

Research on Application of UAV for Maritime Supervision

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Abstract: Unmanned aerial vehicle has low cost, good flexibility, low risk and high efficiency. When it is applied in maritime supervision, such as maritime patrol, sea cruise, investigation and emergency response, maritime search and rescue, navigation channel measurement, monitoring and inspection of the oil and sewage spills from ships at sea, it can effectively expand the uses of monitoring sea areas, reduce the phenomenon of illegal use of sea, which can improve modernization construction in maritime supervision. According to the UAV (unmanned aerial vehicle) development and application, this paper explores the advantages of the UAV application in maritime administration, as well as the characteristics of maritime administration, put forward some countermeasures and suggestions of UAV applied in maritime administration.

Key words: UAV, maritime supervision, duty load, technology standard.

1. Introduction

As a modern telecraft, the technology on UAV (unmanned aerial vehicle) has become maturing and widely used in the field of military affairs and civil purpose. Due to the good flexibility, high efficiency, low cost and damage, low risk, and excellent monitoring ability and widespread coverage, the UAV is capable of the waterborne supervision. Nowadays, the Tianjin Maritime Safety Administration, Guangdong Maritime Safety Administration and Changjiang Maritime Safety Administration have taken a trail and commerce project on the UAV used for the maritime supervision and monitoring of aerial cruise [1]. At the same time, the UAV has been put into monitoring the oil leakage at sea. A series of instances shows that the maritime system, fitted with UAVs and some monitoring systems, such as patrol boats, VTS (vessel traffic service), AIS (automatic identification system) and LRIT (long range identification and tracking), can improve the

construction of the safety supervision, involving with “full range of coverage, all-day operation and whole process monitoring” and can enhance the ability of law-based administration and public service.

The UAV is a remotely operated unit or it can be a telecraft controlled by programs and unmannedly operated. Generally, it is power-driven tele-controlled, autonomous flying, reused and unattended-aviated. It is quite different from the man-controlled equipment because that under the unmanned condition, the flying process is automatically controlled by the electronic systems [2]. There is no necessary to fit any equipment for the pilot, which can effectively save spaces for the control equipments thus to complete the aimed tasks successfully.

The system used in the UAV consists of the block of the craft, controlling devices, data-chaining system, transferring and receiving units and operating units. The controlling devices, called as flying management and control devices, can be regarded as the heart. It can greatly influence the stability, reliability and accuracy and instantaneity, which plays a fateful part in the flying performance. Data-chaining system can

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ensure the precise transferring of the distant control, the instantaneity and reliability of the information transferring and receiving, which makes the information feedback efficient and the task go smoothly [3]. Transferring and receiving units ensure the UAV to lift successfully and fly at a safe height and speed, after finishing all the tasks, it can launch safely. Operating units is the unit equipped for the task. The great difference between the UAV and man-controlled craft is that the UAV can not carry out any tasks without human operation. It needs a set of precise control systems and utilizing devices to assist the performance, which is called unmanned system.

2. Applications of the UAV

2.1 Applications of the UAV in the Maritime Supervision

For the characteristics of flexibility, timeliness, low coast, low consumption, low risk, strong monitor capability and widespread coverage of the UAV, it is very suitable for the services in maritime safety supervision, i.e., marine patrol and law enforcement, investigation and evidence collection, emergency response, maritime search and rescue, detection of the oil spill and pollution of ship discharge, patrol and examine of the buoy, survey of the channel.

2.1.1 Patrol and Law Enforcement, Investigation and Evidence Collection and Emergency Action

Now, there is an obvious trend that the ship become more and more large and fast, the high-speed vessel and large container ship have got a speed of 28 knots. Unfortunately, most of the patrol craft in maritime system cannot reach this level. At the same time, the objective conditions of patrol craft result in a short view of line and low answering [4]. So, it is difficult to grasp the overall situation and to carry out a continuous and effective tracing. And cannot collect the evidence of illegal and deal with it. The UAV can effectively supplement the shortage of the patrol craft in speed and efficiency. With the introduction of the UAV, it can provide quick-response and

timely-investigation to prevent the hit-and-run of the vessel. It can also record and store the evidence with the use of on-board camera devices for further handling.

2.1.2 Maritime Search and Rescue

In search and rescue, the aircraft or UAV will always get to the scene immediately and fly above the object area with slow speed. The UAV can detect the live objective with the airborne visible-light cooled-infrared pod avoiding the missing for the uncertainty of artificial search. The cooled-infrared sensor of the electro-optical pod can separate the color of the live objective with the unlive within his field of view. To distinct the color, the person on the ground can indicate the object for the rescue helicopter and naval vessel and command the coordination of the rescue helicopter, rescue boat and the shipping. Another advantage of the UAV is that it can resist wind force eight. With this advantage, the UAV can reach the dangerous area that most people and craft cannot get in. It can also transit the high definition videos and images to the monitor centre to facilitate the rapid processing of the information. It can improve the successful rate of the search and rescue with the use of UAV [5].

