The Technology of Dynamic Extension of Attribute Set for the Search of Satellite Images in a Database

Yuri Maglinets, Eugene Maltsev, Ruslan Brejnev
Alexey Sosnin and Victor Kurnosov

Institute of Space and Information Technology, Siberian Federal University
Kirenskogo ul. 26, Krasnoyarsk, 660074, Russian Federation

Abstract. The structures of metafiles for describing satellite images of the Earth we analyze in this article. We describe the architecture of interaction among the satellite images database components at the automated registration of new-type sensors. We offer the technology of dynamic extension of the attribute set for the search of satellite images in a database.

1 Introduction

Last decade has been marked by a rapid development of satellite technologies for Earth remote sensing. Cumulative orbital group of space vehicles (SV) launched in the world is increasing continuously at the expense of new launches; new sensor types are being developed; resolution and accuracy of the data received are improving. Raster images received from SV are accompanied by attributive information which is stored in metadata files. (Image Support Data, ISD).

Notwithstanding certain progress achieved in the world in the field of standardization of geospatial information communication protocols owing to some organizations and consortia such as ESA, CEOS, OGC etc. [1,2], ISD content standardization level leaves much to be desired. Each of the SV producers develops independently formats of the corresponding ISD that leads to wide variability both in data representation formats and in the structure of representation of the information in these files. Syntax Parameter Value Language (PVL) and syntax Extensible Markup Language (XML) are the most widespread.

A regional database of the Earth surface images (RDESI) received with the use of artificial Earth satellites has been created at the Institute of space and Information Technology of Siberian Federal University [3]. The data arrives from various sources: own receiving centers, open databases of partner organizations. The aim of creation of the regional database is to organize access to the geospatial information for a wide range of users such as teachers, scientific employees, post-graduate students and students of the university, representatives of other research institutions, and also public authorities, the commercial organizations and others. It allows to set and solve various tasks of remote sensing of the Earth surface that is especially topical for

Maglinets Y., Maltsev E., Brejnev R., Sosnin A. and Kurnosov V. (2010).
The Technology of Dynamic Extension of Attribute Set for the Search of Satellite Images in a Database.
In *Proceedings of the Third International Workshop on Image Mining Theory and Applications*, pages 29-34
DOI: 10.5220/0002961600290034

sparsely populated Central Siberia where remote sensing becomes the only reliable source of information for decision-making, taking into account underdeveloped transport infrastructure in this region.

It is known that the number of attributes of a separate ISD file can reach several hundred. ISD files from different satellites generally contain different groups of attributes. A structure of information queries of the user of the system differs considerably as well. It is due to the differences in purposes of using the system (scientific, educational, industrial), solved problems, operational experience and other factors, characteristic for this or that user of the system.

Thus it is topical to discuss questions concerning adaptation of satellite images database to the constantly changing requirements of users and appearance of new data representations caused by new-type sensors registered in the system.

In this work we offer a technology of automated RDESI adaptation to the constantly changing external conditions.

2 A Review of the ISIT SFU (Institute of Space and Information Technology, Siberian Federal University) Satellite Images Database

At present we have data collected from optical satellites: Landsat 4-5 sensor TM, Landsat 1-5 sensor MSS, Landsat-7 sensor ETM+, SPOT-2/4 sensor HRV and HRV(IR), Terra and Aqua, sensor MODIS. The support of following metadata formats has been realised:

- satellite SPOT-4; extension .dim; metadata standard DIMAP is based on XML
- satellites Landsat 4-5 TM ;extension .txt; syntax PVL;
- satellite Landsat 7 ETM+ ; extension .met; syntax PVL;
- satellite QuickBird; extension .IMD; syntax PVL;
- satellites Terra\Modis, Aqua \Modis; extension .txt; syntax PVL;

Each satellite image in a database correlates with a certain territory and is presented as a set of raster layers of various spectral channels, generally with different spatial resolution, united into GeoTIFF format, or one of its analogues and ISD accompanying it, describing different attributes of the given image (scene). Indexation of already stored and newly arriving satellite images is realized by means of separate modules which parse metafiles of its type of satellite data and select necessary image attributes and characteristics already specified. The data from different sensors has different sets of metadata attributes. For example, attribute "cloud cover" is absent in SPOT-4 satellite products, but is present in some products of Landsat and Terra\Modis.

With the course of time the number of the satellites launched increases, the capacity of sensors installed on board widens. In this connection attribute sets for one scene are extended. Besides, when new users are added to the system, attribute sets for searching necessary satellite images are modified.

