

# A FRAMEWORK OF WEB-BASED SERVICE SYSTEM FOR SATELLITE IMAGES AUTOMATIC ORTHORECTIFICATION

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## ABSTRACT:

The orthorectification of satellite images is a foundational process in satellite applications. With the improvement of the satellite imaging technology and the orthorectification calculation models, the collection of Ground Control Point (GCP) is becoming the key factor restricting the efficiency and precision of orthorectification. At the same time, the services based on web in the geographic information filed have obtained substantial achievements, and the gradual maturity of GCP chips database construction technology, it is possible to provide remote sensing image ortho-rectification services via the internet based on the exiting GCP chips database. This paper proposed a framework design of Service Platform for satellite images automatic OrthoRectification(SPOR). Under B/S three tired (i.e. Data server, Web application server and Browser) system structure mode, this service platform translated non-corrected images form the user browser to the server side, corrected the images automatically under the assistance of GCPs image database and Digital Elevation Model(DEM), and sent the corrected images to users via the internet. The prototype test of the system shows that, the application of the SPOR can substantially improve the efficiency of satellite image orthorectification, save the labor of ortho-image demand users, and make the correction of the satellite images more professionally and automatically.

## 1. INTRODUCTION

The orthorectification of satellite remote sensing images is a foundational processing operation in satellite applications. Images orthorectification, which involves calculating models for orthorectification, DEM in certain scale and range and enough high quality of Ground Control Point (GCP) chips (Zhang, 1997), is quite a time consuming and difficult work. The efficiency and precision of GCPs collection can affect the image orthorectification directly, for the reason that both of the orthorectification models calculation and DEM superposition are related with GCPs. However, the GCPs collection is really a time consuming work. What's more, the GCPs collected for one image are rarely used in another image, which results in the high waste of material resource and labours. The proposing of GCP chips database improved this situation greatly and reduced the burden of GCPs collection (Zhang, 2000; Chen, 2006; Wen, 2007). However, most of the GCP chips databases are built in local networks with high construction cost and low utilization rate. At the same time, Computer and internet technology has advanced greatly, which makes the exchange and transmission of geographic information via the internet even more mature. It is possible to provide remote sensing image orthorectification services via the internet as the rapid development of communication technology (Qiu, 2004). In recent years, the web-based services in the geographic information filed have obtained substantial achievements, however there are not many researches in the remote sensing image processing service, and there is no website could offer orthorectification service in China until now. Therefore, it is necessary to further study the framework construction and workflow design of the web-based image orthorectification service.

This paper proposed a framework design to provide real-time automatic orthorectification services based on the existing GCP chips database. A prototype of SPOR was designed with the GCP matching, computer calculation and internet transmission technology. Through providing the professional and automatic orthorectification service to the ortho-image-demand departments via the internet, people can be separated from tedious orthorectification work to more professional researches, which can promote the further application of satellite images in various fields.

## 2. WEB-BASED IMAGES ORTHORECTIFICATION SERVICE

### 2.1 Web-based Images Service

Under the web communication protocol, Web-based service can realize the information transmission and remote invocation via the internet. As the rapid development of the internet and web-based service technology, the service of obtaining complex and massive data information is required urgently. In the field of geo-spatial information services, it has obtained certain achievements in providing massive data vector maps and satellite image maps via web services (Tay, 2002; Jia, 2004; Chen, 2005; Huang, 2007). In recent years, a lot of excellent websites that can provide image data and services are spring out. These websites were built in different web application structure, including C/S, B/S, and three tired (or multi-tired) structures.

Google Earth which is the one of the most successful cases based on C/S structure makes the geo-spatial information services reached its climax. Google Earth realized the functions

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of querying, browsing, and measuring on global scale. In addition, users could upload images superimposed on Google Earth (Jia, 2006). Under C/S structure, the client side of Google Earth could get the image data through real-time downloading from the server side, while the pyramid algorithm and other compression technologies were employed in images transmission. With this structure a complete set of application that is the integration of subroutine has to be installed in the client side, which can share the tasks with the server side. It can demise the communication cost of the whole system and improve the capacity of the data manipulation and management. However, it also has some disadvantages, such as high developing cost, difficult to update and frequent communication via the internet.

B/S structure that is mainly employed by electric map systems is consisted by browser and server. The server is used to storing the data and application programs, while the browser realizes the particular functions through implementing programs of the server side. The B/S structure has the following advantages: reducing the burden of the browser in maximum, maintenance-free for clients, and making full use of storage and computation capacity of the large-scale server in the server side. But the security of this kind of structure is difficult to insure for the unpredictability of users.

