Software Agents for Learning Resources of Digital Library

D.A Milashenko, S.D Makovetskiy, R.V. Boblovskiy, I.N. Keleberda, N.S. Lesna

Kharkiv National University of Radio Electronics
14, Lenin ave., Kharkiv, Ukraine
swell@kture.kharkov.ua

Abstract: Software agent based on the learning resource in digital library development is described in this work. Using of distance learning technology standards and agent technologies provides ability of creation informational-educational environment in the internet. IEEE 1484.12.1 "Standard for Learning Object Metadata" allows organizing common access to the educational materials on the learning resources. Agent technologies are a mechanism of such access and they create distributed network of learning resources in informational-educational environment in the internet.

1. Introduction

For a long time and nowadays the volume of information is much more than human ability for information processing and searching. According to tendency of world globalization each person has possibility to get access to practically unlimited number of various public documents. However, besides positive moments, this tendency makes its own negative factors. Thus it becomes too difficult to find necessary material in great variety of diverse documents. Especially this problem is topical on one's own education because in this case it is necessary to get qualitative information in short period.

World globalization has an effect on knowledge-generating process too. Systems of distance learning are needed more and more. They allow using the learning materials that divided in the Internet. There are tendencies of amalgamation of distance learning systems into virtual open universities. The decision, which proposes creation of distributed warehouse of teaching resources and which provides access to these resources through the Internet with help of local providers of teaching resources, looks the most actually.

Such International organization as Ariadne, IMS Global Learning Consortium, IEEE Learning Technology Standards Committee, etc. work for creation of distance learning systems, creation of standards and technologies for providing of opportunity of interaction within an unified information learning environment. So, July 25, 2002, IEEE Learning Technology Standards Committee confirmed "Standard for Information Technology of Education and Training Systems – Learning Objects and Metadata" [IEEE02]. The standard allows realizing access to teaching materials that have been developed by different educational benefits providers.

Program of development of distance learning technologies for 2003-2008 was created at OUNL (Open University of the Netherlands) [KS02]. This program suggests using approved standards of specifications and agent technologies for creation distance learning systems.

In Ukraine these developments are supported by Kharkiv National University of Radio Electronics (KhNURE). The electronic library has operated at university since 1999. It is used for educational process. The center of distance learning technologies has functioned since 2001. It coordinates with creation of multiagent ontological system for distance learning [KLR03].

2. Concepts

It is proposed to create learning resources that contains learning materials in some educational institutions (universities, libraries, specially created organizations). Materials should be connected with science profile of institution. Holders take responsibility for the resource filling and maintenance. Various educational service providers can use materials of resources they are interested in. So it is profitable for educational organizations to hold resources even if they are not distance learning providers. Access is realized by means of specialized software (based on software agent technology) of the distance learning system. However it is necessary to provide also possibility of open (according to owner's decision) access to materials by means of standard facilities of WWW.

Software agent [Nw96] is created to provide access to learning resources. It's integrated into Semantic Web [BHL01, He01] and, at the same time, it supports an access from WWW. The agent realizes functions of resources preselection and the interface of access to various databases. Metadata of learning materials satisfies the standard IEEE 1484.12.1[IEEE02]. The marking language XML is used through metadata processing and translation. Database, which supports stored procedures and working with XML, is used for metadata storage. Development is going on taking into consideration of opportunity of using different databases (Fig. 2.1) and with possibility of filling in relational tables or in XML objects [KL02]. This is obtained by concealment of structure of document storage behind general-purpose interface. Also possibility of parallel metadata processing, which located in various servers, has to be existed. This allows to create flexibly structure of the system and to separate resources within organizations. Searching agent can be located either directly nearly database or can be moved off within any distance. However it is necessary to take the possible system loading into account and to provide high-quality communication channel between agents and DB and between agent and external users.
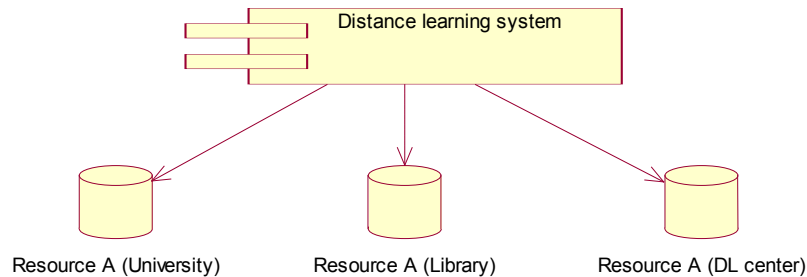
Fig. 2.1 Scheme of multi-database usage

