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New Development Trends of Battlefield Reconnaissance Intelligence Equipment

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Abstract

The world's major military powers have taken the battlefield reconnaissance as an important way of obtaining information and resources, and have put forward higher requirements for the use of battlefield reconnaissance intelligence equipment. Battlefield reconnaissance intelligence equipment has been continuously upgraded and is now mostly intelligent and can further evolve in the direction of intelligence. According to the development status quo of battlefield reconnaissance equipment in the world, this paper boldly predicts the latest development and application trends for the development of battlefield reconnaissance equipment to provide certain thinking direction.

Keywords

Reconnaissance Intelligence Equipment; Development and Use; New Trends.

1. Development Status of Battlefield Reconnaissance Intelligence Equipment

1.1. Space-based Platforms become Major Battlefield Reconnaissance Platforms

At present, space-based reconnaissance equipment has gradually become the mainstream direction of foreign reconnaissance equipment because of its characteristics and advantages of high security and wide coverage, and will progressively replace the traditional air-based reconnaissance and surveillance platform. The U.S. Pacific Air Force has announced that it will use space-based GMTI program construction, the project can complete the rapid positioning of ground targets without relying on airborne equipment; Israel has launched the HR2C high-resolution re-entry constellation system, which has ultra-high resolution and a very high rate of re-entry; the United Kingdom has completed the validation of the high-altitude reconnaissance balloon (HAB) system, which meets the needs of rapid mobility and ultra-long-lasting wide-area reconnaissance, but with minimal resupply and maintenance.

1.2. Battlefield Reconnaissance Equipment with Global Coverage Advantage

The battlefield reconnaissance capability of Western military powers represented by the United States Army has an absolute advantage, and its reconnaissance equipment can cover the entire battlefield environment and conduct full-depth, large-area reconnaissance, surveillance and early warning on a global scale. The reconnaissance and intelligence system, with the aerospace domains as the main reconnaissance domains, supports the United States military and other Western militaries in their global arrival and global operations, provides a near-transparent battlefield posture, and gives an absolutely dominant battlefield capability for the United States military and its allies, which is the most crucial point in the entire combat system.

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1.3. Shortcomings in the Processing of Big Data for Battlefield Reconnaissance Intelligence

In a joint information and intelligence operation, battlefield reconnaissance in nearly real time provides a massive source of intelligence information, but also makes the real-time transmission and real-time analysis of battlefield intelligence has become a difficult problem, especially the battlefield real-time imaging equipment to obtain an exponential increase in the amount of data, bringing a huge test of the existing means of communication. At present, although the U.S. Army and other Western countries' armies are developing rapidly in battlefield reconnaissance technology, their reconnaissance equipment has certain shortcomings in the construction of command networks, encrypted communication technology upgrades, real-time transmission of big data and anti-jamming strikes.

2. New Trends in the Development of Battlefield Reconnaissance Intelligence Equipment

2.1. Three-Dimensional Means of Reconnaissance

In local wars such as the Naka conflict and the Russian-Ukrainian conflict, the battlefield has made extensive use of reconnaissance methods such as unmanned aerial vehicles (UAVs) and low-orbit satellites, with aerospace reconnaissance occupying the mainstream position in target detection. The ground reconnaissance method is limited in terms of distance and range due to the impact of factors such as terrain and geomorphology, as it mainly uses optical, acoustic and infrared means. With the massive application of airborne unmanned reconnaissance methods such as patrol bombs and high-altitude, long-endurance UAVs in the world's major military conflicts, it will break through the limitations of distance and complex geographic environments, greatly expanding the scope of battlefield reconnaissance and becoming the most efficient means of reconnaissance on the battlefield in the future, whereas ground-based reconnaissance will be used as an auxiliary reconnaissance means for battlefield target validation and damage assessment.

2.2. Integration of Reconnaissance Equipment

The gradual development of military equipment has shifted to a fusion development mode of mechanization, informatization and intelligence, development of reconnaissance equipment will also follow this trend in the future. By continuously integrating smarter modules, expanding the mission of existing reconnaissance equipment, adopting the "embedded expansion" approach to modularise the design and improvement of equipment, and enhancing the systematic application of reconnaissance equipment, such as the practical application of information-based munitions such as patrol bombs and various types of dexterous munitions, which further validates the value of the integration of equipment for reconnaissance and strike integration. The integration of reconnaissance and strike platforms is the most effective means of realizing battlefield target discovery and destruction.

