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Concept for the Development of Unmanned Equipment for Urban Counter-terrorism Operations

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Abstract

Cities, as places of political, economic and population concentration, are more and more likely to become the targets of terrorist organisations and extremists to launch terrorist attacks. With the continuous development of unmanned intelligence technology, unmanned equipment such as unmanned aircraft, unmanned dog, detonation robots and other unmanned equipment are continuously put into and applied to urban counter-terrorism operations, and are widely used in battlefield reconnaissance, obstacle removal, coordinated attack, support and guarantee and other tasks. Therefore, analysing the application scenarios of urban counter-terrorism unmanned equipment, summarising the current situation of unmanned equipment development at home and abroad, and researching and proposing the concept of urban counter-terrorism unmanned equipment development are of great significance in helping to enhance the urban counter-terrorism combat capability.

Keywords

Urban Counter-Terrorism; Unmanned Equipment; Development Concepts.

1. Introduction

Urban counter-terrorism incidents are usually characterised by uncertainty of location, diversity of attack styles, and urgency of disposal time, which requires the combat forces attempting the mission to be able to quickly select the preferred route of manoeuvre, comprehensively investigate the situation at the scene, and accurately predict the development of the incident situation, so as to provide efficient support for the successful completion of the disposal operation. With the continuous development and military application of unmanned equipment, unmanned combat and manned/unmanned coordinated combat have added new variables to the evolution of urban counter-terrorism operations. Therefore, analysing the application scenarios of unmanned equipment in urban counter-terrorism operations and proposing the development concept of urban counter-terrorism unmanned equipment are of great significance to the research of urban counter-terrorism combat tactics and the development of unmanned equipment.

2. Scenarios for the Use of Unmanned Equipment in Urban Counter-terrorism Operations

In the Russian-Ukrainian conflict, Russian Seahawk-10 reconnaissance drones identified targets and then guided Lancers to attack them, destroying many important Ukrainian targets. China in the

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organisation of the Shanghai Cooperation Organisation "Counter-Terrorism Collaboration 2024" joint counter-terrorism exercise, the robot dog entered a small compound to check the location of the target, the projectile-type detection and combat UAV attacked according to the location provided by the robot dog, and quickly cleared the compound to produce a threat to the target. From these examples, it can be seen that unmanned equipment is rich in variety and diverse in function, and can replace combatants in attempting some tasks with high security risks. In urban counter-terrorism operations, the application scenarios of unmanned equipment mainly include reconnaissance and perception, organisation of barrier-breaking, coordinated attack, support and guarantee, and so on.

2.1 Reconnaissance Perception

After an urban terrorist attack, combatants can use the UAV mounted with a high-definition zoom camera to take pictures of the architectural layout of the incident site from the sky and send the pictures back to the command organisation, which will provide a basis for decision-making by the commanders in planning the deployment of troops, operational tactics, and the handling of special situations. In the process of manoeuvring combat forces to the mission area, combatants can manipulate the UAV to fly over the front side of the marching echelons, to know in advance the terrain and traffic conditions along the manoeuvring roads, and to guide the echelons to drive in smoothly. When organising on-site sealing and control, combatants can control the multi-rotor UAV to take aerial photographs of the mission area and surrounding key locations such as important intersections, building access routes, balcony roofs and other key locations, so as to promptly detect suspicious persons or terrorists attempting to flee. After an attack is launched, unmanned equipment such as drones, unmanned reconnaissance vehicles, robots and robot dogs can be manoeuvred to penetrate into the interior of the building in advance, to detect possible dangers on the assault route and to provide the assault crews with forward guidance and early warning of dangers.

