

# Application of UAV in Ship Fire

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## Abstract

**In today's innovation of science and technology innovation, the rapid development of drone technology, compared with other tools products, drones has the advantages of strong mobility, environmental adaptability, and so on, in the ship fire accident has important application value, need to use reasonable application form to ensure its more effective use. Article from multiple aspects of the advantages of drones in ship fire accident rescue, analysis of drone rescue function, and discusses the drones in the process of ship fire rescue, in order to maximize the advantages of drone rescue, improve the operability of fire fighting and rescue process, ensure the smooth progress of fire fighting and rescue work.**

## Keywords

**UAV, Ship fire, Rescue work.**

## 1. INTRODUCTION

With the deepening of regional economic and trade cooperation, the role and value of shipping ships in regional trade activities have become more and more obvious, and the overall development level of the shipping industry continues to improve. It must be paid attention to that frequent maritime trade activities have also brought a significant increase in the incidence of maritime accidents, and frequent accidents often cause significant personnel and economic losses, adding hidden dangers to the background of the prosperity and development of the shipping industry.

According to relevant data statistics, about 15% of the maritime accidents are caused by fire[1], has the characteristics of difficulty, loss, shipping ships in the event of fire accident, the fire often with cargo, fuel, ship equipment and living facilities combustible quickly spread to the area of the hull, difficult to get strong effective control in a short time, lead to the relevant personnel of property safety and life safety will face a great threat[2]. In fire fighting and subsequent rescue work, the use of this important technology can make the whole process more effective and flexible, can eliminate adverse effects in advance, for fire fighting and rescue work to build a stable environment, greatly improve the relevant staff to potential safety risk control ability, ensure that the fire fighting and rescue work orderly.

## 2. ANALYSIS OF MODERN SHIP FIRE CHARACTERISTICS

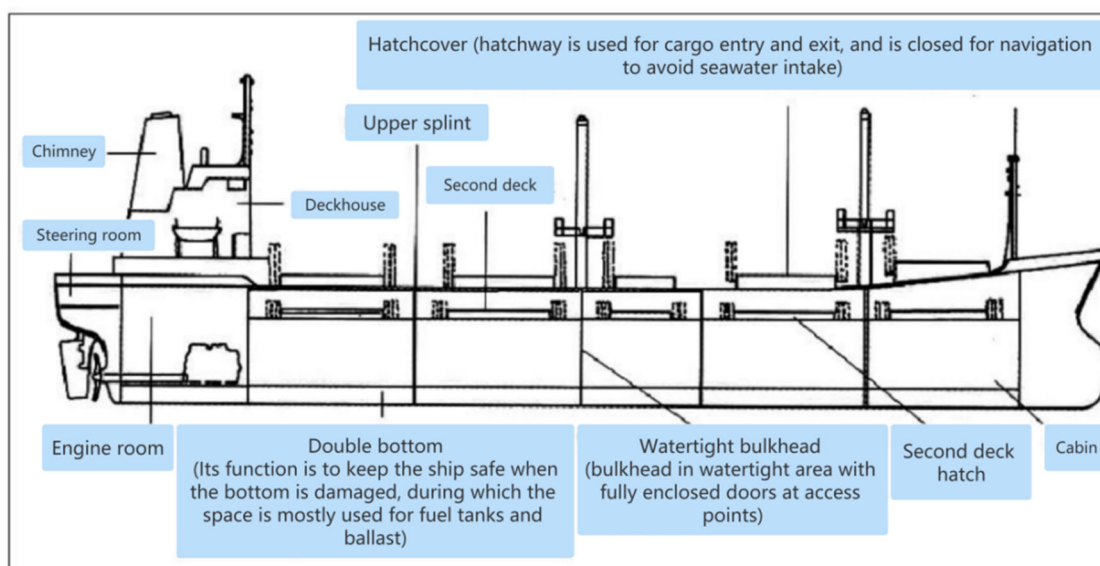
### 2.1. Complex structure makes it difficult to give full play to the advantages of personnel and equipment