Traditional ways of building systems of processing of satellite information call for writing (modification) programs for parsing of metadata for each of the fixed cases of the system extension. The alternative way is to embed parsers from other producers

into the system. Both ways require certain expenses (working hours of programmers, software purchase). Frequent software updating, carried out by developers in the course of step-by-step system engineering, have led to understanding the necessity of partial automation of this process. Reengineering of database architecture allowed to pass from architecture based on a set of highly tailored parsers to the architecture based on the one adjustable metadata parser.

3 Architecture of the Satellite Images Database Components Interaction at the Automated Registration of Sensors of a New Type

We introduce the architecture of component interaction for a developed database (Fig. 1).

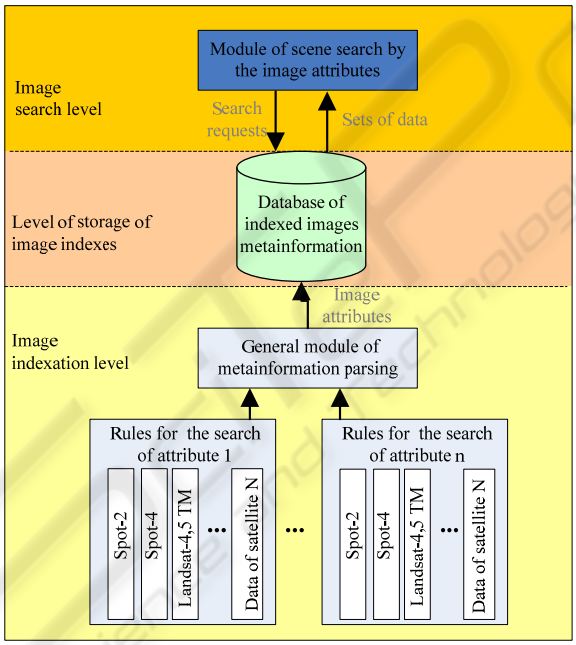

Fig. 1. The architecture of component interaction for a satellite images database.

Database architecture components are distributed into 3 logical levels: image indexation level, level of storage of image indexes, image search level.

Image indexation level is presented by a module of metadata parsing and the rule base for metadata parsing.

Level of storage of image indexes is realized as a relational database with geospatial operations support. It is realized as the storage of image metadata and accompanying supplementary information necessary for functioning of the components of other levels.

Module of satellite scene search by image attributes is functioning at the image search level. The basis of the given module is made of a criteria mechanism connecting user interface, allowing to create search requests, with indexed attributes of the image stored in the relational database.

The scheme of the resulting database is presented below (Fig. 2).

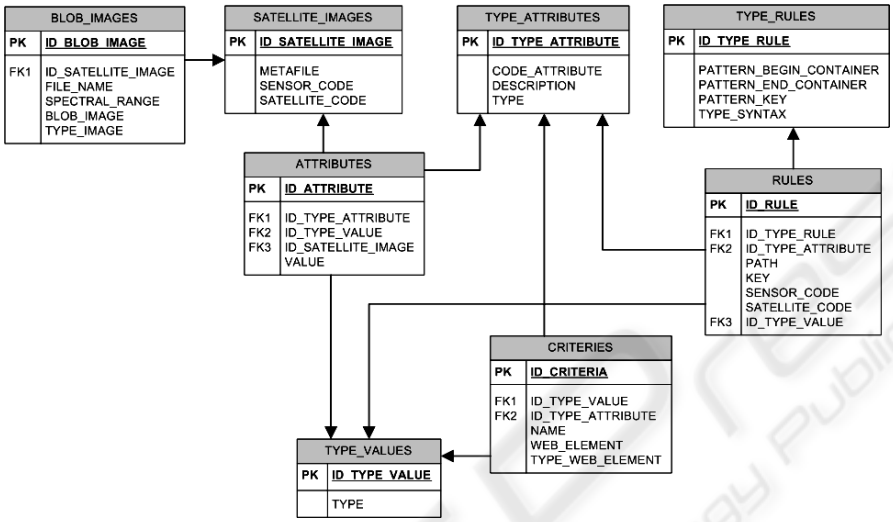

Fig. 2. Scheme of the relational database for storage of satellite image attributive information.

A table with description of a database scheme is presented below:

Table 1. The description of database components scheme.

