Individual Project

Drone in warfare

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1. Introduction

The formal definition of Drone in Federal Aviation Administration (FAA) is Unmanned Aerial Vehicle (UAV) or Unmanned Aircraft System (UAS). UAV can use in military, scientific research, entertainment, agriculture, and emergency rescue. In military part, UAVs are used for reconnaissance intelligence, tracking and positioning, military strikes, relay communications and battlefield search and rescue. In scientific research part, UAVs are used for wildlife tracking, weather observation and space exploration. In entertainment part, UAVs can take photos and perform in the air. In agriculture part, UAVs provide multiple ways to optimal farm to maximum efficiency and reduce labor. In emergency rescue part, UAVs can go to the harsh environments to rescue and delivery the emergency supplies.

2. War History

This paragraph is a brief introduction about the evolution of drones based on famous wars in the world. The first UAV in the world is called Aerial Target (Fig. 1), which was made by British in 1917.It is operate by radio system. Due to Aerial Target was made during the World War I, it believes to carry highly destructive explosives. Next year, Kettering Bug (Fig. 2) is used as an aerial torpedo, which is created by United States Army.

Fig. 1. Aerial Target

Fig. 2. Kettering Bug

During the World War II, Queen bee (Fig. 3) is a radio-controlled version rebuild from a trainer, which was created by British in 1935. Curtiss N2C-2 (Fig. 4) was made by American in 1937. Another UAV is

Radioplane OQ-2 (Fig. 5) was also made by American, which was manufactured more than ten thousand during the warfare. It was used for surface-to-air missile training.

Fig. 3. Queen bee

Fig. 4. Curtiss N2C-2

Fig. 5 Radioplane OQ-2

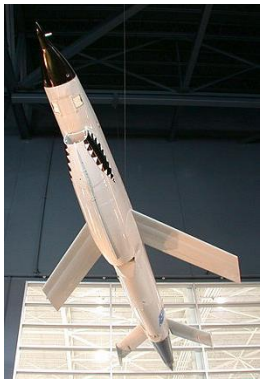

Fig. 6 Ryan Model 147 lightning Bug

During Vietnam War, the United States had more invested in the development of UAVs to reduce the number of casualties of American overseas operators after the intelligence aircraft was shot down by Soviet Union. Therefore, American started using Ryan Model 147 lightning Bug (Fig. 6) for reconnaissance mission. Also developed Ryan Model 147 series to execute specific mission over the next ten years, i.e., surveillance, decoys, electronic warfare, and psychological warfare. It is worth noting that the Ryan Model 147 has no landing gear, so it is launched from the carrying aircraft. After the task is completed, it is directly retracted into the helicopter in the air by the parachute in the drone.

In Gulf War, American used AAI RQ-2 Pioneer (Fig. 7) execute air support, reconnaissance, surveillance, and battle damage assessment missions. But the most important ability is aiming the target with missiles. A US military officer said, “To achieve a certain degree of destruction, you need to fire 50 missiles. With the help of “Pioneer”, we only need launch three missiles at the same time to destroy the target.” As a result, the “Pioneer” cooperated with the warship to destroy Iraq's artillery positions and communication hubs completely.

Fig. 7. AAI RQ-2 Pioneer

Fig. 8. AeroVironment Switchblade

American used AeroVironment Switchblade (Fig. 8) and MQ-1 Predator (Fig. 9) during Afghanistan War. The smallest AeroVironment Switchblade can put in the bag, and its purpose is to crash the target and detonate the drone's internal bomb simultaneously. MQ-1 Predator known as the Eye of Afghanistan, which has cameras and sensors under the nose. It was used for aerial reconnaissance mission. After upgrade, MQ-1 Predator can carry two Hellfire missiles and other munitions to attack terrorist organization.

Fig. 9. MQ-1 Predator

Fig. 10. HESA Shahes-136

In 2022, Russia used HESA Shahes-136 (Fig. 10) which is from Iran and Ukraine used Punisher (Fig. 11) during Russo-Ukrainian War. Both are small size UAV and used for attack certain target. Ukraine also used Bayraktar TB2 (Fig. 12) to destroy Russian’s command position, military vehicles, surface-to-air missile systems and helicopters.

Fig. 11. Punisher

Fig. 12. Bayraktar TB2

3.Case Study

I am going to show some UAV case in different country in this paragraph. First of all, MQ-9 Reaper (Fig. 13) is made by American, which is developed from MQ-1 Predator. MQ-9 Reaper needs two pilot at the control station to operate (Fig. 14). One take control of UAV in the air. Other one control sensors and weapons. The sensor under the nose has spectrum photoelectric sensors to obtain the Visible and Infrared Imaging of the targets and laser distance finder to guide missiles to attack the target precisely. MQ-9 Reaper can carry radar guidance missiles, air-to-ground missiles, and air-to-air missiles under the wings and used for reconnaissance intelligence, surveillance, close air support, combat search and rescue, and attack target. It has the length of 11m, the wingspan of 20m, the height of 3.8m, the empty weight of 2233kg, and the maximum takeoff weight is 4760kg. There is a turboprop engine in the tail let MQ-9 Reaper's maximum speed can achieve 482km per hour and cruise speed is 313km per hour. The most important ability is that the endurance more than one day, also has service ceiling about 16km and operational altitude is 7500m.

