RESEARCH ON THE KEY TECHNOLOGY OF UAV IN THE ACCURACY ASSESSMENT OF LAND COVER CLASSIFICATION

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Commission III, ICWG III/IVb

KEY WORDS: UAV, Surface Cover Classification, Accuracy Assessment, Oblique Photography, Workflow Model.

ABSTRACT:

This paper uses UAV low-altitude aerial photography technology, equipped with orthophoto camera, tilt camera and LiDAR camera, to obtain and process high-precision evaluation data, which is used to evaluate the correctness of land cover classification. Through the design of aerial photography scheme and data collection and processing, the rapidly acquired digital orthophoto, oblique 3D model data and laser LiDAR form a complete set of technical processes, which can relatively accurately and objectively monitor the quality of surface data for the existing geographical conditions. situation is assessed. The main purpose of this study is to further enrich the technical means of quality inspection of surveying and mapping products, to improve the technical level of quality inspection and acceptance of geographic condition monitoring data, and to improve the accuracy and reliability of data quality evaluation.

1. INTRODUCTION

Reliable geographic information data can play a positive and positive role in social management, so it is very meaningful to carry out data quality and accuracy assessment research. At present, China's surveying and mapping geographic information field has established a surface coverage content index system including 8 first-level categories, 59 second-level categories, and 104 third-level categories, and organizes more than 2,000 people to collect high-resolution satellite remote sensing images every year. Therefore, the objective evaluation of the classification accuracy of the data will directly affect the application effect of the government in the fields of cultivated land protection, ecological restoration, and urban governance.

Since 2016, the project team has been carrying out the research work on the quality evaluation of the data. It has carried out the accuracy evaluation of the surface coverage classification by means of remote sensing image instance database, field survey and verification, etc. It is difficult to evaluate the classification accuracy at all levels in a timely, objective and comprehensive manner. As a low-altitude remote sensing data acquisition tool, UAV has the characteristics of flexibility, efficiency, speed, precision and accuracy, wide application range, and short production cycle. Therefore, the team used UAV inspection methods to carry out aerial photography and quickly obtain digital orthophotos. Image data, oblique camera modeling data and lidar measurement data methods, a set of technical procedures for evaluating the accuracy of data classification were designed, and test areas were selected for data classification accuracy evaluation practice. The rest of the paper is structured as follows. In Section 2, we introduce the goals of our work. Section III presents our contribution, a complete workflow for acquiring data and conducting land cover classification accuracy assessments using UAV inspections. Section 4 shows simple result. Finally, Section 5 provides some concluding remarks and suggests some future work.

2. OBJECTIVES

The purpose of this paper is to establish a workflow for objectively evaluating the accuracy of land cover classification results by using UAV to conduct inspections. The content and indicators of surface cover classification include planting land, forest and grass cover, houses (districts), railways and roads, structures, artificial piles and excavations, bare surface, water areas, etc. The third-level classification is the most detailed classification. , the number of three-level categories is shown in Table 1. Accuracy evaluation To use the high-precision data obtained by UAV to evaluate the accuracy of the most detailed first-level classification of the surface coverage classification data. This goal is achieved on the basis of work preparation, verification of key technologies, and evaluation of data classification accuracy. Finally, through the practice of the project, the usability and reliability of the workflow are proved.

Code	Frst-level Categories	Quantity of the Second-level Categories	Quantity of the Third-level Categories
0100	Planting land	9	13
0300	Forest and grass cover	10	20
0500	Housing construction (district)	5	10
0600	Rail and Road	5	5
0700	Structure	9	29
0800	Artificial digging	4	14

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https://doi.org/10.5194/isprs-archives-XLIII-B3-2022-1203-2022

Code	Frst-level Categories	Quantity of the Second-level Categories	Quantity of the Third-level Categories
0900	Desert and bare ground	5	5
1000	Waters	5	8

Table 1. Contents of the first-level categories and quantity of the second-level,third-level categories of land cover

3. WORKFLOW OF UAV-OBTAINED DATA FOR CLASSIFICATION ACCURACY ASSESSMENT

The workflow includes three phases: preparation phase, data acquisition and processing phase, and classification accuracy analysis and evaluation. The specific workflow is shown in Figure 1.

