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Research Report

3D Web Environment for Knowledge-Management

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3D Web Environment for Knowledge Management

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Abstract

We describe a new paradigm in which synchronous and asynchronous collaborative communication using a 3D model is realized for knowledge management in an industrial manufacturing process, such as design or troubleshooting, at a worldwide automotive company with many branch offices. Our module for establishing the shared state of 3D objects, which supports the LivingWorlds specification, will be integrated with a VRML browser plugged into a Web browser, a Web server, and a communication middleware system, as a 3D Web Environment system for knowledge management. Users will be able to record the minutes of their online meetings using 3D models, which may include text annotations or additional object behaviors, and will be able to store them systematically in a database with related documents and images, and retrieve them later to prepare for another meeting or to find out the details of a meeting that they did not attend in real-time. In this report, we discuss the direction of our work and the concept underlying the 3D Web Environment system design.

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1 Introduction

In various areas of industry, accumulation and communication of knowledge are becoming more important than ever. This transmission of knowledge is achieved in various ways, such as standing chatting to people in a corridor, preparing a meeting report, distributing copies of the report to the members of a group, and retrieving it and related reports from a database or drawer. On the basis of the knowledge gathered in such ways, a group leader can predict the future of his/her industry area in order to expand business, an engineer can plan the development of a marketable new product, and a designer can create a new concept to revitalize his/her currently targeted market.

Today, the general goal of knowledge management is to put intellectual assets into a knowledge cycle, that is, to store, collect, re-use, share, and update valuable experience, wisdom, and know-how of individuals belonging to a working team efficiently and in a visible form. Its purpose is to improve responsiveness, development cycle time, productivity, and competence. Especially in manufacturing areas, this knowledge cycle, which can be applied across discussion, decision-making, planning, and production processes, has recently been shortened, and thus its efficiency is more important than ever. Figure 1 shows the knowledge cycle in the manufacturing area. During a discussion, participants share and update 3D contents synchronously or asynchronously, and then store them in the database. The contents are collected through many discussions, and the participants of another discussion retrieve several objects from the collected contents by specifying a key object. We consider that the former comes under a Web collaboration for multi-user communication, the latter does under a geometry search for 3D object systematization.

Several software developers have already devoted their attention to knowledge management, and have offered products to facilitate communication among group members by e-mail or text chat, and to store

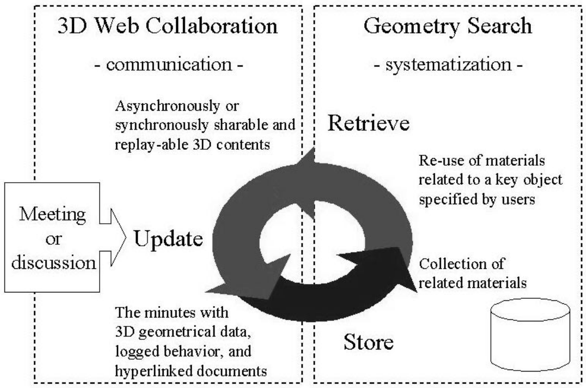

Figure 1: Knowledge cycle

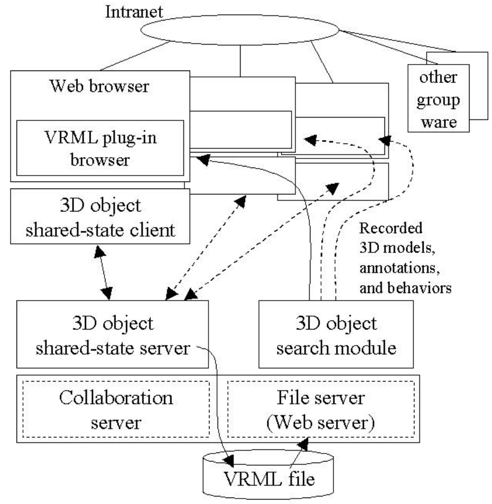

Figure 2: Overview of 3D Web Environment system

related documents for the subsequent reference by members of both the same and different groups. We plan to combine our module establishing the shared state of 3D objects [4], which supports the Living-Worlds specification [2], with a VRML [3] browser plugged into a Web browser and a Web server to form a new knowledge management system, named "3D Web Environment" system.

In section 2 of this report, we give an overview of our system and related work. In section 3, we introduce two examples of applications using the system and show the direction of our activity. Section 4 is a summary of the report.

2 3D Web Environment

2.1 Overview

The goal of our system is to provide functions for the preparation of 3D materials for online or face-to-face discussions among the members of one or more groups, which can be held both synchronously and asynchronously. The 3D Web Environment system is based on a client-server model, and is intended to be used in combination with a groupware system such as Lotus Notes. If users have such a groupware system and some widely available synchronous collaboration tools, they can schedule their next online meeting and retrieve the minutes of the last meeting, along with other related documents and images, by using the groupware's scheduling function and file server function. During the meeting, they can use the whiteboard-sharing function, Web-page-sharing function, and text chat function provided by the collaboration tools. Updated or new documents generated during or after the meeting can likewise be stored on the file server for subsequent reference.

