

The Establishment of the SAR images database System Based on Oracle and ArcSDE

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Abstract. Synthetic aperture radar is a kind of microwave imaging system, and has the advantages of multi-band, multi-polarization and multi-angle. At present, there is no SAR images database system based on typical features. For solving problems in interpretation and identification, a new SAR images database system of the typical features is urgent in the current development need.

In this article, a SAR images database system based on Oracle and ArcSDE was constructed. The main works involving are as follows: (1) SAR image data was calibrated and corrected geometrically and geometrically. Besides, the fully polarimetric image was processed as the coherency matrix[T] to preserve the polarimetric information. (2) After analyzing multiple space borne SAR images, the metadata table was defined as: IMAGEID; Name of features; Latitude and Longitude; Sensor name; Range and Azimuth resolution etc. (3) Through the comparison between GeoRaster and ArcSDE, result showed ArcSDE is a more appropriate technology to store images in a central database.

The System stores and manages multisource SAR image data well, reflects scattering, geometry, polarization, band and angle characteristics, and combines with analysis of the managed objects and service objects of the database as well as focuses on constructing SAR image system in the aspects of data browse and data retrieval. According the analysis of characteristics of SAR images such as scattering, polarization, incident angle and wave band information, different weights can be given to these characteristics. Then an interpreted tool is formed to provide an efficient platform for interpretation.

1. Introduction

Recent years, remote sensing technology plays an increasingly important role in the national economy, such as macroscopical decision, environmental and disaster monitoring. With its capability of all weather, all time, radar remote sensing becomes a great tool in observing crops. At present, there is no SAR images database system based on typical surface features^[1,2]. Considering problems in interpretation and identification of typical surface features, a SAR images database system based on the typical surface features is urgently needed.

The SAR images database system is different with optical-image database system. Extraction of polarization characteristics, geometric characteristics and scattering characteristics are very important to establish a SAR images database system. With the rapid development of aerospace remote sensing technology, problems of storage and management of data also become serious.

The aim of this study was to collect radar data for ten typical surface features, analyse the characteristics of SAR images and establish the SAR images database system based on Oracle and ArcSDE.

2. Spatial database designing

The purpose of SAR images database system is to design metadata table that reflects the scattering,



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geometry, texture, polarization, band and angle characteristics of SAR; select an appropriate method of processing and storing images; organize both metadata and image data consistently; and query spatial data effectively. For the interpretation of typical surface features, then to statistic various characteristics, design weights and form an interpreted tool.

The system is composed of metadata and image data. Metadata can help users retrieve useful information. The image data include not only radar data, but also optical data that is used for the auxiliary of identifying and extracting typical surface features. This section solves the following three questions: collection and processing of radar data; designing metadata table; storing data and link between image data and metadata.

2.1 Image data

This system is used to interpret several typical features such as bare soil, snow, residents, rice, wheat, corn, coniferous forest, broadleaf forest, shrubbery and orchard. SAR image data is processed and meets the requirements of multi-band, multi-resolutions, multi-incidence angles, and multi-temporal. Among them, L-band data is from AIRSAR and ALOS sensor, S-band data is from HJ-1C data, C-band data is from RadarSat2, ERS and Envisat/ASAR sensor data, X-band data is from TerraSAR, Cosmo and domestic airborne SAR data, P-band Imaging is from domestic airborne SAR data. Optical image is from Landsat-5/7 etc.

The original data was processed to analysis scattering characteristics of features quantitatively^[3-6]. A Radarsat-2 SAR Image was used as the test data, whose resolution is 4.9m*4.7m in azimuth and range direction, respectively. The test site located in Inner Mongolia, China. The DEM data is ASTER(The Advanced Spaceborne Thermal Emission and Reflection Radiometer), used for geometric and radiometric correction. Optical image is from Landsat-5. Category of the typical surface feature in this area is rich: bare soil, residents, wheat, coniferous forest, broadleaf forest, shrubbery. The variety of crops makes this area very suitable for the SAR images database.

Radarsat-2 data was firstly calibrated. Because of the mountainous, terrain on the radar image has a strong impact on geometric and radiometric characteristics. Terrain can cause geometric distortion, resulting in foreshortening, layover and shadow phenomenon. Topographic relief also cause(Beaudoin^[7]) large errors of backscattering coefficients that cannot be ignored. To analyse accurately, digital elevation model (DEM) was chosen to correct backscattering changes caused by terrains(Fig.1). After that, spatial subset of the shrubbery, which is homogeneous area select, is selected(Fig.2a).

