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The Literature Review of Unmanned Aerial Vehicle (UAV) Industry

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Abstract: *The development of unmanned aerial vehicles (UAV) originated in the 1920 s of the 20th century and was used for air strikes on the battlefield. In the following decades, unmanned aerial vehicles were developed and used for military activities many times. At present, the energy supply types of mainstream unmanned aerial vehicles are divided into three types: battery power supply, liquid fuel power supply and hybrid oil and electricity power supply. However, the current mainstream unmanned aerial vehicle energy supply system still has disadvantages, so in the future, the development direction of unmanned aerial vehicles must be the lack of improving unmanned aerial vehicle Systems, and innovation is achieved in unmanned aerial vehicle technology with new technology. The commercial and military development of drones depends on new technology, this paper aims to review the current situation of unmanned aerial vehicle industry and predict the future development trend and direction of unmanned aerial vehicle industry in combination with the current situation.*

Keywords: *unmanned aerial vehicle; power supply; power system*

1. Introduction

Unmanned aerial vehicle (UAV) refers to the unmanned aerial vehicle controlled by power drive, radio remote control and internal program control. [1] It can be divided into civil unmanned aerial vehicle, commercial unmanned aerial vehicle and military unmanned aerial vehicle according to its purpose. From the technical point of view, it can be divided into unmanned helicopter, unmanned fixed wing aircraft, unmanned multi rotor aircraft, unmanned airship and unmanned parafoil aircraft. In September 2018, the 62nd. Meeting of the HSC of the World Customs Organizations classified Unmanned aerial vehicle as “Flying Cameras”.

2. Historical evolution of unmanned aerial vehicle

The first unmanned aerial vehicle in history originated in 1917. Peter Cooper and Elmer. A. Sperry jointly invented the automatic gyro stabilizer. This device can keep the aircraft flying smoothly forward. This device was quickly installed into the Curtis N-9 trainer by the U.S. Navy, becoming the world’s first radio controlled unmanned aerial vehicle (unmanned aerial vehicle), it was named Sperry aerial torpedo. Sperry aerial torpedo can carry 300 pounds of explosives for 50 kilometers, but it has not been used in the battlefield. In the following decades, the unmanned aerial vehicle industry developed steadily, but because of the relatively backward technology, unmanned aerial vehicles were not really widely used in the battlefield. Until the Second World War, the V-1 flying bomb developed by German engineers was widely used in the battlefield. The extensive use of V-1 flying bomb laid the foundation for the development of unmanned aerial vehicles in the next few decades. At the same time, it also provides ideas for the research and development of cruise missiles. With the development of technology, the unmanned aerial vehicle industry is also in a wave of development. In the Vietnam War, the United States developed the first jet driven unmanned aerial vehicle Ryan Fire bee, which played a huge strategic role in the Vietnam War. In the Gulf War and the Kosovo war, many countries used unmanned aerial vehicles to effectively carry out military activities, such as real-time reconnaissance, signal collection, signal interference, attracting air defense firepower, helicopter flight path detection, artillery trajectory correction, target damage assessment, and so on. Due to the powerful combat ability of unmanned aerial vehicles behind the enemy, it has attracted the attention of all countries. At the same time, due to the end of the cold war, the military layoffs of various countries have provided a good prospect for the

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development of unmanned aerial vehicle. Compared with military reconnaissance satellites, the advantages of unmanned aerial vehicle lie in its low cost, high mobility, high-resolution camera and other advantages. In the 20th century, the unmanned aerial vehicle market has experienced two waves of development. [2]

2.1 Development trend long sailing unmanned aerial vehicle

The successful application of the predator unmanned aerial vehicle of the United States in the war in Bosnia and Herzegovina and the war in Kosovo has led to a wave of development of long endurance unmanned aerial vehicles. Many countries are attracted by the long endurance and all-weather operation ability of this type of unmanned aerial vehicle as the Figure 1 mentions.

Figure 1: Long endurance unmanned aerial vehicle

Small unmanned aerial vehicle is suitable for short-range battlefield detection, target indication, target calibration, etc. However, it is difficult to meet other high-intensity military activities. The main problems are its small load, low electric power and short endurance. Therefore, it was an inevitable trend to develop long-range unmanned aerial vehicles at that time. The endurance time of the long-time unmanned aerial vehicle can be as long as several days or even half a month, and it can complete high-intensity tasks such as naval, land and air military monitoring, real-time positioning of enemy aircraft, and high-resolution rebroadcasting of war conditions.[3]

2.2 Development trend of fixed wing unmanned aerial vehicle and rotor unmanned aerial vehicle system

At the end of the 20th century, the development technology of unmanned aerial vehicle has been constantly improved. Fixed wing (as the Figure 2 mention) unmanned aerial vehicle and rotor unmanned aerial vehicle have attracted the attention of many countries because of their small size, high mobility and low price. Many countries use it in their army and Navy fleets.

