

# Small Quadrotor Plant Protection UAV System Based on Big Data

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**Abstract.** Unmanned aerial vehicle (uav) can not be fully used in all application fields without the assistance of cloud computing and big data. All changes in the uav's movements during flight, including track, altitude, speed, position, course and image, will be incorporated into the cloud database and stored in real time. For example, plant protection uav based on big data can assist in the analysis of plant protection efficiency. In this paper, small quadrotor plant protection uav system based on large data and plant protection database system design as the research focus, this paper puts forward a complete set of big data, small quadrotor plant protection uav system and plant protection database system design scheme.

## 1. Introduction

At present, the agricultural plant protection industry in China is still dominated by semi-mechanized equipment such as manual and electric sprayer, accounting for more than 90%, and aviation plant protection less than 2%. At 2015, the plant protection uav calculation, the total operating area of 11.528 million Mu at a time, the plant protection uav less than 1%, while the United States, Japan's agricultural aviation operation of cultivated land area ratio reached 50% and 54%, respectively, have also reached far higher than the world average 17% of our country, our country is still in its beginning stage in terms of aviation plant protection<sup>[1]</sup>.

Plant protection uav is the key to build accurate agricultural plant protection through big data. A large amount of farmland data can be obtained, providing problems that cannot be detected by human eyes. For example, whether the irrigation is uniform, the soil color changes, the temperature changes, whether the nitrogen fertilizer exceeds the standard, the insect disaster is serious, and whether the plant lacks water through the color spectrum analysis of branches and leaves, etc. According to these analyses, farmland can be adjusted in real time to improve crop yields.

## 2. Plant protection uav system design

The plant protection uav system for constructing the precise agricultural plant protection big data is mainly composed of the plant protection uav image transmission system, Uav digital transmission system, Uav route planning system and Uav fixed high speed setting system, as shown in figure 1.

Plant protection uav image transmission system is a system that sends real-time and stable images of crops captured by uav to ground wireless receiving equipment. In the process of image transmission through image processing algorithms for image enhancement processing, such as through electronic stability as removing shake, shake, etc factors exist in the video, makes video images more smoothly, and then use a 5.8 GHz wireless technology for transmission. Ground stations also receive images at 5.8GHz and display them in real time on video devices.

Uav digital transmission system is a system that sends real-time and stable data from each sensor on the uav to wireless data receiving equipment on the ground. The data acquisition system USES

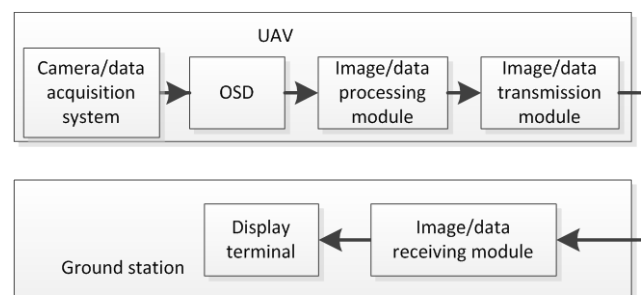




8-channel multi-channel switch to expand the analog input channel, which is used to collect the simulated signals of each sensor of uav. A/D converter is used to convert it into digital signal. After data processing, COFDM modulation was used to send data to ground stations. After receiving the ground station, the flight data can be displayed in real time in the video equipment through D/A conversion and through amplification and filtering<sup>[2]</sup>.

Uav route planning system refers to finding the optimal or feasible route from the starting point to the target point and satisfying the uav performance indicators under certain constraints. The essence of the problem is the optimization of the extremum of the multi-objective function under the condition of multiple constraints. It is of great significance to improve the weapon system performance of uav by planning a better route that can meet the requirements of mission, navigation, security and other constraints. Uav route planning mainly includes four parts: environment information, flight constraint, route target and route planner. The route planner relies on the route planning algorithm, which can be divided into the traditional classic algorithm and the modern intelligent algorithm. The former includes dynamic programming, derivative correlation and optimal control. The latter includes heuristic search, genetic algorithm, artificial neural network, swarm intelligence (mainly including ant colony algorithm, particle swarm algorithm, swarm intelligence algorithm), etc.

Uav system for high speed, uav fixed height is in flight control system with sensors to cooperate to complete, commonly used fixed high sensor has GPS, barometer, ultrasonic sensors, optical flow sensor.



**Figure1** Plant protection uav system

### 2.1 plant protection uav chart transmission system design

The plant protection uav map transmission system consists of two parts: uav and ground station.

The uav part includes camera, OSD module, image processing module and image sending module.