2.2 Organisational Breakdown

In urban counter-terrorism operations, terrorists may set up obstacles and explosives in or near buildings, and some explosives are in hidden locations, which may cause casualties once the team members touch them. Using unmanned equipment with low cost, carrying reconnaissance payloads, and diverse functions, it can carry out tasks such as clearing obstacles and de-explosive removal independently or under human control, which not only ensures the completion of the task, but also reduces personnel casualties. In the case of obstacles near buildings, drones will fly to appropriate heights above the obstacles and irradiate them, so as to provide positional guidance for fire strikes or forward clearance. For places in the building where terrorists may set up explosives, with the help of robotic dogs and robots to detect them first, after confirming that they are explosives, manipulate the detonation robots or send detonation professionals to go out to detonate, or use unmanned equipment with the function of detecting and hitting one, equipped with special ammunition, to effectively implement the clearance of obstacles [1].

2.3 Collaborative Attacks

In urban counter-terrorism operations, unmanned equipment, by mounting and carrying different payloads, can carry out attack missions independently or in coordination with ground forces. The use of unmanned aircraft mounted with shouting devices, flying to a position closer to the terrorists to organise on-site shouting, breaking the will of the terrorists and shaping a favourable battlefield situation. Using robots, robotic dogs or drones carrying infrared, thermal imaging and other reconnaissance payloads to guide the actions of ground combat forces in front of them and to detect possible threats from terrorists. Use drones to mount non-lethal munitions such as smoke bombs or tear gas canisters to drop smoke bombs and tear gas canisters on terrorists hiding in staircase corners, behind doors and on roof terraces, so as to provide cover for ground forces to safely approach and attack terrorists. The use of drones carrying anti-personnel munitions, such as hand grenades, to drop munitions on locations where terrorists are hiding on the heights of buildings, in order to strike the terrorists accurately.

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2.4 Support Aids

In urban counter-terrorism operations, different unmanned equipment can perform different support and auxiliary tasks according to the needs of the mission. For example, they can carry out public opinion propaganda, organise communication relay, and transfer materials and oil. Using unmanned aerial vehicles to mount shouting devices and propaganda banners, etc., to carry out legalistic propaganda and political attacks, to educate and evacuate the people gathered near the scene of the incident, and to seize the right to control information on the battlefield. Relying on unmanned equipment carrying communication payloads, communication relay points are established in blind areas on the periphery of buildings, entrances of underground passages, dead corners inside buildings and other locations where communication frequencies are easily blocked, so as to ensure that the internal communication links of combat forces are smooth and good. According to the operational requirements, it can also cooperate with the combat forces to carry out other tasks such as delivering combat materials, life supplies and battlefield rescue materials to the mission area, and supplementing light for illumination at night. In recent years, the U.S. Army has begun to explore unmanned equipment for material transport, fuel supply and casualty transport and other security tasks.

3. Current Status of Unmanned Urban Counter-terrorism Equipment Development

3.1 Unmanned Aerial Equipment

(1) Foreign airborne unmanned equipment

The United States has an early start in the development of unmanned aerial equipment and is in a leading position in the world. Typical airborne unmanned equipment includes RQ-4 Global Hawk, RQ-7 Shadow, RQ-11 Big Raven, MQ-1C Greyhawk, A160T Hummingbird, etc. ([2]) (see Table). Grey Eagle", A160T "Hummingbird", etc. [2] (see Table 1).

Table 1. Typical United States airborne unmanned equipment

serial number	typology	Model Name	typology	mandates
1	Airborne unmanned equipment	RQ-4 Global Hawk	Can carry a 900kg mission payload, with an endurance of over 32h and a maximum altitude of over 19,000 metres.	Carrying out long-duration all-area reconnaissance, surveillance and other missions
2		RQ-7 Shadow drone	Lightweight fixed-wing, close-range tactical drone with an operational ceiling of 4,600 metres and a maximum flight time of 9 hours	Conduct reconnaissance, surveillance and other missions
3		RQ-11 "Big Raven" drone	Small hand-launched unmanned reconnaissance aircraft with a cruising speed of 30km/h and an endurance of 60-90 min	Perform reconnaissance, targeting, etc.
4		MQ-1C Grey Eagle UAVs	Unmanned aerial vehicle with a mission payload capacity of 360 kg, an endurance of 25 h, an operational ceiling of 8,800 m and 4 mounting positions	Performed reconnaissance, target guidance, fire strike and other missions
5		A160T Hummingbird.	Medium to high altitude unmanned helicopter with an altitude of up to 9,000 metres and an endurance of more than 18h	Performed reconnaissance and surveillance, communications relay, cargo transport and other tasks