Figure 2: Fixed wing unmanned aerial vehicle [3]

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The Rotary wing unmanned aerial vehicle (as the Figure 3 mention), it's a kind of unmanned aerial vehicle that use rotor as its main feature mainly changes the space attitude and position by controlling the rotor speed. Rotary wing unmanned aerial vehicle has the ability of vertical take-off and landing, hovering and turning in the air, and moving forward, backward, left and backward, so it has relative advantages for ordinary unmanned aerial vehicle. Rotary wing unmanned aerial vehicle can perform more diverse tasks, such as nuclear pollution detection, firing accuracy evaluation, offshore and underwater detection, etc. The main power system of the Rotary wing unmanned aerial vehicle has only one large propeller, which is mainly used to provide the ascending power for flight. As the Rotary wing unmanned aerial vehicle has only one main propeller, when the main motor rotates at high speed, the rotation of the propeller will produce a reverse force on the fuselage - reverse torque. Under the action of anti-torque, the aircraft will produce a spin opposite to the rotation direction of the propeller. In order to solve the problem of Rotary wing unmanned aerial vehicle spin, it is necessary to add a small horizontal propeller at the tail of the aircraft. The pull force generated is mainly used to offset the fuselage spin. When the Rotary wing unmanned aerial vehicle needs to change its course, it can also be adjusted by the tail propeller. In addition to the main power motor and tail motor, there are usually three steering engines, which are used to change the pitch of the main propeller to make the aircraft fly forward, backward or left or right. [4]

Figure 3: The rotary wing unmanned aerial vehicle [5]

3. Analysis of current situation of unmanned aerial vehicle industry

The current unmanned aerial vehicle production direction is divided into two types: Civil unmanned aerial vehicle and military unmanned aerial vehicle. In the following, unmanned aerial vehicles will be classified according to the two production directions of unmanned aerial vehicles, and the industry status of unmanned aerial vehicles will be analyzed.

3.1 Current situation analysis of civil unmanned aerial vehicle industry

Civil unmanned aerial vehicle belongs to the consumer unmanned aerial vehicle market. As the unmanned aerial vehicle technology matures, the cost of manufacturing unmanned aerial vehicle decreases, and the civil consumption unmanned aerial vehicle market erupts.

The China Association of Aircraft Owners and Drivers estimates that there are about 300 civil unmanned aerial vehicle enterprises in China. To promote the benign development of its industry, the first is to improve the laws and regulations on unmanned aerial vehicles, and the second is to open gradually low-altitude flight.

Ren Fuhu, deputy secretary-general of the Strategic Alliance for Technology Innovation in the Unmanned Aircraft Industry of the Ministry of Science and Technology of China, said that if unmanned aerial vehicles were to pass the national approval like large airplanes before flight, they would lose their flexibility. In order to promote the development of the unmanned aerial vehicle industry, the State needs to study specific plans for supervision and promotion of the development of unmanned aerial vehicles and open the low-altitude areas, so that the Chinese civil unmanned aerial vehicle market will develop.[5]

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In recent years, the development of civil unmanned aerial vehicle industry is on the rise, and it has been widely used in many industries, such as commercial aerial photography, agriculture, forestry, environmental monitoring and so on.

In agriculture, plant protection unmanned aerial vehicle technology is maturing. The plant protection unmanned aerial vehicle has a wide range of applications, such as aerial pesticide spraying, detecting farmland information, and predicting pest disasters. At the same time, the plant protection unmanned aerial vehicle has the advantages of environmental protection, high efficiency and safety. The speed of plant protection unmanned aerial vehicle spraying pesticides is 100 times faster than that of human spraying. When plant protection unmanned aerial vehicle sprays pesticides, the operator will not have direct contact with pesticides, which ensures the safety of the operator.

In terms of commercial aerial photography, the civil unmanned aerial vehicle industry has new intelligent control technology, flexible positioning, automatic and intelligent built-in programs, and highly mobile and accurate positioning. Great achievements have been made in aerial photography, meteorological monitoring and evaluation, resource development, etc. “ Da jiang” China's largest civil consumer unmanned aerial vehicle manufacturer, as an example, the operating income of “ Dajiang” was only 820 million yuan in 2013 and nearly 170 billion yuan in 2022, accounting for more than 52% of China's aerial photography market share. It can be seen that the civil unmanned aerial vehicle industry has broad prospects and broad development prospects.

