Quality Inspection and Problem Analysis of Satellite Image Data in Land Use Survey

Shuai Dong [1,2], Chenni Lu [1,2], Wenchao Gao [1,2], Chang Liu [1,2], Jin Bai [1,2]

[1] National Quality Inspection and Testing Center for Surveying and Mapping Products, Beijing
[2] The Technology lnnovation Center for Remote Sensing intelligent Verification, Ministry of Natural Resources, Beijing

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ABSTRACT:

In order to improve the data quality of land use remote sensing monitoring images, this article introduces the process of generating satellite image data, elaborates on the content of satellite image data verification in land use remote sensing monitoring, and proposes quality issues and improvement measures for satellite image data. Taking the discovered satellite image data quality issues as an example, compared with quality inspection standards, it was found that the main problems in the results were projection parameter errors, image color distortion, image blurring, and position accuracy exceeding limits. It is recommended to check the above issues during the image production stage, analyze the reasons for exceeding the position accuracy limit, image distortion, and embossing, and provide relevant suggestions. Provided strong technical support for land use surveys.

1. INTRODUCTION

With the continuous development of satellite technology and remote sensing technology, the application of satellite image data is becoming increasingly widespread. At present, satellite image data plays a huge role in surveying and remote sensing, smart cities, environmental supervision, illegal land use, especially in land use surveys. [1]The use of satellite imagery enables remote assessment of land use, replacing traditional methods that require manual observation in the field.

2. REMOTE SENSING SATELLITE IMAGE PRODUCTION

Using domestic satellites such as Gaofen-1 and Yuanyuan-3 as the main data sources, and fully utilizing high-precision control data such as digital elevation models and control points, the control points of satellite images are obtained through image feature matching in PixelGrid and other software. After regional network adjustment, image correction, image registration, image fusion, image enhancement and uniform light and color, image inlay, image cropping and other operational processes, orthophoto products are finally produced.[2]

2.1 Image Preprocessing

Preprocess the original image with radiometric correction, geometric correction, atmospheric correction, etc. to eliminate the impact of different factors on image quality.

2.2 Regional Network Adjustment

By controlling point data, regional network adjustment can accurately determine the absolute position of panchromatic images in geographic space, thereby ensuring the positioning accuracy of the images.

2.3 Image Registration

Register panchromatic and multispectral images to achieve complete spatial overlap.

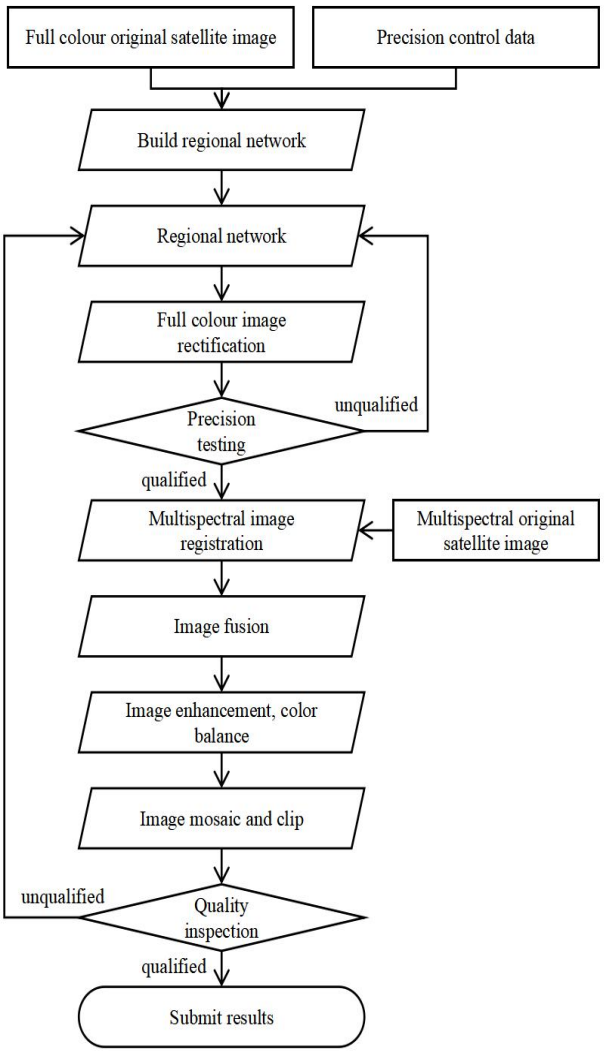

Figure 1. Database diagram of checkpoints

2.4 Image Fusion

Fusion of panchromatic and multispectral images to improve spatial resolution and spectral information of the images.