2.3. Intelligence for Equipment Application

The world's new military transformation is accelerating. The world's major military powers focus on the militaristic application of advanced technology, riding on the rapid development of network technology and intelligent technology in recent years, the military equipment of various countries in the Internet of Things, big data, artificial intelligence, quantum communications, the Internet Star Chain program and other advanced technology applications have been seen in the first signs and the intelligence of reconnaissance information equipment is the main trend. For example, the application of UAV swarm technology, while enhancing the information interaction capability between reconnaissance equipment, realises autonomous

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intelligent collaboration between unmanned reconnaissance equipment, and realises command and control precision and battlefield situation transparency through the construction of a powerful Internet of Things for military equipment.

2.4. Information Sharing in Real Time

The rapid development of battlefield reconnaissance intelligence equipment has greatly enhanced the ability to acquire information, but the sharing of intelligence relies on efficient network transmission links, which require scientific networking, reasonable permission settings and rapid redundant information processing, and require stable means of communication to ensure real-time information transmission at the same time. Without efficient communication networks and standardized communication interfaces, it is impossible to achieve free interaction and rapid sharing of information, limiting the scope of application of intelligence information. In the future, the real-time interaction of battlefield information will be based on high-speed information and communication networks, with 5G communication technology and star chain low-orbit Internet satellite technology as the direction of development, and at the same time, the quantum pass technology will be applied to the field of military communication, so as to open up the obstruction of the information interaction between the combat forces, to ensure the absolute safety of the transmission of military intelligence information and to achieve the most effective way of real-time sharing of intelligence information.

3. Trends in the Use of Battlefield Reconnaissance and Intelligence Equipment

3.1. Concept for the Development and Application of Unmanned Aerial Reconnaissance Equipment

3.1.1. UAV Swarm Control

The UAV can be used as a command-and-control center for battlefield unmanned equipment, to unify the command and coordination of small reconnaissance platforms such as attack UAVs swarms or patrol bombs in the region of the mission, to carry out pro-aircraft mission planning and target allocation, and at the same time to organize the autonomous coordination of the airspace supplemented by manual intervention, so as to prevent airborne mishaps and injuries. The use of medium- and large-sized UAVs as control platforms for small UAV swarms (or patrolling bomb swarms), the implementation of communication relay or intelligent control in airspace close to the enemy, and the commanding of small UAV reconnaissance and attack swarms (or patrolling bomb swarms) to carry out reconnaissance or attack operations, which need to enhance the UAV's intelligent networking capability and realize intelligent control of the swarms.

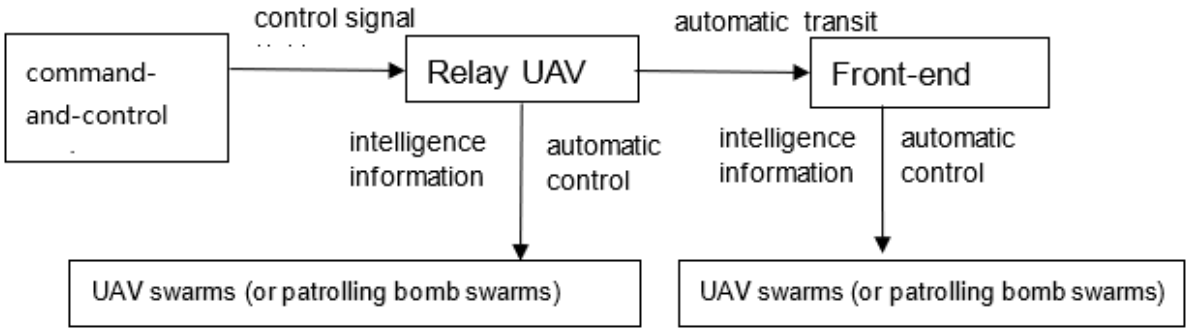

Fig 1. UAV swarm relay control

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The first is joint mission planning. Improve the functions of UAVs for collaborative decision-making, task allocation, mission planning and route planning. Realize automated command and guidance control of UAVs over "swarm" UAVs or patrol bombs and including multi-machine cooperative task allocation technology and multi-machine cooperative task planning technology. The mission planning technology can be divided into two parts depending on the content of the assigned tasks, reconnaissance mission planning and attack mission planning. Reconnaissance mission planning is based on the scope of the reconnaissance mission area scientifically assigned to the number of UAV swarms, and attack mission planning is based on the information on the target of the attack, the nature of the target, and the battlefield environment to determine the UAV unit that will carry out the attack.

