

Web Service Systems for Cooperative Work Support in Knowledge Creation Processes

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Abstract. The emergence of Web service results from the business needs as mentioned below. Web service as the evolution of software engineering is also required to explore the possibility of adapting to cooperative work support with knowledge management. Web service technology is becoming the focus of interest as an open standard for web software, because of its service-oriented architecture. Web service facilitates Internet commerce, or e-commerce, because it enables the execution of inter-organization in a typical business application or logic area such as dynamic supply chain composition. Web service technology is successful in the above business with a fixed procedure. It is therefore desirable to adopt an atypical task requiring a wide variety of task procedures. This research focuses on a method of applying Web service to atypical tasks with a non-fixed procedure, such as a knowledge creation task, to improve the task performance in a cooperative work. The results presented in this paper are expected to validate the performance of Web service in carrying out a dynamic search for a document from various information resources.

Keywords: Web Services, Knowledge Sharing, Document Retrieval, Cooperative Work Support, SOAP, WSDL.

1 Introduction

The rapid progress of information and communication technology has recently produced many software application systems, such as automatic seat reservation systems, Internet shopping systems, and so on, that contain several business processes in which business objects interact with one another. For example, in the automatic seat reservation system, the web-based self-service solutions include quick booking for go-show passengers and on-line payment functions. The practical use of these systems is enabled by using Web service technology, which is defined by the W3C (World Wide Web Consortium) as "a software system designed to support interoperable machine-to-machine interaction over a network" [1]. Web services can also implement application software components according to service-oriented architecture (SOA) concepts, where the basic unit of communication is a message rather than an operation. Therefore, Web

service is attracting much attention because it allows access over a network such as the Internet and is executed on the remote system hosting the requested services.

Generally, business processes are carried out through a business life cycle such as the Plan-Do-See cycle. The Do phase is typical work with a fixed process, such as a business transaction. Web service is well suited to business processes with a fixed task pattern. The above-mentioned service systems of quick booking for go-show passengers and online payment functions have primarily been adapted to a fixed procedure.

However, knowledge is one of the most important assets in an organization. Real concern exists about the knowledge and know-how drain as well as the lack of technology transfer following the retirement of the current experts. For a business organization to enhance its competitiveness, it must acquire collective knowledge in the context of their business, and effectively put this knowledge and information into practical use for various task performances [2].

Both information and knowledge in the business community depend on particular individuals or organizations that are identified as senders or receivers in a collaboration. The challenge is to transform this information into knowledge that can be reused and shared in knowledge-intensive work, such as in design offices and business communities. In addition, because this knowledge and information exist in many types of resources, such as web sites and local site documents, varied but effective application software tools are needed to support cooperative work. Web service systems can provide a retrieval method that enables individuals and organizations to manage contents and application software by using an XML-based protocol for exchanging information over an HTTP protocol.

These knowledge workers in cooperative work environment typically are part of a planning or analyzing task in the Plan-See phase. These tasks are called atypical work tasks with a non-fixed pattern. Since information system problems are possible in this area, SOA will be needed to support atypical work performance.

This research focuses on a method of applying Web service to atypical tasks with a non-fixed procedure, such as a knowledge creation task, to improve task performance in cooperative work. As an example, this research uses a "literature survey in research work" as a target application for knowledge creation and reuse work. This paper describes the Web service implementation procedure applied to the atypical cooperative task, in which knowledge and information in a community is shared through dynamic retrieval of various contents from several location sites; here, the Web Serve procedure includes an information organizing system that is based on ontology to represent task models.

2 Knowledge Sharing in Cooperative Creation Work as a Target of Web Service

Due to the number of documents shared in physical environments and database systems, conventional knowledge management or groupware system development in the business field needs improved electronic document retrieval and management functions. Knowledge systems should be able to enable knowledge workers to create knowledge and reuse the knowledge of others.

Knowledge can be categorized into tacit knowledge and explicit knowledge. Tacit knowledge is knowledge that is normally difficult to formalize and articulate. It often exists only in a person's mind. Explicit knowledge is knowledge that has been codified and formalized into procedures and rules. Transforming tacit knowledge to explicit knowledge is very important to an organization, as it enables people to derive knowledge instead of only information. However, it is not easy to share or learn tacit knowledge that is more instinctive than rules and procedures. Personal tacit knowledge can be shared and sanctioned in a group or an organization, and the knowledge becomes larger and twice the original size through four transformation processes: socialization, externalization, combination and internalization (SECI model) [3].