2.1.3 The Monitor of Oil Spilling and Pollution of Ship Discharge, Emergency Action

One of the first care themes of the maritime state is the protection of the sea environment. With the transportation of offshore oil increasing annually and upsizing of the oil tanker, the risk of oil spill increased correspondingly. Statistics shows that the oil is the main source of pollution. Forty-two percent of the discharging of oil into the sea is caused by the oil transition every year. So, each maritime state drew up the emergency plan of oil spilling and the IMO also adopted some related resolutions. With the increasing of import volume of oil and marine petroleum exploitation, it is important to real-timely monitor the oil spill. The first few hours is the best chance to prevent the oil spread and hazard. Once there is

leakage of the oil, when monitoring the import routings and petroleum exploitation area with UAV, the airborne multispectral imaging radar can detect the sea surface even in the night [6]. At the same time, with more and more secret of the night pollution discharge work, the airborne petroleum exploitation of the UAV can be used to confirm these actions by detection the temperature and color values of the discharges.

2.1.4 Patrol and Examine of the Buoy

The buoy is the main method to insure the safety navigation. There are lots of important light house, light beacon locating isolated island along the coastal area. It is difficult to maintenance for the too much points, long lines, scatter, traffic inconvenience. So, with the devices on board the UAV, the buoy can be quick patrolled and examined and be reported the state of buoys timely and effectively avoiding the aimless patrol. Increase the normal rate of the buoy.

2.1.5 Survey of the Channel

It has been widely used that by shooting the ground and water surface using aerial photography and acquiring image information, by processed processing and analysis, to extract the spatial position and related information, especially the application of measurement methods of full digital photography, the UAV photography is fully able to meet the requirements of aerospace measurement.

2.2 The Application of UAV in International Maritime

2.2.1 The Application of UAV in International Maritime Supervision

In recent years, along with the advance of technology of unmanned aerial vehicle, the security and dependability of the UAV has been gradually improved. Combined with much superiority, such as light weight, small size, and low cost, fast response and so on, UAV has increasingly wide applications in military and civilian fields. The unmanned aerial vehicle's application in the maritime regulatory is also increasing in America, Japan and other developed

countries.

America is the most advanced in technology of unmanned aerial vehicle and its civilian UAV are also the most widespread. The U.S. Coast Guard has more than 200 kinds of plane, including 73 fixed wing aircraft and 136 helicopters, but because of the long coastline, the air patrol ability of U.S. still need to continue to strengthen. In early 2004, the U.S. Coast Guard signed a procurement contract, planned to purchase 76 UAVs, including "eagle eye" and "fire scout"—two kinds of models of bell company. The number of purchasing quantity for the first time have surpassed the man-machine (35 fixed wing aircraft and 34 helicopters). At present, the "eagle eye" UAVs are listed in establishment. In addition, the United States still uses MQ9 "reaper" UAV to deal with the threat of Somali pirates for global shipping lines, etc..

Today, Japan is one of the world's largest countries in using UAV and its applications are mainly concentrated in civilian areas. In civil field, its unmanned aerial vehicles are widely used in the service of agricultural production and other departments. Recently, in response to the maritime disputes with China, Japan has begun to use UAV for maritime surveillance, and plans to study new drones to strengthen maritime warning surveillance capability.

The S-100 UAV of Austria representing the highest level in Europe, is a multi-functional general-purpose autonomous UAV system. They are widely used military and civilian fields and have been adopted in maritime agency service by several countries, such as Pakistan, Spain and India [7].

In addition, the Coast Guards of South Korea, the Philippines and many European countries put forward different quantity requirements for the application of UAV.

2.2.2 The Application of UAV in Chinese Maritime Supervision

After more than 40 years of research and development, China has gradually mastered the key

technology of UAV, the products are also more mature. With the steady accumulation of experience, the UAV has been widely used in civil fields such as aerial photography, agriculture, electric power supervision, forest fire prevention, which has made remarkable achievements. But the application in water safety supervision aspect is relatively small, the Ministry of Transport in recent years has been to research and explore the application of UAV in maritime, which has been underway for a variety of application testing, and conducted pilot application. According to understand, the Maritime Safety Administration of Tianjin, Guangdong and Changjiang has carried on the multiple subject for maritime application and air monitoring of UAV. For example, the Maritime Safety Administration of Tianjin who rented the fixed-wing UAV aerial surveillance, was carried out on the pilot work in jurisdiction area and founded the UAV monitoring team, who worked closely with technology company, and explored the UAV airborne cruise mode. At present, the frequency using UAV to carry out air cruise is up to 1-2 times a week. The air cruise is a total designed three main routes, monitoring the area of 1.6 square kilometers area of the Tianjin bureau and basic covers the area of main channel, anchorage and key sea and offshore oil platform.

