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Personnel Training and Emergency Drills in UAV Outfield Flight Support

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ABSTRACT
The rapid development of UAV technology makes it widely used in agricultural inspection, disaster relief, and other field operations. However, the complex external environment and the particularity of the flight mission pose a higher challenge to the support team's ability. The lack of operator skills or team cooperation will lead to mission failure. If unexpected weather, equipment failure, and other accidents are not handled properly, it can easily cause safety hazards. Therefore, based on the actual needs, this paper discusses constructing an efficient personnel training system and a flexible emergency mechanism to deal with risks to improve the safety and mission execution efficiency of UAV outfield flights.

KEYWORDS
UAV flight; Outfield support; Emergency drill

1 Introduction

The complexity of the field operation scene of UAVs puts forward multi-dimensional requirements for flight support. In tasks such as topographic mapping and material delivery, UAVs need to deal with unpredictable problems such as strong wind interference and signal interruption; the support team needs to master basic operating skills; it also needs to have the ability to rapid judgment and collaborative disposal. At present, many teams tend to value equipment and despise personnel, and there are many problems such as Operation Training fragmentation and emergency drills' formalization. Therefore, this paper will analyze the optimization path of personnel training and emergency exercise in order to build a guarantee mode that is more adaptable to the needs of complex environments.

2 Personnel Training System for UAV Outfield Flight Support

2.1 Training Requirements for UVA Operators

The uncrewed aerial vehicle (UAV) operator is the person who controls the aircraft to complete the task, and his ability is directly related to whether the flight is safe and effective. The core of the training is to make the operators understand the technology and deal with unexpected problems. They need to understand the basic working principles of UAVs, such as how the aircraft takes off, how to maintain balance, and how to adjust direction using remote control devices. This knowledge can be acquired through in-class lectures and simulator exercises. The simulator can restore the real flight scene, allowing the operator to repeatedly practice the basic operations such as take-off, landing, and route planning and gradually become familiar with the handling. Hands-on training should be gradual, starting in a simple environment, such as a windless, open field, and then moving to a complex terrain or obstacle course. Focus on training in the face of strong winds, rain, fog, and other weather changes in response to capacity, such as early deceleration and switching flight mode. Operators also learn to remain calm during signal interruptions or equipment failures, such as automatic returns or manual takeovers. This training requires increased responsiveness through drills that simulate sudden failures[1].

2.2 Training Content and Responsibilities of Assistants and Logistics Support Personnel

The assistants act as the"Eyes" and"Ears" of the mission, mainly monitoring the flight status of the UAV on the ground; computer software is needed to check the aircraft's position, battery life, and pictures in real time. If the picture is blurry or the plane is unstable, contact the operator immediately to make adjustments. Also, learn to look for data changes, such as a sudden signal weakening that means the plane is flying too far or has a shield that needs to remind the operator to turn back in time. The logistics support personnel ensures that all equipment is operational before, during, and after the mission. The training focuses on routine inspections of the UAV, such as whether the propeller is loose, the battery is fully charged, and the camera lens is clean. Before the flight, you need to test each function one by one according to the list. After the flight, you should clean the fuselage and store the battery to avoid a wet or high-temperature environment. If a UAV falls off during a mission, the logistics personnel must quickly determine the damage's extent, such as whether it can be repaired on-site or returned to the factory. Also need to choose a suitable landing site, avoid the crowd and high-voltage lines, check the weather forecast in advance, and meet sudden rain can organize team safe evacuation [2].

2.3 Collaborative Training and Cooperation of UAV Flight Support Teams

The goal of UAV flight training is not to let everyone go alone but to learn to work together under pressure. For example, in a simulated flight, the operator controlled the plane when a strong wind blew. The assistants found that the plane's batteries were dropping faster than expected, and the logistics personnel had to prepare an emergency landing site simultaneously. This situation required simultaneous communication among the three parties, with the operator deciding to turn back early, the assistants calculating whether the remaining power was sufficient, and the logistics personnel needing to clear debris from the landing zone immediately. This comprehensive exercise allows the team to find coordination problems and avoid information transmission being too slow or unclear responsibility division [3]. At the same time, the daily training should be a unified command language. Avoid vague statements, such as"The plane is not too stable," but explicitly state"Altitude drop too fast" or"Frame offset 30 degrees". Teams can shorten communication time by creating simple codes, such as"Code 1" for low battery and"Code 2" for outages. Role reversal training is also important, allowing the operator to act as a temporary assistant to experience the view of the monitor screen and analyze the data. The logistics personnel learn basic operations and help stabilize the aircraft in an emergency. The team can react quickly in a complex environment and minimize the task risk only by running continuously.

