RESEARCH ON REMOTE SENSING INFORMATION PROCESSING SERVICES BASED ON SEMANTIC WEB SERVICES

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ABSTRACT:

In recent years, with the rapid development of satellite remote sensing technology, the obtainable remote sensing data has been increasing at striking rate. However, because of heterogeneous storage, resources of different stations and domains can't be operated mutually and shared. Integration of semantic WEB service and remote sensing information processing can help to solve these problems. On the one hand, the remote sensing information processing service provides the function of on-line processing, which can realize dynamic transferring with the help of web; on the other hand, the semantic information introduces semantic-based service description and reasoning, which makes WEB services automatic. So building a semantic service environment by combining the advantages of these two respects and conducting service-oriented research into semantic service description and reasoning can provide richer and better services for the users. This article mainly discusses classification of remote sensing information processing service, semantic description of the ontology-based service, and development and implementation of the service.

1. INTRODUCTION

With the development of modern information society, especially development of the computer network, more and more information need to be processed in different softwares, and can be released to the network. Especially in the domain of remote sensing information processing, spatial resolution, spectral resolution and time resolution of remote sensing information have been developing constantly, and obtainable remote sensing data has been increasing at striking rate. Consequently, it becomes very important to know how to make these integrated data mutually operable in different systems, and to know how to acquire needed data from the heterogeneously -distributed databases.

In order to realize sharing and mutual operation of the remote sensing information processing service, this article has summed up different kinds of remote sensing information processing services systematically, and has put forward a new extensible classification tree for remote sensing information processing service based on international standards. At the same time, it has realized part of the remote sensing information processing service with the semantic WEB service technology, including research into semantic aspects and implementation of WEB service. Ontology is a key technology in semantic research, which provides knowledge system of the corresponding domain. So ontology of remote sensing domain is established in this article based on the service classification tree, and it is introduced into service description, so that service description can be understood commonly, and service can be intelligently and automatically conducted. Web Services is a service-oriented distributed calculation mode. Using this technology, part of the service has been developed, and key technologies have been verified in this article.

Semantic WEB service has combined the advantages of semantics and service. It encapsulates remote sensing information processing into service and adds semantic support into it to conduct research into semantic service description and reasoning. At last, a semantic service environment is built, so that the computers can understand what they have communicated, and can provide richer and better services for the users.

2. CLASSIFICATION OF REMOTE-SENSING INFORMATION PROCESSING SERVICES

After studying ISO19119 and OGC geo-information service pattern for reference, this article has carded and summed up the remote-sensing information processing services systematically, and has put forward a new classification tree of multiple semantic granularity hierarchy for remote-sensing information processing service. Before the remote-sensing information processing service is classified, domain knowledge of remote-sensing information and the various methods and process of remote-sensing information processing shall be gone deep into first to abstract the relative concepts and relationship between concepts. At the same time, the main international classification methods and standards and rules for processing service shall be studied and analyzed. Then combining needs of different remote-sensing information processing, conduct semantic decomposition of different semantic granularity hierarchy to the

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remote sensing information processing service to form a scientific classification.

The function of remote-sensing information processing is divided into four levels, shown as follows:
(1)Processing service of atomic level: at the bottom of information processing service classification, it includes large numbers of atomic functions, namely, the basic, non-dividable image processing functions. Many more complicated functions are realized by reintegrating them.
(2)Basic information processing service: Based on the atomic level information processing, it has summarized the basic functions of remote-sensing image processing, such as radiation rectification, geometrical rectification, image registration, image fusion, image classification and so on. Remote-sensing image products of all levels can be got after a series of processings.
(3)Subject information processing service: This division of processing functions is aimed at different tasks or different transducers, and it is concerned in crossing using of different remote-sensing information sources related with transducers.
(4)Processing service for comprehensive application: aimed at large-scale information system, it is involved with the join up of several systems such as remote-sensing image processing system, geo-information system and so on. For example, it needs support from such systems as remote-sensing image receiving system, remote-sensing image processing system, geographic database and web transport system and so on.