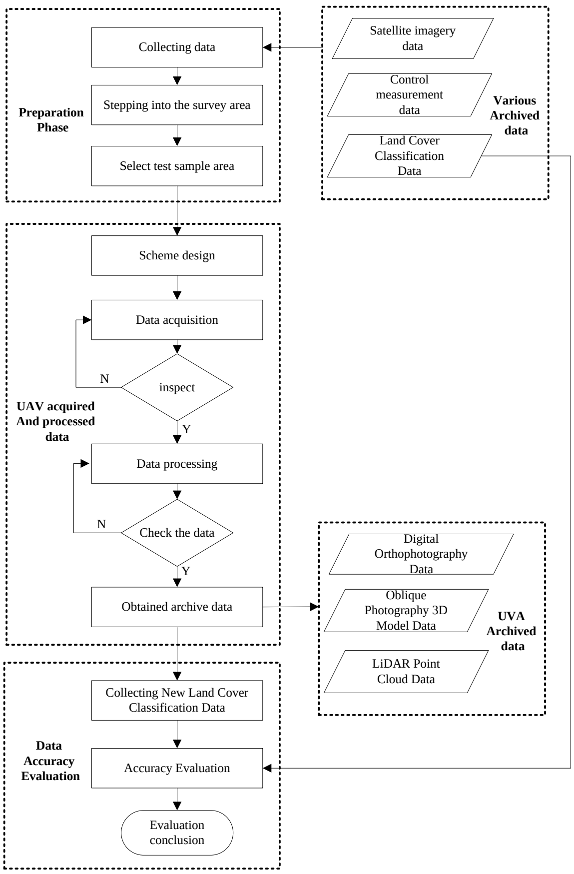

Figure 1. Workflow of the UAV inspection and classification accuracy assessment

3.1 Preparation phase

In the preparation stage, data collection, site survey, and test area selection were carried out. Firstly, by collecting and analyzing the satellite image data of geographical conditions monitoring and the classification data of land cover, 3 experimental test areas with rich ground feature types were initially selected, including 8 first-class ground feature categories, which can meet the test requirements. Then, the candidate test area was surveyed, and the traffic conditions and surrounding buildings in the test area were further understood on site. Finally, a 2 square kilometer area with convenient transportation and no tall and dense buildings was selected as the final test test area, and collected For relevant control and control data, prepare to use UAV to obtain digital digital orthophoto image data, oblique photography 3D model and lidar point cloud data of the test area.

3.2 UAV acquired and processed data

In order to obtain high-precision data for evaluation, we selected aerial photography UAV, aerial cameras and other equipment according to the design goals, and designed an aerial photography scheme suitable for this task to ensure the smooth implementation of data acquisition.

3.2.1 Data acquisition equipment: To obtain digital orthophoto and oblique photography 3D model data, use the "CW-10" small all-electric vertical take-off and landing fixed-wing UAV aerial photography platform to collect data by replacing the orthophoto camera and the oblique camera. The specific parameters of the UAV and cameras used for collection are shown in Table 2, Table 3, and Table 4.

content	parameter	content	parameter
maximum takeoff weight	12KG	vertical direction accuracy	3cm
task load	1.5KG	horizontal direction accuracy	1cm+1ppm
best sailing airspeed	72km/h	practical ceiling	4000m
maximum flight airspeed	108 km/h	wind resistance	6th wind
battery life	90minutes	using environment	-20℃-50℃

Table 2. CW-10 UAV configuration parameters

content	parameter	content	parameter
pixel	42 million	sensor size	35.9*24mm (full frame)
lens	35mm fixed focus	resolution	7952*5304