The second is autonomous airspace coordination. Airway information is synchronized in real time to the joint airspace system through the information system to ensure orderly flight of aircraft in the airspace and to prevent unsmooth airspace coordination from leading to UAV air collision damage. The internal establishment of a flat command network requires access to the airspace coordination system. Realize real-time information interaction between UAVs and "swarm" UAVs. When the UAVs navigates autonomously, data communication is maintained between multiple UAVs to implement autonomous route planning and mission area coordination. At the same time, it ensures full coverage of the mission area and the safe autonomous flight of UAVs.

Third is the creation of a "loyal wingman" intelligent mission control center. This requires the UAVs to have strong data computing and processing capabilities, to use the UAVs as a command-and-control center in a certain area, to unify and coordinate the actions of unmanned airborne attack equipment within the domain, and to establish a target information-sharing mechanism and an automatic target-allocation algorithm. Command process optimization realizes multi-machine adaptive collaborative and cooperative control based on the unmanned aircraft command and control system.

3.1.2. Integrated Design of Small and Medium-sized UAVs for Reconnaissance and Strike

In the Russian-Ukrainian conflict, Ukraine used a large number of small civilian UAVs to drop grenades, artillery shells and other anti-personnel weapons, causing large casualties to the Russian army, which shows that reconnaissance equipment with its own weapon attack capability can change the battlefield situation when it matters. At present, a large number of UAVs installed in various countries are not equipped with weapon system loads and do not have the ability to detect and fight as a whole, so that they cannot achieve instantaneous strikes when important targets or moving targets are found, and the time for temporarily summoning artillery and aerial firepower is longer, which is easy to miss the opportunity to fight, therefore, the design of detecting and fighting as a whole is the trend of unmanned aerial reconnaissance equipment on the battlefield in the future.

First, as a key reconnaissance intelligence force, UAVs are capable of providing uninterrupted battlefield intelligence information and continuously monitoring the battlefield. In terms of the positioning of UAVs functions, it is also necessary to go beyond the limitations of battlefield reconnaissance and focus on the development of the unit of reconnaissance and strike. Expanding the direct fire attack capability of reconnaissance equipment and realizing the integration of reconnaissance and strike is the trend of UAVs development. The battlefield situation is changing rapidly, and the highest goal of modern war is to achieve discovery and destruction. UAVs can be used as the most direct attacking firepower platform, which is an effective means to meet the need for immediate strikes.

Secondly, small and medium-sized UAVs are equipped with guided weapon payloads, and aerial reconnaissance and strikes are carried out in an integrated manner to implement counterfire,

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shorten the fire response time, and make it possible to achieve destruction upon discovery. Airborne UAVs platforms can also be pre-positioned in the combat airspace to patrol bomb groups, relying on the rear cloud control computing platform, determine the strike task in an intelligent coordination way, zoning the pro-air cruise standby, and decision-making on the spot to implement the destruction of firepower.

Thirdly, unmanned weapons equipment systems need accelerate the decision-making and striking cycle, which is an inevitable trend in the development of aerial reconnaissance platforms for future battlefields. The integration of unmanned aerial reconnaissance and strikes can effectively shorten the time from discovery to strike, and has a great deal of lethality for surveillance and strikes against time-sensitive targets; the use of unmanned aerial vehicles carrying precision-guided weapons to carry out precision strikes can efficiently carry out the task of targeted killings, effectively striking important targets on the enemy's side, while reducing collateral casualties.

3.1.3. Design of Airborne Relay Platform Module

Generally, the electromagnetic environment in the combat area is complex, while the two warring parties implement electromagnetic suppression and confrontation between each other, resulting in the stability of the command-and-control network and long-distance communication links being affected, and the UAVs can be used as a data chain relay platform to enhance the data interaction capability. Under the premise of seizing control of the air, to ensure that UAVs flights are not threatened by anti-aircraft fire, it can provide wireless communication relay for ground reconnaissance equipment in accordance with the principle of proximity configuration, so as to ensure smooth communication.

In the whole "OODA" loop, it can complete the interconnection and interoperation between UAVs and regional reconnaissance equipment, and the fast, reliable and long-distance voice and data transmission between UAVs and the rear command post. It can carry out real-time indication of remote targets and real-time transmission of video images, so as to achieve the synchronization of reconnaissance, command and strike between man and aircraft.