3 DESCRIPTION OF ONTOLOGY-BASED SERVICES

3.1 Semantic Web Services

Only abstract concepts and specifications are mentioned in the classification of the remote sensing information processing service established above. However, it has several implementation methods, which can be based on CORBA， JEEE， and Web environment respectively. Seen form the supportiveness of the latest technical users, the web-based geo-information service is the most popular and the most promising technology. Web service refers to the self-contained, self-described and modularized application, which can be issued, oriented and called dynamically by WEB. Other applications, including other WEB services can discover and call this service. Consequently, WEB services technology can realize mutual operation very well at the WEB level, and can lay good foundation for integration of services and forming of services link.

In April, 2001, Web Services Stack was put forward in Web Services seminar of W3C. It defined what technology (standards) can be used and how it can develop. One of the core treaties is service description language(WSDL). It has defines a XML grammar, and describes the communication protocols and information format of the WEB services in formalized way. When a request project is searching for the needed service, it can acquire the WSDLdocument and bind the service. Then WSDLdocument is analyzed to get the detailed information on service method, parameters, and calling. At last, call the service. WSDL puts emphasis on the base of services. Though it has defined input and output type in XSD, it doesn't support definition of logic constraint between input and output parameters. So it is necessary to improve the semantic description of services.

Semantic WEB Services is semantic-based and intelligent, and is aimed at the understandability and processibility of computer. So building a semantic service environment by combining the advantages of these two respects and conducting service-oriented research into semantic service description and reasoning can provide richer and better services for the users. In research into semantic web, ontology is a key research item, which will bring semantic information to service, after it is introduced into service description

3.2 Ontology Construction in Remote-Sensing Domain

Ontology is the detailed and formalized specification of sharing conceptual model. It shows the relationship between concepts. Its aim is to acquire knowledge of the corresponding domain, provide common understanding on knowledge of the domain, and give specific definitions to the vocabulary (technical terms) and relationships between words from formalized modes of different levels. Although there isn't a standard construction method at present, in many methods we should acquire domain knowledge at first. That is, collect, extract and abstract the core concepts and concept relationships to form a knowledge system. The above classification tree has extracted the main processing methods and relationships between methods in the remote sensing information processing domain, based on which the commonly-recognized glossary can be defined, the ontology can be constructed and used in service description.

3.3 Service Description of OWL-S

OWL-S (Web Ontology Language for Services) is the ontology of Web Services described in OWL language. A service is mainly described in three parts, namely, ServiceProfile, ServiceProcess, and ServiceGrounding. In short, ServiceProfile describes what the service does; ServiceProcess, how the service work, and ServiceGrounding, how to access the service. A plug-in unit of Protégé compiler is adopted as OWL-S compiler in this article. Taking creation of remote sensing image of flood as an example, description process of the service is introduced in detail.

3.3.1 Creating a Service Process

Service of flood remote sensing image creation (cartography) consists of three sub services implemented in sequence. In OWL-S, three sub services will be modelled to atomic Process, and they combine to form the flood remote sensing image creation service. Functions of the three atomic processes are as follows:

Calculation of normalized vegetation index (NDVI)：NDVI has been used as one measurement of type features of different surface features and objects on the ground (especially the vegetation) for a long time. And it has been widely used in the remote sensing domain. So it has been chosen as a reference factor for extracting water body and for image creation.

Water body extracting：Figure out the water area according to the NDVI value, and express it by two-valued image. When NDV I < 0, the ground may be covered by cloud, water or snow; when NDV I = 0, the objects may be rock or bare earth. The reflectivity of the Band 1 and Band 2 are approximately the same. When NDV I > 0, it means that the ground may be covered by vegetation. And NDV I value increases with the increase of vegetation covering rate.

Superposition of two-value images: superpose the two-value images of the water body got before flood, during the flood and after the flood. And show the water body of different periods of time with different colours.

