An Open Source Software and Web-GIS Based Platform for Airborne SAR Remote Sensing Data Management, Distribution and Sharing

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Abstract. With more and more Earth observation data available to the community, how to manage and sharing these valuable remote sensing datasets is becoming an urgent issue to be solved. The web based Geographical Information Systems (GIS) technology provides a convenient way for the users in different locations to share and make use of the same dataset. In order to efficiently use the airborne Synthetic Aperture Radar (SAR) remote sensing data acquired in the Airborne Remote Sensing Center of the Institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Sciences (CAS), a Web-GIS based platform for airborne SAR data management, distribution and sharing was designed and developed. The major features of the system include map based navigation search interface, full resolution imagery shown overlaid the map, and all the software adopted in the platform are Open Source Software (OSS). The functions of the platform include browsing the imagery on the map navigation based interface, ordering and downloading data online, image dataset and user management, etc. At present, the system is under testing in RADI and will come to regular operation soon.

1. Introduction

With the development of the Earth observation technology, more and more valuable Earth observation data are available to the community both for scientific research and practical implementation of Geographical Information Systems (GIS). As a result, the efficient way of management, distribution and sharing these vast remote sensing data is becoming more and more important. On the other hand, the Web-GIS technology provides services that can browse, inquiry, and download the data through the internet at different locations, if the World Wide Web (www) service was available.

Comparing with optical Earth observation sensors, Synthetic Aperture Radar (SAR), first being developed in the 1950s and being much more matured recently, has unique advances, such as penetration of the cloud, not relying on the sun illumination, and high resolution independent of...
platform altitude and operating wavelength, etc., which make it to be a promising tool for the photogrammetric mapping and bio- and geo-physical remote sensing applications. With the flexibility of flight path designing and fine resolution, the airborne SAR has been widely used for natural hazards (such as earthquake, flood, landslides, etc.) relief, environment monitoring and scientific investigation. The Earth observation data acquired by different institutes in different regions or countries can should be shared by the researchers from all around the world, as a result the open data strengthens international science community’s contribution to the benefit of society. Web-based GIS technology has been becoming an efficient way to promote scientific and technical data management and sharing.

The objective of this paper is to develop an Open Source Software (OSS) based platform for airborne SAR data, acquired in the Airborne Remote Sensing Center of the Institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Sciences (CAS), management, distribution and sharing.

2. System Architecture and implementing

Three-tier architecture (Fig.1) was employed as the main frame of the system [1], with the first tier named as client service, second as business processing consisted of web server and map server, and third as database service implemented by PostgreSQL and PostGIS (a plug-in to PostgreSQL for geospatial objects support)[2]. The business processing and database service tiers, called as the server side, is the place where the major data processing are happened at, which ensures the minimum computing at the client side. This system architecture, featured as “fat-server thin-client”, minimizes the requirement of web client. Another feature of the platform is all the adopted software are OSS under the GNU General Public License and abiding Open GIS Consortium (OGC), which saves the development cost, however, without losing the system’s compatibility and robustness.

![Figure 1. System Architecture. The system adopts three tiers: client, business processing and database service. The client service tier is taken as client side and other two tiers as server side](image)

The most important part of the system is the business processing tier, who interacts with both the client and the spatial data. This tier has two parts: one is Web server implemented using Apache; another is Map Server implemented using Mapserver. Mapserver is an OSS based platform for publishing spatial data and interactive mapping applications to the web, which is the core part of this system and plays a critical role in the operation of the platform. Many OSSs adopted in this system are
some what compiled with Mapserver, such as PHP employed in client service tier; Geospatial Data Abstraction Library (GDAL) and OpenGIS Simple Features Reference Implementation (OGR) library, which are used to process the raster and vector data respectively, in business processing tier; and PostGIS in database service. Additionally, the PROJ.4 Cartographic Projections Library for coordinate conversion between different projection and datum is also compiled with Mapserver. Furthermore, the different GIS layers, i.e., road, administration line, rail way, etc. display in the interface window are also managed by Mapserver.

The client tier, implemented by using PHP, Asynchronous JaveScript and XML (AJAX) and Ka-Map, is a web interface. The features of web interface are: 1) A map-based interface window to allow users to conduct searches via spatial coordinates. 2) Smooth viewing experience by only refreshing the contents that need to be updated. 3) Multiple layers, including railways, cities and towns, highways, lakes, rivers, and other geographic features, have been incorporated into the system to help users to identify the targets.

The database service tier has all the images and its essential information stored in a storage server and managed by the Postgresql and its spatial extension - PostGIS. For each image, three type information are needed, the attribute information, thumbnail in PNG format and full resolution image in GeoTIFF format. The attribute information and the stored loaction of thumbnail and full resolution image in the local server are stored in Postgresql, while the spatial attribute information of the image is stored in PostGIS. Although the PostGIS allows storage of the binary data such as images in the database, the strategy of storing images as external PNG or GeoTIFF files and linking the images to the database through their regular and spatial attributes can, not only constrain the database’s size and hence improve its management efficiency, but also make sure the images can be searched geographically by the spatial operations such as intersection or containment.

3. System functions
As shown in figure 2, there are four major parts, including SAR data, user, information management and overall management, in the system functions. The home page of the system is shown in figure 3 (a).

### Figure 2. System Function Diagram

3.1. Image data management
The image data management is the core part of the system functions, including data pre-processing, data warehousing, database overview, data querying and browse. Before the airborne SAR data being put into the database, the attribute information is extracted from the head file of the SAR dataset, and
the thumbnail, usually is much coarser than the original resolution, in PNG format and the full resolution image in GeoTIFF format are generated. Then the attribute information, such as acquiring date, location etc., along with the storing location of the images (thumbnail and original resolution image) will be stored in PostgreSQL, and the spatial information will be stored in PostGIS, respectively. After warehousing, the dataset is ready for database overview, data querying and browsing. As shown in figure 3 (b), when performing data querying, maps with different layers, map navigation tools and query setting will showed up in a window to help the user to locate his/her area of interested. After performing query, the search results list will show up, and the image thumbnail, the full resolution image, and image detail can showed up by clicking the corresponding buttons (figure 4 (c)). The purpose of the designing of thumbnail showing up is to tell the user about the overview of each image. If the user was interested in the certain image, after clicking the “details” button, the full resolution image will be shown in another window overlying on the map according to its geographic coordinate with the attribute information shown beside the window (figure 4 (d)). Furthermore, the user can choose to show the image in a full window, such that more details in the image can be detected. These functions adopted in our system provide the user a smooth operation with a friendly interface.

Figure 3. Screen-shot of the system’s home page (a) and the map navigation based search interface (b).

3.2. Other Functions
The user management module is to manage the user’s account whose functions include user registration, user login, account modification, and order history. The information management module is responsible for the information publication on the website, i.e., the introduction to aircraft, knowledge of the sensor, remote sensing data type, the mission information, and news. Another important part of the platform is administrator management mainly designed for the system administrator, whose functions include system configuration, information management, user registration and data download application approval, the overall management of data, user and information.
4. Conclusion
In the demand of the SAR data management in Airborne Remote Sensing Center of RADI, CAS, a platform for SAR data management, distribution and sharing was designed and developed to manage the SAR data and help the user to search, browse and download the dataset they are interested with a friendly and convenient interface. The main features of the system include that all the software adopted in the platform are all OSS, saving the development cost; the map navigation based geographic search innovation; thumbnail showing along the search results which can give the user a overview of the image, and full resolution image shown overlaid the map according to it coordinates that give the user a good experience. The preliminary test suggests that the system can work well and all the designed functions were accomplished.

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