Research on the Joint Construction of a National Multi-source and Multi-resolution image Checkpoint Database

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ABSTRACT:

In the process of quality inspection of Remote sensing image data results, the reuse of spatial location information of multiple units, multiple projects and multiple sources can not only overcome the problems of long time to obtain control information, high cost and difficulty in obtaining some areas, but also the basis for achieving efficient and high-precision geometric correction. From the perspective of reusability of checkpoints and saving the cost of quality inspection of remote sensing images, this paper discusses the necessity of joint construction of multi-source and multi-resolution image checkpoint database. And put forward the construction principle and management objectives of checkpoint database. At last, this paper briefly introduces and prospects the application of the national multi-source and multi-resolution image checkpoint database.

1. INTRODUCTION

With the rapid development of remote sensing application technology, more and more earth observation and remote sensing data are widely used in land change investigation, natural resource management, vegetation classification, land use planning, environmental pollution monitoring, seismic monitoring, meteorological observation and military reconnaissance.As an important achievement of surveying and mapping geographic information, remote sensing image results,spatial positioning is the primary problem to be solved to carry out surveying and mapping production by using aerial survey and remote sensing technology, and it is also a key problem to be solved to serve social application services[1].The accuracy of spatial location accuracy is a key indicator to determine the quality of Remote sensing image data results.

The traditional working mode is that different quality inspection units carry out field collection of location accuracy checkpoints according to the needs of their respective projects. There are two drawbacks to this mode of working. First, for the same quality inspection task area, the same quality inspection unit carries out the quality inspection task of image results at different time, and repeatedly carries out field collection of inspection points, resulting in a waste of business resources within the unit. Second, for the same task area, different quality inspection units carry out the quality inspection task of image results at the same or different time, and carry out field collection of location accuracy checkpoints, resulting in a waste of business resources between industries.

Domestic scholars [2-4] have focused more on the construction of image control point databases, which focus on the production sector, and it involves a single production department operation, which is difficult to establish and difficult to achieve. From the perspective of quality inspection of remote sensing image data results, this paper carries out a joint research on the construction of a national multi-source and multi-resolution image checkpoint database. The purpose of this study is to study the construction and design, the collection and storage management of the checkpoints, and put forward the joint construction idea of the national multi-source and multi-resolution image checkpoint database. The comprehensive management of multi-source and multi-unit spatial location checkpoint data across the country realizes quality inspection of remote sensing image results of multi-unit and multi-project in the same task area, which can jointly use the checkpoint data of the same accuracy.

It can achieve the purpose of effective, repeated and shared use of the checkpoints in the sample area, save the inspection cost between the units of remote sensing image quality inspection, improve work efficiency and reduce the workload of field measurement.

2. CHECTPOINT DATABASE DESIGN

Database design is an important step in the life cycle of a database, and the rationality of database design determines the convenience and longevity of later popularization. The national multi-source and multi-resolution image checkpoint database not only has the characteristics of complex data types and large data volumes [5], but also has characteristics that are different from conventional data types, such as they are highly structured data, including location, shape, texture and other information. Therefore, in addition to following the basic principles of database design, the database design department also has some special requirements [6]:

(1) Meet the basic principles of database design: consistency, integrity, security, scalability, and standardization.

(2) Use for operating, managing, and displaying large amounts of graphic image data.

(3) Meet the needs of multi-user concurrent access and editing.

(4) Support powerful query and retrieval functions.

2.1 General Design

The fundamental purpose of the checkpoint database is to effectively manage the checkpoints and convenient inquiry, extraction and utilization, so as to realize the spatial location accuracy detection of the quality of remote sensing image results.

The checkpoint database includes a vector library and an image library for storing and managing the graphics and image data of the checkpoints. Figure 1 shows the structure of the checkpoint database.

