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QUICK IMAGE PROCESSING METHOD OF HJ SATELLITES APPLIED IN AGRICULTURE MONITORING

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ABSTRACT—Multi-temporal and large scale remote sensing images are very useful for crop monitoring, the HJ Satellites become one of the most important data sources in crop monitoring as the broad-spectral and high-temporal relatively. The paper focused on the agricultural remote sensing monitoring which based on the HJ satellite images, a method of quick processing was carried out. Firstly, image radiation correction, atmospheric correction and more than 10 vegetation indexes are calculated by ENVI/IDL. Secondly, the ArcSDE combined with Oracle Database realizes fast storage of images. Finally, thematic image of agriculture remote sensing monitoring is quickly published in ArcGIS Server. This work provides a complete solution towards fast remote sensing image preprocessing, storage and publishing for agriculture monitoring.

Key Words: HJ Satellites, Remote Sensing, Agriculture Monitoring, Image Processing

1. INTRODUCTION

Agriculture monitoring such as growth, yield, diseases and insect pests can be processed by remote sensing technique which is multi-temporal and large-scale. In China, it is difficult to realize agriculture monitoring by traditional method because of large farming area, complex terrain and diverse planting structure [1]. The agriculture monitoring using remote sensing technique not only calls for professional images obtaining, high efficiency image preprocessing, storage and management, but also publishing the referred maps quickly.

To deal with the complex environment and natural disasters, China launched the HJ-1A and HJ-1B satellite with independent intellectual property rights, which is part of the Environmental and disaster monitoring and forecasting of small satellite constellation system [2]. More data is provided after this delivery, But mature processing software is still needed to process the above numerous data. The massive images can't be organized and managed effectively using the traditional document management mode. Additionally, the networks' bandwidth and speed limit the publishing of the thematic images [3]. These factors have restricted the agricultural remote monitoring in timeliness and regular operation level.

Facing above problems, the paper designed detailed solutions including data batch preprocessing, image storage and publishing applied in agriculture monitoring based on HJ satellites data. The ENVI/IDL program is used to realize the batch preprocess such as image radiometric calibration, atmospheric correction, classification and vegetation indexes calculating, the ArcSDE combined with Oracle were adopted in storage and management. Quick publishing and presentation of images are based on ArcGIS Server Rest techniques.

2. TECHNOLOGY ROADMAP

Crop growth is complex, which may be affected by breed and ecological environment. Pests, floods, droughts, and so on can affect the growing of crops. The agriculture monitoring based on remote sensing needs to be cyclical and real-time to get previous information timely. Meanwhile, massive images need to be processed and published. The paper designed detailed solutions including data batch preprocessing, image storage and publishing settling the agriculture monitoring based on the HJ satellites data. The Technology Roadmap is shown in Figure 1.

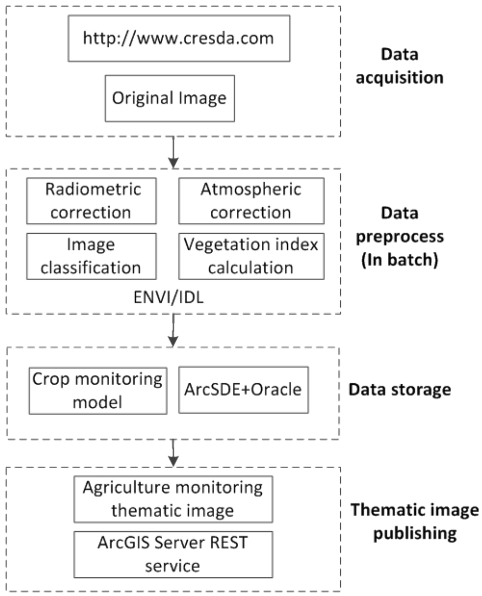

Figure 1. The technology Roadmap.

Free environment of small satellite image could be downloaded in China Resources Satellite Center site. The data varies depending on preprocessing levels. In this paper, the secondary data is in study and preprocessing such as radiometric calibration, atmospheric correction, geometric correction is essential. Vegetation Indexes in agriculture monitoring are stored and managed in Oracle Database by ArcSDE technology. These satellite data is statistically analyzed on the basis of crop monitoring model. And the thematic images of agriculture monitoring are hierarchical rendered and published as REST services, which is convenient to overlay the Google Map.

3. PRINCIPLE OF THE METHOD

3.1 Remote sensing images preprocessing in batch

The HJ-1A and HJ-1B satellite were equipped with wide-band multispectral visible CCD camera, which is 30 m spatial resolution. The parallel observation time is shortened to two days and covers 360km two cameras networking. In short, the operation data retain apposite temporal resolution and spectral range for needs of agriculture monitoring [4]. The Table I lists the settings of CCD camera and the main applications.