Table 3. Orthophoto camera parameters

content	paramet er	content	parameter
total pixels	⩾1.2× 108 （px）	ccd size	23.5*15.6mm
camera synchronization	20ms	exposure interval	⩽0.8s

Table 4. Oblique-shooting camera parameters

Obtain lidar point cloud data, using the "Hornet" UAV platform, equipped with AS-900HL lidar way to collect data. The specific parameters of the UAV and lidar used for collection are shown in Table 5 and Table 6.

content	parameter	content	parameter
maximum takeoff weight	28KG	vertical direction accuracy	2cm+1ppm
task load	7.0KG	horizontal direction accuracy	1cm+1ppm
maximum climb speed	5m/s	practical ceiling	5000m
maximum flight airspeed	14m/s	wind resistance	6th wind
battery life	40minutes	using environment	-10℃-40℃

Table 5. "Bumblebee" UAV configuration parameters

content	parameter	content	parameter
Laser class	Level 1	Measuring range	920m
measurement accuracy	10mm, repeatability 5mm	field of view	360°
scanning frequency	200Hz	point cloud density	550000 points/sec

Table 6. Lidar parameters

3.2.2 Technical solutions: The plane coordinate system adopts the 2000 national geodetic coordinate system, Gauss-Krüger projection, the central meridian is 126°, and the 3° zone; the elevation datum adopts the 1985 national elevation datum. In terms of accuracy indicators, the digital orthophoto (DOM) resolution is better than 0.03 meters; the plane accuracy and elevation accuracy of the 3D model have reached level III, the error in the plane is not greater than 0.8 meters, and the height accuracy is not greater than 1 meter. The error in the digital elevation model (DEM) grid point level ground elevation is not more than 0.37 meters (the error can be relaxed by 0.5 times for special difficult plots such as shadows, photography blind spots, and concealment).

3.2.3 Route design: During route design, the terrain heights and tall buildings in the area are fully considered to ensure a safe height and at the same time to ensure the fineness of modeling at the top of tall buildings, strictly control the length of the baseline in each route, and ensure that the aircraft speed can meet the camera exposure. interval requirements. The aerial photography design is based on the actual survey area, the ground resolution is 3cm, the course overlap is 80%, the side overlap is 75%, and the average altitude of the aerial photography reference plane is taken. The coverage of the aerial photography range of oblique aerial photography must ensure the coverage of the oblique viewing angle image and sufficient safety factor in the edge area of the survey area. 3 routes.

3.2.4 Aerial photography flight: We require good weather when shooting, to ensure sufficient illumination, the sun altitude angle should be greater than 45°, and the shadow should not be greater than 1 times. Under the conditions of comprehensive consideration of the above factors, this data acquisition experiment completed the flight mission from 10:00 to 14:00 Beijing time, the original data was successfully obtained.

3.2.5 Lidar point cloud data acquisition: Before the point cloud data is formally acquired, the unmounted flight test is carried out first, and the normal mounted flight is started after confirming that the system is stable to ensure flight safety. In order to ensure the data accuracy, the lidar system is stationary for 3 minutes to ensure that enough static epochs are collected. At this time, the equipment cannot be touched to ensure that the static collection of the ground GNSS base station has started. Finally, parameters such as scanning frequency, scanning angle, and photographing interval are set. After the preparatory work is completed, according to the predetermined route, first circle the "8", and then enter the route to start collecting data. After data collection, the drone was stationary for 5 minutes.

3.2.6 Get data quality checks: For the acquired data, on the basis of checking the quality of the data, post data processing is performed. If the requirements are not met, the data acquisition is performed again.

3.3 Data accuracy evaluation

3.3.1 Technical process of digital orthophoto (DOM) data production: For the acquisition of image data, the production of digital orthophoto (DOM) data is finally completed through distortion correction preprocessing, acquisition of aerial triangulation data, DEM production, image production and other processes (Sun, 2019). The specific production technology process is shown in Figure 2.

