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POSITIVE AND NEGATIVE ASPECTS OF USING NAVIGATION EQUIPMENT IN MODERN ARMED CONFLICTS

Lieutenant Colonel Valijonov Akrom
Senior Lecturer, University of Military Security
and Defense of the Republic of Uzbekistan

Abstract
The rapid development of information and communication technologies has significantly influenced the nature and methods of conducting modern armed conflicts. Navigation equipment based on satellite systems and inertial technologies has become an indispensable element of military operations, ensuring high precision, effective command and control, and increased operational capabilities. At the same time, the widespread use of navigation systems has created new vulnerabilities associated with electronic warfare, cyber threats, and dependence on satellite infrastructure. This article examines the positive and negative aspects of using navigation equipment in modern armed conflicts and analyzes practical examples from the Russia–Ukraine conflict and the military confrontation involving the United States, Israel, and Iran. The study also highlights current trends and future prospects for the development of military navigation technologies.

Keywords: Navigation systems, GPS, GLONASS, satellite navigation, electronic warfare, drones, precision-guided weapons, military operations, Russia–Ukraine conflict, Israel–Iran confrontation.

Introduction

Modern armed conflicts are characterized by the extensive application of advanced technologies, which have fundamentally transformed the methods and means of warfare. The increasing role of information superiority, precision weapons, and network-centric operations has made navigation equipment one of the key components of contemporary military activities. Satellite navigation systems, together with inertial navigation technologies, provide armed forces with accurate positioning, timing, and guidance capabilities, thereby increasing the effectiveness of combat operations.

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At present, the most widely used global navigation satellite systems include the Global Positioning System (GPS) of the United States, the Russian Global Navigation Satellite System (GLONASS), the European Galileo system, and China's BeiDou Navigation Satellite System. These technologies enable military units to determine their coordinates with high accuracy and ensure effective interaction between land, air, naval, and unmanned platforms.

The growing importance of navigation equipment has become particularly evident during recent armed conflicts, where precision-guided munitions, unmanned aerial vehicles, and network-based command systems have played a decisive role. The Russia–Ukraine conflict, which began in 2022, has demonstrated the importance of satellite navigation for artillery systems, reconnaissance drones, and long-range precision strikes. Similarly, military operations involving the United States, Israel, and Iran have highlighted the significance of navigation technologies in conducting accurate strikes and maintaining operational superiority.

Despite their numerous advantages, navigation systems are increasingly exposed to various threats. Electronic warfare systems capable of jamming or spoofing satellite signals, cyberattacks targeting navigation infrastructure, and excessive dependence on space-based assets have revealed several vulnerabilities that may negatively affect military operations. Consequently, the analysis of both the advantages and limitations of navigation equipment has become one of the important issues in contemporary military science and practice.

The purpose of this article is to examine the positive and negative aspects of using navigation equipment in modern armed conflicts and to analyze practical lessons derived from recent military confrontations.

Positive Aspects of Using Navigation Equipment in Modern Armed Conflicts

The development of navigation technologies has significantly increased the effectiveness of military operations and has become one of the key factors influencing the outcome of contemporary armed conflicts. Satellite navigation systems, inertial navigation technologies, and integrated positioning systems enable armed forces to conduct operations with greater accuracy, flexibility, and operational efficiency.

One of the most important advantages of navigation equipment is the ability to ensure high-precision strikes against enemy targets. Modern precision-guided weapons rely heavily on satellite navigation systems to achieve accurate target engagement. The

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use of Global Positioning System (GPS)-guided munitions has considerably reduced collateral damage and increased the effectiveness of military operations. In particular, the Guided Multiple Launch Rocket System (GMLRS) used by the M142 High Mobility Artillery Rocket System (HIMARS) has demonstrated exceptional accuracy during the Russia–Ukraine conflict. Ukrainian forces have successfully employed these systems to strike ammunition depots, command posts, and logistical facilities located deep behind enemy lines, thereby disrupting Russian military operations and supply chains.

Another significant advantage of navigation equipment is the enhancement of command and control capabilities. Satellite navigation systems provide commanders with real-time information regarding the location and movement of friendly forces, which improves situational awareness and enables more effective decision-making. The integration of navigation technologies with communication and reconnaissance systems has become an essential component of network-centric warfare. Such capabilities allow military units to coordinate their actions more effectively and respond rapidly to changes on the battlefield.

The widespread use of unmanned aerial vehicles (UAVs) has further increased the importance of navigation equipment. Reconnaissance and strike drones depend on satellite and inertial navigation systems to carry out surveillance missions and deliver precision attacks. During the Russia–Ukraine conflict, both sides have extensively employed unmanned aerial systems equipped with GPS receivers and autonomous navigation technologies. In particular, first-person-view (FPV) drones have become an effective and relatively inexpensive means of engaging armored vehicles, artillery systems, and military infrastructure. The integration of navigation equipment with artificial intelligence and digital communication technologies has substantially increased the combat effectiveness of these platforms.

Modern military aviation also relies heavily on navigation systems. Advanced combat aircraft, including the F-35 Lightning II operated by the United States and Israel, utilize integrated navigation systems that combine GPS, inertial navigation, and sensor fusion technologies. These capabilities enable aircraft to conduct precision strikes and operate effectively in complex combat environments. During military operations involving the United States and Israel against Iranian-backed groups and strategic targets, precision-guided Joint Direct Attack Munition (JDAM) bombs and

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various guided missiles have been employed with high accuracy, demonstrating the critical role of navigation technologies in ensuring operational superiority.