In order to ensure the stability of the navigation and the crew's daily work life demand, the structure design of modern ship is very complex, as shown in fig. 1, the location of the cabin and shipboard equipment and crisscross cables, pipes on the distribution of dense environment limited ship ventilation effect and potential safety risks, the limitations of the hull itself in the space for internal corridor and channel width is narrow, and the space of ship fire has airtight,

fire point to meet, in the event of fire often too late reaction has developed into uncontrollable disaster. In the navigation of the ship fire, the fire ship (boat) is difficult to reach the fire site in time, it is also very difficult to approach, board the ship for rescue, plus the emergency rescue equipment inside the ship is difficult to effectively play the advantages[3], to control and extinguish the fire, it is easy to cause major catastrophic accidents.

## 2.2. The fire spreads quickly and it is difficult to extinguish the fire

Due to the complexity of the ship's internal structure and the limitations of internal use of space, once the fire, the fire spread very fast, a very short time can spread from the area near the fire point to other areas, with the surrounding gases such as rising temperature, extremely easy in a short time ignition ship inside all kinds of flammable and explosive items[4], this for fire fighting and rescue work is very bad. The thermal radiation, heat convection and smoke formed by the fire can not only hinder the rescue workers from finding the fire point, but also affect the choice of the boarding position and the fighting surface[5], making the rescue workers unable to carry out the internal attack operation within the appropriate time point, leading to the failure of the fire fighting operation. In addition, if the fire of the ship is not effectively controlled for a long time, it will increase the risk of the ship's overturning, which is also a big problem in the disposal of the ship fire[6].



**Figure 1.** Schematic diagram of ship structure

## 2.3. High risk factor, easy to cause secondary disasters

Ship inside the narrow space tend to pile up a large number of flammable and explosive items, such as gasoline, diesel oil, part of the ship because of demand factors also back loading configuration of liquefied gas, natural gas, etc., the flammable and explosive items in the fire, not only accelerate the spread of the fire, the risk of explosion[7], associated with a large number of smoke and toxic gas for trapped personnel and rescue workers, may face smoke inhalation poisoning hypoxia and high temperature burning.

When the sailing ship and port ship fire accident, easy to occupy the original channel, berth make other shipping ships cannot normal driving cause subsequent collision and sinking accidents, and once the fire spread the ship fuel storage, toxic liquid, dangerous chemicals, in addition to prone to explosion danger, if the residual liquid into the rivers and lakes, will cause serious environmental pollution to the large river basin, not only to the corresponding ship

company enterprises and the affected area bring heavy economic blow, also can endanger the Marine ecosystem and water resources, cause a huge negative impact.

### **3. THE MAIN ADVANTAGES OF DRONES IN DEALING WITH SHIP FIRES**

Unmanned aerial vehicle (Unmanned Aerial Vehicle) is a vehicle that does not require a traditional pilot and can be programmed by a pre-programmed flight path or controlled by a ground operator to complete a assigned mission[8]. In sudden and emergency situations, lack of comprehensive assessment and preparation for the field situation to some extent; the rescue task involves great responsibility, which puts forward higher requirements for the action plan and implementation guarantee[9];the accident is often in the area with dangerous and complex environment, and the influence of wind, wave, cloud and fog increases the rescue risk factor greatly[10], all the above conditions affect the rescue work of ship fire accident, and the addition of UAV can weaken this influence to the greatest extent.

#### **3.1. Intelligent control**

UAV itself with integrated intelligent technology, carrying advanced flight controller, with reliable performance and strong perception, pre-programmed control strategy can make the drone in the state of autonomous operation with obstacle avoidance ability, under the condition of no signal control can also do autonomous flight, meet the requirement of smooth control, machine belt camera device and image sensor can be based on fire situation timely guide, make the control process more accurate.

