Web-GIS based collaboration environment and remote GIS application experiment using lunar exploration data

Junya Terazono[1], Shinichi Sobue[2], Hayato Okumura[2], Noriaki Asada[1], Hirohide Demura[1], Naru Hirata[1], Taketo Fujita[3], Aya Yamamoto[3]

[1] The University of Aizu
Tsuruga, Ikki-Machi, Aizu-Wakamatsu, Fukushima 965-8580, Japan
Email: terazono@u-aizu.ac.jp, asada@u-aizu.ac.jp, demura@u-aizu.ac.jp, naru@u-aizu.ac.jp

[2] SELENE Project Team, Japan Aerospace Exploration Agency (JAXA)
Tsukuba Space Center, 2-1-1, Sengen, Tsukuba 305-8505, Japan
Email: Sobue.Shinichi@jaxa.jp, Okumura.Hayato@jaxa.jp

[3] Remote Sensing Technology Center of Japan (RESTEC)
Roppongi First Building 12F, 1-9-9, Roppongi, Minato-ku, Tokyo 106-0032, Japan
Email: tfujita@restec.or.jp, aya@restec.or.jp

ABSTRACT

The GIS-based data browsing system are planned and is implementing in Kaguya project, the Japanese first large-scaled lunar exploration. In this GIS system, we must pull through several problem characteristic in lunar and planetary exploration. One major problem is the large amount of its data, possibly more than several terabytes. And data distribution for researchers is also an important issue because of the security awareness and data transmission.

In this paper, we will present our Web-GIS systems using Kaguya data. Our system is the combination of WebGIS-based system which can handle remotely stored data as if it was stored in the main server. Another system is an on-line collaboration environment, which can ensure researcher groups to work and discuss online to make scientific result. By co-operating these systems, scientists and engineers involved in Kaguya project are expected to have a easy-to-use, ubiquitous research platform.

1. INTRODUCTION

Kaguya (SELENE), the first Japanese large-scaled lunar explorer, was launched in 14 September 2007, and is orbiting around the moon with the altitude of approximately 100 kilometer as of 15 October 2008. Kaguya's main objective is to make total understanding of the moon from scientific aspect by using 14 instruments onboard.

Among them, three scientific cameras, generically called as LISM (Lunar Imager and SpectroMeter), consists of MI (Multiband Imager), SP (Spectral Profiler) and TC (Terrain Camera), is obtaining global data of the moon with the finest resolution in wavelength and surface area. Moreover, by adding the data obtained by Laser Altimeter, the comprehension of lunar surface structure in three dimensional basis will be realized.

To understand lunar geologic history and evolution totally, the combination of the data obtained by several instruments are mandatory. For proceeding this "Integrated Science", discussion and data processing by the scientists from different fields are required. However, it is not realistic to meet the scientists frequently in one place to talk about the lunar science. Moreover, as the scientists involved in Kaguya project are distributed nationwide, it is financially and geographically difficult to gather so often.

Other problem is the data amount of Kaguya, estimated as twenty terabytes in total.

Additionally, scientists will produce interim data and scientific result in addition to the primary data, the total data amount will be several tens of terabytes, which is inadequate to bring every time in the meeting.

The best solution for this limit is to establish the “virtual laboratory” in the network and gather data, or at least the pointer for the data, at there. The scientists will access the laboratory over the Internet and browse or upload the data. They can even talk and communicate with colleagues using chatting function or electronic blackboard-like facility. It will also be desirable to facilitate some basic analytical function.

As the data is appropriate to be shown by the form of a map, it will be best to select the camera data as the base of the system. By overlaying the scientific data, the data visualization and comparison can be enabled. The most suitable architecture to realize this function is GIS, particularly Web-GIS, as we can make maximum use of off-the-shelf web technology by construction of the system. The loose link of the analysis systems with the GIS system set as the core will form the “online collaboration environment”.

In this lecture, we will first address the system concept and structure, and report current implementation status and future tasks.

2. SYSTEM CONCEPT

2.1 Basic Requirement of the System

The following functions are required for our system:

- System is web-based, and operated with the alignment of the database server.
- System has data uploading and downloading function not by command-line based, but web-based for usability.
- All access to the system should be web-based except for the maintenance by administrators.
- System should be arranged based on open-source software as the latest capabilities can be implemented.
- System should handle large amount of data, gigabytes in one file and terabytes in total, without any stressful operation and complicated procedures.
- System should be security-aware. Here, the term security refers not only the protection from the intrusion by the outsiders but the care for the users which share same system resource.

2.2 System Design

This system consists of two components:

(1) The WMS (Web Mapping System) server at SOAC (SELENE Operation and Analysis Center) at JAXA Sagamihara Campus at Kanagawa Prefecture, and WMS server at The University of Aizu (UoA) which is connected to one at SOAC.

(2) Servers to enable Web-GIS based collaboration environment, located at UoA.