Though the SECI model is only conceptual, all progressive company practice this model mechanism. Therefore, the computer implementation of the SECI model is very significant. This model is called the "knowledge spiral" because the interaction process between tacit and explicit knowledge continually spirals upward as newly created knowledge continually evolves. There are two issues in the implementation of the SECI model. One is dialoguing system to support the externalization of tacit knowledge. and another is network system to support the combination of knowledge, knowing what anyone is knowing best among peers of an organization. This paper pays attention the former system. In other words, organizational knowledge creation and sharing is a spiral process, starting at the individual level and moving up through an organization. In addition to the people working in an organization, an information-organizing tool should also drive this spiral. Codification of this knowledge puts the organizational knowledge into a language that is accessible to all members of the organization [4], [5].

This SECI spiral process is accompanied by information structuring of knowledge using any document retrieval tool and a comprehensive framework of the domain task procedure. Therefore, Web service has the potential to provide effective implementation support of information systems based on the SECI model.

3 Web Service Systems for Atypical Business Task Processes

This research investigates the system requirements and implementation feasibility of the interoperating between different software applications supporting knowledge management and atypical cooperative work. In accordance with the task characteristics, knowledge workers select and combine the most suitable application tools from application service sites. A Web service method can be applied to this information processing as a standard means of interoperating between different software applications running on a variety of platforms. Figure 1 shows a schematic diagram of the system architecture of the Web service.

A Web service method is conventionally applied to interoperating between typical business software applications with a fixed logic pattern. It does not adopt an atypical task requiring task knowledge. This research considers a "literature survey in research work" as an example of knowledge creation and reuse work. The task procedure of literature retrieval is strategic and needs to use various search means because of different contents media or sites. So it is used to evaluate capability of the Web service method to improve task performance in cooperative office work.

Web services provide a standard means of interoperating between different software applications running on a various platforms. Web services are characterized by their great interoperability and extensibility, as well as their machine-processable descriptions using XML. The descriptions can be combined in a loosely coupled way to achieve complex operations. Programs providing simple services can interact with each other to deliver sophisticated added-value services.

A W3C Web Services Activity is to design the infrastructure by defining the architecture and creating the core technologies for Web services. Web service components are themselves equivalent to general web application software and communicate with each other through the SOAP protocol and XML data exchange. With a Web service, the service requester uses the service from a service provider.

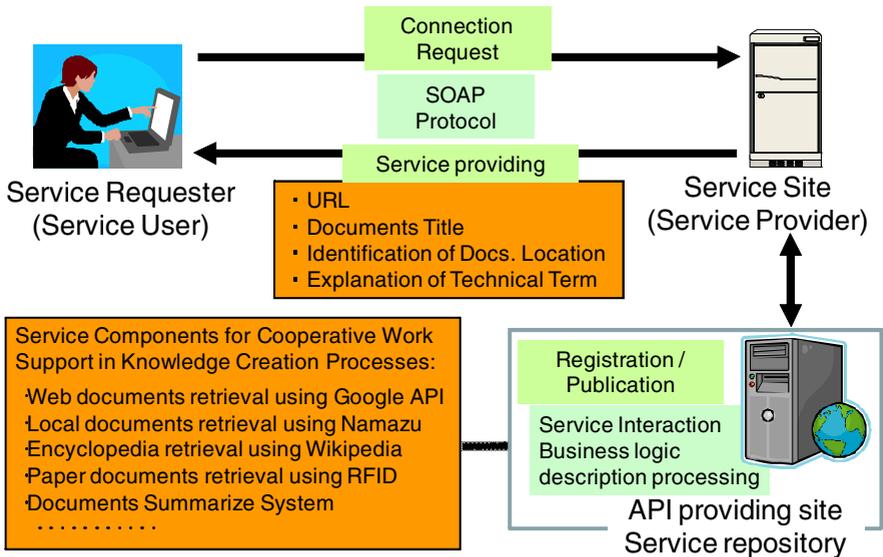


Fig. 1. Service systems for task knowledge sharing support

4 Web Service Systems for Supporting Cooperative Creation Work by Retrieval Application Interoperation

This paper uses search tasks of reference documents as a cooperative work example with a non-fixed task process. The Web service implementation and design procedure is a means of interoperating between different software applications, including web document retrieval using Google API, local document retrieval shared in a group or work organization, and encyclopedia retrieval using Wikipedia API. The information organizing and retrieval system [5] is a core application software program for Web service trial and is used as follows.

