Application of Remote Sensing Technology in Remote Surveying and Mapping Engineering

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Abstract

With the rapid development of science and technology, remote sensing surveying and mapping technology has become a new type of geodetic surveying and mapping technology In this paper, the related content of remote sensing technology is described, and the application of remote sensing surveying and mapping technology in surveying and mapping work is analyzed. This paper puts forward the specific measures to optimize the application effect of remote sensing technology from many angles and aspects. This paper systematically summarizes the integration scheme of UAV digital remote sensing surveying and mapping system, and discusses the use of UAV digital remote sensing surveying and mapping system for image acquisition. At the same time, this paper studies the operation method and technical process of network data fast processing based on parallel computing. It provides a certain reference for the application of small area and large scale mapping, emergency mapping and UAV digital remote sensing mapping system image acquisition and data fast processing in difficult areas.

Keywords*: Remote sensing mapping, UAV, digital remote sensing mapping, image acquisition.*

I. Introduction

Remote sensing flight platform is divided into satellite remote sensing and aerial remote sensing, and the former aerial remote sensing platform is mainly manned aircraft [1-2]. In the 1990s, with the rapid development of electronic technology, small UAVs have made significant breakthroughs in remote control, endurance time and flight quality, and become a new remote sensing means in recent years, which is generally considered to have a good development prospect in the remote sensing field [3].

Compared with the UAV, the advantages of UAV mainly lie in the following aspects: first, it has extremely high mobility. All the equipment, that is, more than 100 kilograms, can not be compared with any manned aircraft in terms of mobility speed, mobility range, mobility conditions, etc. Second, it has strong environmental adaptability, without special take-off and landing field, and has low requirements for meteorological conditions [4]. The superior low altitude performance makes it easy to work under the cloud, thus greatly improving the work efficiency. Third, it has excellent economy. The purchase price of the aircraft is low. Most companies can afford it. The use cost is also very low, and there is no need to carry people into the air. The safety pressure of users is greatly reduced.

In terms of aircraft performance, the important differences between UAV and UAV are as follows: first, the flight of UAV outside the field of view is completely carried out by autopilot according to the preset procedure, which can not be manually intervened according to the actual flight situation. Second, the UAV is small in size, and its carrying space and weight are greatly limited, so it can only carry small ordinary sensors. Thirdly, the flight state deviation of UAV caused by air flow disturbance is mainly recovered by the flight stability of the aircraft itself, so there is obvious delay [5-6]. The above characteristics directly affect the quality of aerial photography. With UAV aerial photography, there are many problems, such as low imaging quality, large overlap error, missing shot and so on.

So, whether UAV can be applied in the field of aerial survey, what are the technical problems and difficulties, how to give full play to the application function of UAV in aerial survey, and how to make UAV become a new force in aerial survey system. With great interest and responsibility, I have devoted myself to the research of UAV Remote Sensing Surveying and mapping system.

II. System integration

2.1 Selection and modification of flight platform

At present, there are many domestic manufacturers of UAV used in aerial photography, which can be divided into "vertical tail" type, "inverted mast tail" type, "double tail support" type and so on. Because of the different installation parts of the engine, it can be divided into "forward pull" UAV, "backward push" UAV and "forward pull backward push" UAV (often referred to as "double engine" type). Due to different fuselage materials, it can be divided into light wood type, glass fiber reinforced plastic type and carbon fiber type. Recently, there are mainly the following types of UAVs for aerial photography in China: "vertical tail" type, "inverted mast tail" type, "double tail strut" type and "double engine" type [7-8].

In this paper, aiming at the aerial photography of snowy plateau, considering the current domestic UAV for remote sensing tasks, we choose the "double engine" UAV on the platform one day, which has strong horsepower and good power performance. The burning machine is equipped with two horizontally opposed two cylinder air-cooled 62cc engines, and adopts a tandem power structure, with front pull in and rear push in. A single unit can output 6.2 HP / 6500 rpm. Under normal conditions, the dual engine can run normally with only about 50% power. In case of single engine flameout, the flight can be maintained by relying on another engine.

