Research on the application of computer track planning algorithm in uav power line patrol system

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Abstract. Unmanned aerial vehicle (UAV) has the advantages of high safety, accurate detection results and long time continuous operation in power grid patrol inspection. Article several kinds of commonly used in electric power inspection for unmanned aerial vehicle flight mode is analyzed, and the planning track of unmanned aerial vehicle (UAV) in power patrol autonomous optimization, power patrol scheme based on path planning was proposed, at the same time on the ground calibration start and end position of the workstation USES route planning algorithm for flight points, of course, so as to realize the tracking of on line.

Keywords: Uav, Flight Mode, Track Planning Algorithm

1. Introduction
With the gradual expansion of urban development, the demand for electricity continues to increase, and the demand for stability of power supply lines becomes more and more important. At present, manual inspection is the main method of power system inspection, which leads to problems such as low work efficiency, low safety and limited work. At present, the mainstream UAV technology not only has the advantages of fine size, controllable speed and easy operation, but also can realize remote image shooting, which provides a new means for electric patrol inspection [1]. The core of using UAV for inspection is the design of inspection algorithm. Therefore, in order to improve the efficiency of electric inspection, a scientific and reasonable route planning scheme for inspection is neede [2]. In this paper, the analysis, algorithm design and flight path planning of electric patrol UAV are discussed.

2. Flight mode setting of electric patrol UAV
In order to reduce manpower, unmanned aerial vehicles (UAVs) are usually used in electric inspection. UAVs are mainly divided into fixed-wing UAVs and helical wing UAVs. Heliwing UAV is full of power, which can complete many difficult flight actions and can be used for small load transport services. Compared with fixed-wing UAV, it is able to quickly adjust the flight direction, height, and is more flexible and adaptable to the environment [3]. By analyzing the six-axis rotor UAV and combining with the differences in flight behaviors of electric patrol UAV, several different flight modes can be designed [3~5].
2.1. **Stable pattern**
The pattern belongs to the six axis rotor unmanned aerial vehicle (uav) flight is the most basic model, usually USES the stable model of flight attitude to manipulate the six axis rotor unmanned aircraft take-off and landing, the biggest advantage of this model is that can fully guarantee the stability of the six axes rotor unmanned aerial vehicle (uav) attitude, therefore, in the actual setting track this mode is indispensable.

2.2. **Fixed altitude mode**
The flight attitude of fixed altitude mode is mainly to ensure that the six-axis rotorcraft uav always maintains a certain flight altitude [4]. When there is no need to adjust the altitude, the six-axis rotorcraft UAV can complete the left and right operation by itself under the premise of equalaltitude through sensors. When switching between the above two modes, the throttle fixed advanced channel needs to be switched, so as not to cause a sharp rise and fall of the aircraft due to the mode switch, affecting the intuitive flight.

2.3. **Hover mode**
This mode is mainly to ensure that the six-axis rotorcraft uav can maintain its hover attitude in the air and never change. Even if the external interference to its flight status causes a certain deviation, it can correct itself and then return to the set point again [5]. As it is required for the uav to approach and keep hovering when approaching the power facilities for inspection, the operator shall perform remote focus shooting or other operations, so for the inspection of power facilities, the fixed-point hovering mode is one of the necessary conditions for the work of the six-axis rotor UAV.

2.4. **Headless mode**
The headless mode does not need to adjust the nose of the six-axis rotorless UAV, but only needs to take it as a point in flight. The operator can adjust the change of the uav's elevation Angle by remote control, so as to control the flying area. The six-axis rotorcraft can also move to the left or right by changing the Angle of roll. This kind of flight attitude is mainly used to test the flight control function of the six-axis rotorcraft UAV.

2.5. **Return mode**
The system will conduct self-check after each unlocking of the six-axis rotorcraft UAV. After completion, the GPS position signal will be read first and recorded in the memory, taking it as the starting coordinates. When turning on the turn-back mode or when the UAV is low power or out of the remote control range, the six-axis rotor UAV will finish the current task and return to the take-off point according to the original elevation set by the system. Due to the diversity of the surrounding environment, the default uav is elevated first and then gradually landed, with the fixed-point circling mode. After the uav is controlled by the flight channel to the fixed-point circling mode, the six-axis rotor UAV will set the center as the center of the circling circle. During the flight, the front of the six-axis rotor UAV will always face the circling center point. We can control the flying motor to change the flight trajectory through sensors such as gyroscope, geomagnetic, camera, etc. We can also control the surrounding point and radius parameters of the UAV through the upper computer. During the circling flight, the yaw Angle is not controlled by the ground. The fixed-point circumnavigation mode is mainly used in the detailed inspection of power supply lines, such as the inspection of power towers. As for the failure point of the power tower, the six-axis rotor UAV can take the way of shooting and recording from bottom to top for full analysis and final determination.