2.5 Image Enhancement, Uniform Light And Color

Adjust the grayscale of the image and enhance the information in the areas covered by shadows and thin clouds, so that the overall grayscale of the image is moderate, the color tone is basically consistent, the texture is clear, and the layers are rich.

2.6 Image Inlay And Cropping

After multiple steps such as tiling, edge joining, and cropping, the image in units of scenery is finally synthesized into a digital orthophoto image in units of frame or county, and the file is named according to the requirements.

3. QUALITY REQUIREMENTS FOR IMAGING RESULTS

The image results need to meet the requirements of land use survey related schemes in terms of spatial reference frame, positional accuracy, logical consistency, image quality, color texture, and attachment quality.

Focus on controlling the accuracy of the matching position between the image results and the three tone base map or other high-precision data, the accuracy of the overlapping or inlaying position between image blocks, the color coordination and tone consistency processing of the image, texture noise, twisted flower and cloud snow fog shadow occlusion, cloud snow fog shadow hooking and filling, etc.

4. QUALITY INSPECTION CONTENT OF IMAGE RESULTS

The main purpose of land use survey is to accurately grasp the true use of land at a certain point in time, and authenticity and accuracy are the core contents of land use survey. Therefore, the image quality and positional accuracy of orthophoto results are important parameters to ensure their authenticity and accuracy.

Image quality refers to whether satellite remote sensing images can clearly reflect the boundaries and textures of land objects, in order to distinguish their categories and uses. The positional accuracy determines whether the spatiotemporal positional information of a feature is correct.

According to the relevant provisions of "Quality Inspection and Acceptance of Digital Surveying and Mapping Achievements", the quality elements of image result inspection include: spatial reference frame, positional accuracy, logical consistency, temporal accuracy, image quality, attachment quality, etc[3].

4.1 Space Reference Frame

Check if the coordinate system, elevation reference, projection parameters, etc. of the image data are correct to ensure that the basic parameters of the data are correct.

ARCGIS software can be used to query the spatial reference frame parameters of image results and check whether they meet the requirements. Figure 1 shows the spatial reference frame.

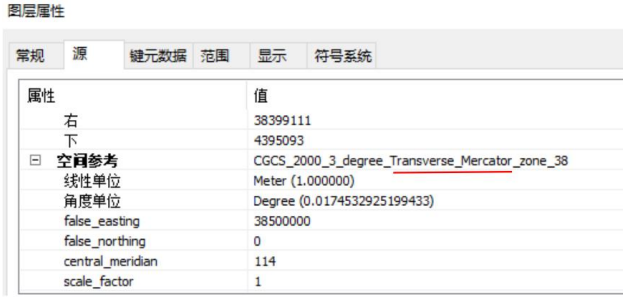

Figure 2. The spatial reference frame

4.2 Position Accuracy

Check whether the absolute positional accuracy and edge accuracy of the image data meet the requirements, ensuring that the image has correct geographic positioning information.

Existing control data or high-precision image results can be used to select landmark points with the same name for planar accuracy statistics of image results. Use two adjacent image results to perform edge accuracy statistics on their edges. Mountainous areas and elevated bridges are prone to location accuracy exceeding limits due to significant projection differences, and these areas require special inspection.

When calculating planar accuracy, if the number of detection points is less than 20, the arithmetic mean is used instead of the mean square error. When the number of detection points is greater than 20 groups, calculate according to equation 1.

$$M = \pm\sqrt{\frac{\sum_{i=1}^{h} \Delta_i^2}{n}} \tag{1}$$

where M = Mean square error

4.3 Logical Consistency

Check if the image data format, file naming, etc. are correct, and if the data files can be used normally.

Due to the established rules for file naming and data file organization, software can be edited in advance to check the quality element.

4.4 Time Accuracy

Check if the acquisition time of the original image meets the requirements to ensure that the image can reflect the current situation of the terrain well.