The camera, used to collect real-time images and video, determines the image quality directly. The camera is generally evaluated for its sensor, lens, ISO (sensitivity), video resolution, video storage maximum code stream.

OSD module, in terms of hardware chip, the main control chip adopts Atmega328, while the character superposition chip adopts MAX7456 solution. Atmega328 has 32kb flash, 2kb SRAM and 1kb EEPROM; MAX7456 can store 256 characters, enabling Pal signal or NTSC signal character superposition. In the aspect of software, minimOSD uses Mavlink communication protocols, encapsulated in a serial port on the flight data for Mavlink protocol, and it can be displayed in the video output, at the same time support plate type and contents of the user to set the display information<sup>[3]</sup>.

The image processing module and image processing module are integrated into the micro-control unit of the image transmitting transmitter, including image preprocessing and image encoder. Image processing technology includes a variety of image processing algorithms to achieve different image processing effects. The common functions are: decoding video with different definition, image enhancement processing, electronic image stabilization, scene locking, target tracking, etc. One of the most important is the video codec, efficient video compression algorithm to high compression ratio, the digital signal to reduce signal source code rate, save the channel bandwidth, the purpose of implementing high-speed transmission, such as H.264 standard.



Image sending module, will execute the image real - time stable transmission to the ground wireless receiving equipment. The distance of image transmission, the quality of image transmission and the stability of image transmission are the key factors to measure the performance of uav image transmission.

The ground station is mainly the image receiving module, PC terminal and video terminal image display module. The graph transmission receiving module is the module that receives the graph transmission information. It is often integrated in the receiving terminal, such as the integrated display screen, which can be directly opposite the transmitter frequency to obtain real-time image transmission. In addition, the picture transmission receiver can also cooperate with video collector to connect with PC terminal and communicate with serial port through software to obtain real-time picture transmission.

## 2.2 *plant protection uav digital transmission system design*

The digital transmission system of eppo consists of data acquisition system, data processing module, data sending module and data receiving module.

Data acquisition system for collecting sensor data. Such as the GPS module, the current coordinates of the aircraft obtained. The course correction instruction is calculated based on the deviation Angle and quadrant of aircraft course and target course obtained by electronic compass. Acceleration sensor acceleration sensor is the standard equipment of many uav, which is mainly used to determine the position and flight attitude of uav. The inertial measurement element can obtain three - dimensional acceleration. The geomagnetic compass takes the course. The combination of barometer and GPS can obtain the precise height of uav [4].

Data processing module, MPEG-2-4 compression coding and data encryption for A/D converted data.

Data transmission module, through channel coding and COFDM modulation. The main carrier signal is added to the transmitter, and the transmitter's output signal is sent to the converter and sent out by electromagnetic wave.

Data receiving module. The modulated signal output by the receiver is sent to the main carrier demodulator to demodulate the modulation signal from the modulated main carrier signal. Finally, the flight data is displayed on the video screen.

## 3. **Plant protection uav database design**

The plant protection uav system constructs the accurate agricultural plant protection big data, cloud computing provides the most reliable and safest data storage center. Its ground station cloud intelligent management system, which can record and save the current plant protection machine work plots of land, as well as the flight routes, at that time, operation parameters permanently, and in the face of the different climate and environment of the same crops can timely correction parameters <sup>[5-7]</sup>.

Plant protection uavs work at the same time, using the sensor acquisition and plant protection database system for data processing, information fusion ground station multi-source data, such as implementation of agricultural information, plant diseases and insect pests, pesticide information such as low-cost precision agriculture as the foundation of data collection and synchronous transfer, the background to establish plant protection database mining application.

The uav information system has the function of fixed-point height setting and route planning, and can transmit uav coordinate and flight data in real time.