In addition to combat applications, navigation equipment plays an important role in search and rescue operations, logistical support, and troop movement. Accurate positioning systems facilitate the rapid evacuation of wounded personnel, improve the delivery of supplies, and enhance the mobility of military units. These capabilities contribute significantly to maintaining combat readiness and ensuring the successful execution of military missions.

Therefore, the experience of recent armed conflicts demonstrates that navigation equipment has become an indispensable element of modern warfare. The ability to conduct precision strikes, improve command and control, enhance the effectiveness of unmanned systems, and support logistical operations highlights the strategic importance of navigation technologies in contemporary military affairs.

Negative Aspects of Using Navigation Equipment in Modern Armed Conflicts

Despite their considerable advantages, navigation systems are associated with several limitations and vulnerabilities that may significantly affect the effectiveness of military operations. The increasing dependence of armed forces on satellite-based navigation technologies has created new challenges related to electronic warfare, cyber threats, and disruptions of communication and positioning systems.

One of the major disadvantages of navigation equipment is its vulnerability to electronic warfare measures. Modern electronic warfare systems are capable of jamming, disrupting, or spoofing satellite navigation signals, thereby reducing the accuracy and reliability of weapons and military platforms. Such activities may lead to navigation errors, mission failures, and reduced operational effectiveness.

The Russia–Ukraine conflict has clearly demonstrated the growing importance of electronic warfare in modern military operations. Russian forces have extensively employed electronic warfare systems such as Pole-21, Zhitel, and Tirada-2 to interfere with satellite communications and GPS signals used by Ukrainian forces. These systems are capable of creating powerful electromagnetic interference over large areas, complicating the operation of drones, precision-guided munitions, and communication networks. As a result, both sides have increasingly relied on alternative navigation methods, including inertial navigation systems and autonomous guidance technologies.

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Another challenge associated with satellite navigation systems is the threat posed by cyberattacks. Modern navigation infrastructure relies on complex digital networks that may become targets of cyber operations. Unauthorized access to navigation systems or manipulation of positioning data can lead to serious operational consequences. Therefore, protecting military navigation infrastructure against cyber threats has become one of the priorities of contemporary defense policies.

Recent developments in the Middle East have also highlighted the vulnerability of satellite navigation systems. During periods of increased tensions involving the United States, Israel, and Iran, several reports indicated disruptions and interference affecting satellite navigation signals in the Persian Gulf region. Iranian electronic warfare capabilities and signal spoofing activities have raised concerns regarding the security and reliability of navigation systems used by military aircraft, unmanned aerial vehicles, and maritime vessels operating in the region. Such incidents have demonstrated that excessive reliance on satellite-based navigation may create significant operational risks.

Furthermore, modern navigation systems require substantial financial investments and highly qualified personnel. The development, maintenance, and modernization of satellite infrastructure and associated military equipment involve considerable costs. In addition, the effective use of advanced navigation technologies requires specialized training and technical expertise, which may impose additional burdens on defense institutions.

Consequently, the experience of recent armed conflicts indicates that, although navigation equipment provides substantial operational advantages, it also creates vulnerabilities that can be exploited by adversaries. The increasing sophistication of electronic warfare and cyber capabilities emphasizes the necessity of developing resilient, integrated, and multi-layered navigation systems capable of operating effectively in contested environments.

Future Prospects of Military Navigation Technologies

The rapid evolution of military technologies indicates that navigation systems will continue to play a decisive role in future armed conflicts. The increasing complexity of the electromagnetic environment and the growing capabilities of electronic warfare systems require the development of more resilient and reliable navigation technologies.

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One of the most promising directions is the integration of satellite navigation systems with inertial navigation systems and artificial intelligence technologies. Hybrid navigation systems are capable of maintaining acceptable levels of accuracy even in environments where satellite signals are degraded or denied. Such systems can automatically process data from multiple sensors and ensure uninterrupted navigation capabilities for military platforms.

Another important trend is the development of anti-jamming and anti-spoofing technologies. Modern armed forces are investing considerable resources in improving the resistance of navigation equipment against electronic attacks. Advanced signal processing methods, encrypted military satellite signals, and multi-source positioning systems are expected to increase the survivability and reliability of navigation technologies on future battlefields.

The growing use of autonomous systems also emphasizes the importance of advanced navigation capabilities. Unmanned aerial vehicles, autonomous ground platforms, and maritime systems require highly accurate and secure navigation technologies to perform complex missions without direct human intervention. Consequently, the integration of artificial intelligence, machine learning, and sensor fusion technologies will become an important element of future military navigation systems.

Conclusion

The analysis of recent armed conflicts demonstrates that navigation equipment has become one of the fundamental components of modern warfare. Satellite navigation systems and integrated positioning technologies significantly enhance the accuracy of precision weapons, improve command and control capabilities, and increase the effectiveness of unmanned systems and military operations.

At the same time, the experience gained from the Russia–Ukraine conflict and the military confrontation involving the United States, Israel, and Iran has revealed several vulnerabilities associated with satellite navigation. Electronic warfare systems, signal jamming, spoofing techniques, and cyber threats have shown that excessive dependence on satellite-based technologies may negatively affect combat effectiveness.

Therefore, ensuring the resilience and security of navigation systems has become one of the key priorities of modern military science and defense planning. The development of hybrid navigation systems, anti-jamming technologies, and artificial

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intelligence-based solutions will contribute to maintaining operational superiority and increasing the effectiveness of armed forces in future conflicts.

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