3 Emergency Drill in UAV Outfield Flight Support

3.1 Objectives and Implementation Process of Emergency Drill

The core goal of the emergency drill is to ensure that the team can quickly and orderly resolve the risk when it encounters a sudden problem. The process design should be based on "Problem finding, problem-solving, and optimization ability," divided into three stages: plan preparation, exercise implementation, and evaluation improvement. In the preparation phase of the plan, the setting basis of the exercise scene should be clarified, and the targeted training content can be designed according to the common risks in the operation area, such as signal interruption in mountainous areas and unstable flight in windy environments. Scenarios should include clear mission objectives (such as emergency landing and equipment failure repair) and reasonable pressure settings that are realistic but within the team's current capabilities. The execution phase of the exercise should emphasize authenticity and seriousness. It is necessary to simulate the unpredictability of emergencies, such as randomly cutting off signals in UAV flights or artificially creating battery failures, and require teams to initiate emergency responses without warning. The assessment and improvement phase focuses on identifying systemic issues through re-profiling, which requires on-site observers to combine data feedback (such as operation time and command response interval) and subjective feedback, analysis of team weaknesses in emergency response [4].

3.2 Organization of Emergency Drills and Roles of Participants

Emergency drills are organized into regular drills and special assault drills. Regular exercises are conducted regularly, such as once a month, covering common risks (such as equipment failure and sudden change of weather)，primarily aimed at consolidating basic emergency response capabilities. The special drill is aimed at specific high-difficulty tasks or the first field operation of new equipment, such as night flights or complex terrain mapping, enhancing the team's specialized adaptability through high-intensity simulations. The personnel role is divided into command group, execution group, and observation group according to the function. The command group, headed by an experienced team leader or technical leader, is responsible for overall coordination and key decision-making. It must have a global perspective, quickly assess risk levels, and balance mission objectives with security requirements. The execution team comprises operators, assistants, and logistics personnel who operate strictly according to predefined procedures. The Observer Group is independent of the executive team and usually consists of technical experts or supervisors not involved in the task. Through on-site records or monitoring equipment, pay attention to whether the necessary inspection steps are missed, whether there is responsibility shirking in the collaboration link, and whether the practicability of the emergency plan meets the standards [5].

3.3 Common Emergencies and Corresponding Coping Strategies

In outdoor operations of UAVs, signal loss, equipment failure, and sudden weather changes are the three significant high-frequency risks. A typical scenario of signal loss occurs when the UAV enters a signal shielding area or encounters strong electromagnetic interference. Operators must immediately switch to alternate communication modes, assistants synchronize the last known coordinates, and support personnel activate location-tracking devices. If the connection is not restored after the set time, the automatic return or hover procedure should be forced to start to avoid blind manual

intervention and increase the risk of losing control. Equipment failures include hardware damage and software failure. If the motor stops and the plane tilts, the operator immediately switches into attitude stabilization mode and tries to land on a flat area; the assistant switches to a backup lens or reconstructs the shooting logic from the flight data. The principle of dealing with sudden weather changes is dynamically adjusting mission priorities. In the event of sudden high winds or rain, the operator needs to lower the flight altitude and retrieve the mission equipment, the assistants to calculate the safety redundancy of the remaining power. The logistics personnel to evaluate whether there are local shelter conditions. All emergency strategies must be translated into muscle memory through daily practice to ensure stable execution under real stress.