“Dajiang” has driven the development of small unmanned aerial vehicle companies in the civil unmanned aerial vehicle market and formed a complete industry chain, which strengthens the integration of the unmanned aerial vehicle manufacturing industry with the third industry, and strengthens the training of unmanned aerial vehicle technicians. This has driven the entire unmanned aerial vehicle market in China.[6]

3.2 Current situation analysis of military unmanned aerial vehicle industry

The current trend of the world's military division is towards unmanned and intelligent battlefield, and military unmanned aerial vehicle is the focus of development. At the same time, with the development of the times, the form of war is also changing. Therefore, unmanned aerial vehicle technology needs continuous innovation to adapt to the pressure of the new battlefield. At present, more than 80 countries in the world have unmanned aerial vehicles. In 2019, the global unmanned aerial vehicle market is about 25.9 billion US dollars, while the military unmanned aerial vehicle market accounts for two-thirds. [6]

In the current unmanned aerial vehicle market, military unmanned aerial vehicles have a dominant position. Among them, the United States is in the forefront of the development of military unmanned aerial vehicles. It has the largest number of unmanned aerial vehicles in the world. The United States is the country with the highest level of unmanned aerial vehicle technology, and uses unmanned aerial vehicles to participate in the war for the first time. China's unmanned aerial vehicle development is in the second echelon, with a relatively complete industrial chain and production scale. China's military unmanned aerial vehicle has developed rapidly and has become a competitor of the U.S. military unmanned aerial vehicle. China's unmanned aerial vehicle has outstanding cost performance advantages. The price of rainbow-5 (Ch-5) domestic unmanned aerial vehicle is only half of its competitors. Taking this advantage, China has gradually become the unmanned aerial vehicle import object of other countries, and China's military unmanned aerial vehicle will gradually strengthen its international competitive position.

4. Future development forecast of unmanned aerial vehicle industry

4.1 The proportion of military unmanned aerial vehicle market in China is gradually increasing

In the proportion of the global unmanned aerial vehicle market in 2018, military unmanned aerial vehicles accounted for 65% of the global unmanned aerial vehicle market, which indicates that the global military unmanned aerial vehicle industry is greatly accelerating development, and the development of the military unmanned aerial vehicle industry will also drive the development of its surrounding industries. [7] China's unmanned aerial vehicle industry will follow the international trend and vigorously develop the military unmanned aerial vehicle industry.

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4.2 Unmanned aerial vehicle is developing towards low loss and high survival rate

The current unmanned aerial vehicle technology tends to be mature, but the cost and use cost are becoming more and more expensive. In order to reduce the cost, unmanned aerial vehicle technology will improve its survival rate and use new energy to save costs in the 21st century.

4.3 Development direction of unmanned aerial vehicle power system

At present, the unmanned aerial vehicle power system is divided into liquid fuel, lithium battery and hybrid oil and electricity. However, there are still defects in the current power system. The power lithium-ion battery has the characteristic that the larger the volume is, the larger the capacity is, but the corresponding weight will also increase. In order to extend the endurance time, a battery with a larger capacity is required to provide more sufficient kinetic energy. Increasing the capacity, the weight of lithium-ion battery and unmanned aerial vehicle will increase, resulting in the bottleneck of endurance time, Therefore, the current research direction of lithium battery power system is to lighten the battery to increase the battery energy storage. The stability of liquid fuel driven unmanned aerial vehicle will decline after long-time operation, with poor adaptability to the environment and site, insufficient plateau performance, and great maintenance difficulty. Therefore, the safety and stability of the liquid fuel power system is a major research topic at this stage. The oil electric hybrid unmanned aerial vehicle can effectively make up for the shortcomings of the former two. However, the research on this kind of unmanned aerial vehicle at home and abroad is still in the primary stage, and further research is needed to optimize the balance of the oil electric system, so as to combine the respective advantages of the oil electric system and the electric system.

5. Conclusion

Unmanned aerial vehicle (UAV), as a relatively new technology, has rich uses. This paper analyzes the current situation of unmanned aerial vehicle industry and analyzes the future development trend and direction of unmanned aerial vehicle technology. In 1917, unmanned aerial vehicles were developed and applied by the military. Until the 21st century, unmanned aerial vehicles have experienced two huge waves of development, namely, long endurance unmanned aerial vehicles and fixed wing and rotary wing unmanned aerial vehicles. The current development trend of the unmanned aerial vehicle industry can be analyzed from three aspects. The first aspect is that the proportion of civil unmanned aerial vehicles in China is increasing. The government will open more low altitude areas for flight, and improve the relevant laws and regulations for civil unmanned aerial vehicles. The second aspect is that unmanned aerial vehicles are developing towards high efficiency and low power consumption, because the cost of unmanned aerial vehicles is gradually increasing over time, and they want to use unmanned aerial vehicles in more scenarios, it must cost more. The third is the development of unmanned aerial vehicle power system to hybrid power. The disadvantage of electric unmanned aerial vehicle is its low endurance; the disadvantages of diesel unmanned aerial vehicle are high weight and difficult maintenance; Oil electric hybrid unmanned aerial vehicle and other energy hybrid unmanned aerial vehicles are under development.

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