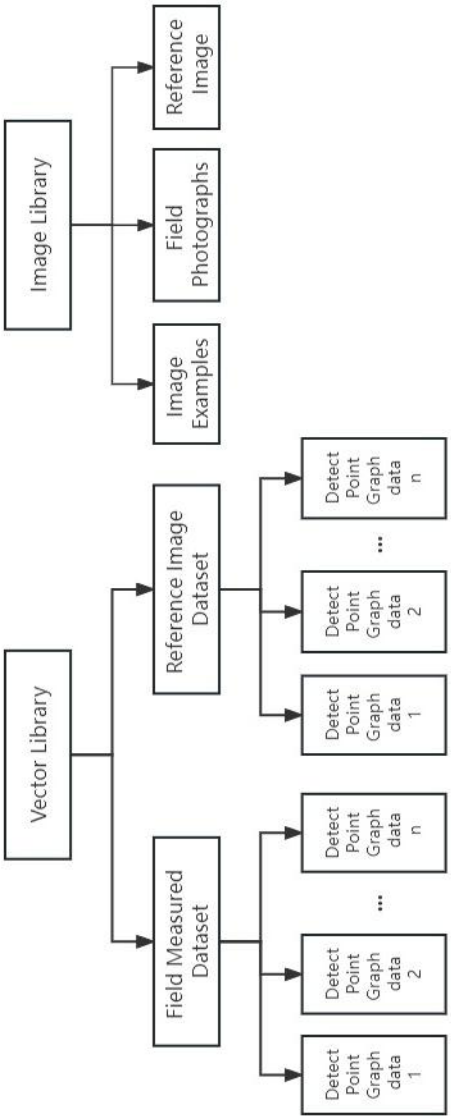

Figure 1. Database diagram of checkpoints

The vector library is used to store the spatial position graphic information of the checkpoints, which can intuitively and conveniently view the distribution of the checkpoints in the sample area. Due to the inconsistency of the attribute information recorded by the field measurement data and the checkpoint data collected based on the reference image results, it is necessary to establish the field measurement dataset and the reference image dataset under the vector database.

According to the source of the checkpoint, the corresponding checkpoint graph data is established under the corresponding dataset.

The image library is used to store data such as image examples, field photos, and reference images. The image example is the image of the checkpoint with a spatial position in the orthophoto image, which is collected on the remote sensing image achievement. With the point of the checkpoint as the center, it expands 100 meters in the four directions of up, down, left and right. The point is marked by a cross wire, and the size and color of the cross wire should be clearly identified. The field photos are forensic photos of the field location of the field measurement and checkpoints. The location of the measured points should be obvious, and the surrounding identifying features should also be included, so as to quickly and clearly identify the location of the measured points. The reference image is the reference data that is used to collect the location accuracy checkpoint.

2.2 Database Logical Design

It needs to consider vector data and image data, as well as the correlation between the two data types when designing the checkpoint database.

2.2.1 Vector library: The vector library data includes two types of datasets: field measured datasets and reference image datasets. The field measured dataset includes field measured checkpoints, field settings shown in Table 1. The reference image dataset stores the checkpoint data retained in the existing project source and collected based on the reference image, field settings shown in Table 2.

S/N	Field Name	Field Type	Field Length	Number of decimal places
1	Periods	Text	50	-
2	X coordinates	Double	-	4
3	Y coordinates	Double	-	4
4	Z coordinates	-	-	-
5	Point of Mind	Text	50	-
6	Image examples	Text	50	-
7	Field photograph	Text	50	-
8	Province	Text	50	-
9	City	Text	50	-
10	Country	Text	50	-
11	Sheet number	Text	50	-
12	remark	Text	50	-

Table 1. Field settings for field measurement points

S/N	Field Name	Field Type	Field Length	Number of decimal places
1	Periods	Text	50	-
2	X coordinates	Double	-	4
3	Y coordinates	Double	-	4
4	Image source	-	-	-
5	Precision	Text	50	-
8	Province	Text	50	-
9	City	Text	50	-

S/N	Field Name	Field Type	Field Length	Number of decimal places
10	Country	Text	50	-
11	Sheet number	Text	50	-
12	remark	Text	50	-

Table 2. Refer to the field settings for image checkpoints

2.2.2 Associative processing of vector libraries and image libraries： The correlation between the vector library and the image library is established through the dot number [7-8], which is convenient to quickly obtain information, such as image examples, field photos, and reference images at the point, etc.