4 Measures to Improve the Quality of UAV Outfield Flight Support

4.1 Strengthening Personnel Training and Improving Technical Capabilities

Improving the team's professional skills is the key to ensuring the quality of UAV outfield flights. Training should not only stay at the basic level of operation but also focus on enhancing practical ability and cultivating long-term learning habits so that everyone can not only work but also know how to respond flexibly under different circumstances. The training content needs to be designed according to the needs of the post. Operators need to master conventional flying skills and undergo training for extreme scenarios, such as quickly switching to emergency mode when suddenly encountering strong winds or equipment alarms. Technical assistants need to learn how to predict potential problems from the data, such as early warning when abnormal speed of battery consumption is found. Logistics support personnel should be familiar with the main points of equipment maintenance and quickly check the hidden dangers before the task. At the same time, technical updates should keep pace with the times. UAV technology is developing rapidly, and it is necessary to regularly learn how to use new features and understand safety boundaries. For example, when introducing a new model with obstacle avoidance capabilities, it is important to teach the operating methods and make the team aware of its limitations.

4.2 Improve Emergency Drill Mechanism and Contingency Plans

A reliable emergency mechanism is the"Safety rope" to deal with emergencies. The key is to let the team form a reflexive response ability through regular drills and ensure that the plan is practical and straightforward and can adapt to the needs of different scenarios. On the one hand, the drills must be conducted with "realistic exercises and training. "Training content should be designed with varying levels of difficulty based on the task characteristics. For example, in mountainous operations, the focus should be on handling signal loss, while urban flights should emphasize emergency obstacle avoidance training. The key is not to give the team a script but to simulate a real-life emergency, such as a mid-flight interruption of the remote signal, and see if the operator can switch to the backup plan in the first place. After the end of the exercise, the exposed problems should be rectified immediately. For example, if it is found that the signal recovery step takes too long, the operation process or additional equipment support should be optimized.

On the other hand, the emergency plan should be both principled and flexible. Standard operating procedures should be prescribed for common problems, and after equipment failure, personnel safety should be given priority before trying to repair. However, field commanders should also be allowed to adjust according to the actual situation. For example, in the event of sudden heavy rain, if the UAV has enough power, you can choose to pause the mission to shelter from the rain, and when the power is tight, you need to return immediately, not stick to the original plan.

4.3 Improving Equipment Support and Environmental Adaptability

The"Adaptation" of equipment and environment is the basic support of flight safety. Equipment management should be"Prevention is better than remedy. " Pre-mission testing focuses on core functions, such as motors and signal transmission; mid-mission periodic spot checks on ancillary modules, such as camera stability; and post-mission comprehensive checks for wear, such as battery life or loose screws. Early warning of replacement of vulnerable components should be established to avoid air power outages due to aging. Environmental adaptation needs to be planned and adjusted dynamically. Before the operation, the risk points were analyzed through weather forecasts and topographic maps. The strategy was flexibly adjusted during the flight according to the actual situation. The altitude was reduced when there was a strong wind, and the speed slowed. When the battery was insufficient, the priority was to return instead of completing the mission. At the same time, the device presets various modes to deal with different conditions, such as"Wind-resistant mode" to increase motor power and "Energy-saving mode" to turn off non-essential functions. The main goal is to equip the team with the instinct to respond quickly, to skillfully navigate using ground landmarks when completely losing positioning signals, or to immediately activate backup plans in case of sudden

equipment failure instead of waiting for instructions. The response to complex issues becomes simple and efficient through repeated training and standardized processes.

5 Conclusion

This paper clarifies the main factors to improve the quality of UAV field flight support. It reveals the key influence of personnel training shortcomings, emergency response blind spots, and insufficient equipment environment adaptation on flight safety. Therefore, UAV flight should be carried out around systematic capacity-building, periodic skill training needs to be institutionalized, and the compound problem-solving ability of personnel needs to be strengthened through real-world scenario simulation to avoid simple training into"Formal assessment" and to establish a dynamic emergency mechanism, combined with regional characteristics and technical iteration synchronization update plan standards, make process tools always meet the actual needs, a full-link control system covering people, equipment and environment is formed, in order to realize the synchronous jump of UAV flight mission efficiency and safety, and provide reliable support for large-scale application in the industry.

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