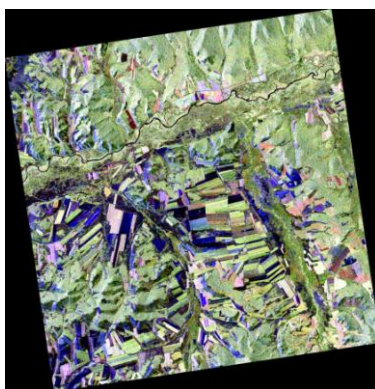


Figure 1. the processed Radarsat-2 data

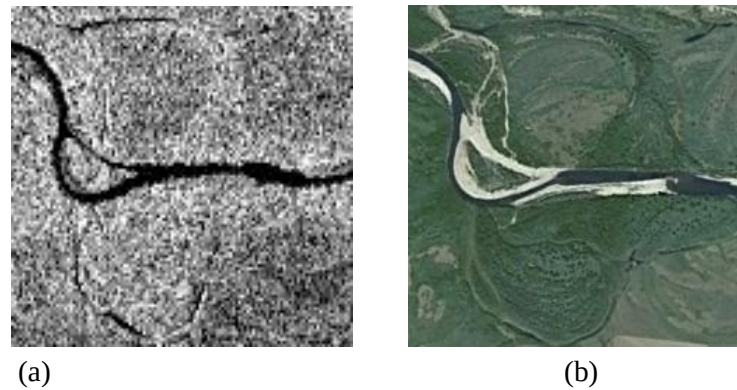


Figure 2. shrubbery (a. SAR image b. optical image)

The polarization of Radarsat-2 data is HH, VV, HV, and VH. Fully polarimetric data contains both intensity information and phase information. It is the most comprehensive description of the target scattering characteristics^[8]. To preserve the polarimetric information, the image was processed as the coherency matrix $[T]$. The elements of matrix were saved as a file, which was observable within Fig 3a. The dual-polarimetric data is stored as Fig.3b.

$$[T]_{3 \times 3} = \begin{bmatrix} T_{11}^{①} & T_{12}^{②③} & T_{13}^{④⑤} \\ T_{21} & T_{22}^{⑥} & T_{23}^{⑦⑧} \\ T_{31} & T_{32} & T_{33}^{⑨} \end{bmatrix}$$

(a)

$$I_{pp1} = \begin{bmatrix} I_{hh}^{①} & I_{hv}^{②} \end{bmatrix}$$

(b)

Figure 3. Storage of multi-polarimetric data(a. fully polarization b. dual-polarization)

2.2 Metadata

SAR images not only reflect the geometric properties of the target, but also reflect the scattering characteristics of the target^[9], one of the most basic characteristics is the backscatter coefficient σ^0 . Many factors can influence σ^0 , some belong to the parameters of the radar system: wavelength (frequency of electromagnetic waves), polarization^[10], incident angle etc. Others are geographical parameters: geographical geometry and texture characteristics. All the parameters are useful to the formulation of interpreted tool.

Metadata must describe the attribute information of SAR image, help users find the right data, and improve the capability of interpretation. Considering these information, the metadata table was defined as: IMAGEID; Name of features; Latitude and Longitude; Sensor name; Range and Azimuth resolution; Number of columns and lines; Storage type; Amplitude/Power; Azimuth angle; Slant/Ground distance; With or Without photo; Description. To create the metadata, edited the SQL(Structured Query Language) statement in PL/SQL (Procedural Language/SQL) of Oracle. The contents of metadata were read from the header files of satellites.

2.3 Dataset Storage and Management Approach

This section, two techniques were selected for storage and management of data. GeoRaster is a new part of Oracle11g which can store, query and analyze raster data. ArcSDE is ESRI's technology for accessing and managing geospatial data within relational databases.

Test environment is as follows: operating system is windows7; database is Oracle11g; CPU is 2.4GHZ; and memory is 4G. To compare the ability to import data, selecting an ERS2 C-band data of 24.6M,

GeoRaster took 17.6s, and ArcSDE took 5.3s; selecting an ALOS L-band data of 385M, GeoRaster took 143.6s, and ArcSDE took 45.7s. Results showed that ArcSDE import data more quickly than GeoRaster. Therefore, we established a SAR images system based on the ArcSDE and Oracle in this article.

Both SAR image and optical image were stored as a series of tables by ArcSDE. If images were stored separately in Oracle, it would bring a lot of inconvenience to management. Raster catalog is a container for raster datasets. Raster catalogs can be created as unique objects within a geodatabase, or they can be defined using a table^[11].

Exemplified by a SAR image, this paragraph explained the data storage structure in the database. If we created a catalog named SARImage to store SAR images, all the images would be stored in the same tables. Those tables were stored in SDE Tablespace of Oracle: SARImage Table, RASTER_COLUMN Table, Raster Table, Raster Band Table, Raster Band Auxiliary Table and Raster Block Table(Fig.4). Similarly, optical images were stored in the catalog named OpticalImage. IMAGEID was the primary key of SARImage Table, OpticalImage Table and metadata Table, which was the unique sequential identifier of each image block of typical surface feature. One image block had a unique metadata, a unique SAR image and a unique optical image.