3. Conclusions and Suggestions

3.1 Top-Level Design for Maritime UAV Configuration

The conditions of the UAV for maritime application has been basically mature, but the unmanned aerial vehicles are high-tech products, so the preliminary application in the maritime system must be carefully and should not be comprehensive construction blindly. From the local pilot to comprehensively promote should be practiced step by step. Using unmanned helicopter platform monomial technical indicators and comprehensive technical performance, such as take-off weight, load, cruising speed, cruising time, to

determine the UAV model for marine applications, so as to meet the needs of the maritime supervision.

3.2 Making Technical Standards of the Pod Equipment for Maritime UAV

At present, the equipments mounted to the UAV mainly has: airborne electro-optical pod, airborne AIS, airborne VHF (very high frequency), synthetic aperture radar, 3D laser radar, airborne multispectral imager, airborne VHF, location identification signal device, alarm device, image transmission equipment, etc.. For specific business of maritime supervision, making the technical standards for the task load of maritime UAV need consider pod sensor type, stable precision, detection range, the maritime target recognition and tracking, and matching with UAV alignment, etc., so that we can choose different UAVs platform and its adaptation task load according to different maritime application of task type.

3.3 Proper Solving Problems for Airspace of UAV

At present, domestic airspace management has not let go. Both UAV and man-machine face air traffic control, so they cannot take off at any time. According to related policies and regulations for the UAV, they need apply for relevant formalities to the air force and civil aviation air traffic control department in order to guarantee the normal use of the maritime UAV [8]. Draw lessons from procurement procedures for flying license of the domestic agriculture monitoring, power patrol drones, maritime UAV cruising flight need to complete the following two aspects to ensure the normal flight: (1) apply for charter flight certificate to the civil aviation administration; (2) in view of the airspace and flight route, the flight plan is reported to the air force air traffic control department.

3.4 Complete the UAV Staffing and Manipulation Training

In order to meet the requirements of UAV maritime regulation, there must be corresponding operation and

maintenance personnel. So, it need special training in related technical knowledge, equipment working principle , technical performance, system structure and configuration, installation and debugging, maintenance, system configuration, data collection and analysis, etc.. The learners can master system daily operation management and maintenance of hardware and software, and diagnose, eliminate and recover the fault; they are able to skillfully use the various tools provided and collect, analyse and process the data of system. Finally, through the trainees, the learners can be independently responsible for UAV flight and normal maintenance of unmanned aerial systems.

References

- [1] Jonke, A. A. 1972. "Pollution Control Capabilities of FBS." *AICHE Symp. Series* 126 (68): 241-51.
- [2] Yang, X. 2013. "Application of Unmanned Air Vehicle Remote Sensing System in Land and Resources Law Enforcement and Supervision." *Geology of Anhui* 3: 220-30.
- [3] Everaerts, J. 2008. "The Use of Unmanned Aerial Vehicles (UAVs) for Remote Sensing and Mapping." *International Archives of the Photogrammetry, Remote Sensing and Spa-tial Information Sciences* 37: 1187-91.
- [4] Zhou, W., Song, J., and Cheng, X. 2012. "Application of Unmanned Air Vehicle in Maritime Supervision and Assistance and its Selection." *Shipping Management* 4: 23-5.
- [5] Zhou, M. 2013. "Research on Application of Unmanned Air Vehicle in Maritime Supervision in the Area of the Yangtze River." *China Waterway* 9: 36-8.
- [6] Wang, F., Song, S. L., and Ge, Q. Z. 2013. "The Prospect of Application of Unmanned Air Vehicle in Oceanographic Research." *Ocean Development and Management* 2: 52-4.
- [7] Cui, M. H., Zhou, J. J., and Chen, C, 2004. "The Discussion on the Key Technology of Uavs Shipborne of its Application." *Aeronautical Science and Technology* 5: 40-2.
- [8] Zhao, J. S., Mi, W., and Bai, S. X. 2014. "Research on the Application of Unmanned Air Vehicle in Maritime Search and Rescue." *Chinese Maritime* 8: 26-7.