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Development of an Intelligent Database System for Welding and Joining Technology†

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Abstract

We have introduced a new database system, by which various users can utilize the expertise in welding and joining technology as knowledge resources. The system is constructed as a web application and consists of the presentation server, the application server, and the database. The presentation server has a website and the application server has a presentation logic for skills. The database server has the expertise, the user profile, the skill, for relating information among the expertises. The intelligent database concerning welding and joining technology has been developed in this paper. The system will give the best outcome by knowledge management of the expertise.

KEY WORDS : (Intelligent Database System) (Knowledge Management) (Welding and Joining Technology) (Java) (Web Application)

1. Introduction

Because of the aging of experienced welding operators and the decrease of researchers and engineers of welding and joining technology in Japan, it has become important recently to create a database of expertise by digitizing their skills. Several reports related to the field have been published. They include the analysis of wire supply behavior in TIG manual welding[1)], the analysis of welding skill for CO_2 semiautomatic welding and reproduction of motion by the robot[2)], the development of database for welding instances[3)] and so on. However, problems still remain in digitizing skills. The skills and expertise stored in the database have been finely classified by their fields such as heat source, process, material and mechanics. Though all experts are not always familiar with whole fields for the stored skills and expertise, it is necessary for them to incorporate unfamiliar expertise.

In the late '90s, Knowledge Management (KM) has come to attract attention as one of the methods to utilize computerized knowledge effectively[4)]. There was no universal definition of KM, but the purpose of the method was to utilize knowledge. It tries to focus on "knowledge resources" and to use them as motive power for generating new idea in companies. Such kinds of activity are very important, not only for company members, but also for researchers and engineers. It is very important for researchers and engineers to utilize various the "knowledge properties" which they have.

The purpose of this research is to develop a database system that various users, including beginners and also experts of welding and joining technology, can utilize expertise in knowledge resources. To realize the system, at first, the requirements have been arranged. Then the database system has been developed, and finally the developed system has been applied to the database of the welding and joining technology.

2. Concept of Intelligent Database System Based on Knowledge Management

2.1 Knowledge management and the system

In the KM, the knowledge is defined as including information, experience, know-how etc, and it is stored up in one of two categories: explicit and tacit. The former consists of things that can be documented and digitized. The latter consists of things such as experience and know-how, which are not easy to be documented and digitized. These two kinds of knowledge have a strong connectivity, that is called "knowledge-creating process"[4)] as shown in **Fig. 1**. The process creates new knowledge continuously by repeating the four stages that is socialization (from tacit to tacit), externalization (from tacit to explicit), com-

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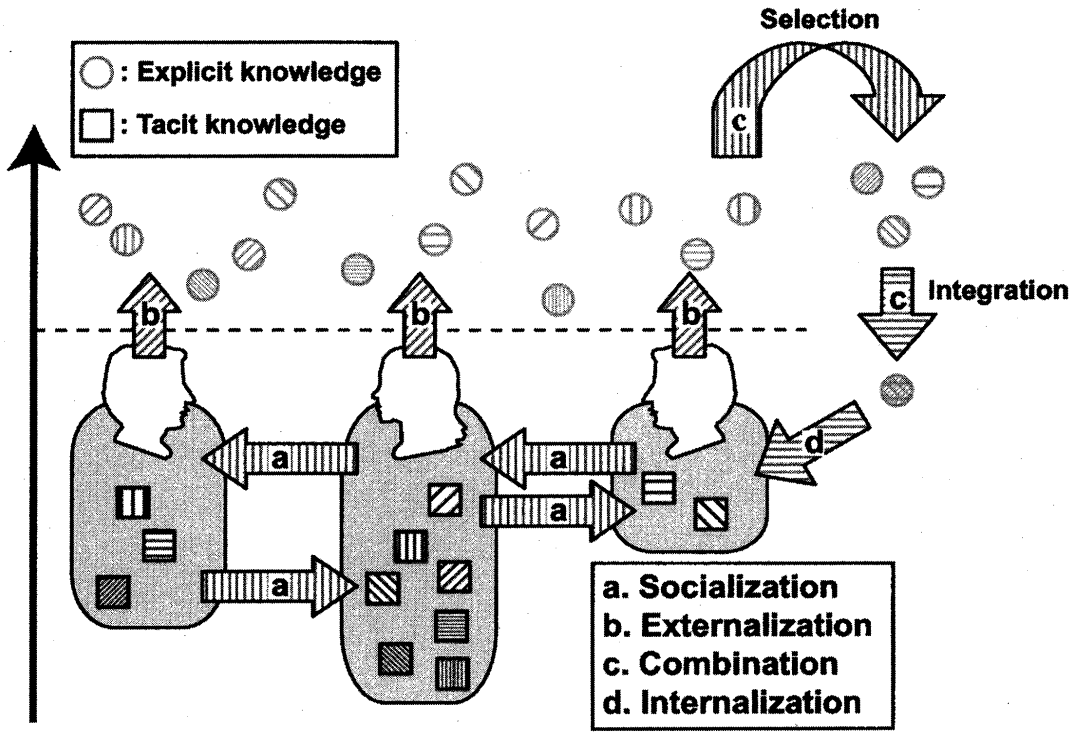

Fig.1 Knowledge-creating process (the SECI model).

bination (from explicit to explicit), and internalization (from explicit to tacit).