#### **3.2. Flexible operation**

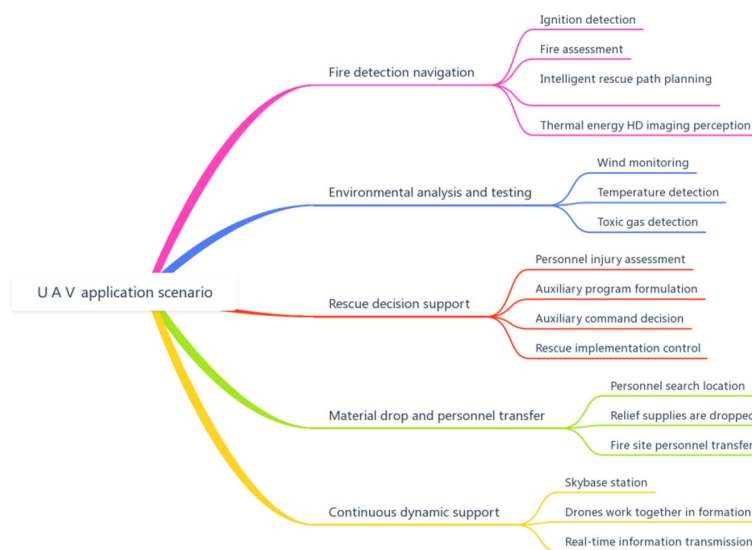
The quality of drones mostly in 10~20kg, only 1~2 people can host the operation process, light, small characteristics makes its flexibility in aerial work and easy to operate, can be stable in the complex environment launch and landing process, in the case of lost signal, encounter obstacles can also autonomous obstacle avoidance, automatic return, in the field of ship fire accident can play a bigger role.

#### **3.3. High fire detection efficiency**

UAV has high quality detection effect, when the accident occurs, it can quickly arrive at the scene of the accident, in the aspect of field information acquisition drones can record 4K HD scene images and 12 million pixel resolution above HD photos, can realize the fire fire fire real-time monitoring, and according to the record of real-time image edge calculation to determine the spread of the fire. The UAV can provide extremely accurate and comprehensive investigation conditions for the smooth development of fire fighting and rescue work with the ability of real-time information transmission, and serves as a decision-making basis for rescue workers and a guide for the formulation of relevant action strategies.

### **4. SPECIFIC APPLICATION OF UAV IN SHIP FIRE**

UAV itself has the flexibility, easy operation and the operating environment requirements determines its has great application space, the airborne involves path planning, image processing, information transmission and other intelligent technology makes it has great use value in ship fire accident processing, specific application scenario as shown in fig. 2.



**Figure 2.** The UAV is applied to the ship fire scene framework

**4.1. Fire investigation and navigation**

Fire rescue team after receiving the alarm information due to traffic, regional, sea conditions may not be able to the scene within a certain period of time, but the drone can fly in the nearest flight platform, can expand the scope of view of fire rescue workers, and can be in the first time to provide the most intuitive, real fire location and surrounding situation, the fire situation information, and advance the subsequent development of the fire and field assessment and intelligent prediction, will be assessment and prediction results together with system intelligent planning rescue path feedback to fire rescue team, not only reduce the security risk also improve the efficiency of rescue work. UAV by airborne hd camera device, signal receiver and heat hd imaging and infrared thermal imaging can realize the accurate positioning of fire, error within 1m[11], according to the control instruction can realize hovering, tracking lighting operation such as fire fire continuous observation, improve the level of drone aerial reconnaissance rescue actual combat[12].

**4.2. Environmental analysis and testing**

The airborne wind instrument enables the UAV to detect the wind and wind direction, and give feedback to the command and dispatch center according to the collected information, so as to avoid the impact of the wind on the fire site and the great impact on the rescue process, and ensure the stable progress of the rescue work[13].