Determine whether the image acquisition time meets the requirements by checking the time attribute items in the original image information file. Since the acquisition time of the original image is required to be within a specific time period, this inspection can also be carried out by quality inspection software.

4.5 Image Quality

Check if there are any missing images, if the colors in the images are true, if the edges of the images transition naturally, if the shapes and lines of the objects are smooth, and if there are

any issues such as stretching or blurring of the objects to ensure a good visual experience of the image data. This section requires manual use of visual software such as ARCGIS to conduct a comprehensive inspection of special features and overall effects.

4.6 Attachment Quality

Check if the attached materials are complete and if the image data is produced according to the requirements to ensure that the image data production process meets the requirements.

5. QUALITY PROBLEM ANALYSIS AND SUGGESTIONS

In the process of quality inspection of remote sensing image results, various problems may be found, which can have a negative impact on the authenticity and reliability of the data. Based on the analysis of the causes of the problems, some quality inspection methods and precautions are proposed.

(1) The projection parameters of the orthophoto result are incorrect.

(2) The local position accuracy and edge accuracy error of the image results exceed the limit.

(3) The image result file name does not meet the requirements.

(4) The image file is damaged and cannot be displayed properly.

(4) The image results are incomplete and there are loopholes in the frame.

(5) Waving and twisting of features.

(6) The transition at the edge of the image is unnatural.

5.1 Space Reference Frame

There are undefined projections or incorrect projection parameters in the image results, which can prevent the image results from matching with vector data, mosaic information files, etc., ultimately leading to systematic deviations in the range of vector data. This type of problem is usually caused by the carelessness of the workers during the production process. It is recommended to improve the sense of responsibility of the workers. For this type of problem, software can automatically check during the quality self inspection process, read the projection information in the image results, and determine whether it meets the specified requirements.

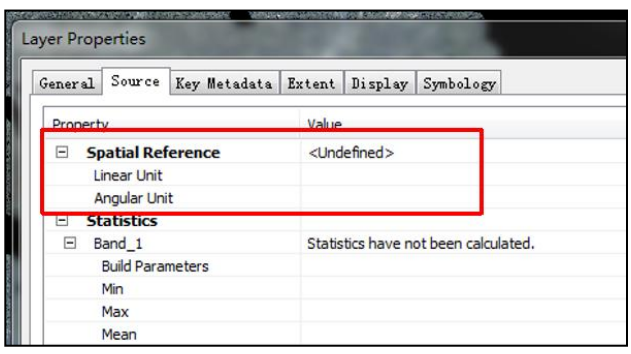

Figure 3. Undefined projections

5.2 Position Accuracy

Part of the imaging results may have errors in planar position accuracy exceeding the limit, mainly due to insufficient control point data during image correction in the production process. This type of problem mainly occurs in mountainous areas. Due to the high altitude of the mountain and the large projection difference of the image, it is easy for the mountain to shift when there is insufficient control point data. In response to this situation, it is recommended to use high-precision control points to accurately check the homonymous landmark points that are prone to errors, in order to ensure the accuracy of the planar position of the image results.[4]

Figure 4. Plane position error exceeds the limit

Another situation is that there is a tendency for edge accuracy errors to exceed the limit in the edge connection area of the two images, which is due to the fact that the two images did not find the same named ground points for edge registration during the production process. Suggest targeted edge registration for line and ground objects such as houses, roads, rivers, etc. at the junction.

Figure 5. Edge Accuracy Exceeds The Limit

5.3 Logical Consistency

There are strict requirements for the naming and file organization format of image results, in order to facilitate the smooth storage of data in the database. Due to operational errors by the operators, some individual achievements were unable to be smoothly stored due to errors in document organization or missing achievements. It is recommended to conduct software

automatic checks on file names, organizational formats, etc. before submitting the image results for storage.

5.4 Time Accuracy

Image accuracy can effectively reflect the timeliness of image results. It is possible to verify whether the image acquisition time meets the requirements through the attribute table in the metadata.