Table name	Function
SATELLITE_IMAGES	Contains the identifier of each satellite image (scene) and the accompanying metadata file saved as a bit sequence
BLOB_IMAGES	Contains a quicklook of each scene
ATTRIBUTES	Contains attributes for each scene
TYPE_VALUES	Is a directory of types of attribute
TYPE_ATTRIBUTES	Is a directory of attributes for all the scenes used for indexation and search
TYPE_RULES	Contains templates for lexical analysis of various metafile types
RULES	Contains the rules for searching attribute types in a metadata
CRITERIES	Contains connections between user interface elements and the attribute type used for the scene search

4 Process of Dynamic Extension of the Supported Satellites Nomenclature

Process of expansion of image attributes in RDESI can be described as follows: newly added attribute which gives the possibility of satellite data search realization should be subjected to preliminary indexation. The process of formalization of rule types describing the metafile structure template and a set of rules for search of the necessary attribute in each metadata file type was provided for this purpose. Then adding of new attribute records in the corresponding tables of the relational database is carried out. After that reindexation of the whole image storehouse and selection of a new (never used before) data attribute is performed. For the possibility of search request formation and new attribute support there is a new search criterion in user interface being created which is connected to a new image attribute. One of the predetermined elements of display in user interface is directed to the given attribute. From the point of view of a system administrator, it is necessary to point a new attribute in the administrator interface, to specify its metafile search rules, to create a new criterion of search for this attribute and to compare the criterion with the display type in the user interface.

At adding a new type of satellite data the description of which has the structure different from the ones already existing, the process is reduced to selection of necessary attributes from a metafile and formalization of rules on their reception.

Here is an example of a part of accompanying metafile structure of the data received from satellite “Landsat-7”:

```
GROUP = METADATA_FILE;

            GROUP = ORTHO_PRODUCT_METADATA3

               SCENE_UL_CORNER_LAT = +69.3563042

            END_GROUP = ORTHO_PRODUCT_METADATA

END_GROUP = METADATA_FILE
```

Here is an example of attribute receiving rule formalization: “upper left corner of the image” from Landsat 7 ETM+ (syntax PVL):

- select parent container: METADATA_FILE
- select child container: ORTHO_PRODUCT_METADATA
- select key value: SCENE_UL_CORNER_LAT

Formal record of the rule for the given example in the database is as follows (Table 1 and Table 2):

Table 2. Part of table “TYPE_RULES”.

PATTERN_BEGIN _CONTAINER	PATTERN_END _CONTAINER	PATTERN_KEY
GROUP = {0}	*END_GROUP = {0}*	*{0}= {1}*

Table 3. Part of table “RULES”.

PATH	KEY
METADATA_FILE / ORTHO_PRODUCT_METADATA3	*END_GROUP = {0}*

Further, syntactic templates from the table “TYPE_RULES” are filled with values from the table “RULES” and passed to the module of metainformation parsing.

Accordingly, the process of working out of new modules for new metafile types analysis is excluded completely from the process of RDESI support and extension. The exception takes place when appears a metafile storage standard which differ essentially from the ones already known. In this case it is necessary to add the types of rules describing the attribute search process in a new metafile type.

5 Conclusions

The technology of dynamic extension of a set of attributes for the search of satellite image data in a database has been developed. This technology allows to adapt the image database to the constantly changing external conditions. The technology is introduced into the database of satellite earth surface images at the Institute of Space and Information Technologies, Siberian Federal University, Krasnoyarsk.

Acknowledgements

This work was supported by the Ministry of Education and Sciences of the Russian Federation in the program “Scientific and scientific-pedagogical personnel of innovative Russia for 2009–2013”, lot 1, “Carrying out of scientific researches in the field of processing, storing, transferring and protection of information by the teams of scientifically-educational centers” №2009-1.1-214-001-032

References

1. Kussul, N., Rudakova, A.: Development of metadata catalogue for GEO-UKRAINE., Aleksey Kravchenko. International Conference “Knowledge-Dialogue-Solutions”. June 18-24, (2007), Varna (Bulgaria), p. 585-594
2. Zinovyev, V. G., Poletayev, A. M., Prisyajnyuk, S. P.: Problems of standardization in the field of Earth Remote Sensing. Modern Problems of Earth Remote Sensing From Space (2007). v. 4, iss. 1. p. 133-137.
3. Tsibulskiy, G. M., Maglinets, Y. A., Latyntsev, A. A., Sirotin, E. E., Maltsev, E. A., Romanov, A. A., Sidorov, A. Y., Brezhnev, R. V., Kurnosov, V. Y., Sosnin, A. S., Perfilyev, S. Y.: Multi-Purpose Regional System of Earth Remote Sensing at Siberian Federal University. Problems of Region Information, Krasnoyarsk, Nov. 2-3, (2009). p. 22-26.