The system structure of the WMS servers noted in (1) is shown in Figure 1.

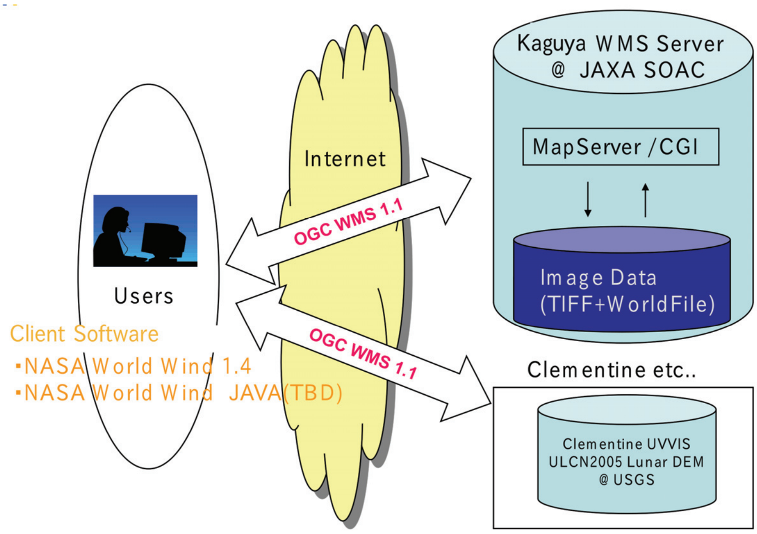

Figure 1. System architecture of GIS system in SOAC.

NASA WorldWind (NWW) software 1.4 (and NWW JAVA in future) (NASA, 2006) is used as a client. Figure 2 shows a test screenshot of the NWW JAVA displaying observation area of HDTV (High Definition Television) Kaguya onboard. The mosaicked image take by Clementine is used in this background image. By clicking the icon located in the center of each observation area, users can watch the corresponding HDTV movie at JAXA's website. (Okumura *et al.*, 2008)

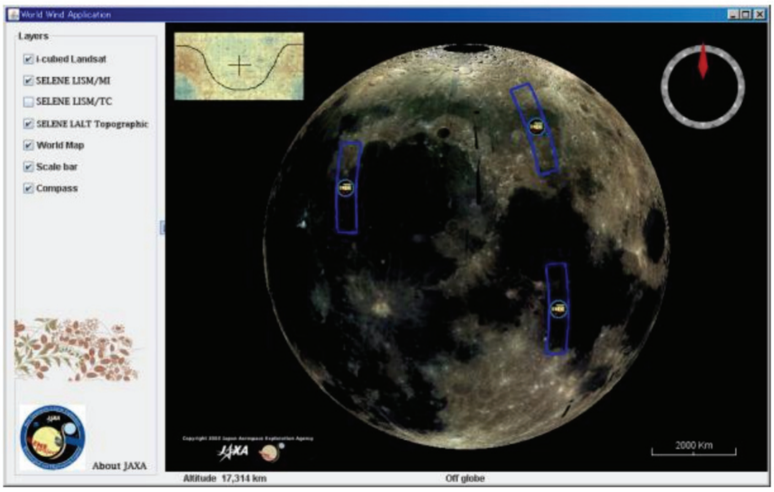

Figure 2. The snapshot of the NNW JAVA which displays observation coverage of HDTV. Center icons are seen in each coverage window (blue squares). (after Okumura, 2008)

Also, this system aims for the experiment of the distributed GIS, which enables displaying remotely stored files in another Web-GIS system. This experiment will be conducted between SOAC/JAXA and UoA. The distance between these two facilities are approximately 300 kilometers.

The schematic system architecture of WebGIS-based collaboration system is shown in Fig.3. The "WMS/DB" server denotes server used in system described in (1), and other two servers are dedicated to serve collaboration environment. There is a storage subsystem which amounts to 12 TB connected to the two servers.

Both systems are connected to the Internet using the Japan Gigabit Network (JGNII

Plus), 100 Mbps in maximum due to the limitation of the facility at UoA.

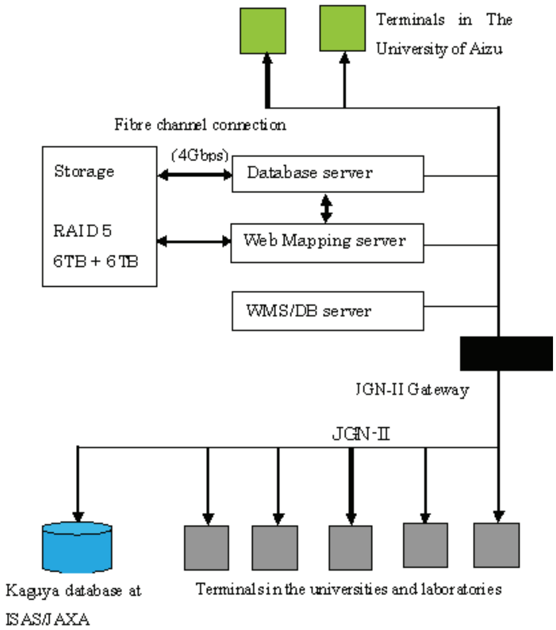

Figure 3. The diagram of WMS systems and collaboration environment system.