2.3 Database Platform Selection

The database uses Geodatabase under the ArcGIS platform to store the checkpoint data. Geodatabase uses object-oriented data modeling to more freely represent geographic information by defining topology, spatial associations, and ordinary associations between objects, as well as defining the interactions between them. The advantages of Geodatabase can be summarized as follows:

(1) The Geodatabase data model is a warehouse for the unified storage of geographic data, and all data can be stored and managed in the same database.

(2) Data entry and editing are more accurate. Intelligent attribute validation reduces a lot of editing errors, which is the main reason why the Geodatabase data model is widely adopted.

(3) The data model is processed more intuitively, including the data objects corresponding to the user data model.

(4) The elements have a rich association environment. Using topological relationships, spatial representations, and general associations, you can define not only the characteristics of a feature, but also the correlation situation between features.

(5) Define the shape of the element more vividly. In the Geodatabase data model, you can use straight lines, arcs, elliptical arcs, and Bezier curves to define feature shapes.

(6) Multi-user concurrent editing of geographic data. The Geodatabase data model allows multiple users to edit features in the same area and can reconcile conflicts [9].

2.4 Data Warehousing Process Design

The data storage includes four parts: the source of the checkpoint, the data processing and quality control, the data storage and management, and the application of the checkpoint database. The flowchart is shown in Figure 2.

3. CHECKPOINT SELECTION

3.1 The Source of the Checkpoint

The checkpoint can be obtained from the remote sensing image results that have been checked and accepted. The checkpoint can be obtained from the location accuracy checkpoint results that have been carried out and retained from the quality inspection projects. The checkpoint can also be obtained through field collection.

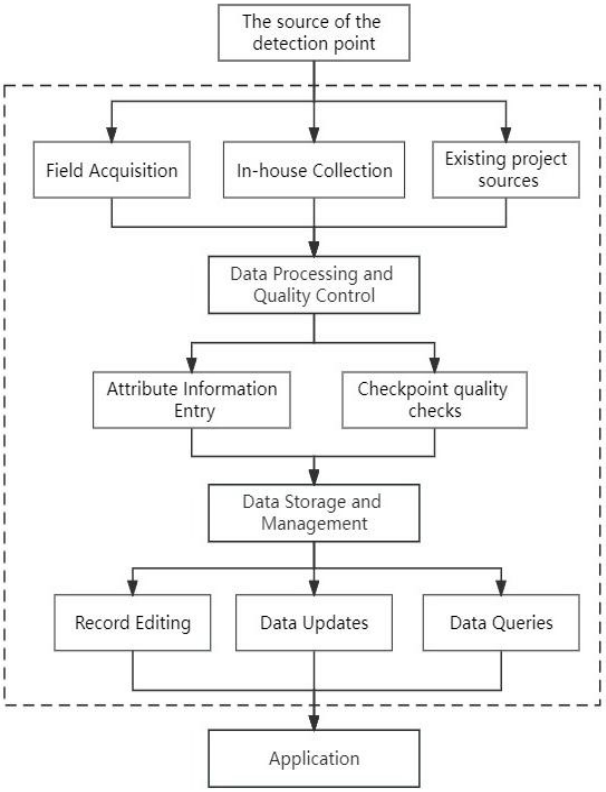

Figure 2. Flow chart of checkpoint data storage

3.2 Checkpoint Collection Requirements

Select an image result data and collect detection points while meeting the accuracy requirements. The principle of collecting checkpoints is uniform distribution and follows the following principles:

(1) Mainly artificial linear features, such as roads, basketball courts, etc., generally take the intersection of linear features as the center of the control point;

(2) The stability of the features is strong, that is, it is not appropriate to choose the types of features that change frequently, such as river beaches, beaches, roads under construction, houses under construction, etc.;

(3) There is less interference information, that is, the details of the image features are clear, the contrast is moderate, the layers are clear, the color is basically balanced, and the image histogram should be basically close to the normal distribution, which is very beneficial to manual interpretation and computer automatic matching;

(4) The characteristics are prominent, and the checkpoint is selected as far as possible at the inflection point of the fixed feature with obvious features;

(5) The density is uniform, and the checkpoints should be evenly distributed within the detection area, so as to avoid the checkpoints in some areas being too dense and the checkpoints in some areas being missing, resulting in uncontrollable accuracy of the results in the area;

(6) The number of testing points is sufficient, and the number of testing points in the testing sample area shall not be less than 30.

3.3 Checkpoint Collection

Based on the above collection principles, carry out the collection of detection points. The collection process is shown in Figure 3.

For the detection area where there are image results that can be referenced, check the acceptance materials of the reference images, and if there are multi-scale reference images that meet the requirements of the project inspection point collection, the large-scale and current image data results are preferentially selected for the checkpoint collection; For the situation that there are no relevant reference materials and no other items to retain the checkpoints, in accordance with the above collection principles, RTK measurement, GPS precision single-point positioning measurement and other methods are used to carry out field collection.

4. WAREHOUSING, INSPECTION AND MANAGEMENT OF CHECKPOINTS

4.1 Warehousing of Checkpoints

There are three types of warehousing at the inspection point. For the test points that have been retained by the existing projects, they can be directly imported into the test point library, and the index and sample area registration of the source and accuracy of the test points can be done. For those who do not have the surviving checkpoint data, but have high-precision image result data for reference, a graphic file can be created under the vector dataset of the database, and then the checkpoint can be collected, entered, and indexed. In the case that there are no surviving checkpoints and no high-precision image results to refer to, the checkpoint data is processed and entered based on the checkpoints collected in the field.

4.2 Quality Control

In order to ensure the accuracy and completeness of the information in the database, an inbound quality check must also be carried out after the warehousing work has been completed. It mainly includes the inspection of the attribute information of the vector data in the database, the inspection of the image information, and the inspection of the association between the attribute information and the image information. The attribute information check of vector data is mainly to check whether the attribute information input of the graphic data is complete, whether there are omissions in the process of storage, and whether the input information is correct and clear. The image information inspection mainly checks the quality of the selection of image examples, the standardization of production, the availability and clarity of field photos, etc. The correlation between attribute information and image information is checked to check whether the graphic information and image information have corresponding correlation targets.

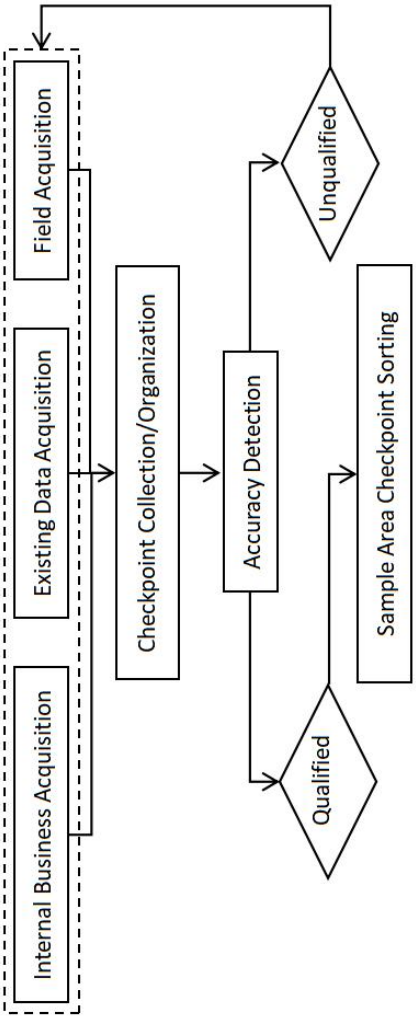

Figure 3. Flow Chart of Checkpoint Collection Technology

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4.4 Management of the Checkpoint Library