Fig. 13. MQ-9 Reaper

Fig. 14. MQ-9 Reaper's control station

MQ-9 Reaper derived four types for different needs. First, MQ-9 Reaper Block 5 has automatic landing system and use a new communication system to increase bandwidth and encrypt transmission. Second, SkyGuardain is built for Europe, which has lightning protection system, deicing system, collision avoidance system, automatic takeoff, and landing system. Third, SeaGuardain has sonobuoy system, which can detect targets in the mission of search and rescue operations at the sea. Finally, Protector is modified by British, which able to carry 18 missiles. Among them, the Seaguardian is related to Taiwan. In November 2020,

the United States approved the sale of four Seaguardian to Taiwan, and it is expected to receive the first one before 2025.

Next is Taiwan's military UAV. Albatross I (Fig. 15) was developed by National Chung-Shan Institute of Science & Technology, which is responsible for reconnaissance and battlefield surveillance, and become an air communication station and conduct disaster assessments during the disaster. Operation method is the person at the control station report data to the outdoor person to control it. In data transmission part, Albatross I uses microwave communication antennas and full-duplex mode, also uses frequency hopping spread spectrum technology to avoid interference. It has the length of 5.3m, the wingspan of 8.6m, the height of 1.6m, the weight of 317kg, and the flying range is 150km and altitude is 4000m. Its speed can achieve 180km per hour and the endurance is 12 hours. But its service ceiling only has 400m. Reportedly, Albatross II is nearly finished development, which can carry missiles and flying range is 250km. Next Taiwan's military UAV is Teng Yun (Fig. 16), which is also developed by National Chung-Shan Institute of Science & Technology. Although Teng Yun is still in development stage, we can know its uses is for long distance and long air-time mission and take responsible for the target detection and attack. It has the length of 8m, the wingspan of 18m, the height of 3.2m, the weight of 1590kg, and the flying range is 1000km. Teng Yun uses the same powerplant as MQ-9 Reaper at the tail, so the maximum speed can achieve 463km per hour and cruise speed is 296km per hour. Its endurance ability is at least 24 hours.

Fig. 15. Albatross I

Fig. 16. Teng Yun

When it comes to Taiwan's military, it always reminds me the threat from China. Therefore, I am going to introduce two series of Chinese military UAV. Rainbow-5 (Fig. 17) is an UAV with reconnaissance and attack together in the Rainbow series, also can execute interference mission and matched with Rainbow-3 and Rainbow-4 in the air. Rainbow-5 has BeiDou Navigation Satellite System, which can provide

all-weather, all-day, high-precision in positioning, navigation, and timing services. It has the length of 11m, the wingspan of 20m, the height of 3.8m, the maximum takeoff weight is about 3000kg, the flying range is 3500km and altitude is 7500m. Its maximum speed can achieve 350km per hour and endurance ability is 40hours. The next military UAV is GJ-11 Sharp Sword, which is in Pterodactyl series. It is an UAV with attack and invisible together and execute mission as J-20's wingman (Fig. 18). The foreign military experts believe that GJ-11 Sharp Sword will become an UAV on an aircraft carrier to enhance the combat power and expand the combat range. It has the length of 12m, the wingspan of 14m, the height of 2.7m. The empty weight is 6350kg and the maximum takeoff weight up to 20215kg. It also has the flying range about 4000km and the altitude is 12500m. It is worth noting that the maximum speed can achieve 1000km per hour.

Fig. 17. Rainbow-5

Fig. 18. GJ-11 Sharp Sword execute mission as J-20's wingman

4.Conclusion

I am going to show some Pros and Cons about military UAVs in this paragraph as my conclusion. The UAV doesn't require any human operate in the plane in the air, so it is safer than the plane which need human to operate whole time in the plane when the plane be attack in the warfare. The cost of UAVs is much cheaper than fighter aircraft when we

need to manufacture it, for example, The F35-A fighter aircraft's cost is 78million dollars, but the MQ-9 Reaper's cost is 30million dollars, this isn't included maintenance cost. In the operating time part, most of fighter aircraft can stay in the air about 10 hours, however the UAVs can stay in the air more than one day. Therefore, UAVs have the better ability to monitor the battlefield and execute long-distances mission. The human's maximum affordable force is 9G, so the performance of the aircraft is restricted. Because the maximum affordable force of UAVs is 20G in theory, the UAVs can achieve faster speed than any aircraft that required human operate it in the air. However, the military UAVs still have some disadvantages. Most of military UAVs only can execute certain mission, so the utility is low. During the emergency, such as bad weather, bird strikes and the system failures, the operator is controlling the UAV from a far distance, so the operator is difficult to obtain the situation of the aircraft at that time that cause the probability of crash increase. The last disadvantage is that UAVs also required to resist the interference. We only need to launch the electromagnetic waves, which has same frequency as UAV's communication channel and navigation system, can let UAV's data be steal and out of control. The UAVs can make a tremendous influence in the warfare as long as it improves above disadvantages and enhances the strength.

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