In the KM system, it is necessary to establish the function that can accelerate the process and support the generation of new ideas or values from the knowledge. The knowledge includes the explicit and the part of the tacit ones in the computer network. In recent years, some researchers and programmers have developed the various KM systems. The systems have been separated into one or more of the following categories: knowledge repositories, expertise access tools, e-learning applications, discussion and chat technologies, synchronous interaction tools, search and data mining tools. The aim is to create new knowledge from the stored one. However, most systems have the limitation of sharing an area of knowledge, because the closed computer network has distributed them: local area and virtual private network.

2.2 Requirements of intelligent database system

The requirements to realize a database system have been clarified. First of all, it will be a very useful database if we can use it without any limitations or restraints through the Internet in order to expand the sharing area of the knowledge. Secondly, it will be also essential if the system can store the knowledge and has the supporting function to evaluate and to understand the stored one. From these considerations, we have to design the system, which has intelligent functions, to present related knowledge according to the skill level of the user. Skill level that is needed to understand the knowledge is specified and stored as a property of the knowledge. The relation of the knowledge is defined and stored. The skill level of the user is also stored. Moreover, all operations are recorded, and the skill level of each user and related information are updated based on this record. The stored information is increased and polished according to the improvements in user skill and increasing number of users.

3. Structure of Intelligent Database System and Its Application

Figure 2 shows the overview of a developed intelligent database system. The system has been constructed as a web application. The system has the requirements mentioned above and consists of presentation, application, and database servers. The users profiles, including their skill level in each field of expertise and the relation among the expertises, are stored in the database. The user accesses the system through the Internet, searches the expertise and stores the new expertise in order to update it. If a user asks about a technology, the reply will be modi-

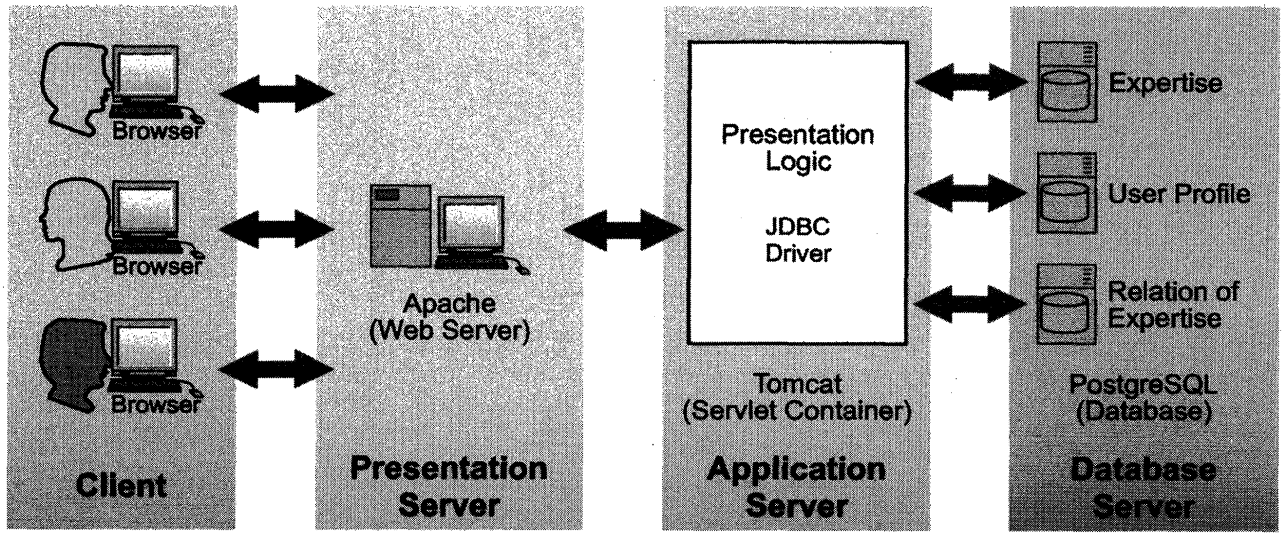

Fig.2 Schematic illustration of intelligent database system.

fied according to the skill level of the user profile and the expertise relation. Moreover, all operations are recorded, and each user profile and the expertise relation will be updated. Considering enhance scalability and portability of various operating systems of the server, the system has been developed by PostgreSQL as the database, Tomcat as the application server, Java as the development language of the presentation logic and the input-output interface for the database, Apache as the transmission to the client computer, respectively.

As an example of the application, the reported papers and research results in Transactions of JWRI have been stored. In the example, the information of papers is stored as expertise, and they are classified the five fields. The skills are also classified at three levels: beginner, intermediate, and advanced. The stored information is title, authors, key words, type of research, fields, and skill level. The total number of papers is 166 and they are reported from volume 26 to 30 of the Transactions of JWRI. Moreover, key words closely related to welding and joining technology have been selected from the stored information, and the information of the key word is also stored as another expertise. The stored information of key word is word, meaning, language, fields, and skill level. As the users information, name, password, the each skill level for five fields of the expertise, and language are stored. The relation among their information is defined as follows; the papers are defined by key words and the key words are defined by the meaning of the key word.

The following are considered in the presentation logic for the reply to a query about paper information. The field of expertise that users need is specified by the relation between the words of the query and the stored key words, the paper information belonging to the specified field is shown preferentially. In the paper information the skill level corresponding to the user's skill level in the specified field is prioritized. Moreover, the relating information for the key word shows how the key word corresponds to the user's skill level.

4. Conclusions

We have considered the requirements for the system by which various users can utilize the expertise in welding and joining technology as the knowledge resources, and have designed a system structure, and have developed an intelligent database system. It has been revealed that the developed system is very useful, functional and expandable. In future work, we'd like to store more numerical data, visual images and movies as the expertise, and to develop a more convenient and intelligent system.

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