JADE (Java Agent DEvelopment framework) [JADE] is used for system creation, a software framework fully implemented in Java language. JADE distributed under GNU GPL (http://gnu.org). JADE completely realizes the information model FIPA. It allows using system independently from chosen platform and from regional and language features. Since JADE is written in Java, it is quite easy to integrate JADE agents with JSP. Thus there is possibility to realize the access to resource by means of WWW.

3. Goals and objectives

Resource agent is a gateway that getting some requests transmits them to the DB servers for a processing and sends the working result to a client with different level of detail. Also it is necessary to create system of agents, which provides possibility of filling, control and supporting the DB capacity for work.

Agent or JSP generates XML request to resource agent that includes information about a document for searching and overhead information. Information for searching includes values of fields (that conforms to LOM standard) and information about degree of conformity of fields' values and logical field manipulations. Engineering information includes the fields that are responsible e.g. for level of answer detail. Level of answer detail must have been accounted, because e.g. agents in Semantic Web will carry out semantic analysis of a document directly after getting info about location of metadata and/or a document. In respect of web, level of detail must be higher as it's necessary to afford an opportunity to look over e.g. annotation of document, authors, version or date of creation.

On the other hand it's necessary to provide a possibility of quality and trivial filling of the DB with metadata of documents. It is necessary to provide a consistency of incoming data for quality filling the DB. It may be provided by creation of comprehensive approach of metadata testing. Resource data manager intends it to storage the provisional metadata with following their approval. The creation of filler's agent, which can control presence of obligatory fields and accuracy filling the field with fixed value set, is

necessary for maximum correct data composition. Also it is necessary to organize possibility for metadata filler to make a request for change the list of possible values of some field. Filler has to have possibility to save metadata for recurring using or for other aims.

Control of accuracy of metadata formation is imposed on resource data manager. The resource data manager exercises control of giving information accuracy and decides about placement of metadata (and document) into general DB.

The resource manager exercises control of data that stored in the DB, possible modification and removing. The process of decision-making about data removing or modification has to be regulated by system working rules that drew up at each organization, which uses the product. Also manager has to take a decision about creation of fillers accounts (if registration of these users demands rigid account).

The system of site administration is necessary for completely working of resource. It must include backup systems of received data, information processing, control of system's work, management of users that control the processing.

4. Realization

In accordance with principles of system working the next structure of system is intend. Logically it is possible to mark out two parts: searching part and part of filling and administration.

Searching part is an agent that receives XML request and generates threads, which generate child threads. These child threads know how to call stored procedure of one's of another's database with help the JDBC-ODBC bridge. After receiving answer the leaf thread transfers the results to the nearest parent that combines the data, sends it to recipient and ends his working. Thus, every request to database is processing independently from other request, i.e. inquiry answer that has come later may be sent to user (agent) before sending inquiry answer that has come earlier. It depends from concrete request processing time or from sum of requests processing time, if the agent is figured for a processing with several DB.

Part of filling and administration is several agents, serving to play roles as a filler of metadata, resource manager, manager of resource data, and as a system administrator.