Table I. Sensor band parameters and the application list

Sensor	Band	Wavelength (um)	Spatial resolution (m)	Main application
CCD camera	Blue	0.43-0.52	30	Water
	Green	0.52-0.60		Vegetation
	Red	0.63-0.69		Chlorophyll, suspended sediment, land
	Near-infrared	0.76-0.90		Vegetation, soil moisture, water and land boundary identification

Geometric distortion and Radiation distortion exists in images as the influences of atmospheric and solar zenith angle when obtaining images, which affected the image quality. So preprocessing including geometric correction, radiometric calibration and atmospheric correction of images is designed in the solution. Simultaneously, ten vegetation indexes in agriculture monitoring are selected shown in Table II.

Table II. The most common used 10 vegetation indexes

ID	Vegetation Index Lists	Abbreviation	Formula
1	Normalized Difference Vegetation Index	NDVI	NDVI=(B4-B3)/(B4+B3)
2	Soil-Adjusted Vegetation Index	SAVI	SAVI=(B4-B3)/(B4+B3+0.5)(1+0.5)
3	Optimization of soil-adjusted vegetation index	OSAVI	OSAVI=(1+0.16)(B4-B3)/(B4+B3+0.16)
4	Nitrogen Reflectance Index	NRI	NRI=(B2-B3)/(B2+B3)
5	Green normalized difference vegetation index	GNDVI	GNDVI=(B4-B2)/(B4+B2)
6	Structure Insensitive Pigment Index	SIPI	SIPI=(B4-B1)/(B4+B1)
7	Plant Senescence Reflectance Index	PSRI	PSRI=(B3-B1)/B4
8	Enhanced Vegetation Index	EVI	2.5*(B4-B3)/((B4+6.0*B3-7.5*B1)+1)
9	Difference Vegetation Index	DVI	DVI= B4-B3
10	Ratio Vegetation Index	RVI	RVI= B4/B3

Note: B1 is the blue spectral reflectance, B2 is the Green spectral reflectance, B3 is the Red spectral reflectance and the B4 is the red band reflectance of the remote sensing data.

The above preprocess is aiming at HJ images, which is realized by ENVI/IDL in batch mode. The whole procedure is automatic except for geometric correction process, which needs human interaction.

3.2 Quick storage and publishing of massive remote sensing images

The remote sensing images, vegetable index data, auxiliary vector and raster data are stored in Oracle Database by ArcSDE, and ArcCatalog links spatial database to maintain and manage the datum. Agriculture monitoring model is regressed by sample vegetation indexes and auxiliary data. The vegetation indexes are processed with ENVI/IDL technology in step 1, and auxiliary data include Meteorological data and soil data are achieved by experiment in farm field. Thematic images are obtained by hierarchical rendering based on the above crop monitoring model.

Commonly, the publishing of agricultural monitoring data consists of two parts: the one is geographic data, and the other one is monitoring images that need to be updated dynamically. After superimposed on geographic data, remote sensing thematic images can express agriculture monitoring results more clearly. The publishing of remote sensing data is limited by network environment as the amount of data, so it is works to reduce transmission of data between the server and client. This demands that dynamic data is merged with geographic data, and the static geographical data are not refreshed together with the dynamic data [5].

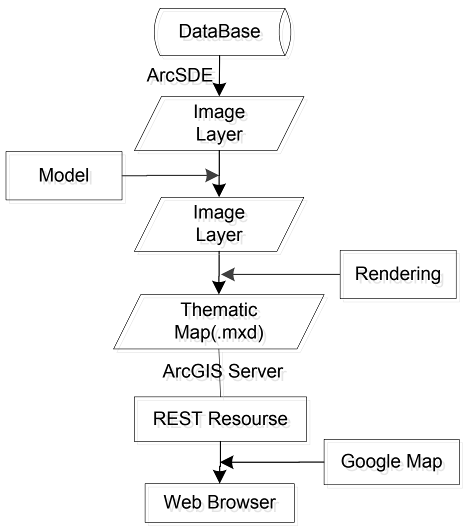

Figure 2. Remote sensing images publishing process.

To solve this, Google Map API is produced in this study. Namely, Google Maps is served as basic geographic data. Images on agricultural monitoring are published as REST resources by ArcGIS Server, then are superimposed and displayed with Google Maps ArcGIS Server JavaScript API. The images quick storage and publishing process is shown in Figure 2.

3.2.1 The ArcSDE with Oracle storage model

ArcSDE is a spatial data engine of ArcGIS products. ArcSDE provides the extended relational database management systems, such as binary string types of data storage, and provides data projection coordinates as well as point, line, surface and these elements of topological relations and other related information model [6]. The spatial data is stored in ArcSDE in the form of

ArcSDE data layer. The ArcSDE is adopted whenever related to spatial data editing operation in the process of ArcGIS Server development.

In addition of remote sensing image, crop biochemical data and environmental data are also required in crop monitoring. In this study, the agricultural auxiliary data is directly stored in Oracle database.