Three tired or multi-tired structure develops rapidly in recent years, it has been employed by many large-scale network systems. The system under three tied structure is divided into presentation tier (client or browser), function tier, and data tier (See Figure 1). Presentation tier is used to send requests to the server side and display the final results. The function tier which could be one or more layers in the system is responsible for dealing with client request, generating retrieve sentences, and sending the searching result to the browser. While the data tier employs the database or file systems to store all kinds of data. With three tired structure the real "thin client" can be realized, which supports the distributed computing environment well and improves the system security greatly.

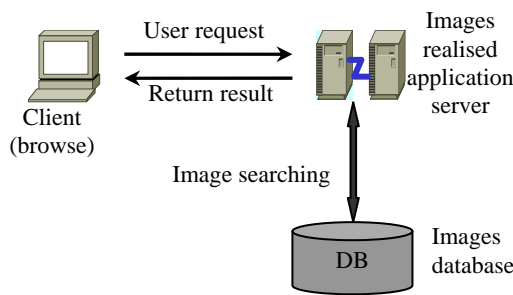


Figure 1. The structure of three tired service system

## 2.2 Web-based Satellite Images Orthorectification Service

With the flourishing development of geo-spatial information services, the studies on providing image processing service via the internet have appeared. A few attempts were made under C/S structure, and most of them were mainly focus on normal geographic correction without the support of DEM data.

Qiu(2004) proposed a remote sensing image geographic correction service platform based on the industry standard such as XML、SOAP、WSDL and UDDI. The client side of this

service platform was designed to do GCPs collection. While the server side was constituted by the place finder service, the transformation service and the map image service. This platform not only avoided the complex processing procedures and high cost of installing the RS image processing software, but also could get the reference images from the data supplier via internet. Seong (2005) realized remote sensing image geographic correction service by providing GCPs and correction models via the internet. Under C/S structure, the client side was responsible to image information extraction, corresponding points automatic matching and image geographic correction, while GCP chips searching and correction equation calculation were executed in the server side.

However, the B/S structure was rarely used in the satellite images geographic correction services, which can not only reduce the burden of the client side, but also has high security levels. Based on the previous researches, this paper proposes a new service framework under B/S three tired structure to provide satellite images automatic orthorectification

## 3. THE STRUCTURE DESIGN OF SPOR

### 3.1 The Design of Workflow

The main problem this SPOR has to solve is how to provide the satellite images automatic orthorectification service based on the exiting GCP chips database. The work flow of this service is analyzed as Figure 2.

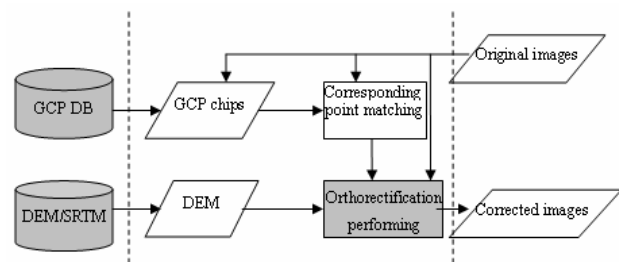


Figure 2. The flowchart of satellite images orthorectification based on GCP chips database

Whatever method adopted both of GCPs and DEM are needed in image orthorectification. As the Figure 2 shows, the GCP chips database and DEM database are designed as the data supporting part, while the applications including GCP selection, responding points matching, and satellite image orthorectification performing are put in the middle part. Therefore, this workflow can be divided in to three parts, the data management section (Data Tier), the application service section (Web application tier), and the image I/O section (Browser Tier).

### 3.2 The Design of Data Flow

According to the workflow of the SPOR, the data transmission of this platform includes images transmission and GCP chips extraction.

#### 3.2.1 Images transmission

Two basic protocols in image transmission are HTTP and FTP. It is more easily to control the files type and file size as well as transmission record of the files with HTTP protocol, while the

data transmission efficiency of HTTP is much lower than FTP (Sun, 2003). For these reasons, this platform employs HTTP protocol in the main transmission web page. While providing FTP service to users when the files in big size or huge numbers(see Figure 3). Among the three HTTP transmission protocols PUT, WebDAV and RFC1867, RFC1867 is mainly used in system development, for the protocol PUT can realize the files storage after user certification, but deprives the programmability of the server side; the protocol WebDAV which is an extension of HTTP/1.1 does not support the file uploading control in web application programming (Zhao, 2007). For the reasons stated above, this system uses RFC1867 protocol in system developing and improves the transmission efficiency through rewriting the httpmodule.