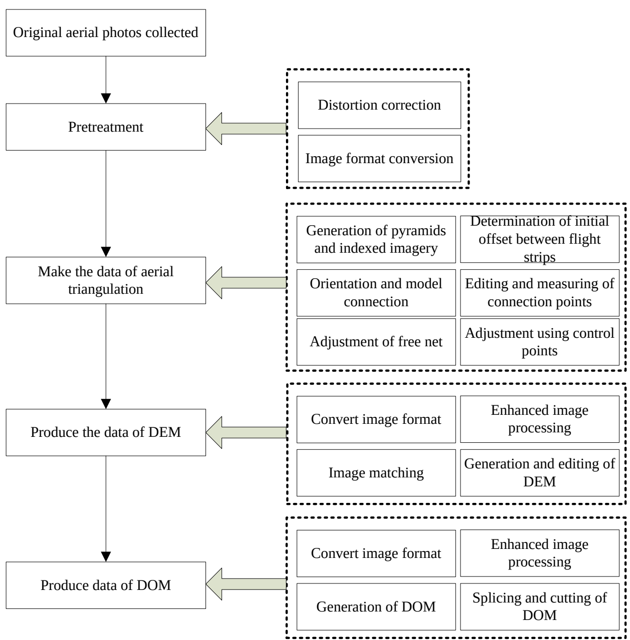

Figure 2. UAV production of digital orthophoto (DOM) data technology process

3.3.2 Technical process of oblique photography 3D model data production: For the obtained tilt photography data, the 3D model data is obtained through preprocessing, tilt image aerial triangulation, DEM matching and editing, point cloud construction, tilt 3D model reconstruction and editing

(Zhang,2021). The specific production technology process is shown in Figure 3.

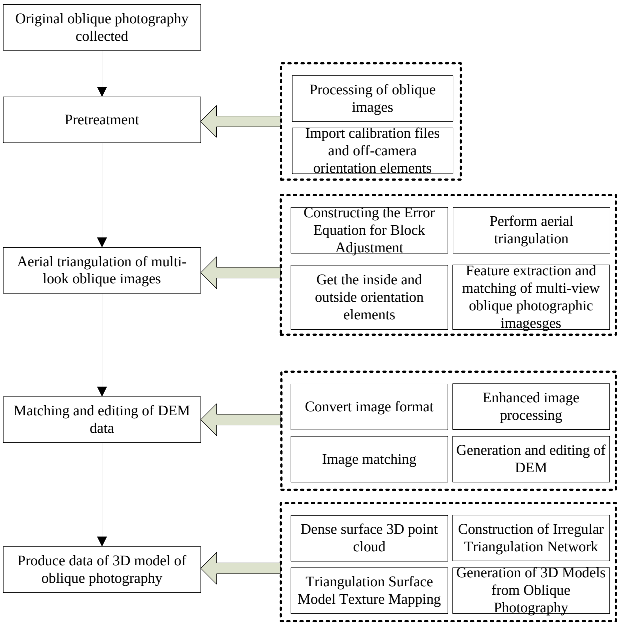

Figure 3. UAV production oblique photography 3D model data technical process

3.3.3 The technical process of making liDAR point cloud model data: The specific production technology process is shown in Figure 4 (Zhang,2021).