3. SYSTEM IMPLEMENTATION

3.1 Outline of the System

The photograph of the system at UoA is shown in Figure 4. The all components are set in a half-height 19 inch rack, and installed at the facility of The Information and Systems Processing Center at UoA.

Figure 3. The GIS system server and collaboration environment servers.

The remote GIS server connected to ones at ISAS is located at the uppermost of the rack. This server (HP Proliant DL380) has 10 GB memory and 500 GB disk.

Two servers for collaboration environment, each for a web server and a database server, are located at the lower part of the rack. These two servers (Fujitsu Primagy RX2000) has the same specifications, 8 GB in memory and 73 GB RAID1 disk.

Below this server, there is an external storage attached to the two servers. This storage array (Fujitsu ETERNUS 20000) has approximately 12 TB disk capacity in total. It has 48 disks (750GB per each disk) enclosed and forms RAID5 structure. Therefore, the total physical capacity is approximately 18 TB. However, due to the limitation of the ext3 file system used in Linux system (maximum size 6 TB), these disks are divided into two partitions. Each partitions are mounted to each servers directly using 4 Gbps fibre channel interface, and also cross-mounted using NFS (Network File System).

To ensure flexible architecture and high security level, we are using open source based software to construct the server environment. Here is some of main software used in our system:

- Web server: Apache 2.2.8
- Database server: PostgreSQL 8.2.5
- WMS server: MapServer 5.0.0
- Scripting Language: PHP 5.2.6

Upon announcements of vulnerability for those software, we promptly update using manual installation or semi-automatic update provided by the vendor.

3.2 Online Collaboration Environment

Recently, many software like Wiki or XOOPS, which aims for online collaboration and rapid creation of web pages, are released. Our requirement for the online collaboration environment is to communicate among the group and to enable information exchange including file transfer and sharing.

One of the platform we are attempting is the OLAT (OLAT team, 2008), Opensource Learning Management System. Though OLAT is aimed for use in education environment, it can be also used in the group working. As OLAT has many functions required for online collaboration for the small team, including file uploading and sharing, calendars, messaging and so on, it is suitable to use as the front-end of our collaboration environment. Moreover, OLAT is opensource, and can be downloaded free.

The OLAT has its own internal database and uses it as a default, however, it can be linked with external database such as PostgreSQL and MySQL. Once OLAT can be linked with these database systems, the connection between GIS system and OLAT can be enabled.

3.3 Link with External System

One of the system we are now working to link is a search system of lunar nomenclature, based on data compiled by USGS. The system (Terazono *et al.*, 2008) is now working as a stand-alone database system, which can search lunar nomenclature from lunar features and location. By extending this system, with linkage of GIS, we expect to point the exact location of position on the moon both from the position (latitude and longitude) and nomenclature.

3.4 WMS system

Currently, the setup of the server at SOAC has been completed. The following functions are implemented:

- Data display of MI (Multiband Imager)

- Display of observation area and link to the obtained movies of HDTV (High Definition Television).
- Operation check using NASA WorldWind 1.4.
- Operation check using OpenLayers.

The development of WMS and WMC (Web Map Client) has been completed. Some of images are available online at "Kaguya Image Gallery" (JAXA, 2008).

4. FUTURE TASKS

As the shakedown of the server at SOAC has been completed, we will shift to the improvement of servers at UoA, and will conduct the performance test of the distributed GIS.

We will also continue the registration of observation data, as Kaguya operation is continuing (as of October 15, 2008). We will extend target data for the ones obtained by sensors which have not been registered before. Also, as for the client software, the special version of NWW JAVA, dedicated for Kaguya data, will be developed.

Several software aiming for integration of online collaboration environment include communication function (chatting, making comments, and online discussion with sharing the same image displaying) (Kanzawa et al., 2008). These software will be integrated into this collaboration system and will form the "virtual laboratory" on the network.

Once this system is going into the operation phase, the security issue will rise as the important issue. The problem means not only the attack from externals but the internal concerns. For example, one's data before release to the other members of the group should not be seen from them, unless he or she admits data opening. On the other hand, collaboration inevitably requires data sharing among the team or groups who has same research interest.

These requirements are very specific to the research circumstance, therefore the special care of the security which takes their needs into account are required. Several basic design of the function are underway.

We will conduct some testing by lunar researchers, future target user, and will be given the feedback from them. These will be used for our deliberation of improvement. Our goal is to realize the online research and analysis environment of lunar and planetary exploration which researchers can use easily and effectively.

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