Filler's agent allows customer, which is not a metadata legalization specialist, to create metadata that meet the standard and that are not conflicting and/or redundant and send them to the server. Filler brings in required and additional metadata fields answering to the questions of the filler's agent that is completed as a master. Filler agent makes excerpts of value list from the server and proposes to choose required value. In the case if the value list doesn't fulfill requirements then filler sends the request of some field's value list modification to the resource manager with filler's agent's help. Request should

contain argumentation. Also filler's agent is a client of resource agent for providing with comprehensive approach of accordance of services to the filler. So, for instance, filler can call for receiving earlier metadata for legalization the new material on their basis. For security of safe operation and for generating of right metadata the filler's agent have access to DB for filling after filler's authentication only.
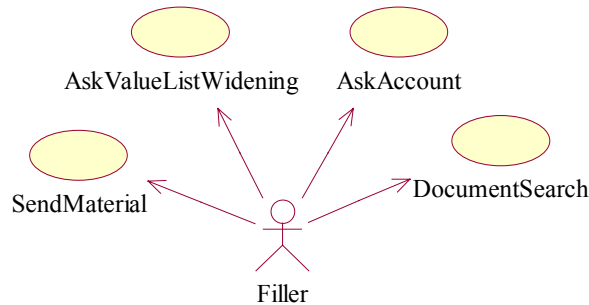

Fig. 4.1 Use Case diagram for role "filler"

The process of creation the new accounts may be in several kinds:

1 The filler trough the filler's agent sends the request for creation filler's account thru the server to resource manager's agent. Then resource manager makes a decision about creation the account. After filler's account was created he should be informed about this.

2 The filler trough the filler's agent creates account on the server for itself in autonomous behavior. This approach can't completely guarantee the conformity of information about the filler and he's data on the server. Also this can't guarantee the filler's responsibility for given information.

Choice of variety of new users' creation process is entrusted to the resource administration.

The resource manager's agent is an application that provides receiving of requests for creation an account of fillers, removing the metadata and documents that are stored in database and the master of the accounts creation. When the agent connects to the system all raw data are requested. After decision about adding the user to the system was made the resource manager, which uses his agent, calls a stored procedure of adding the user and deletes the request from the list. The agent has to allow deleting the metadata of document and consequently appropriate document from the local base of documents. The possibility of the document removing from the local base has to been realized. Also it is necessary to provide possibility of the broken document replacement.
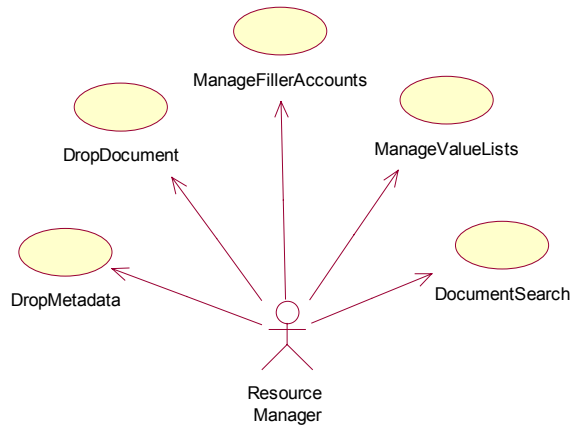
Fig. 4.2 Use Case diagram for role "recourse manager"

The resource data manager agent takes list of documents, which had been sent to the intermediate base of documents, and provides with funds for viewing the metadata of document and technical information about conditions of setting. After checking the correctness of completing, the metadata are added to list as approved. After that the metadata are available for searching within them by resource agent. Also possibility of searching metadata in the intermediate base has to been realized. In case of wrong competing of metadata the resource data manager sends the message about error with help of contact info that was indicated at the filler's registration. Also possibility of editing the received information by data manager has to been realized.
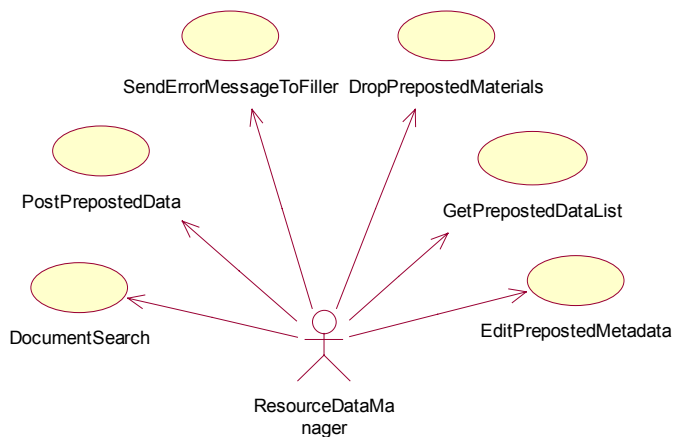
Fig. 4.3 Use Case diagram for role "resource data manager"