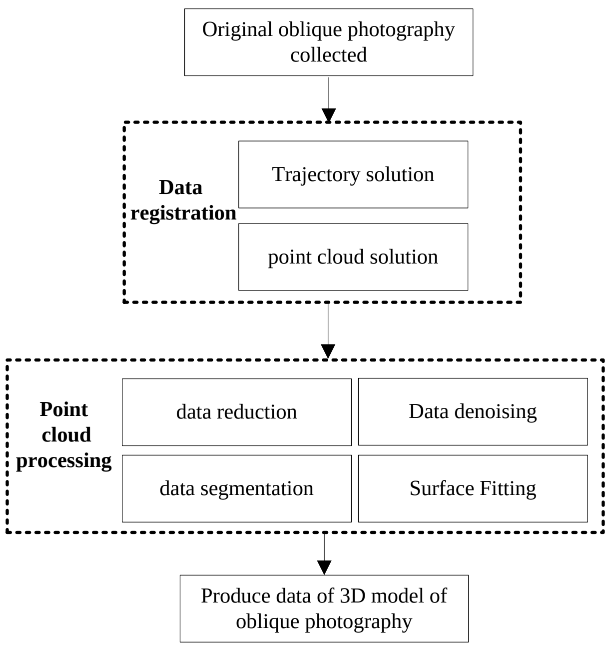

Figure 4. UAV production making liDAR point cloud model data technical process

We use the following methods to process the acquired data, and the detailed steps of the data are shown in the figure. The static data in .HCN format collected by the system is converted into Renix3.02 data in general format, and the antenna oblique height measured in the field is corrected to the phase center, so that it can be read normally. The converted data is checked, and fusion is performed after it is qualified. Otherwise, the data is checked again to ensure the accuracy of the data.

Data fusion is firstly to fuse the inertial navigation data collected by the field liDAR and the static data collected by RTK to generate high-precision POS trajectory information, and give accurate position and attitude information to the point cloud collected by the liDAR. Then, assign the .RXP file obtained by the system to POS information to obtain .las point cloud data with actual coordinates. Finally, extract and edit the ground points, start the pre-programmed automatic processing command, and classify the point cloud by selecting points by group.

3.3.4 Acquired high-precision evaluation result data: According to the plan we designed, the acquisition and processing of various data was completed by using UAV, and the high-precision data obtained for the subsequent quality assessment of the data are shown in Figures 5 and Figures 6.

Figure 5. LiDAR point cloud data

Figure 6. Digital orthophoto data

3.4 Geographical State Data Accuracy Assessment

The accuracy evaluation of the surface coverage classification data mainly uses the high-precision digital orthophoto (DOM) data obtained by the UAV for comparative analysis to check the correctness of the data collected by the original production and use of aerospace images. When digital orthophoto (DOM) data is difficult to interpret, the 3D model data of oblique photography and LiDAR point cloud data are combined to assist judgment and interpretation, such as broad-leaved forest in the three-level classification system of 0300 Forest and Grass Cover (0311) It is easily confused with broad-leaved shrub forest (0321), broad-leaved shrub forest in southern China (0321) and high-coverage grassland (0391).

3.4.1 Collecting land cover classification data using high-precision digital orthophoto (DOM) data: This evaluation uses the land cover classification data comparison method. First, the high-resolution digital orthophoto image data (DOM) obtained by the UAV is used to collect the land cover classification data (new) from the test area, and then the collected two The surface coverage classification data of the version is analyzed and extracted, and the patches with different classifications are extracted to facilitate the direct search for differences in the later stage. The two versions of the land cover classification data were fitted to the newly collected digital orthophoto image (DOM). On the whole, the data collected by satellite imagery had obvious classification errors. The details are shown in Figures 7 and Figures 8.

Figure 7. Surface classification data collected by satellite imagery and image overlay obtained by drone

Figure 8. Land cover classification data (new) and the use of UAV to obtain image overlays

3.4.2 Elimination of assessment objectivity factors: The image used in the production of the classification data for the geographic and national conditions monitoring of the test area is GF2, with a resolution of 0.8 meters, which is quite different from the 0.03-meter resolution of aerial photography. The difference of fit caused by different sources, resulting in the fragmented image spots formed by the cutting of the data boundary differences between the two versions, is not within the scope of this accuracy evaluation and comparison. In addition, considering that the minimum index of the surface coverage classification data is 200 square meters (because the area is not an urban area, the green grassland and green forest land in urban areas are not considered to be a minimum index of 100 square meters), the small map with an area of less than 200 square meters will be used. Or the narrow and long image spots with a width of less than 3 meters are removed.

