DEVELOPMENT OF OPERATION PLAN AND LOG MANAGEMENT SYSTEM FOR LISM/KAGUYA.
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Introduction: KAGUYA (SELENE) is a Japanese lunar explorer that launched on Sept. 14, 2007. Its major scientific objective is "the Moon's origin and evolution." LISM (Lunar Imager/Spectrometer), an optical instrument on-board KAGUYA, will provide precise and detailed topographic, geologic, and mineralogical information of the moon. During a one-year operation of KAGUYA, LISM will observe the whole surface of the moon systematically [1-3].

To obtain the systematic global coverage, operation planning should be well organized. We develop a database system to manage LISM observation plans. This system stores all observation plans and logs into a database. Users can query planned or finished observations from the database, and review footprint locations, observational conditions and other attributes relating those observations. This information is also useful to search available data matching to researcher's interests.

Target Data: Strip is a unit of observation of LISM. As LISM is a push-broom type imager, it continuously observes the lunar surface along an orbital motion of the spacecraft. Therefore, a shape of its footprint looks like a narrow strip. As a single observation continue over 20 minutes, one Strip is too long to handle as a single data file. A Strip is divided into small rectangular image files called "Scene" during the ground data processing. This is a minimum unit of observation data files. Thus, one Strip has several subordinate Scenes. The system distinguishes between observation plans and observation logs on the database. Four types of data files, "Strip Schedule", "Scene Schedule", "Strip Log" and "Scene Log", are managed on the system. Appoloximately thirty kinds of attributes are associated to a Strip. They are sensor type, observation mode, observation start time, end time, and footprint location. The observation plans and logs are delivered in CSV text tables. Figure 1 shows structure of data tables in the database.

System Development: PostgreSQL [4], one of the most common database systems, is adopted for a database engine of the system. PostgreSQL is the worlds most advanced free software object-relational database management system (ORDBMS), released under a BSD-style license. PostgreSQL is widely used in large commercial database systems. It was based on "POSTGRES", which was developed at University of California Berkeley (UCB), and is continuing to be developed by programmers of the world. In this research, version 8.1.5-1 is used.

Frameworks and Technologies. Main components and user interface is developed with Java. The system is developed as web-based application software working on the Apache HTTP Server [5] and the Apache Tomcat [6] of Java-Servlet container, because it is the least platform-dependent. The various technologies of Java development frameworks are introduced to reduce a development time and to warrant the quality of the system. With these technologies, further extensions and additions of the system will be easy. The total amount of them for a one-year observation will be huge, and quick and easy access to the large database is required. For that purpose, we introduce a Hibernate framework [7]. We also optimize SQL queries to tune-up the performance.

Utilities for Development. For improvement of the development efficiency and the quality, we used several utilities. All of them are all free of charge. For example, Eclipse is the most famous IDE (integrated development environment), and widely used among the software development with Java. The pgAdmin is used for managing PostgreSQL respectively.

System Functions: This system provides functions for managing systematic observations of LISM. Available functions are as follows:

- Login Certification (Session Management)
- Data Import
- Management of Coverage Rate
- Search Function
- Data Deletion
- KML Export

Login Certification (Session Management). For secure operation of LISM, unauthorized access to the system is prohibited. The function to manage login sessions is implemental to the system.

Data Import. Plans and logs of LISM observations are delivered in CSV text tables. Since LISM operation planning is performed once in a week, a number of table files are produced. They are provided to the database system as a single zipped file. The data import function automatically unzips the target zip file, and check the format of importing tables strictly.

Management of Coverage Rate. Overlaps of footprints between adjacent scenes are automatically detected after importing, and the overlap information is added onto the database. Percentage of coverage is also estimated and stored.

Search Function. Observation strips on the database can be search with strip id, sensor type, observation mode, observation time, and footprint location. A search result is displayed as a table.

Data Deletion. This function is implemented to delete data which imported by mistake or unnecessary data. In the search result table, users select check box of deletion target. To improve usability at this operation, we provided a button which can select all checkbox. All scenes that are associated to the target Strip for deletion are deleted automatically.

KML Export. Footprint locations can be browse by users more easily by visualization with digital globe software such as Google Earth or NASA World Wind. Both can be display a skin of the lunar basemap instead of the Earth image. KML (Key-hole Markup Language) is the de-facto standard language to describe geographic data in the digital globe software and GIS tools. The system has a function of KML exportation to visualize status of observation. Figure 2 shows sample image using Google Earth by importing sample KML.

Conclusion: A database system that can manage real observation data of LISM/KAGUYA is developed. With this system, the efficiency of operational administrative of LISM observation improves dramatically, and obtaining the systematic global coverage becomes possible more smoothly. The Coverage Rate manage function and the KML Export Function can visualize administrate works. We try to improve the system to treat a huge amount of data.

References: [1] Haruyama J. et al (2008) *Earth Planets and Space*, in press. [2] Ohtake M. et al. (2008) *Advances in Space Research,* in press. [3] Matsunaga, T. et al. (2001) *Proc. SPIE*, 4151, 32-39. [4] PostgreSQL Global Development Group (2008) *PostgreSQL*, http://www.postgresql.org/. [5] The Apache Software Foundation (2008) *Apache HTTP Server*, http://httpd.apache.org/. [6] The Apache Software Foundation (2008) *Apache Tomcat,* http://tomcat.apache.org/. [7] Red Hat Middleware, LLC (2008), *Hibernate,* http://www.hibernate.org/.

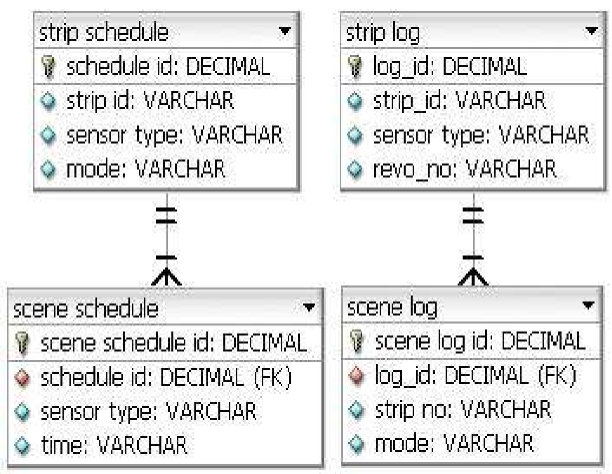

Figure 1. Structure of Data Tables

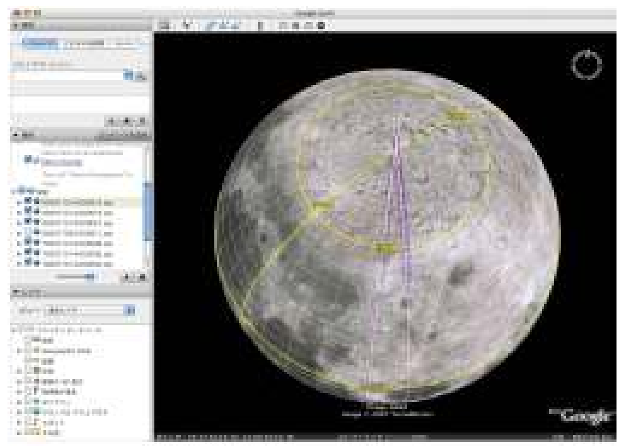

Figure 2. Example of footprints exportation as KML files. The exported KMLs are displayed on Google Earth with the lunar basemap skin.