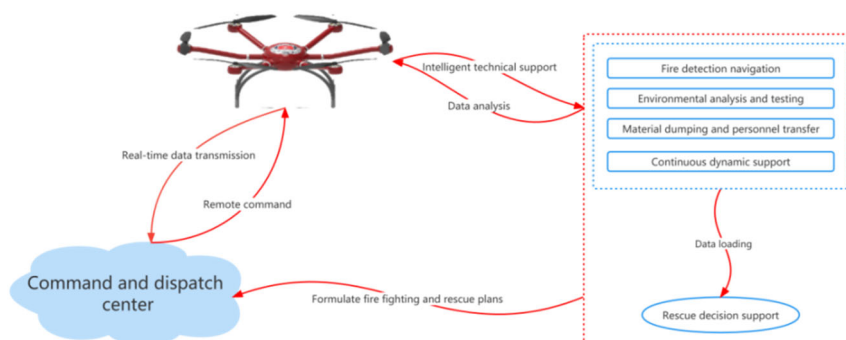
Due to the complexity of the ship structure and closed, if there is no appropriate temperature detection and fire rescue fire, not accurate temperature control, fire control, may be because of improper rescue route set cause secondary disasters, drones carry infrared thermal imaging can assist determine the fire distribution and temperature domain, to assist in the higher temperature point targeted, ensure the completion of the fire fighting work.

A large number of toxic gases are distributed in the fire area. The combustible gas detector of the UAV can detect them to remind rescuers to control the circulation of toxic gases and ensure that the fire fighting and rescue work goes hand in hand with the prevention and control of toxic gases.

**4.3. Rescue decision support**

When the UAV arrives at the fire site, the UAV can make a preliminary assessment of personnel injuries, which facilitates the command and dispatch center to issue appropriate

instructions according to the real-time situation and assist in the reasonable formulation of rescue plans. The brief operation summary is shown in Fig. 3.



**Figure 3.** Diagram of UAV assisted decision operation

Under the premise of data transmission link open, the drone can be connected by 5G network and satellite link, accurately grasp the fire fighting and rescue site condition at the same time according to the collection of information through real-time interactive auxiliary command dispatching center for rescue decision execution, improve the precision and rationality of rescue site control, maximize the external factors reduce the influence of the rescue process, security command scheduling process has the corresponding technical support, also can further improve the application of drones in ship fire[14].

#### 4.4. Material delivery and personnel transfer

UAV can be in the complex, harsh environment with its load transportation and high-speed flight ability for distance transportation mission, high power drones carrying capacity up to 100kg, some special drones can even reach 150 km/h flight speed and 500kg load, if the fire personnel drowning or suffer other trauma can use drones will inflatable life buoy rescue device and some emergency medical supplies, related technical index design should meet the requirements of accurate, practical and waterproof[15]. The drone can also communicate with medical staff in real time, and some critical patients can be transported to safe areas for treatment, seeking more treatment time for the wounded to solve the lack of supplies during beach or offshore first aid[16].

#### 4.5. Continuous and dynamic guarantee

Although the UAV can move quickly in complex environments to ensure the implementation of the reconnaissance of information, its communication coverage is often limited, so it can extend the communication range of UAV formation cooperative operation to ensure the real-time transmission of information. UAV aerial base stations can be established to strengthen the communication capability of fire sites. At present, UAV base stations have been developed at home and abroad. The model of communication UAV is mainly battery-level milliwatt UAV. For example, the KDDI UAV base station developed in Japan uses LTE base station and carries CPE equipment, and integrates wireless channels in the UAV. At present, DJI companies engaged in UAV manufacturing in China have also developed the DJI Spirit 4 fire UAV with similar functions.

## 5. CONCLUSION

This paper analyzes and summarizes the characteristics of ship fire and the advantages and application scenarios of UAV in ship fire, which provides some reference for the application of UAV when ship fire occurs. With the continuous development of science and technology and the

development of experiments, the integrated equipment intelligent and operation and fire scene adaptation will further strengthen, in the future, the application of drones will be more and more widely, need to strengthen attention to provide greater benefits for fire fighting and rescue work.

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