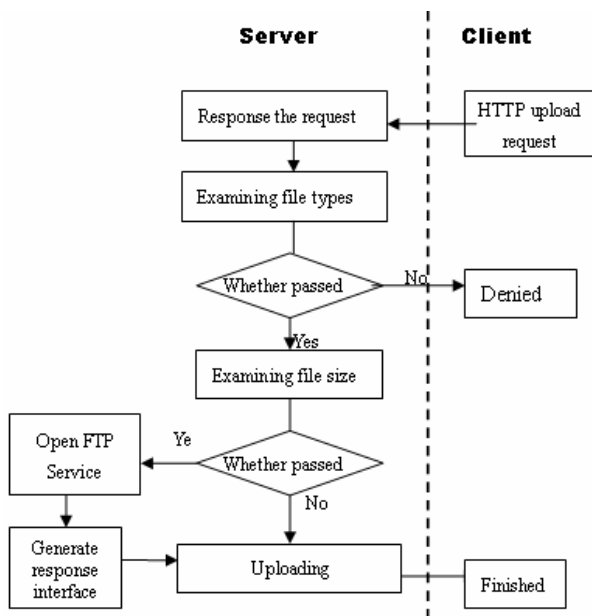


Figure 3. The design chart of satellite image transmission via the internet

In the procedure of transmission, the security of satellite images should be ensured with the encryption technology. Encryption algorithms (i.e. DES, 3DES, and Joseph algorithm) can be selected according with the security demands.

### 3.2.2 GCP chips extraction

The searching results received from GCP chips database include not only the GCP chips but also their attributes which would be very useful in the later corresponding points matching. So the main problem of this procedure had to solve was how to transfer these results from database to the application system. XML standard was employed to fulfil the demand of GCP chips transmission.

As Figure 4 shows, the application system can get the information about the non-corrected image obtained from the browser side, such as image ranges, type, and so on. All of which were used to generate the searching condition in the application server. While the application service can search the GCP chips, and the result will be saved in XML file, which will be send to the application system and stored in files system.

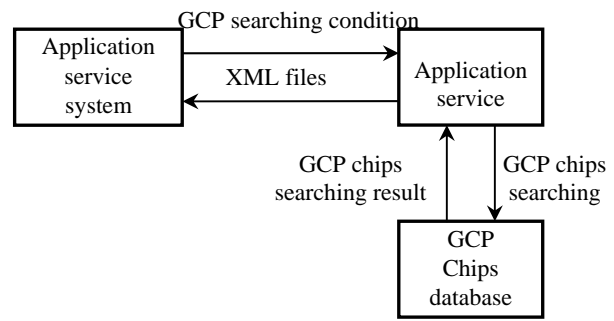


Figure 4. The transmission of GCP chips

### 3.3 The Structure Design of SPOR

The framework of SPOR based on existing GCP chips database was designed as Figure 5. Based on B/S three tired (i.e. Data server, Web application server and Browser) system structure mode, SPOR was divided into three tires and each tier had its own functions. Data server was responsible for the data storage and management, and the web application tier was designed to complete the business processing, while the browser enabled the users to interact information with the server.