The inputs and outputs of three atomic processes are designed as follows:

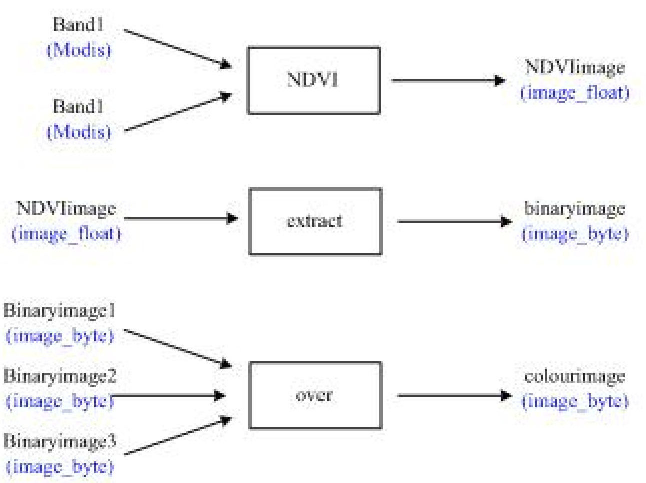

Figure 1. Inputs and outputs of atomic processes

Firstly, compile atomic process in the OWL-S compiling table. Put the input and output parameters of the above services into the compiler, and choose the parameter type. Then, assemble the atomic processes with the OWL-S control structure as shown on the left side of the following picture. At the same time, the data stream is shown on the right side. Taking service of flood remote sensing image creation as an example, its three atomic processes appear in sequential structure. Here, P(Perform)stands for atomic process, and S(Sequence)stands for sequential structure. And the final result is shown as follows:

3.3.2 Creating a Service Profile

Profile can be created in the dialog box of profile:Profile. In the following part, an example called cartography_Profile will be created, which will be related with cartography_process, the newly-created compound service, by the attribute-profile:has_process. Fill in the other information at last. The specific process is as follows:

profile:serviceName： service of flood remote sensing image creation

profile:textDescription：Show the water area of different time periods with colourful pictures

profile:hasInput：Band1,Band2

profile:hasOutput：colourimage

The input and output parameters in profile are the subsets of all the parameters in processes. The parameters are defined by the designer in accordance with parameters displayed in Profile. In most cases, except for the neutral parameter, all the parameters are included.

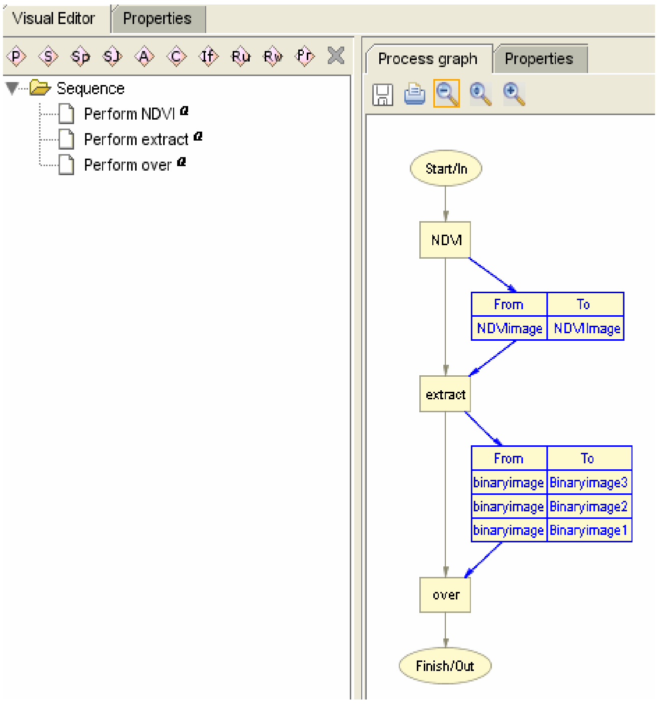

Figure 2. Data stream diagram of service on flood remote sensing image creation

3.3.3 Creating a Service Grounding

Grounding can be created in the dialog box of grounding:WsdlGrounding. In the following part, an example called cartography_Grounding will be created, and grounding will be created for each atomic process respectively. They are named as NDVIGrounding, extractGrounding , and overGrounding. Other properties, such as grounding:wsdlReference, grounding:wsdlDocuments and so on, must be defined by the user.