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Israel established a drone brigade in 1971, and drone technology has developed rapidly. The airborne unmanned equipment currently in use includes the RQ-2 Pioneer drone, the Hermes 450 drone, the Hermes 900 drone, the Harpy drone, the Harrop drone, the Heron-1 drone, and the Heron-TP drone.

(2) Domestic airborne unmanned equipment

China began to use airborne unmanned equipment in the 1980s, and with the continuous development of unmanned technology, it already possesses a number of types of airborne unmanned equipment for reconnaissance, attack, transport and rescue. Reconnaissance drones include the No-Detection-7 and No-Detection-8 drones, of which the No-Detection-8 drone can fly at an altitude of 50,000 metres, and can carry out strategic reconnaissance, surveillance and other tasks; combat drones include the Rainbow-7 and Nine Skies drone, with a range of 10,000 kilometres, and the Nine Skies drone with a maximum payload of 6 tonnes and 8 external mounting points; transport drones include the Rainbow-YH1000 and the Hongyan (HY100) drone, and the Rainbow-YH1000 has a payload of 6 tonnes and 8 external mounting points. HY100) UAVs, the Rainbow-YH1000 has a load capacity of more than 1 tonne and a practical ceiling of 8 km, and the Hongyan (HY100) UAV has a load capacity of 1.9 tonnes and an endurance of 10.6 hours; rescue UAVs include the AR-500C, which has an endurance of 5 hours, and can carry out tasks such as reconnaissance and material delivery. In addition, China's defence enterprises in the Zhuhai Airshow launched a variety of different sizes and combat objects of the cruise bomb, including a relatively large WS-43 cruise bomb length of more than 3 meters, more than 1 hour of air time, the longest striking distance of 90 kilometres.

3.2 Ground Unmanned Equipment

(1) Foreign unmanned ground equipment

Typical ground-based unmanned equipment in the United States includes the "Black Knight" unmanned combat vehicle, the RIPSAW M3 unmanned combat vehicle, the "backpack" multitasking robot, and the "Magic Claw" series of robots, Small multi-purpose equipment transport vehicle, SUGV small unmanned vehicle.

Table 2. Typical ground unmanned equipment in the United States [3]

serial number	typology	Model Name	typology	mandates
1	Ground unmanned equipment	"Black Knight unmanned combat vehicle	Manually operated and unmanned autonomous combat vehicles equipped with machine guns and side-by-side machine guns	Carrying out tasks such as forward fire reconnaissance and surveillance
2		RIPSAW M3 unmanned combat vehicle	Amphibious operational vehicle capable of carrying weapons such as 30mm calibre cannon, Javelin anti-tank missiles, etc.	Carry out reconnaissance, surveillance and firefighting missions
3		"Backpack multitasking robots	Smaller size, easy to carry and operate	Carry out reconnaissance, mine clearance and explosive ordnance disposal missions
4		"Magic Claw" series robots	Smaller size, can be controlled remotely	Perform reconnaissance, surveillance, targeting and other missions
5		Small utility equipment carrier	All-terrain applications with wireless communications and high payload capacity	Performed reconnaissance, surveillance and logistical support missions
6		SUGV Small Unmanned Vehicle	Small tracked multi-purpose unmanned vehicle with modular design and over 6 hours range	Perform tasks such as reconnaissance, surveillance and explosive ordnance disposal

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(2) Domestic ground unmanned equipment