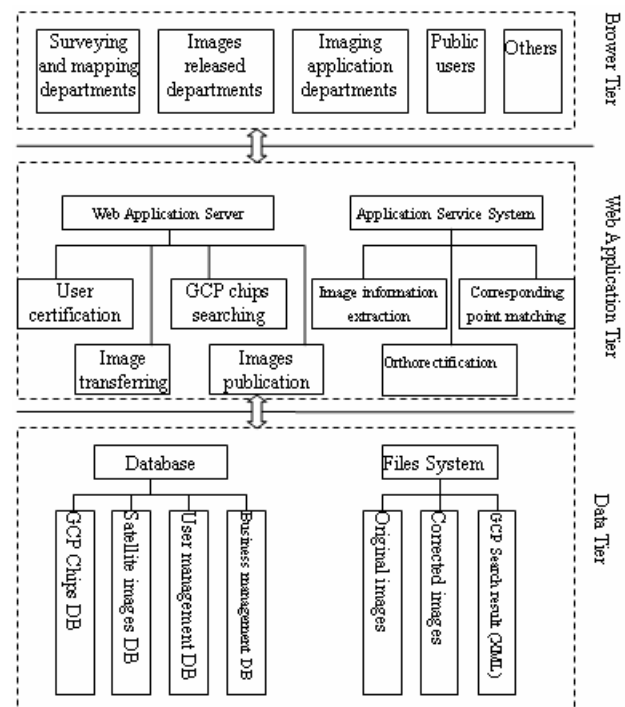


Figure 5. The Framework design of SPOR

Under the framework showed in Figure5, the server side did not need to install any other software but the browser with internet access, which could reduce the burden of the browser in maximum and maintenance-free for clients. The web application tier included application service system and web application server. Application service system realized the application functions, such as image information extraction, corresponding points matching, and orthorectification models calculation. While the web application server was responsible for the user certification, image transmission, GCP chips searching and corrected images publication. Data tier was

divided into the database system and files system. The SPOR employed Oracle9i to store GCP chips and their attributes, DEM data and their related attributes, original images attributes, web users information and service business procedures records, while used file systems to store the remote sensing images whose storage path were recorded in the Oracle database, therefore it could deal with the storage problem of massive remote sensing image data and had not any influence to the images management.

#### 4. IMPLEMENTATION AND APPLICATION

The prototype of SPOR was developed using C# language in Visual Studio 2005 platform. This platform provides the humanized interactive interfaces (see Figure 6), optimized web-based services and convenient database access functions. The IKONOS image (size is about 370M) with 1 m resolution of Kunming city in Yunnan Province, China was chosen as study data to test this service platform. The main steps are as follows:



Figure 6. The default webpage of SPOR

- Login in this service platform via the web browser,
- Complete the order form and submit, (see Figure 7)



Figure 7. The order filling webpage of SPOR

- After the order form has processed by the service side, the user could upload the original images, and then the order procedure was completed. (see Figure 8)

SPOR Order Form			
订单编号	10007	下单时间	2008-4-29 20:24:31
确认时间			
服务需求			
影像纠正方式	影像正射纠正(GCP支持)	影像存储类型	1024000彩色影像
影像处理精度	2米以内	计费标准	按影像幅数计费
单价	100	数量	1
总金额	2000元		
订购备注	Yunnan Kunming City in Yunnan Province		
上传文件路径	gs_5551_gw_002/ks/gp_5551_gw_002/ks/gp_5551_gw_002.tif		
客户资料			
用户ID	3	用户名	User
办公室电话	010-6221332	手机	
电子邮件	sporaas@spora.com	单位名称	Chinese Academy of Surveying and Mapping
通信地址	16 Shuangqing Road, Haidian, Beijing, China	邮政编码	100080
提交			打印订单

Figure 8. The order form of SPOR

- When the original images and the corresponding information were received by the server side, it would be processed according to the users' requirements. Finally, the corrected images with in the precision and other acquirments were generated. In this test, the GCP chips matching condition was shows in Figure 9,
- The user would be informed to download the corrected images, and the service would be complemented if the user was satisfied with the corrected images.

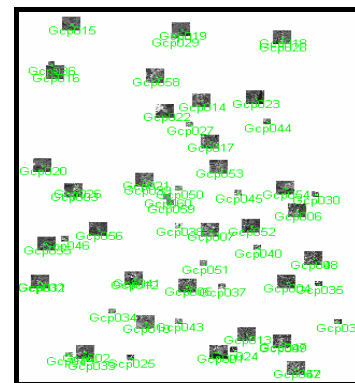


Figure 9. GCP chips matching condition

#### 5. DISCUSSION AND CONCLUSION

This paper introduces the web-based service technology to the field of remote sensing image processing, and tries to realize the remote sensing image automatic orthorectification online service based on the GCP chips database. The testing results of the prototype showed that SPOT which were built based on the exiting GCP chips database could provide orthorectification service to users. In the prototype application test, the user in the browser side only needed to connect twice with the server side in the procedure of orthorectification. While all the remaining operations were completed in the server side, which could reduce the burden of the web browser and save the labours of users. The experiment showed that less then twenty minutes were needed to finish the orthorectification of an image in the server side if enough GCP chips were storing in the GCP chips database.

The testing results of SPOR shows that the processing efficiency of image orthorectification is improved greatly than manual operations, and the correction of the satellite images is more professional and automatic. In addition, it separates the ortho-image demand users from tedious orthorectification works to other research works in image processing or professional applications. However, this service platform still need to be further improved in the orthorectification efficiency and system security due to the limitation of internet bandwidth and potential insecurity of the internet.

#### ACKNOWLEDGMENT

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