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The Current Research Status and Prospect of Multi-rotor UAV

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***Abstract**: With the rapid development of micro-electric and computer technology, multi-UAV has drawn much attention. Multi-UAV has become an important research topic in recent years and the major domestic and foreign scientific research institutions, commercial companies, military institutions are carried thoroughly research to it.In this paper, the development process of multi-UAV are introduced and some representative research projects of multi-UAV at home and abroad are listed and the key technology of multi-UAV are summarized .Finally, the future development trend of multi-UAV are given.*

***Keywords**: multi-UAV; the Status of the Current Research; the Trend of Development*

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I. Introduction

Multi-UAV is a helicopter that can take off and land vertically,its development history can be traced back to 1907, when Breguet brothers Louis and Jacque under the guidance of the French scientist Charles Richet designed and manufactured the world's first manned multi-rotor aircraft - "rotor craft one". [1] As shown in Fig.1, the aircraft with the pilot, the total weight is 578 kg. The aircraft frame consists of four long welded steel pipe brackets, and distributed as a level crossing. The four rotors are in the diagonal position of the frame, one of which is rotated in a clockwise direction and the other is rotated counter clockwise. The power unit is a 36.7 kW engine, which is controlled by the driver to control the throttle Control, but due to the technical constraints at the time, they could not achieve the control of the aircraft. From then on, people turned their attention to helicopters and fixed-wing aircraft. Until the nineties of the twentieth century, the development of multi-rotor has been in a state of stagnation. Since the 1990s, with the development of MEMS technology, brushless motor technology and micro-processing technology, the small multi-rotor unmanned aerial vehicle has reintroduced into the field of vision, which has become a hot spot in the research institutes.

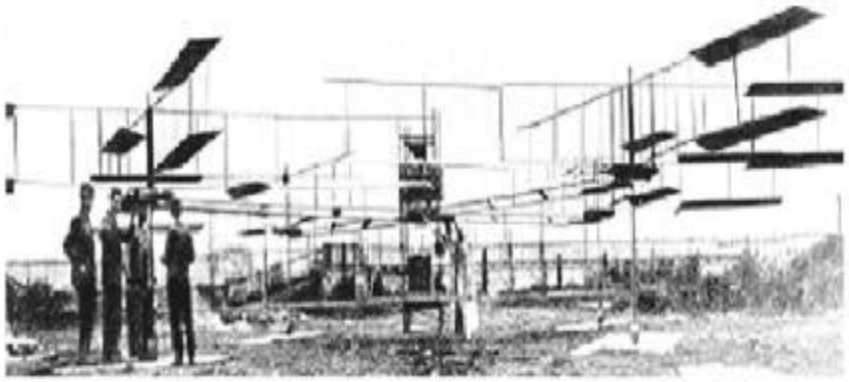

Fig.1 Breguet-Richet's "Gyroplane No1" oil move multi-rotor unmanned aerial vehicle (multi-rotor UAV)

According to the number of rotors, multi-rotor unmanned aerial vehicles (multi-rotor UAV) can be divided into four rotors UAV, six rotors UAV, eight rotors UAV and other types. There is special shape of UAV, its most prominent feature is the multiple rotors, and each pair of rotors turning opposite, reverse torque to offset each other.[2] Fig.2 is a schematic structure of a typical four-rotor UAV, and four rotors are cross-structure. (In the "+" font mode) The rotors 1, 3 are rotated in the counterclockwise direction, and the rotors 2, 4 are rotated in the clockwise direction so that the reverse torque generated by the four rotors can be offset from each other. By changing the speed of the four rotors, you can achieve the control of pitch, roll, heading and height.

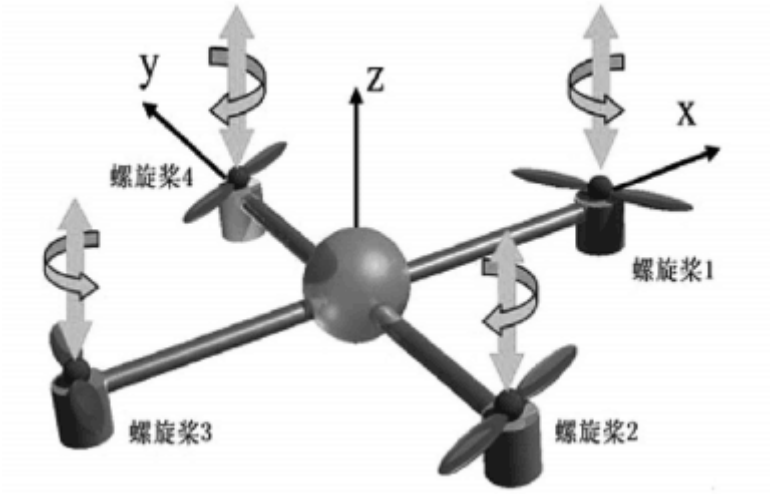

Fig.2 Schematic structure of a typical four-rotor UAV

Multi-rotor inorganic compared to other unmanned aerial vehicles have a unique advantage. Compared with the fixed-wing aircraft, it has the advantages of vertical takeoff and landing, can be fixed-point hover; Compared with the single-rotor helicopter, it uses brushless motor as a driving force, and no tail rotor device and therefore it has a simple structure, high security, low cost. Many advantages of multi-rotor UAV make it access to a wide range of applications in the following areas:

1）Application of multi-rotor UAV in educational research

The research of multi-rotor unmanned aerial vehicle (UAV) is related to automatic control technology, MEMS sensor technology, computer technology and navigation technology. It is an ideal platform for mult -science field integration research.

2）Application of multi-rotor UAV in aerial

Multi-rotor UAV equipped with camera equipment (visible camera/infrared camera), and equipped with image transmission system, known as the "flying camera" has been widely used in film and television aerial, power line patrol, Mapping and other industries.

3）Application of multi-rotor UAV in Military

Multi-rotor unmanned aerial vehicle equipped with detection equipment can quickly fly to the dangerous area to carry out the investigation task for the combatants to provide battlefield information, so it is ideal for individual combat equipment.

4）Application of multi-rotor UAV in agricultural

The use of multi-rotor is more alternative for spraying pesticide, which has low cost, high efficiency and reduce pesticide harm to human body.

5）Application of multi-rotor UAV in express industry

The use of multi-rotor unmanned aerial vehicles to deliver courier with the cost of saving labor costs, and the speed is not limited by the advantages of ground traffic restrictions.US Amazon, China's SF Feng are in testing the multi-rotor UAV transport express. United States Domino's Pizza has been successfully airlifted the first pizza delivery in the UK. [3]

The advantages of multi-rotor UAV, the broad application prospects make it a hot spot in the field of UAV research. The major scientific research institutions have set off a wave of multi-rotor research, and commercial applications of multi-rotor UAV also blossom everywhere, from the laboratory to the national economy in the field, the following development of the status of multi-rotor UAV and some typical multi-rotor UAV are introduced.

1 Research Status at Home and Abroad

1.1 Swiss Confederation Institute of technology OS4 four-rotor UAV

OS4 is an electric miniature four rotors craft developed by EPFL Automation Systems Labs. The focus of their research is the development of flight control algorithms, the goal is to achieve multi-rotor unmanned indoor and outdoor completely independent flight. At present, the organization has developed a control algorithm called Integral Back-stepping, which combines the advantages of PID algorithm and Back-stepping algorithm, and has successfully implemented hover, takeoff and landing of OS4 UAV.

Fig.3 OS4 experimental platform

OS4 project Next step: Improve the bandwidth of the actuator to make it have a faster response speed; Enhance the detection capability of the vision sensor and use the filtering algorithm to integrate the inertial navigation sensor with the visual navigation sensor data; integrate the IMU module into the control board, And on the airborne processor to complete the visual navigation data processing.

1.2 Australian National University X-4 Flyer Multi-Rotor Unmanned Aerial Vehicle

X-4 Flyer is the Australian National University developed heavy load multi-rotor unmanned aerial vehicle, its mass is 4kg, load capacity of 1kg. The X-4 Flyer is shown in Fig.4.

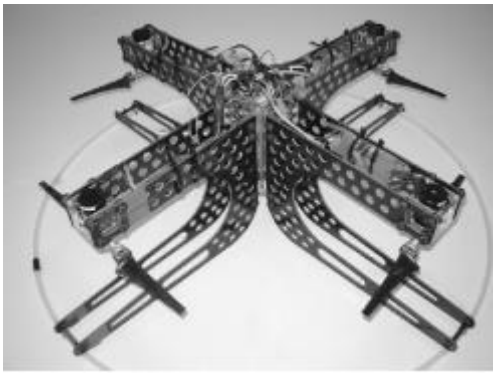

Fig.4 X-4 Flyer multi-rotor UAV

1.3Commercial Multi-rotor UAV

Dajiang "Enlightenment" multi-rotor UAV is equipped with a 12 million 760 thousand pixel high-definition camera, with visual navigation function, can realize stable hover indoor without GPS. ; Dajiang "MG-1"agricultural plant protection machine is a realization of dustproof, waterproof and corrosion protection of the industrial design products, each small operation amount can reach 40 to 60 acres, the operation efficiency is more than 40 times the manual spraying.

Fig.5 Dajiang "Wu" multi-rotor inorganic / "MG-1" agricultural plant protection machine

Germany micro-drones GmbH was established in October 2005, its products are industrial multi-rotor UAV representatives, the latest product md4-3000 maximum takeoff weight of 15 kg, the standard load of 3 kg in the case of sustainable flight 45 minutes, Maximum cruising speed of 16 m/s.