4.1 Web Service Systems Development Environment and Procedure

Knowledge and document retrieval based on information organizing is an example task for a Web service of business logic. The retrieval objects here are publication documents on the web and local site documents. Google and Namazu [6] are used for the document retrieval engine.

Figure 1 shows the Web service systems for task knowledge support implemented using Java platform technology. This figure also includes JSP, Servlet, JavaBeans, a service requester and a service provider site. Apache Tomcat is the server side software and Apache Axis is used as the Web service framework. This figure also shows an interoperating scheme between different software applications, running on a variety of platforms, that is, web documents retrieval and local documents retrieval software to share the task knowledge and information.

(1) Information organizing and retrieval software with Web service. Using a former research paper for reference [4], [5], the information organizing and sharing system is explained as follows. Such a system is desirable in a knowledge community of creative workers, such as in the product research, design and development departments. This paper expresses task knowledge as a task model consisting of a work procedure and documents of explanatory contents. Here is taken up a creative task example as literature search in research work, and a task model is expressed as the table form structure. A description of task model, information organizing and document retrieval are as follows.

(2) Description of Task Model, information Organizing and Document Retrieval.

The information retrieval process attempts to sort out very complex, important issues as precisely as possible by selecting the appropriate information resources and planning the retrieval strategy. This process of sorting out issues indicates the task model is a problem-solving method that forms task knowledge. Ontology is defined as the specification of concepts to be used for expressing knowledge. Our system task model is based on the task ontology concept. The most typical kind of ontology for the web has a taxonomy and a set of inference rules. Task ontology consists of the terminology, vocabulary and ontology of a task. The task model consists of the task procedure and task ontology.

In this paper, a table form is typically considered as the expression of a task model for document collection [4], [5]. The table form is suitable for expressing a relationship and presents an organizing structure and at-a-glance understanding of the relationship of items classified in the table. One example given in this paper is mentioned about a literature searching problem for assist of one's research. Figure 2 shows the task knowledge spiral cycle using a task model of the table form expression. A good researcher can compose the task model in a table using task items from his own knowledge and register it in a database. The retrieval engine would collect documents using these items and organize them in the table. This information of organizing results with a table form of documents could be referenced, changed and updated with the new ideas of other workers in the case of task progression or other expert participation.

For example, the task case in figure 2 is a survey of literature documentation about the “method of installation and setting of computer server”. The researcher selects “WWW server” and “mail server” for the server service software and “Windows Server 2003” and “Fedora Core Linux” for the related server OSs. These selected keywords are deployed in table rows and columns. Document retrieval is carried out and produces an information organizing result with the combination of keywords. The XML sample of this task model is also shown in figure 2. The data can be represented as follows: <name>: the task name, <author>: the creator of the task model, <keyword>: combinations of the selected keywords, <row>: the arranged keywords in a row of the table, <column>: the arranged keywords in a column of the table, <task-model>: the container for the prescribed element of task model in the task model list <task-model-list>.

Information retrieval is carried out based on the combination of items in this table. Radio buttons are used for the selection of Web site documents, local site documents in an office, paper documents at a local site, or a mixture of paper and electronic documents, in accordance with the classification of the information source. Retrieval processing is carried out by using an adequate search engine, such as Google for web documents and Namazu [6] for electronic documents, paper documents, and also task model definition data in a local site.

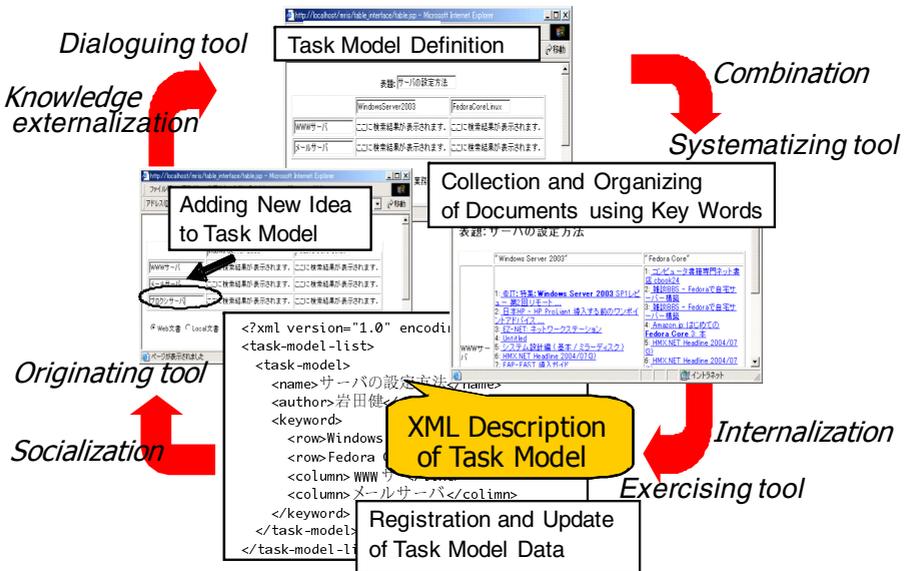


Fig. 2. Task model sharing using an example of a table form, and information collection and organizing