2.6. **Autonomous mode**
This flight mode is the most advanced flight mode of electric inspection six-axis rotorcraft UAV. In this flight mode, other flight modes can be arranged and combined in an orderly manner. By means of algorithm optimization with sensors such as vision and laser, flight tasks can be planned in advance in
combination with ground station software, and then the tasks can be uploaded to the six-axis rotorcraft UAV for sequential execution. For example, after autonomous takeoff, the UAV navigates from Point A to Point B, and then autonomously recognizes after capturing feature points such as wires and power towers. It flies according to the trajectory, avoids obstacles autonomously, and finally lands autonomously after arriving at Point B [6].

Different flight attitudes are often used in different missions. Among them, autonomous flight mode is the most difficult flight mode, which is mainly completed autonomously by the six-axis rotorcraft UAV through the onboard sensor identification, algorithm, control and so on, without the intervention of operators.

3. Algorithm design
The underlying algorithm of the six-axis rotorcraft UAV is derived from the core support of automatic control, but the design of the underlying control algorithm of the six-axis rotorcraft UAV is inseparable, but interrelated.

PID is a commonly used feedback-based closed-loop controller. In the PID controller, the upper part is composed of: proportion (P), integral (I) and differential (D) [7].

The transfer function is:

\[ G(s) = \frac{U(s)}{E(s)} = P(t)[1 + \frac{1}{I(t) \times s + D(t) \times s}] \]

Where P(t) is the proportional coefficient; I(t) is the integral constant; D(t) is the differential constant.

The PID model is shown in Figure 1:

![PID model diagram](image)

**Figure 1.** PID model diagram

Transfer function in PID controller:

\[ H(s) = \frac{D s^2 + P s + I}{s + C} \]

C is a constant in the PID controller's transfer function. The function of the specific relationship between proportional-integral-differential is as follows: (1) The ratio P, which controls the current error of the function, corresponds to the control speed of the reaction system [8]. The higher the value of P, the faster the speed will be, and the higher the response frequency will be, and the generated control will be divergent. (2) Integral I, the output of the controller is proportional to the integral of the input error signal, and the stability of the system is adjusted. (3) Differential D, the output of the controller is proportional to the differential of the input error signal, so that the system stability time can be accelerated.

In the experiment, it was found that the proportional + integral (PI) controller in the control can make the system have no steady-state error after stepping into the steady state, while the proportional + differential (PD) controller can effectively improve the dynamic characteristics of the system in the
regulation process. The parameters of each flight mission of the six-axis rotorcraft UAV are adjusted by experimental data.

The control strategy design is the key of UAV autonomous flight strategy controller, and the design scheme is two-layer control mode. The first level is the navigation level, and the second level is the control level. The relationship is shown in Figure 2. The navigation level control mode can control how the aircraft arrives at the specified position. The control algorithm in the system is used to calculate the target pitch Angle, target roll Angle, throttle adjustment quantity and yaw Angle, etc., and then the control level is assigned to complete the following work.

![Diagram](image)

**Figure 2. Navigation and control level relationship**

The structure of the autonomous control system is shown in Figure 3. The main task is to continuously collect the flight attitude parameters and surrounding environment of the six-axis rotorcraft UAV, and the flight task is transmitted by the remote control station received by the host computer.

Autonomous control system structure as shown in figure 3, the main work task is continuous acquisition of six axis rotor unmanned aerial vehicle (UAV) flight parameters, the surrounding environment, the launch of the mission in the receiving to remote control station, here the main PC instruction, as flight controller receives commands at the same time send motor PWM wave combined with optimization algorithm, by adjusting the duty ratio all adjustment of unmanned aerial vehicle (UAV) flight tasks. In order to achieve the purpose of simple control, the mathematical model is the hierarchical and hierarchical intelligent control structure proposed by Saridis [9]. The autonomous flight control system of the UAV is designed with a set of layered control structure through experiments. The bottom layer is also the mission execution layer of the six-axis rotor UAV. After the decomposition of various complicated flight instructions, the MOTOR of the UAV is finally controlled through PWM, and it can also be remotely controlled by the upper computer on the ground. There are usually two control modes, one is the flight attitude mode of the six-axis rotor UAV, and the other is the position mode of the six-axis rotor UAV. The bottom control algorithm is the control method adopted, and the take-off and landing of the six-axis rotor UAV is also controlled in this layer. As far as autonomous flight management is concerned, it belongs to the highest level of six-axis rotor UAV flight controller, which can control autonomous flight. It usually manages the switching of flight mode of the six-axis rotor UAV and the analysis of environmental parameters, and mainly manages the flight mission of the six-axis rotor UAV.

4. Conclusion

Flight path planning algorithm has always been a very important and hot research direction in the field of electric patrol UAV. In this paper, to solve the problem of electric inspection flight control system design of the six-rotor UAV in electric inspection, and the performance test of the flight control system is carried out, which is feasible to some extent. In this paper, the route planning algorithm is designed, which is applied to the autonomous patrol line of six-rotor UAV, the route planning model of the route planning algorithm is studied, and the system model is designed by the algorithm. Simulation test and MATLAB simulation verify the feasibility of the algorithm [10]. The practical application shows that this method can be used to optimize the inspection route, improve the scientific and rational of the inspection scheme, and improve the work efficiency of the electric power inspection department.
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