The aircraft has large payload and large body space, which can provide enough space and weight for auxiliary equipment such as tilt correction pan tilt; The aircraft has good wind resistance performance, can resist the strong wind of level 7 or so, and can ensure that it will not stall and fall in case of turbulence in the air [9]. The aircraft is heavier than other UAVs, so it can fly more smoothly in the air, and can ensure that it can fly along the set track accurately, and the attitude maintenance is better than other UAVs.

Fig 1: Selected UAV flight platform

2.2 Digital camera selection

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When purchasing non-measurement digital cameras, we should try to choose cameras with high resolution and large image size; At the same time, in order to ensure that the camera's internal orientation elements are fixed during photography, a camera with manual exposure function should be purchased, which is beneficial to self-inspection and calibration of all images in the survey area. Specific selection indicators are as follows:

(1)CCD resolution
The resolution of digital camera depends on the number of pixels on CCD device. The more pixels, the higher the resolution. Therefore, the resolution of CCD can be expressed by the number of pixels. The ground resolution of aerial photography is determined together with focal length and altitude. The imaging system for aerial remote sensing must have the capability of high resolution and wide coverage. For CCD digital back, the size of the output pixel (corresponding to one or more photosensors) must be as small as possible, generally below 15 μm. The resolution is as high as possible, above 2K × 3K.

(2) Geometric characteristics
Digital remote sensing images of unmanned aerial vehicles should also have the universal characteristics of remote sensing data, that is, physical meaning, spectral information and spatial geometric information. The imaging system is required to have high imaging geometric accuracy, so as to correct the positioning and calculate the area length. For CCD, it is the uniformity of plane distribution and the flatness in depth direction. At present, the precision of CCD plane array is (0. 2-0. 5) μm, and the chip roughness is about l0um, which can not be ignored in high-precision measurement.

(3) Radiation characteristics
Aerial photographic images require multi-channel information, and the gray level of each channel is more than 8 bits. At present, the images taken by digital cameras are mostly three channels. The more channels, the higher the channel bit length, which is beneficial to the interpretation of the target. The dynamic range of digital cameras in the market is from 8 bits to 16 bits, which can fully meet the basic needs of aerial remote sensing for such data.

(4) Sensitivity index
Sensitivity ISO is one of the commonly used indexes of film in traditional cameras. CCD digital cameras also have the problem of sensitivity. When shooting on cloudy days, the sensitivity is generally increased to get bright images. However, high sensitivity will cause image distortion and obvious graininess, which will affect the later mapping quality. Therefore, in actual aerial photography, the sensitivity should be flexibly selected according to the needs, generally set between 100 and 200.

III. Aerial photography flight and image control

3.1 Route design

Like traditional aerial photography, UAV low altitude digital aerial photography also needs route design, aerial photography, quality inspection, according to the results of inspection dagger or heavy altar, image control measurement and other steps. The difference is that the route design of UAV digital remote sensing surveying and mapping does not need to consider the change of earth curvature because of its small area. The quality inspection of aerial photography can be completed on the spot without printing photos; In some special conditions, the image control survey work must first make the whole area fast mosaic map, such as the digital aerial photography of the snow covered plateau County, must use the fast mosaic and electronic photo pricking. The overall process of image acquisition of UAV digital remote sensing mapping system is shown in Figure 2.

UAV digital photography is usually a small area of digital aerial photography, unlike traditional aerial photography, in the course design, there is no need to consider the earth curvature changes, and do not need to know the ground point elevation very accurately. Traditional aerial photography has clear operation specifications and procedures. It

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is necessary to use 1:10000 or 1:50000 topographic map or existing DEM to design the datum plane. If necessary (when the altitude difference is greater than 1/6 altitude), the photographing zone shall be set, and encryption zone can also be set if necessary. For low altitude digital aerial photography, generally speaking, the four angle coordinates of the known photographing area can be used for route design. Photography zones are only set under extremely special conditions.