With the development of unmanned intelligence technology, domestic unmanned ground equipment has kept pace with operational needs, and has unmanned armoured vehicles, unmanned artillery, unmanned combat vehicles, unmanned mechanical dogs and unmanned tanks and other equipment. Among them, the "sharp" ground unmanned combat vehicles developed by China National Weapons Industry Corporation, belonging to the small unmanned combat vehicles, equipped with a 12.7mm machine gun remote control weapon station, can achieve enemy reconnaissance, fire assault and other functions. The "Red Wing Vanguard" combat robot dog can be loaded with Type 95 automatic rifles, squad machine guns and grenade launchers, and has a powerful striking capability. In addition, the VU-T10 unmanned mine-clearing vehicle of the Hydrocarbons Industry Group is equipped with a minesweeper at the front of the vehicle, which can carry out high-risk urban demining tasks, while the robotic hand on the top of the vehicle can transfer suspected explosives to a safe zone.

3.3 Waterborne Unmanned Equipment

(1) Foreign unmanned equipment on water

The United States has a wide range of typical waterborne unmanned equipment, including unmanned boats and unmanned underwater vehicles. Unmanned boats include the Sea Hunter and the Spartan Scout. The "Sea Hunter", developed by the US Department of Defense Advanced Research Projects Agency (DARPA), is about 142 feet long, with a speed of about 50km/h and a range of 10,000 kilometres, and is capable of carrying out tasks such as detecting, tracking and identifying targets on water. Unmanned Submarine Vehicles (UAVs) include the "Big Mackerel" and "Swordfish". The "Big Mackerel" UAV was developed by the United States Office of Naval Research, with a length of 4.9 metres, a maximum dive depth of 6,000 metres, an endurance of more than 25 hours, and a modular design that allows it to carry different mission payloads according to the mission requirements and carry out aquatic surveillance missions [4].

(2) Domestic unmanned equipment on water

China's waterborne unmanned equipment is developing rapidly and is rich in variety. Typical unmanned boats include the "Killer Whale" JARI-USV-A large unmanned combat boat, the Thunder A2000 unmanned surface ship, and 50-tonne unmanned boats; unmanned submersibles include the "Sea Wing" series of underwater gliders, and the "Submarine Dragon" series of unmanned cableless submersibles, "The HS-880-6000 autonomous underwater vehicle unveiled at the Zhuhai Airshow in 2024 is the first domestic search and rescue unmanned submarine, equipped with high-resolution low-lighting lighting system, acoustic beacon directional guidance sonar, hydroacoustic sound detection side-scan sonar, etc., which can perform fully autonomous fine search, detection, positioning, and execution of underwater targets. It can search, detect and locate underwater targets in full autonomy and carry out the tasks of searching and detecting underwater targets.

Generally speaking, unmanned equipment is in the stage of vigorous development, but there are also many shortcomings, for example, unmanned equipment into the traditional combat system still needs advanced technology support, suffered from strong signal interference may lead to the receiver and the ground station to lose contact, different unmanned equipment corresponding to the system standards and technical specifications are not completely consistent. The author believes that with the continuous development of unmanned intelligence technology and the practical test of unmanned equipment in urban anti-terrorism combat, the functions of unmanned equipment in future urban anti-terrorism combat will be more diversified and the system will be more perfect.

4. Concept for the Development of Unmanned Equipment for Urban Counter-terrorism Operations

With the continuous development of unmanned equipment technology, more and more unmanned equipment will be put into urban counter-terrorism operations in the future, and manned/unmanned co-operation and unmanned equipment air-ground combination will become the main style of urban

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counter-terrorism operations, and all kinds of unmanned equipment will have a significant increase in the performance of modular combinations, intelligence and autonomy, fusion and co-operation, stealthiness and endurance.

4.1 Flexible Assembly of Modules According to Mission Needs

The United States "orca" extra-large unmanned underwater vehicle (XLUUV) has large hatches on the top and bottom for access to payload modules for mine-laying missions, and a module with side hatches for access to payloads for launching and recovering small underwater aerial vehicles. Israel Plasan North America's tandem all-terrain electric power mission module (ATEMM-T) unmanned vehicle, can carry a drone to perform reconnaissance tasks, but also mounted weapons station to perform machine gun fire, launch javelin anti-tank missiles and other strike tasks. It can be seen that the future development of unmanned equipment will pay more attention to the modular superposition combination, unmanned equipment will be based on different combat tasks, on-demand or mounted reconnaissance, patrol, combat, communications, transport and other applications accessories, plug-and-play, flexible assembly, to shorten the combat readiness time, and improve the effectiveness of the attempted mission.