Fig.6 md4-3000 multi-rotor UAV

1.4 Open Source UAV Project

The open source multi-rotor unmanned aerial vehicle project has Micro Copter, Auto Quad, Open Pilot, MWC, KK, APM, PX4, etc., which is the most famous, the largest number of users is the United States launched 3DR APM open source flight control.

Fig.7 Pix hawk flight control hardware and Mission Planner ground station software

Auto Pilot Meg, referred to as APM, is an open-source self-drive instrument, which supports fixed wing, helicopters, rotor-craft and other models. Pix Hawk is the Zurich Polytechnic University, the development of an autopilot, the cooperation between the two companies will 3DR in 2013, APM flight control code into pix hawk hardware, so pix hawk hardware can run two sets of flight control procedures, APM flight control procedures and the Zurich Polytechnic University developed primary program.

II. The Key Technology Of Multi-Rotor Unmanned Aerial Vehicle Development

Microelectronics technology and the development of computer technology makes the study of multi-rotor UAV has made rapid progress, but the development of multi-rotor is also facing many key technical challenges, there are the following aspects:

2.1 Accurate modeling of multi-rotor unmanned aerial vehicles

UAV accurate modeling is the premise to design a high performance controller for multi rotor, but due to the influence of various physical effects of structure characteristics and flight process of the complex rotor itself, so the present study basically established a relatively simplified model. To establish a more accurate mathematical model of the rotor, measuring technology and model of dynamic performance parameters of the dynamic problem, the air condition of low Reynolds number of flexible rotor gas measurement and verification methods need to be further solved.

2.2 Energy and power systems

Multi-rotor UAV general use of lithium batteries as a driving force, the flight time is generally about 30 minutes, load from a few hundred grams to a few kilograms, life time and load capacity to control the development of multi-rotor UAV an important factor. Therefore, The development of lighter and more efficient power and energy devices is the key to multi-rotor aircraft.

2.3 Flight Control System

Multi-rotor aircraft is one with six degrees of freedom and 4 control inputs (rotor speed) of the under-actuated system (Under actuated System), is a multi-variable, nonlinear and strong coupling and interference sensitive characteristics, which makes the design of flight control system becomes very difficult. In addition, the performance of the controller will be affected by model accuracy and sensor accuracy. Multi-rotor UAV attitude control is the core of the control system, the current domestic and international research shows that the advanced attitude control algorithm due to model uncertainties and other factors, the control effect is better than the PID controller, or only in a particular environment has better control effect. Therefore, it is very important to study a flight control algorithm for multi-rotor UAV.

2.4 Positioning, Navigation and Communication

Multi-rotor UAV generally work in complex environments such as indoor, tunnel, and urban areas, so there are problems with positioning, navigation and communication. On the one hand, in the indoor, tunnel or city building environment, GPS as the signal block cannot work normally, need integrated inertial navigation, optics, acoustics, radar and terrain matching positioning and navigation technology; on the other hand, multi rotor flight environment is complex, the interference source, to achieve a communication chain the reliability, security and anti-jamming is the need to increase the power of the communication link, so it will increase the weight of the communication system. Therefore, the development of small, lightweight, low power consumption, stable and reliable and anti-jamming communication equipment for micro multi-rotor aircraft technology (especially multi-aircraft collaborative flight technology) development is very critical.

III. The Future Development Trend Of Multi - Rotor Unmanned Aerial Vehicles

The development of multi-rotor unmanned aerial vehicles will continue to be intelligent and integrated development, the future of multi-rotor UAV flight power and energy problems will be resolved, the use of fuel cells, solar cells or oil-based engine, its life will be And its flight control system will be an integrated navigation, communication, automatic control of the flight chip, the use of more advanced control algorithm to achieve multi-rotor UAV in the complex environment of independent decision-making and autonomous control; micro-multi-rotor UAV And large multi-rotor aircraft to keep pace with the development of large-scale multi-rotor aircraft can carry more task equipment and even manned flight.

IV. Conclusion

As a low-cost UAV platform, multi rotor unmanned aerial vehicle (UAV) has been widely used in military and civilian fields, but there are still some key technologies that restrict its development. With the development of science and technology change rapidly, in the near future, problems of multi rotor UAV problem will be solved one by one, multi rotor UAV UAV will become a new platform, and play an important role in all walks of life.

Reference

[1] Zhang Xin. Research on attitude and navigation information fusion algorithms for multi rotor UAV [D]. 2015:6-6 (Changchun Institute of optics, fine mechanics and Physics),
[2] Jiang Chengping. Design and implementation of a four rotor UAV control system [D]., Harbin Institute of Technology, 2014:6-8
[3] Li Chenglong. Research on flight stability control of multi rotor UAV at high altitude [D]., Zhejiang University, 2016:3-4

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