3.4.3 Accuracy assessment of land cover classification data: We evaluated the correctness of the three-level classification of planting land、forest and grass cover、housing construction (district)、rail and road、structure、artificial digging、desert and bare ground、waters data in the land cover classification. From the evaluation point of view, there are relatively many problems in Planting land, Forest and grass cover, and relatively few other classification problems. The problem situation is shown in Figure 9 and Figure 10, Figure 11 and Figure 12.

Figure 9. Incorrect representation of dry land as natural grassland in the classification of land cover

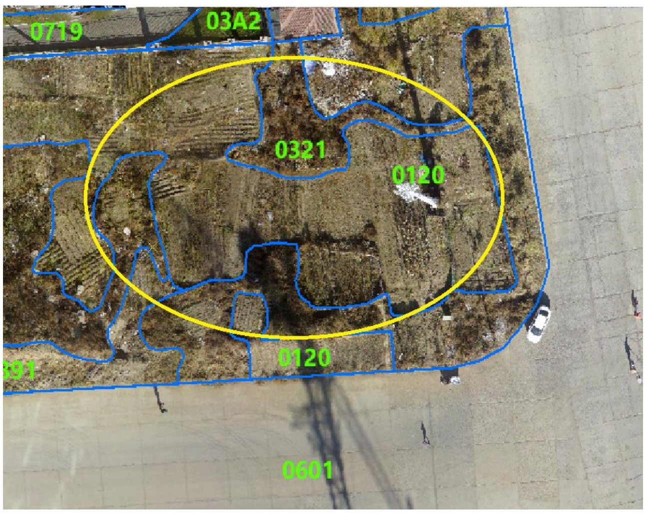

Figure 10. UAV aerial imagery identifies dry land incorrectly represented as natural grassland

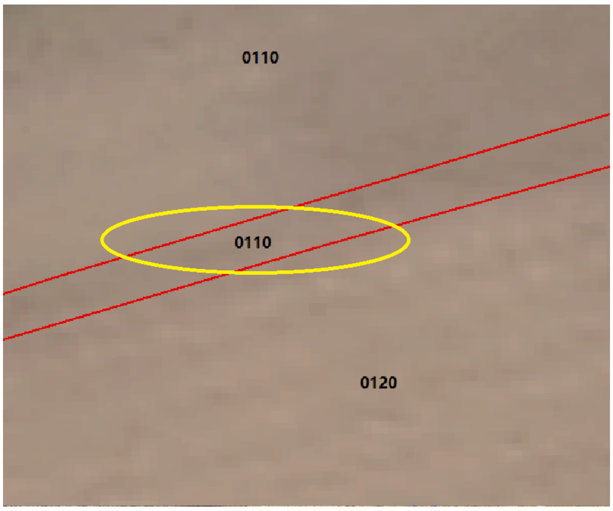

Figure 11. Incorrect representation of dry land as paddy field in land cover classification

Figure 12. UAV aerial imagery identifies dry land incorrectly represented as paddy field

4. CONCLUSION

In our work, a complete workflow for evaluating the accuracy of land cover classification using UAV is proposed. Through the practical verification in the project, it is possible to objectively evaluate the correctness of the classification of geographical and national conditions monitoring data. Although the characteristics of the restricted area and the aerial survey area, the research conclusions obtained still have room for improvement and refinement, but from the perspective of innovative quality management concepts , is the enrichment and supplement of traditional quality inspection and control methods.

5. COMMENTS AND SUGGESTIONS

If the country or locality develops urban areas in the future, there will be a need for more refined and high-precision data in terms of the boundaries between roads, buildings and hardened ground, the boundaries between green forests, green grasslands and hardened ground, and accurate classification of young forests and grasslands. more reliable data can be obtained with the help of drone technology. In addition, provinces can use it as a way to check and accept the quality of data when they carry out basic geographic information classification accuracy tests and national land change surveys.

ACKNOWLEDGEMENTS

The authors would like to thank the valuable comments from anonymous reviewers.

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