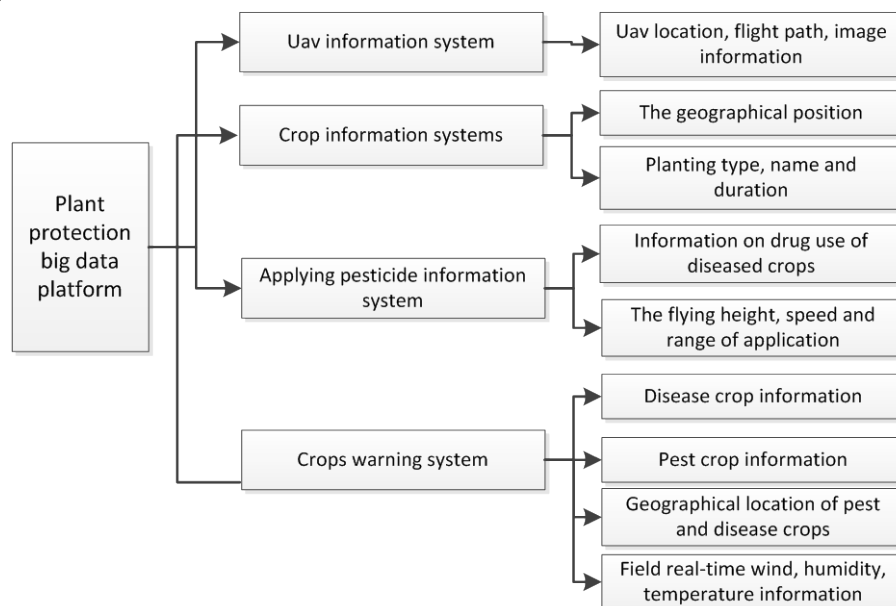
The crop information system, data including crop type, name, growth period and geographical location.

The applying pesticide information system includes the types of drugs used in the crops, the concentration of drugs, the flying height, the speed and the range of uav spraying.

Crops warning system, the data including crop types, the types of diseases and insect pests, diseases and pests of crops, parameters, such as geographical position precision applying pesticide, the system will automatically generate a reference formula, at the same time can get the speed, height,



environment temperature and humidity parameters, adaptive adjustment parameters, such as enhanced additionally.

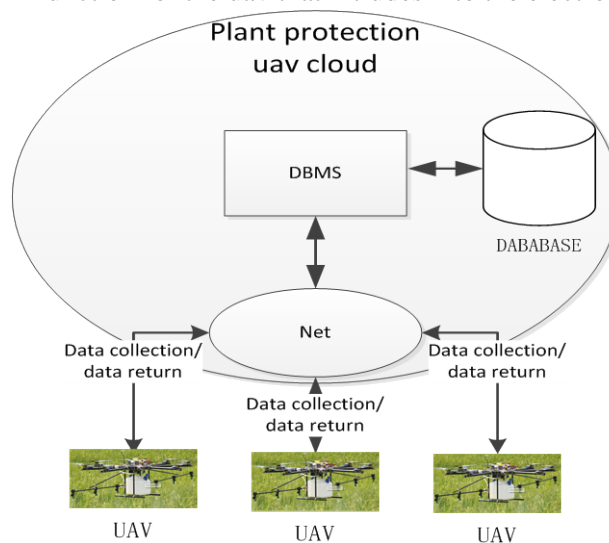


**Figure 2** plant protection big data platform

#### 4. Plant protection uav database system

Plant protection uav database system for data exchange between plant protection uav and plant protection big data platform. In real time, plant protection uav will send the collected data to the uav cloud and save the data to the database of plant protection big data platform through the database server (DBMS). At the same time, plant protection uav can access plant protection big data platform in real time through the cloud, so as to ensure that plant protection data can return the latest data of plant protection database in real time and accurately, and improve the efficiency of plant protection.

Plant protection uavs cloud, will plant protection uav, the database server, plant protection big data platform connected to the database via the Internet, is refers to the eppo uav dynamic database system, used to plant protection uav users with navigation service, weather service related data, and the flight data of plant protection uav (including position, height and speed, etc.) in real-time monitoring. The access system of plant protection uav should upload flight data immediately. The cloud system of plant protection uav has alarm function for the uav that intrudes into the electronic fence.



**Figure 3** plant protection uav database system



## 5. Plant protection uav system implementation

The experimental results of uav flight picture transmission show that the image and data transmission of the image transmission and digital transmission system is stable, and video and flight data are collected in real time at the video screen end and PC end of ground station. See figure 4.



**Figure 4** ground station PC terminal display

Ground station can be seen at the screen shows the following data, uav flight speed, unmanned aerial vehicles, uavs working voltage of battery accounted, unmanned aerial vehicles, uavs working current, flight distance, uav coordinates longitude and latitude, altitude and heading, the body temperature of uav data. These data indicate that the uav image transmission module, digital transmission module, OSD and camera work normally. The PC terminal of ground station can display and save the same data as the video screen end of ground station, and can save images and video in real time, providing data sources for data analysis.

## 6. conclusion

To sum up, this paper summarizes a set of small quadrotor plant protection uav system based on large data and plant protection database system design. Now the small quadrotor plant protection uav system can perform data acquisition, the plant protection database system has yet to be perfect, at present based on large data of uav can be applied for teaching and scientific research in uav laboratory.

## 7. Acknowledgement

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