(3) **Web Document Retrieval Component using Google API.** In this paper, a table form is typically adopted to represent the task model. Terms in the rows and columns of the table are given as retrieval query words for the Google engine. The row data

and column data are viewed by the user with task knowledge. The number of rows and columns is variable and depends on the task.

Google Web API as a Web service component provides a programming interface to query web pages through Google from our own computer programs. This library is a processing as a resource in our applications for Google Web API. Google Web API has great potential for creating table organizing information, especially since a huge amount of data is available through Google. Therefore, web document retrieval in this study uses the Google API because it helps to decrease system development by providing a set of scripts for a wide range of platforms that can be used to launch almost any Java Application controlled by our library.

(4) Local Documents Retrieval Component using NAMZU. A pre-developed, ready-made web application is reused as the Web service. In this paper, a software application for local content retrieval is used to search a local file repository site at a laboratory or organization by using the table form of the information organizing and sharing system [5]. The local content retrieval components are customized for JavaBeans. JavaBeans components are reusable software programs that can be developed and assembled easily to create Web service applications for the task knowledge support system. The Namazu component is executed as the command line form in a JSP program source.

The Web service deployment procedure [7] on the server side of local document retrieval is summarized as follows, using the abovementioned JavaBeans. Figure 3 illustrates the Web service arrangement.

- (1) Creation of application program (JavaBeans, in this case) for service deployment
- (2) Application program is added in the Apache Axis engine
- (3) Execution of deployment program using Deployment Descriptor for Web service
- (4) Creation of WSDL (Web Services Description Language) and publishing the application service program on the web server.

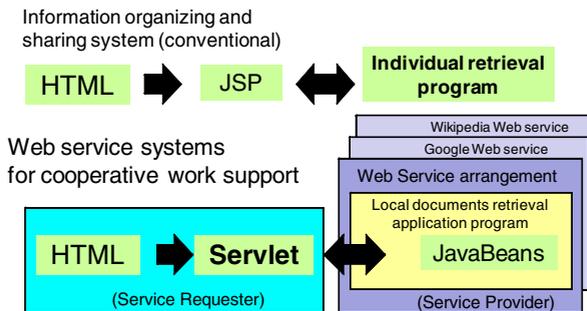


Fig. 3. Web service arrangement using JavaBeans for usual web application

(5) Encyclopedia Retrieval using Wikipedia API. Wikipedia is a multilingual, Web-based, free-content encyclopedia project. Because it is written collaboratively by volunteers from all over the world, anyone can edit it. Encyclopedia retrieval is useful

for creative collaborative work. Therefore, this application software is used for the implementation trial of Web service. Implementation is carried out in the same way as the abovementioned web document retrieval application. The JSP source for Wikipedia API implementation is as follows.

```
<%@ page contentType="text/html;charset=UTF-8"
import="javax.xml.transform.*,javax.xml.transform.stream.*" %>
<%
request.setCharacterEncoding("UTF-8");
String keyword=request.getParameter("keyword");
String xml=("http://wikipedia.simpleapi.net/api?keyword=" + keyword);
String xsl=application.getRealPath("table.xsl");
StreamSource xmlSS=new StreamSource(xml);
StreamSource xslSS=new StreamSource(xsl);
StreamResult outSR=new StreamResult(out);
TransformerFactory fac=TransformerFactory.newInstance();
Transformer tran=fac.newTransformer(xslSS);
tran.transform(xmlSS,outSR);
%>
```

4.2 Web Service System Prototype for Knowledge Sharing in Cooperative Creation Work and Discussion

As stated above, this research focuses on an application method of Web service to an atypical task such as a knowledge creation task for improving task performance in cooperative office work. A Web service interoperating system is produced as a prototype using the Google Web service, local document retrieval Web service, and the Wikipedia API.

Conventional system construction for interoperating of web application software is costly and time consuming. Web service technology provides the interoperability of the server's call server instead of the user's services call operation. Web services are expected to carry out creative work effectively, because the contents are retrieved from the appropriate site by using tools suitable for sharing creative work with an atypical type procedure.