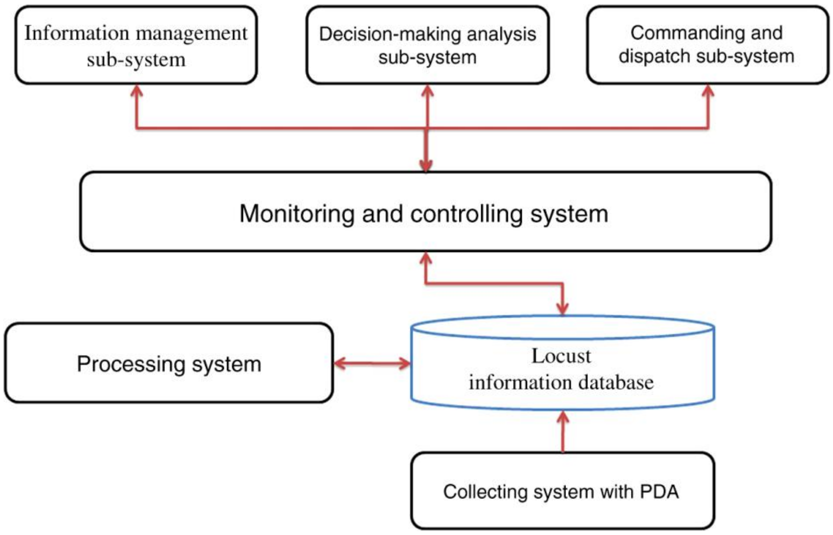

Fig 2: The overall process of image acquisition of UAV digital remote sensing mapping system

3.2 Equipment check before takeoff

At the same time of route design, use this time to install airborne flight control and camera. After the installation, or when the aircraft takes off and lands before entering the flight, this series of inspection must be carried out. It is necessary to ensure that the zero point of gyro is correct, the pitch angle is correct, and both data are positive upward. In UAV mode, when the aircraft's pitch changes, the elevator deflects towards the corresponding direction to damp the pitch change. The zero point of gyro is correct, the roll angle is correct, and the right roll is positive. In UAV mode, when the aircraft rolls around the fuselage axis, the aileron rudder deflects to the corresponding direction and the rolling damping changes. The zero point of gyro is correct, turning right is positive. In UAV mode, when the PID value of turning channel is not 0, the rudder deflects towards the corresponding direction to damp the yaw change. After the flight control is installed in the aircraft, the pitch angle and roll angle of the flight control are corresponding to the aircraft attitude by setting the pitch roll offset. Place the wing horizontally and clear the pitch roll angle of flight control. Cover the air flow with hands in front of the airspeed tube. At this time, the airspeed display value is near zero. Otherwise, please reset the airspeed zero position. Then plug the airspeed tube with fingers and compress the air in the tube slightly. The airspeed display value should be gradually increased or maintained, otherwise it may leak or block. If it is possible to get the air pressure value at the height of the current control box, set the current air pressure value and the current height value on the ground station. Change the altitude of the aircraft, the altitude display value will change accordingly. If the aircraft is equipped with a speed sensor, turn the engine by hand to see if there is a speed display at the ground station. Whether the speed division setting is correct. Turn on the remote control and check that the RC and RPV control mode switch is normal (ground station observation). All remote control channels are under normal control and the direction is correct (otherwise, adjust the steering gear from the ground station to reverse direction). If you feel that the amount of control is too large, you can modify the remote control stroke of the steering gear from the ATV of the remote control. Remote control pull distance (do not pull out the antenna), control distance at least 20 meters. Turn off the remote control and switch to UAV mode. The time from power on to GPS 3D positioning should be about 1