	FID	Shap	YXMC	SJY	JH	SX	CSJ	CYJG	ZYJX
	0	面	5226232022JL1+SV2DOM	SV2	SV2-01_PMS_E108.5_N2	20221018	-3.8	0.5	108
	1	面	5226232022JL1+SV2DOM	SV2	SV2-02_20221025_L2A0	20221025	-12.2	0.5	108
	2	面	5226232022JL1+SV2DOM	JL1	JL1KF01B_PMSR2_20221	20221014	1.6	0.5	108
	3	面	5226232022JL1+SV2DOM	JL1	JL1KF01B_PMSR2_20221	20221014	1.6	0.5	108
	4	面	5226232022JL1+SV2DOM	SV2	SV2-02_20221025_L2A0	20221025	-12.2	0.5	108
	5	面	5226232022JL1+SV2DOM	SV2	SV2-02_20221025_L2A0	20221025	-12.2	0.5	108
▶	17	面	5226232022JL1+SV2DOM	SV1	SV1-04_20221104_L2A0	20221104	-1.5	0.5	108

Figure 6. Temporal attribute

5.5 Image Quality

Image quality is an important quality element that describes the overall appearance of an image. Common problems include the presence of loopholes in the image results, stripe noise in the image, large areas of cloud obscuring objects in the image, abnormal values at the edges of the image, unreal colors in the image, distortion of linear objects such as roads, blurred vegetation images, ghosting of objects, and inconsistent colors at the edges of the two images.

The above issues are difficult to automatically check through software and can only be checked manually. To address issues such as image vulnerabilities, cloud blocking, and stripe noise caused by the original image, it is necessary to promptly supplement the original image for production. Timely manual repair should be carried out to address issues caused by the production process, such as stretching, twisting, and ghosting. Various quality issues can be found in figures 7-13.

Figure 7. Image vulnerability

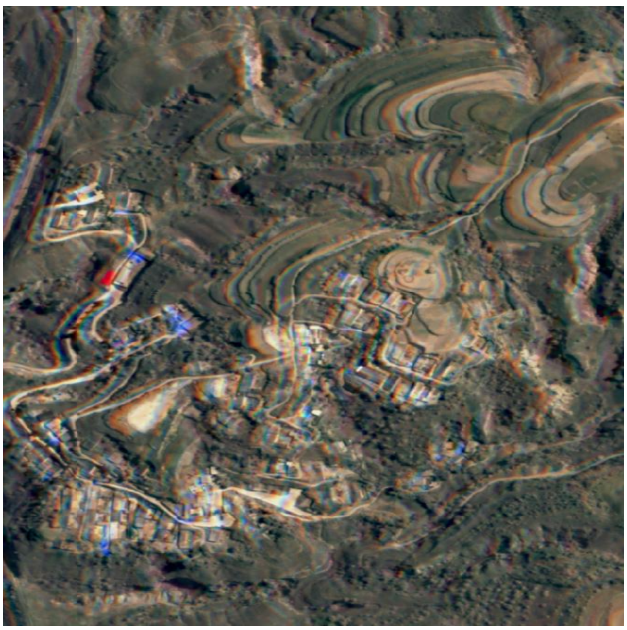

Figure 8. Ghosting of objects

Figure 9. Unreal colors

Figure 10. Distorted features

Figure 11. Clouds cover the terrain

Figure 12. Stripe noise

Figure 13. Abnormal values at the edges

5.6 Attachment Quality

The relevant information of the production process will be submitted together with the attached results, ensuring the compliance of the attached materials is also a means to ensure the compliance of image production.

6. CONCLUSION

As an important tool for land use surveys, the quality of satellite imagery is crucial. This article analyzes and elaborates on the key inspection items of achievement quality, provides examples of quality problems encountered during the inspection process, and proposes some improvement measures for production and quality inspection. Adopting software automatic inspection to address normative issues. For problems caused by the original image, the original image should be replaced as soon as possible. Supervision should be strengthened to reduce the occurrence of problems caused by manual operations.

At present, there are still many manual steps in the production and quality inspection of satellite image data. It is hoped that through the development of image recognition technology, image accuracy can be controlled based on the data of eponymous landmarks and control points. By training AI models, linear landmarks such as roads can be further identified for automatic image smoothing processing. The implementation of these functions still requires a lot of help from image recognition technology and artificial intelligence technology, and it is believed that these functions will become a reality in the near future.

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