3.2.2 ArcGIS Server technology

The ArcGIS Server, a WebGIS platform product on server-side was launched by ESRI, which combines GIS and Web techniques. The GIS is mainly used for spatial data query, analysis and processing operations [7]. As a distributed system, the ArcGIS Server could be deployed on one or more machines. The ArcGIS Server was usually consisted of GIS Server, Web server, desktop applications and Web browsers [8] and can be divided in presentation tier, application tier and data storage tier. The architecture is shown in Figure 3.

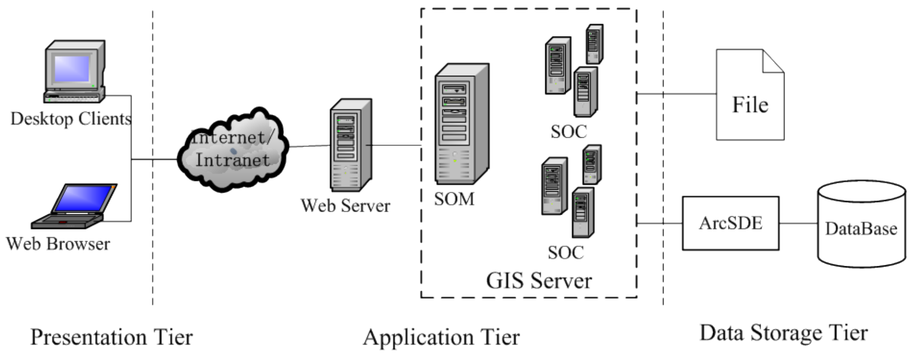

Figure 3. ArcGIS Server Architecture.

The presentation tier usually includes web browsers and desktop applications which are able to call the function developed by ArcGIS Server. The application tier includes the Web Server layer and GIS Server layer. Web Server layer is mainly responsible for collecting user request by Web browsers and Web Services, and returns the results back to the client according to some requests. The GIS Server layer includes a server object manager (SOM) and one or more server object containers (SOC). The data tier provides spatial data for SOC. The data resource is accessed through ArcSDE and could also be the data in the usual file type.

Representational state transfer (REST), as guideline for the Internet hypermedia distributed systems, is a way to design and develop network applications [9]. The REST-style Web is more flexible, scalable and stateless [10]. Since ArcGIS Server 9.3, the REST-based Web Service architecture was introduced. It provides a new way to create and publish REST Web Service for users [11]. Parts of functions and services of ArcGIS Server could be realized by ArcGIS Server REST API, which is convenient for ArcGIS Server client development. Besides, the ArcGIS JavaScript Extension for the Google Map API was utilized to realize ArcGIS JavaScript Extension for the Google Map [7].

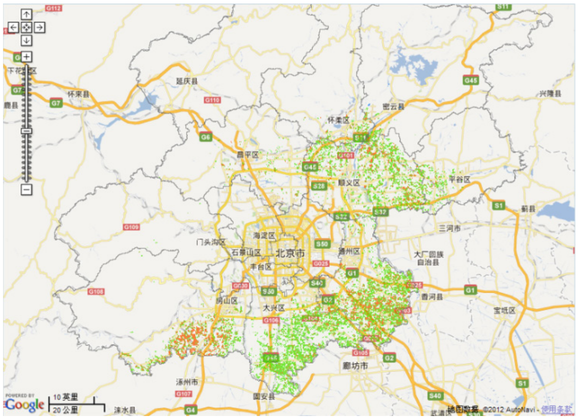

Figure 4. Agriculture monitoring thematic image published with Google Map.

The crop monitoring thematic image is published by ArcGIS Server REST API, and then created as dynamic map services layer using ArcGIS JavaScript Extension for the Google Map API. Finally, the layer was overlay together with Google Map which is shown in Figure 4.

4. DISCUSSION AND CONCLUSION

This research puts forward a complete solution for HJ Satellite Images preprocessing, storage and publishing. In the solution, remote sensing images could be preprocessed in batch, and more than 10 vegetation indexes are calculated once, and mass remote sensing data is published fast. But many problems have to be solved if operated in practice.

(1).The study designs methods of remote sensing preprocess, and the image could be processed in batch which increased the efficiency applied in crop monitoring. However, the procedure from image preprocess, storage to publishing in the solution requires human interaction, and could not be connected seamlessly. Further studies are required to determine the images fully automated processes.

(2). Satellite image is varied, and at resolution of different temporal and spectral meet different requirements in crop monitoring. This study aimed at the environmental satellite CCD sensor on image preprocessing, storage and publishing method and achieves certain applicability. But for other satellite images, some necessary parameters need to be specified.

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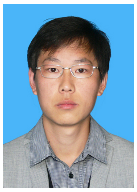

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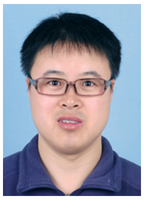

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