4.2 Higher Degree of Autonomy

At present, many unmanned equipments still require manual intervention or semi-intervention to operate, which requires a high level of control ability for the operator. With the continuous development of artificial intelligence technology, machine deep learning and data processing capabilities, the battlefield perception capability, computing decision-making capability, interconnection and intermixing capability, and battlefield adaptive capability of unmanned aircraft are continuously enhanced, and the unmanned equipment will be able to independently carry out observation, judgement, decision-making, and action in accordance with pre-programmed instructions according to the combat mission, while accepting, analysing, and processing the on-scene information fed back by other combat units to form a chained collaborative network to achieve unmanned combat under the control of manned authorisation. On the battlefields of Iraq and Syria, the United States MQ-9 Reaper UAVs have played a prominent role by relaying back to the command structure the target information of the important figures in the bases found by patrols, and then carrying out precision strikes against the targets under the authorisation of the command centre.

4.3 Integration with Manned/Unmanned Equipment

From the point of view of the development of artificial intelligence, weak intelligence is gradually moving towards strong intelligence, and new combat styles such as man-machine fusion, machine-machine jointness, and intelligent collaboration are changing the urban counter-terrorism combat style. Through the system support of cloud-connected information network, unmanned equipment will be able to achieve autonomous perception, learning, reasoning, and autonomous execution of combat tasks. Driven by new technologies such as network communications, artificial intelligence and cloud platforms, urban counter-terrorism operations are conducted by combining a large number of manned and unmanned equipment, for example, using manned equipment to command and control unmanned equipment, using unmanned equipment to provide support for manned equipment, and commanding manned and unmanned equipment to collaborate to carry out precision reconnaissance and attacks on targets from multiple dimensions and directions, and this mode of generating joint combat systems through coupling of local combat units can be achieved through a combination of local combat units. The mode of joint combat system can be better adapted to the urban counter-terrorism combat environment, quickly achieve the purpose and effect of combat operations, resulting in the effect of "1+1>2" [5].

4.4 Significant Increase in Stealth and Endurance

Excessive engine noise of unmanned equipment may cause unmanned equipment to expose targets on the battlefield and suffer damage from strikes; therefore, future unmanned equipment should adopt more advanced composite materials, radar-absorbing materials and low-noise engines, etc., to reduce

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detectability. The endurance of unmanned equipment determines the durability of the unmanned equipment to perform the task, small multi-rotor UAVs by virtue of the advantages of small size, speed, mobility and flexibility, etc., easy to use in the urban counter-terrorism combat in complex environments, but the endurance is not strong, for example, the DJI Mavi3 series of UAVs, the endurance time is only 46-53 minutes, and if the task lasts for a long time, the batteries need to be replaced halfway through the process. Therefore, future urban counter-terrorism unmanned equipment should also make breakthroughs in perfecting the aerodynamic layout, improving the power system, perfecting the airframe design, etc., so as to continuously improve the performance and enhance the application effectiveness.

5. Conclusion

In recent years, the practice of unmanned equipment on the battlefields of local wars around the world has triggered a series of changes in combat concepts, combat patterns and combat mechanisms. With the continuous development and extensive use of unmanned equipment, manned and unmanned coordination and unmanned combat will become an important combat style in urban counter-terrorism operations. Building a strong unmanned equipment system is an important weight to win future urban counter-terrorism operations. In the process of unmanned equipment system construction, our army should keep up with the trend of unmanned intelligent technology development in the world, make careful top-level design, co-ordinate military and local resources, increase experimental demonstration, and continuously build a complete and perfect unmanned equipment system [6].

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