3.3.4 Creating a Service

After the creation of ServiceProfile, ServiceProcess, and ServiceGrouding, a service example need to be created, which will be related to the created process, grounding, and profile by attributes? The relationships of the four ontologies are shown in the following picture:

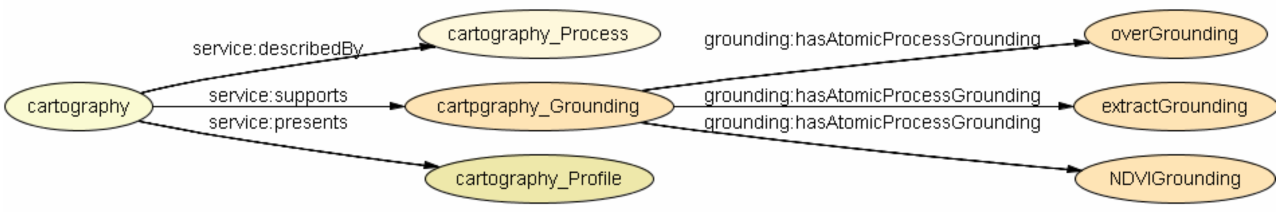

Figure 3. Overview of service of flood remote sensing image creation

4. IMPLEMENTATION OF REMOTE SENSING INFORMATION PROCESSING SERVICE

4.1 Design of Remote-Sensing Information Processing Service

Implementation prototype of Web –Service-Based Remote-Sensing Information Processing Service is designed in this paper, which includes three key parts: processing server, data server and client. Running process of the whole remote-sensing information processing service is as follows: register the service descriptions in UDDI, and then user finds the suitable service among them calls them and enters the client. Input the parameters needed for processing and specify the address of data server for storing data after processing. The processing server finds the remote-sensing information to be processed in data server in accord with input parameters, and downloads the information to processing server, and then uploads the processed results to the data server specified by user and returns the result storing address back to user, which will be displayed at the client. At last, data in the processing server will be emptied. Here, the processing server or data server is not only a machine. Instead it can be dispersed at any place in the world. With it, the user can process remote-sensing information on any computer, and can call any processing service provided by others, only if they have been issued to webs.

4.2 Implementation of Remote-Sensing Information Processing Service Based on NET Platform

Creating and issuing services are major steps of establishing WEB services, which are mainly realized on NET platform, and the procedures are as follows：

(1) Core Codes and Arithmetic for Remote-Sensing Information Processing: They are developed directly by the existing remote-sensing information processing software, which is developed in our lad. Dynamic link library is encapsulated into COM modules with ATL. In this way, it is more convenient to construct small, rapid and COM-based modules.

(2)Compile Codes to Call Modules. Cite the modules produced above in NET to compile codes for calling modules. In addition, the codes for uploading and downloading also need to be compiled, because the codes for processing images are at the processing server, while the remote sensing images are at the data server. Data need to be sent to the processing server, and uploaded to the data server after it has been processed.

(3)Run the testing service： While running the service, NET will generate WSDL of the service automatically. Users input parameters to call the corresponding services. For example, there are three main parameters in the calculation of NDVI, that is , the URL address of the images to be processed and the processed ones.

(4)Build the Client: The aim is to connect it to the server, so that the client programs can call the server programs. Choose “New ASP.NET Web”in NET, and then you can design the interface with the convenient tool box. While compiling client codes, use “Append WEB Services Quotes” to select the needed services. NET will create and call automatically the sub-services of WEB service. When applications call these methods, agent codes will transact the communication between applications and services.

The following is the service interface of flood remote sensing image creation. Three sub-services are included, results of which can be shown in the widget of ImageURL on the right. A final result of image creation service is shown in the following picture with different colours showing the water area of Poyang Lake in different periods of time.