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minute. If the positioning cannot be done after 5 minutes, check the GPS antenna connection or other interference. After positioning, the number of satellites is generally more than 6, and the smaller the PDOP horizontal positioning quality data, the better, generally between 1 and 2. Start the engine and observe the runout of the sensor data and the rudder surface at different speeds, especially the attitude data shown in the attitude table (leveling instrument) [10]. All the jumping must be in a very small range, otherwise the damping measures should be improved. Through the discharge test to determine the effective working time of the battery, to ensure that the future flight in a reliable and guaranteed power supply time. The alarm voltage of ground station is set as: main power supply 7V, steering gear power supply 4.6V. In UAV mode, if the influence is large, check the actual value in the sensor data and observe whether the gyro values are around zero; Otherwise, the transmitter antenna position must be moved. Other transmitters must also be tested in this way. All connectors are firmly connected, especially the power supply. Start the engine, capture the maximum and minimum value of the set damper (stable working idle speed is above) and the position where the damper can stop. Make sure the parking is controlled. Observe all sensor data, especially altimeter, airspeed meter and gyroscope in remote flight. GPS ground speed and airspeed were observed during the flight in windless weather, and airspeed coefficient was corrected. Ground test GPS control camera exposure to see if camera shooting and storage are normal. Make sure the battery in the camera has enough power.

IV. Data photogrammetry processing

4.1 Experiment of image fast processing

This paper selects the digital photogrammetric grid system developed by zhangzuxun Institute of human studies of the Wu Han Dynasty for parallel processing. Compared with the traditional processing, the parallel processing of cluster computer can decompose a task and compute by multiple computers at the same time, which will greatly save processing time and improve work efficiency. The image processing of l-grid in digital photogrammetry is different from that of traditional photogrammetry. Strictly speaking, digital photogrammetry grid should be classified as computer vision. Because of the difference between the basic relationship between object and image, the basic formula between photogrammetry and computer vision is different. Photogrammetry and computer vision both study the relationship between objects and images. Therefore, the formula describing the relationship between 3D objects and 2D image coordinates is their basic formula. The basic formula of photogrammetry is collinear equation:

$$\begin{cases} x = -f \dfrac{a_1(X - X_S) + b_1(Y - Y_S) + c_1(Z - Z_S)}{a_3(X - X_S) + b_3(Y - Y_S) + c_3(Z - Z_S)} \\ y = -f \dfrac{a_2(X - X_S) + b_2(Y - Y_S) + c_2(Z - Z_S)}{a_3(X - X_S) + b_3(Y - Y_S) + c_3(Z - Z_S)} \end{cases} \quad (1)$$

The basic formula of computer vision is projection equation (M is projection matrix):

$$Z_C \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} f & 0 & x_0 & 0 \\ 0 & f & y_0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} R & t \\ 0^T & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} = MX \quad (2)$$

The difference in the basic formula between the two results in the difference in the later calculation formula.

4.2 Parallel processing ideas

The cluster computer system used in white motion parallel processing is a blade server system. The hardware part consists of management point, cluster (blade) computer, disk array and Gigabit LAN. Among them, the management node is used to manage the cluster computer, the task allocation processing device runs the main control (task allocation) program of the software system, the blade node is responsible for the specific calculation, the disk array stores data, and all devices are connected through Gigabit Ethernet. Figure 3 shows the hardware system composition of blade server. Each blade server has its own independent CPU (center processing unit), memory, hard disk and operating system, and each blade server is a computing node. As a file server, disk array is used to store massive aerial image data. As a client, workstation is used to manage and distribute tasks. Blade server, disk array and client are connected through Gigabit Ethernet switch and optical fiber communication equipment to form a server cluster. In cluster mode, all blade servers can be connected to provide a high-speed network environment and share resources.