For the interoperating system of document retrieval, Google Web service is provided as the existing web retrieval engine. This service performs web document retrieval in an accompanying WSDL file that can be imported into our Web services programming environment. The local content retrieval components are customized by JavaBeans. JavaBeans components are reusable software programs that can be developed and easily assembled to create Web service applications for the task knowledge support system. Encyclopedia retrieval is useful for the identification of unfamiliar technical terms in any creative collaborative work. The implementation of Wikipedia API service provides encyclopedia articles. Consequently, these Web service systems support cooperative work in the knowledge creation process. Figure 4 shows the Web service construction of the user interface for creative work support. Service selection and providing are based on the creative work process.

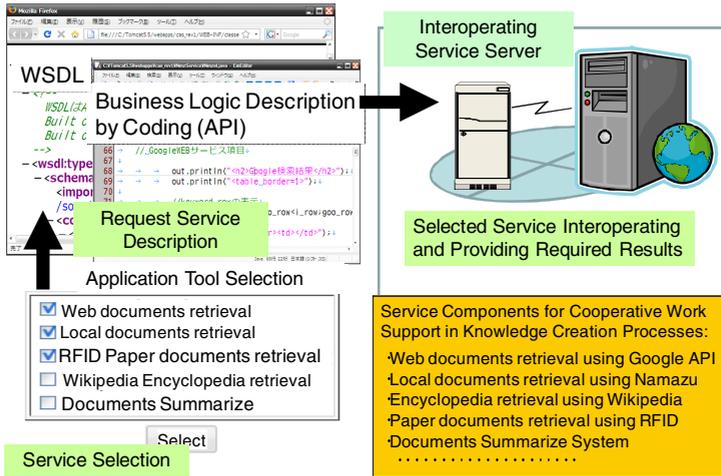


Fig. 4. Service selecting and providing based on the creative work process

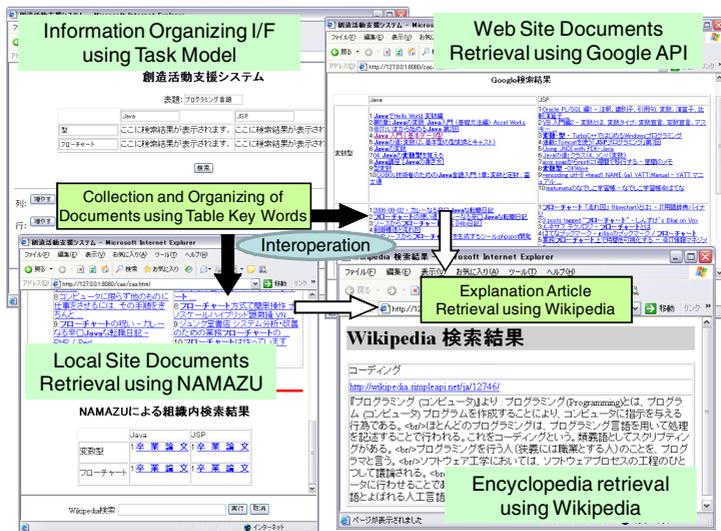


Fig. 5. Interoperating between information organizing and documents retrieval application

Figure 5 shows an overview of the interoperating document retrieval management system. A task model is used as an input key of the retrieval process. A piece of meta-knowledge is made by retrieving the keywords included in the task model, and by embedding links that direct the retrieval results into the task model. These retrieval processes are automatically interoperated according to the location of the document resource. Wikipedia service is allowed to run on this system if the need for an encyclopedia article arises.

5 Conclusion

For effective knowledge creation and sharing in a cooperative environment, the applicability of Web service technology to perform an atypical task is studied. A pre-developed integrated method of information organizing is used, in which a task procedure is structured and shared in tabular form, and document retrieval systems are managed by an open Web service API. The following results were obtained.

1. By using a “literature survey in research work” as an example of a target application of knowledge creation and reuse work, Web service architecture for the atypical work of knowledge creation in an organization is provided. The conceptual design requires interoperating between different software applications running on a variety of platforms.
2. Web service specification is provided, in which web documents and local site documents are automatically retrieved and organized by the table form task model, thus enabling the sharing of task knowledge.
3. A Web service prototype environment for document retrieval and task knowledge support is implemented by using Google for web documents, Namazu for electronic documents and paper documents, and encyclopedia functions by Wikipedia API.

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