After the construction of the checkpoint database is completed, it will be continuously supplemented and improved, and finally a checkpoint database covering all provinces, cities and

counties in the country will be formed. In addition to integrating nationwide checkpoint data, the checkpoint library can also realize a variety of functions such as batch data import, extraction, specified method retrieval, record editing, etc.

In order to facilitate the sharing and use of the checkpoint data in the checkpoint database of the joint construction unit, establish an online index of the district, county, prefecture or map frame with the checkpoint, and regularly update the checkpoint database according to the business development of the unit. Before the joint construction unit carries out the location accuracy test of the quality inspection task area, check whether there are any sample area checkpoints covered by the task area. If it exists, query the source of the checkpoint in the sample area to meet the location accuracy detection requirements, if it is, obtain the checkpoint data of the checkpoint library to carry out the location accuracy detection work, if not, implement the location accuracy detection work that meets the project requirements. After the project is completed, the relevant information of the inspection point will be entered into the checkpoint database.

4.5 Checkpoint Query

In addition to integrating nationwide detection point data, the detection point database can also achieve various functions such as batch data import, extraction, specified retrieval methods, and record editing. There are two ways to perform spatial queries:

(1) Query based on the location of detection points. The attribute information and spatial distribution information of detection points in the database can be queried based on coordinate position information.

(2) Query based on detection point features. Due to the clear interpretation features of detection points in the database, these features can be used as conditions to query the required detection points. The features of detection points, such as intersections of roads, corners of houses, and turning points of walls, are stored as field values in the detection point attribute table of the detection point database, and feature attributes are used to query the features of detection points. The query results can be all selected for output or output through visual filtering. Conduct positional accuracy detection of the detection area based on the query results.

5. APPLICATION AND OUTLOOK

It is the ultimate goal of establishing a national multi-source and multi-resolution image control point database to maximize the joint quality inspection department of surveying and mapping geographic information achievements to jointly create, maintain and use spatial location checkpoint resources, save inspection costs and improve work efficiency at the same time. In the quality inspection of the orthophoto results of the third national land survey undertaken by the unit and the overall guarantee of the annual natural resources satellite remote sensing image data, the checkpoint database of the sample area in the checkpoint database is used to carry out the plane position accuracy detection with the same precision or high precision, which greatly reduces the field workload, greatly improves the work efficiency, and completes the quality inspection task on time under the condition that the accuracy of the checkpoint is controllable.Meanwhile, with the continuous improvement of the database, it will be able to meet the needs of more types and scales of spatial position accuracy detection.

With the increase in the participation of the national multi-source and multi-resolution image checkpoint database in the joint construction, the checkpoint database covering cities, districts and counties across the country and various scale sheets is becoming more and more perfect, and the degree of meeting multiple needs and scales will be higher and higher. Because the checkpoint data involves spatial location information and image information, it is still an urgent problem to be solved for how to solve the resource sharing of online checkpoints, and with the solution of the problem of online sharing, the co-construction and sharing of the national multi-source multi-resolution image checkpoint database will no longer be a myth.

The security and confidentiality of databases cannot be ignored. A series of measures must be taken to ensure the security and confidentiality of data, and to prevent data from being illegally obtained, tampered with, or leaked. Looking ahead to the future, with the continuous progress of technology and the deepening of applications, the national multi-source detection point database will play a more important role in the field of surveying and mapping geographic information. By continuously improving and optimizing the functionality and performance of the database, more comprehensive, accurate, and efficient support will be provided for the quality inspection of surveying and mapping geographic information results.

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