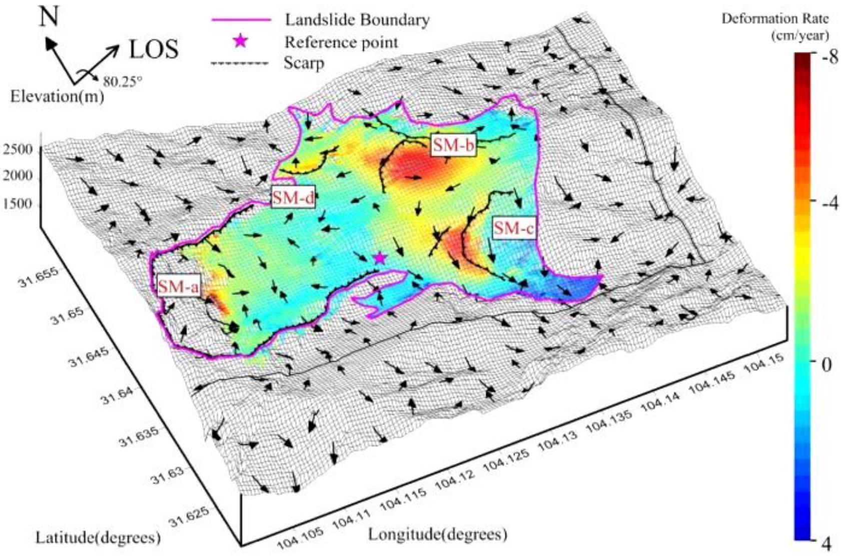

Fig 3: Hardware system composition of blade server

The running flow of the automatic parallel processing software system is that the main control (task allocation) program decomposes the whole processing task and distributes it to each computing node according to the content of photogrammetry processing. The main control program decomposes the total task of photogrammetry processing, allocates it to each calculation. U point and monitors the execution of each task. After receiving the assigned task, each calculation node completes the specific calculation, and all programs share the data on the disk array. The content of photogrammetric processing generally includes: image preprocessing, image matching, spatial three-dimensional solution, DEM (digital elevation model) generation, orthophoto generation and other parts, all of these tasks realize parallel computing.

(1) Architecture and workflow of cluster computer system

The client (workstation) of cluster computer is responsible for the management and distribution of tasks. According to the distributed tasks, the blade server takes images from the disk array for processing, and then stores the results into the disk array. The client should create the task table of the measurement area according to the image of the measurement area, establish the communication with the server through TCP / IP protocol, and divide the measurement area task into several sub tasks to assign to each blade server. When the blade server receives the task, it starts the corresponding calculation module on the server to calculate the data in the disk array. When the blade server finishes processing the task, it will return the success message to the client. If the task processing of any server fails, the client will reassign the task of this server to other servers. For example, there are five blade servers (bladl, blad2,..., blads) to process 500 images, and the client will assign 100 images to each blade server. If the bladl task processing fails, the client will reassign the bladl task to the other four blade servers (blad2, blad3,..., b1ad10).

(2) Task management and distribution

The client creates a task table of the survey area according to the image of the survey area, and establishes the point-to-point connection with the server through tcp/ip protocol. The client automatically sends subtasks in the task table to the available blade server for processing according to the connection status. When a blade server returns the task completion information, the client continues to assign new tasks to the service.

When generating DEM, the traditional photogrammetric system usually uses the method of manual contour interpolation DEM and the method of white motion matching feature line interpolation DEM. The advantages of the above methods are: the acquisition of feature lines can better ensure the accuracy of the survey area, the generated DEM can well reflect the shape of the ground, with high accuracy; the disadvantages are slow speed, low efficiency, and need a lot of manual editing work. In order to process the low altitude image quickly, we must break the traditional feature line acquisition mode in DEM production. The digital photogrammetric grid used in this paper adopts the dense matching of the same name points based on parallel computing, and the multi node computer is completed at the same time. The DSM results can be retained and used for the production of 3D images in the later shooting area.

V. Conclusion

UAV digital remote sensing surveying and mapping system consists of two parts: UAV flight platform, digital image acquisition system, rotation correction pan tilt, airborne feeding control and ground measurement and control station system. Taking the implementation of low altitude digital aerial photography on snowy plateau as an example, a "double engine" UAV flight platform is selected. The fuselage of the UAV is made of special glass fiber reinforced plastic material, and an engine is installed in the front and rear of the fuselage. The flight height of the aircraft can reach 6000 meters. At the same time, it can maintain the flight attitude better. The successful implementation of UAV digital remote sensing surveying and mapping system for the first time in the world provides an excellent solution for image acquisition and post-processing of 1:50000 mapping project in Western China. Using this orthophoto to make a 3D urban system for the relevant counties and districts in Tibet Autonomous Region will provide first-hand information for the anti-terrorism and anti secession of the relevant counties and the maintenance of border stability. DEM and orthophoto results will provide basic data for transportation, water conservancy and electric power. It can be used as a reliable base map for the dynamic monitoring of environmental protection, vegetation and land use.

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