3.2. Ground Reconnaissance Equipment Development and Utilization Concepts

3.2.1. Collaboration with Small Rotary Wing UAVs

When ground reconnaissance equipment is unable to carry out close reconnaissance, it is necessary to increase the range of reconnaissance horizons, but it is difficult to effectively increase the range of reconnaissance by means of optical, infrared and radar means at present. Therefore, ground reconnaissance equipment equipped with small rotary-wing drones will greatly enhance the field of view of ground reconnaissance equipment.

One is the use of manual remote control. The ground equipment serves as a platform for the take-off and landing of the UAVs, which takes turns to go out for reconnaissance and periodically returns to the reconnaissance vehicle to replenish its power; the target information of the UAVs reconnaissance is transmitted back, and the ground reconnaissance equipment edits and then transmits back the valid information. If further verification is required to corroborate the intelligence information, the ground equipment will go out to observe and proofread it.

Secondly, the micro-unmanned aircraft swarms are used in a self-coordinated manner. Ground reconnaissance equipment serves as the energy support and information relay platform for the micro-unmanned aircraft swarm, and the unmanned aircraft go out on their own under the command of the intelligent control system of the ground reconnaissance equipment, without the need for human intervention, and the unmanned aircraft take an autonomous and coordinated approach to completing the reconnaissance of the target area, and the intelligence

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information is fused intelligently, and then relayed and streamed to the Intelligence Centre by the ground reconnaissance equipment.

3.2.2. Reconnaissance and Strike Integrated Design for Light Reconnaissance Equipment

Reconnaissance distance of ground reconnaissance equipment is small, it must be close to the target area in order to effectively reconnaissance. The proximity of enemy targets means that there is a greater threat of hostile situations, at which time there is always the possibility of being struck by fire or small groups of enemies, and at the same time it is possible to find targets of greater value to the enemy, which if not struck will expose their own forces to a greater threat, and the addition of weapons systems is an effective way of responding to the threat.

First, the lightweight anti-tank missile system is an integrated design. Lightweight anti-tank missiles are lightweight, easy to carry, and have the ability to be left alone after launch, so that they can be used in a top-attack mode against enemy armored vehicles, with high striking effectiveness, and they can be used in the face of high-value time-sensitive targets or vehicles with strong armor protection, to enhance the ability of reconnaissance vehicles to attack.

The second is the integrated design of the large-caliber remote-controlled weapon station. The advantage of the remote-controlled weapon station is that it has an automatic targeting and firing function, which eliminates the need for the shooter to be exposed and effectively avoids the threat of light-weapons fire, thus improving the survivability of reconnaissance personnel. The remote-controlled weapon station uses a combination of a large-calibre heavy machine gun and a grenade launcher, which work in conjunction with each other to cope with different hostile threat scenarios and make rational use of the weapon system.

3.2.3. Anti-UAVs Applications

As can be seen in the Russian-Ukrainian conflict, there have been profound changes of modern warfare. The era of unmanned combat, represented by UAVs, has begun to take shape. The Russian and Ukrainian sides are competing in the war to use UAVs to attack each other's ground forces, and it is always possible to surprise personnel and equipment by launching attacks, which cannot be detected by air defense radar, and the existing air defense firepower is basically ineffective against low, slow and small UAVs. Small UAVs are cheap and easy to manufacture in large quantities, and they can easily be transformed into weapons delivery platforms. On the battlefield, we can always see UAVs carrying hand grenades, small bombs or mortar bombs to accurately deliver killings to personnel and vehicles. Anti-UAVs applications for ground reconnaissance and intelligence equipment are imminent.

One is the use of UAVs hijacking equipment. At present, there is mature equipment on the market, and for civilian drones, electromagnetic signals or radio frequency interference waves can be launched in close proximity to make the UAVs lose their communication and navigation functions, forcing them to land or return, while it is possible to decipher the control signals of the drones at the same time and control their fall through the injection of commands to be captured. This approach is technically mature and inexpensive, and can be equipped in large numbers. However, it is more difficult to crack drones with encrypted communications.

The second is the hard destruction of equipment by UAVs. High-energy laser or microwave transmitters are used to fire laser beams or microwave beams in a directional manner to harden and kill the electronic components of the UAVs, rendering them incapable of normal operation. This method of countermeasures against UAVs requires higher-energy transmitters and has a higher overall cost.

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4. Conclusion

This paper predicts the development trend of reconnaissance intelligence, ideas of equipment development and application, boldly puts forward the diversified development trends of future reconnaissance intelligence equipment. One is the intelligent modular function of battlefield reconnaissance and intelligence equipment; and the other is the expansion of battlefield reconnaissance intelligence equipment in the air.

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