The agent of administration makes backup of the data from the server by saving the metadata, documents and overhead information, which was added or changed since last backup copying or for fixed interval, on the backup medium. Also it is planed to realize the possibility of taking statistic data about stored data in the DB. It is necessary to realize the system of stored procedures creation, which should allow the administrators of concrete organizations to complete their stored procedures for satisfaction of needs for taking different statistic information. The system can manage the resource and the resource data managers' accounts easy by means of stored DB procedures. For control of searching agent working it is necessary to anticipate the module that connects with the agent and takes info about amount of started threads, their activity, and quantity of active DB servers.
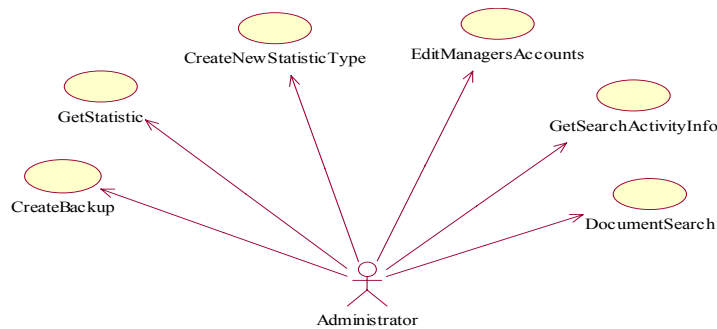
Fig. 4.4 Use Case diagram for role "administrator"

5. Summary

Consequently, the proposed decision allows to put into practice the idea about global systems of distance learning, provides possibility of flexible maneuvering among traditional facilities of access to data and agent systems; provides maximum possible freedom of choice by concrete users of facilities that used for realization their needs within DL system; includes possibility of profit earning at using this system. This system is a base part of DL system, based on software agent technology, which is under development in Kharkiv National University of Radio Electronics.

Bibliography

[IEEE02]   IEEE 1484.12.1: Standard for Learning Object Metadata. PISCATAWAY, NJ, 2002.
[KS02]   Koper, R.; Sloep, P.: Learning Networks. Learning Technology Development Programme 2003 – 2008, http://learningnetworks.org/downloads/ LTD%20Programme%20Learning%20Networks%202003-2008.pdf

[KLR03]   Keleberda, I.; Lesna, N.; Repka, V. : Development of the multiagent
            ontological system for adaptive distance learning. : In proc. of the VII
            International Conference CADSM. Lviv-Slavske, 2003. – pp. 559 – 560
[Nw96]   Nwana, H. : Software Agents: An Overview. Knowledge Engineering
            Review, Vol. 11, No. 3, Sept 1996, pp. 1-40
[BHL01]   Berners-Lee, T.; Hendler, J.; Lassila, O. : The Semantic Web. Scientific
            American, May 2001
[He01]   Hendler, J. : Agents and the Semantic Web. IEEE Intelligent Systems
            Journal, March/April 2001
[KL02]   Keleberda, I.; Lesna, N. : Application of XML, RDF, DAML+OIL to
            creation of information resources for distance education in Internet : In proc.
            conf. on Education and Virtuality, Kharkov, 2002; pp. 68-71.
[JADE]   Java Agent DEvelopment (JADE): http://sharon.cselt.it/projects/jade/