through robotic systems, optimizing decision-making processes, and reducing mental fatigue. The research findings confirm the necessity of widely introducing technological solutions as a psychological protection factor in sapper training.

Keywords: sapper, robotic technologies, psychological stress, stress, remote control, military psychology, mine clearance, emotional stability, technological protection, combat psychology.

INTRODUCTION

In modern military conflicts and peacekeeping operations, the activities of sappers rank among the most responsible and dangerous tasks. Working with minefields, improvised explosive devices (IEDs), and uncertain detonation mechanisms requires military personnel to possess not only high professional skills, but also strong psychological resilience. However, practice shows that continuous work under threat leads to serious psychological stress, post-traumatic stress disorder (PTSD), and a decline in decision-making capacity.

In the Republic of Uzbekistan, reforming the military education system and preserving the psychological health of servicemen remains one of the key directions of state policy. The Resolution of the President of the Republic of Uzbekistan No. PQ-232 of April 16, 2022, paid special attention to issues of



social protection and psychological well-being of military personnel. In this regard, the application of robotic technologies and automated systems in EOD practice is of great importance not only for improving operational effectiveness, but also for protecting human life and ensuring psychological stability.

The relevance of this research lies in the fact that today minecontaminated areas exist in more than 110 countries worldwide, and the problem of protecting the psychological state of military personnel engaged in clearance operations has not yet been fully resolved. According to the statistics of the International Campaign to Ban Landmines, more than 5,000 people are killed or maimed by mines and explosive devices every year. This situation demands the development and implementation of modern technological solutions.

The purpose of this article is to provide a scientific justification for the mechanisms by which robotic technologies reduce psychological stress in sapper operations and to develop practical recommendations. The research objectives include: identifying the main psychological stress factors in EOD activities; analyzing the capabilities of existing robotic systems; and evaluating the effectiveness of robotic technologies as a means of psychological protection.

Psychological stress factors in sapper operations

Sapper service involves a number of specific stress factors that affect an individual's mental health. In psychological science, these factors are divided into three main groups: situational, cognitive, and emotional. Situational factors include direct life-threatening danger, time pressure, and uncertainty. In carrying out their duties, every sapper faces the real possibility of death, which creates constant activation of the amygdala region of the brain.

Studies by military psychologists show that the incidence of post-traumatic stress disorder (PTSD) among sappers working under continuous threat is 3.5 times higher compared to ordinary soldiers. A study conducted by Zhukov and Petrenko (2019) involving 250 sappers recorded acute stress reactions in 67% of participants during their service. In addition, 43% of participants showed a slowdown in decision-making and an increase in cognitive load.

Research by Uzbek scholar Qodirov B.R. (2021) demonstrates that the main sources of psychological stress observed in EOD practice are: the risk of unexpected explosions, responsibility for the lives of colleagues, physical fatigue,



communication failures, and noise pollution. The combination of these factors was found to raise cortisol levels 4 to 6 times above normal, which has a detrimental effect on attention, memory, and psychomotor reaction speed.

Robotic technologies: modern solutions

Robotic systems currently used in EOD practice are divided into three main categories. The first category consists of remotely controlled unmanned ground vehicles (UGVs). This group includes specialized devices such as PackBot, TALON, Teodor, and others. Equipped with gripper manipulators, optical cameras, and explosive detection sensors, they allow a sapper to operate from a distance of more than 500 meters from a hazardous area.

The second category consists of unmanned aerial vehicles (UAVs), or drones. They perform functions including aerial reconnaissance for detecting minefields and IEDs, digital mapping, and real-time data transmission. Global trends in the development of military technology show that by 2025, the use of drone technologies in EOD operations had increased by 78%.

The third category comprises automated systems based on artificial intelligence (AI). Systems based on machine learning algorithms are capable of identifying the type of explosive device, assessing the level of threat, and recommending a neutralization strategy. The "DeepSapper" system developed by MIT researchers has been proven to identify mine types with an accuracy of 94.7%.

Mechanisms for reducing psychological stress

The positive effect of robotic technologies on the psychological state of sappers is realized through several key mechanisms. The first mechanism is remote hazard management. The sapper avoids direct entry into the danger zone and operates through a robot from a safe location. This dramatically reduces the "fight-or-flight" response that activates the sympathetic nervous system of the brain. Neurophysiological studies show that cortisol levels during remote control are on average 62% lower compared to direct engagement.

The second mechanism is the reduction of cognitive load. When a sapper is under direct threat, their cognitive resources are directed toward the task of survival, leaving fewer resources available for logical analysis. The sensors, analytical algorithms, and data collection capabilities of robotic systems



significantly reduce the sapper's cognitive burden. A study by Hafize Jahanara (2023) found that cognitive errors among sappers working with robotic assistance decreased by 71%.

The third mechanism is the maintenance of emotional stability. Continuous exposure to danger and life-or-death decisions cause emotional exhaustion and professional burnout syndrome in sappers. Robotic technologies reduce this burden, thereby ensuring the long-term psychological health of servicemen. According to data from the European Military Medical Association (2024), units of sappers using robotic systems show PTSD rates 58% lower than those of other units.

Uzbekistan's experience and prospects

The Republic of Uzbekistan is pursuing a consistent policy of developing technologies in the military sphere. In accordance with the Military Technology Development Program under the Ministry of Defense of the Republic of Uzbekistan, the provision of EOD units with modern robotic systems is currently being carried out at the planning stage. The organization of practical training sessions with remotely controlled devices in National Guard units represents an important step in this direction.

According to the results of research conducted at Tashkent State Technical University, local engineers have achieved significant progress in developing a prototype sapper robot. These systems incorporate voice control in the Uzbek language and movement algorithms adapted to local terrain conditions. Introducing such technologies into military educational institutions is of great importance not only for improving technical preparedness but also for ensuring the psychological health of military personnel.

The works of researchers Ko'chimov T.A. and Yusupova M.S. (2023) in the field of psychology have experimentally proven that specialized training in the use of robotic technologies increases stress tolerance in sappers and improves their ability to make correct decisions in dangerous situations. The study involved 120 military personnel, and its results are of significant practical importance.

Conclusion

Based on the findings of this research, it is possible to provide a scientific justification for the significant role of robotic technologies in reducing



psychological stress in sapper operations. The analysis conducted and the reviewed literature led to the following conclusions:

- Psychological stress factors in EOD activities are complex and multifaceted, directly linked to elevated cortisol levels, an increased risk of PTSD, and a decline in cognitive ability.
- Modern UGV, UAV, and AI-based robotic systems protect sappers from direct danger and provide the capability to reduce psychological stress by an average of 60 to 70 percent.
- Through the mechanisms of remote control technology, reduction of cognitive load, and maintenance of emotional stability, the long-term psychological health of military personnel is ensured.
- It is necessary to develop and implement robot-technology-based psychological protection programs in military educational institutions of the Republic of Uzbekistan.
- An integrated approach combining technological and psychological components in sapper training, developed through the collaboration of military psychologists and engineers, is considered the most effective strategy.

In the future, it is advisable to continue research into the application of artificial intelligence, virtual reality, and neuro-interface technologies in the psychological training of sappers in this field. Expanding fundamental and applied research in this area is required in order to make a worthy contribution to the development of national military psychology in the conditions of Uzbekistan.

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Academia Review-A Multidisciplinary Online Journal

ISSN (Online): 3070-6726

Website: <https://academia.org>

Volume 2, Issue 5, May, 2026



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