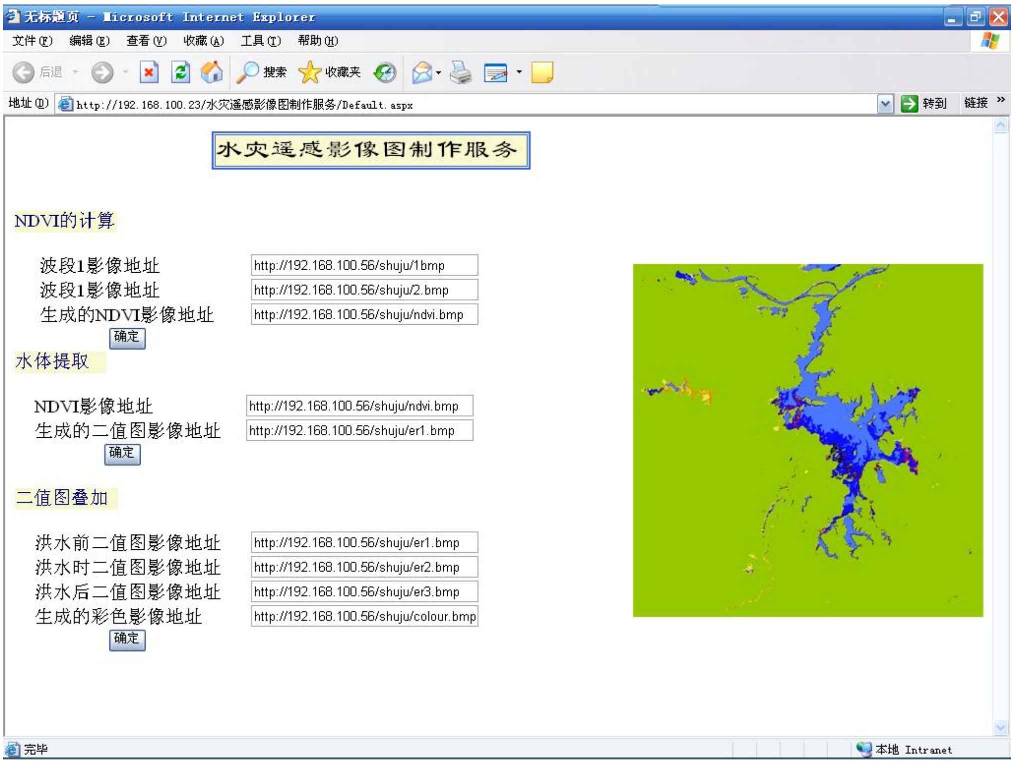

Figure 4. Client interface of the service of flood remote sensing image creation

5. CONCLUSION

This article has put emphasis on classification of remote sensing information processing service, and its semantic description. Based on the research and taking the flood remote sensing image creation service as an example, the service has been described in detail, a developing experiment has been conducted and the solutions and key techniques have been verified. All the work has laid foundation for the following operations of discovering and calling services automatically. All the study has shown that it is feasible to introduce Web service into remote sensing information processing domain. It will bring great change to the development of remote-sensing information processing and will change the ways of using it a lot.. However, as a whole, semantic WEB services in remote sensing domain is still at its preliminary stage with a lot of problems to be solved. For example, the classification tree still needs to be improved in application; strict evaluation technology is needed for the created ontologies. We shall study these problems further in the following work.

All in all, Information share has become one important symbol of the development of modern information society. And the mutual operation of remote sensing information processing is an inevitable product of it, which surely will become an important part of the remote sensing research in the 21st century.

REFERENCE

http://www.opengis.org

Tim Berners-Lee. The Semantic Web. http://www.w3.org/2002/Talks/04-sweb/slidel-0.html,

I Horrocks, P F Patel-Schneider, F Harmelen. 2002. Reviewing the design of DAML + OIL: An ontology language for the semantic Web. Proc of the 18th National Conf on Artificial Intelli2gence , AAAI-2002. Edmonton, Alberta, Canada: AAAI Press.

ISO/TC211.ISO19119,Geographic Information Service

N B Willem. 1997. Construction of engineering ontologies for knowledge sharing and reuse: [Ph D dissertation]. Netherlands: University of Twente.

OWL-S: Semantic Markup for Web Services. http://www.daml.org/services/owl-s /1.0/

T Berners-Lee, J Hendler, O Lassila. 2001. The semantic Web. Scientific American , 284 (5) : 34～43

The Protégé project. http :/ / protégé. stanford. edu. 2002

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