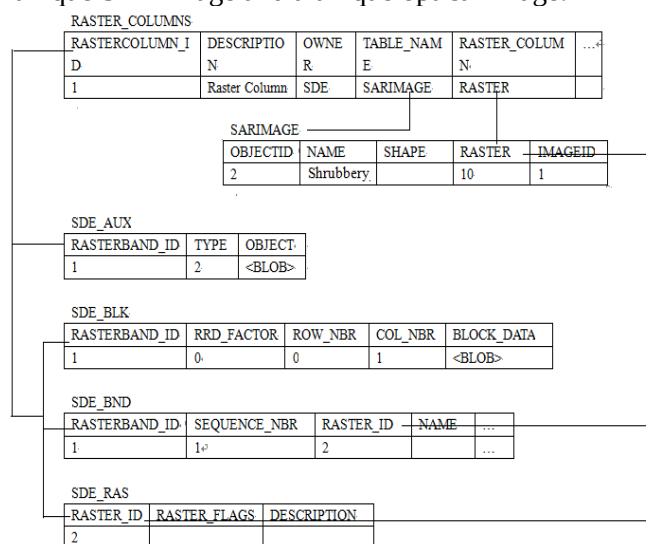


Figure 4. Tables of SAR images in Oracle

Comparison with two techniques showed that ArcSDE is a better technology to store and manage the spatial data in Oracle. It store SAR images and optical images in a central database and support the concurrent multiuser editing necessary for most GIS data management workflows.

3. SAR images system based on Oracle and ArcSDE

SAR image database system adopted three-layer architecture(Fig.5), i.e., application layer, server layer and data management layer. The client application of the system was the application layer; ArcEngine^[11] and ArcSDE function constituted the server layer; and the data management layer consisted of three databases (i.e., metadata database, SAR image database and optical image database) that were related to one another by IMAGEID. Metadata mainly came from header files of each satellite; SAR image referred to extracted image blocks of typical surface features after geometric and radiation correction and optical image was used for distinguishing SAR image block.

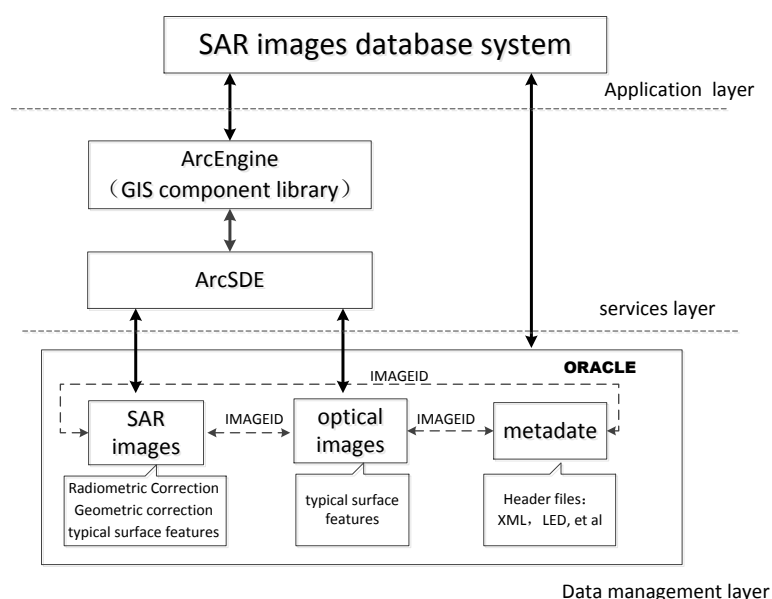


Figure 5. A structural diagram of the system

As a technical support platform of SAR image data management and distribution service, the application layer of the system regarded the satisfaction of the demands for multisource SAR image data storage and management, combined with analysis of the managed objects and service objects of the database as well as focuses on constructing SAR image system in the aspects of data browse and data retrieval. The information, e.g. name of servers, name of database, user names and passwords, can be used to connect or disconnect the SAR image database system as well as finish some operations and queries.

4. Conclusion

In this paper, a SAR image system based on Oracle and ArcSDE was established. We found that: (1) SAR images must be processed by geometrical and radiometric correction; the fully polarimetric image should be processed as the coherency matrix[T] to preserve the polarimetric information; (2) Metadata table is designed with respect to those characteristics of SAR; (3) Comparing with GeoRaster, ArcSDE is a more appropriate technology for accessing and managing geospatial data, and support multiple format of data. The raster catalog of ArcSDE store SAR images and optical images in a central database and support the concurrent multi-user editing necessary for most GIS data management workflows; (4) The system, which ensures effective storage between metadata, SAR and optical image data, provide an efficient solution for the storage of image data and metadata and reflect scattering, geometry, texture, polarization, band and angle characteristics. According to the analysis of characteristics of SAR images such as scattering, polarization, angle, wave band information, and different weights can be given to these characteristics. Then an interpreted tool is formed to provide an efficient platform for interpretation.

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