Moreover, the 3D Web Environment system enables users to handle a virtual 3D model in a similar way to 2D documents and images by means of such conventional groupware. Figure 2 shows an overview of our system. The system consists of 3D object shared-state client and server, a 3D object search engine, a middleware including a collaboration server and a file server, a database, and VRML and Web browsers. Let us suppose that the participants in a meeting usually work with 3D objects such as parts made by an automotive manufacturer. They can share 3D contents consisting of virtual 3D models through the shared window of each client program during their discussion, add several new text annotations or objects, and store them in or retrieve them from the database of the 3D Web Environment system in the same way as they would for 2D materials, using conventional groupware. They can also store in the database behavior data generated by controlling objects in the shared window. The 3D data stored in the database, which may include texts and behaviors, are in VRML format, and in particular use the LivingWorlds nodes to represent objects shared among the clients. The reason the nodes are used for authoring shared objects is to reduce network traffic among clients for sharing content. We consider the situation in which collaboration takes place via a low-performance network connection such as a wireless connection or modem connection between a satellite office and a main site; consequently, the restricted sharing permitted by LivingWorlds is reasonable, although there is a way to share all the parameters of each object in the content, like all the values of each transform or all the values of color and geometrical attributes.

To manage many clients participating in an online meeting, the 3D Web Environment system uses a middleware system such as Lotus Sametime [1] as a communication layer. The middleware offers basic functions related to the multi-user environment, such as a function for determining who is participating in this discussion group. The 3D object shared-state client and server modules [4] in the 3D Web Environment system are ported onto the middleware by using one of the latter's basic functions, and also enables users to add, remove, and share 3D content. Since the users can share the 3D content itself, instead of sharing the view as if they were seeing the same object from exactly the same viewpoint, they can see the same shared object from their own preferred viewpoints - for example, facing each other or facing in the same direction.

The 3D contents are stored on the file server, which is a part of the middleware. In response to operations by the users, the data are first downloaded from the Web server to the respective clients, and then loaded by the VRML browser supporting the VRML Java Scripting API. The 3D object shared-state client module connects to the shared-state server of a part of the system, and starts to share the 3D content for collaborative discussion. When a new client joins the discussion, notification of the fact is sent by the middleware to all participating clients. As a result, the module recognizes the new client and starts the necessary procedures for object sharing. The updated data, such as text annotations and object behaviors added by the user, are also stored on the file server, like the original data, and can be downloaded when required.

We plan to develop a 3D object search module as a part of the 3D Web Environment system, for the next step. The module will be connected to a database in which many 3D models are stored, and will enable the user to retrieve several objects by specifying a key object. Thus, the user will be able to grasp the meaning of data from new viewpoints, as in the text mining method, and to receive help in systematically sorting out numerous stored 3D objects according to various attributes such as their topologies. The details of this search module will be described in another paper.

2.2 Related Work

Lotus Sametime [1] is intended as a knowledge management tool. Its current release mainly provides functions for online text chat meetings. The Sametime provides a function for connecting several clients by means of collaboration tools such as Microsoft NetMeeting, so that each client can have the same view. The view is based on the 2D content like a Web page, so it is not possible for Sametime itself to handle sharable 3D content.

Some CAD software such as IBM EsperViewer has a collaboration function that enables two or more users to synchronously share the same view of a CAD model in peer-to-peer mode. When all the participants in a meeting belong to the same group - for example, a design group - and they can all use the same CAD software, it is reasonable to use the software for collaboration, since each participant requires equally accurate data, and normally needs to use the data and the software that can load the data. However, if the meeting includes members of different groups or companies, they may not need accurate 3D data or they may have data for the meeting in different, incompatible formats specific to the software they normally use. Since the 3D Web Environment system basically uses ordinary VRML data, which are generally simpler than CAD data, it has the necessary and sufficient functions to cover these situations; that is to say, the data handled by this system require only conventional VRML and Web browsers, and the detailed attributes of the data are replaced by simple hyperlinks to related data. There is, however, no need to replace CAD software with the 3D Web Environment system; rather, each should be used as appropriate; for example, one case may require precise CAD data, while another may require simplified VRML data.

3 Application Example

In manufacturing industries, we are investigating applications of knowledge management to 3D data. In the aerospace and automotive industries, products have very many parts, each of which is frequently designed, managed, and manufactured by a branch or division in some different part of the world. In this situation, it is very difficult to hold frequent meetings with many participants from all the different branches, and as a result various kinds of online meeting tools, such as video conferencing systems and virtual shared whiteboard systems, have recently appeared. When a meeting is based on a document

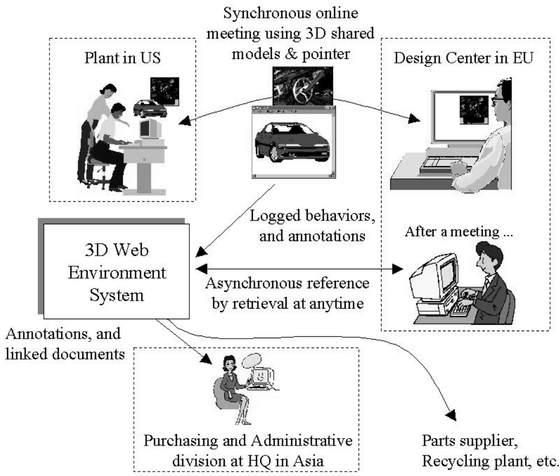

Figure 3: 3D synchronous/asynchronous meeting

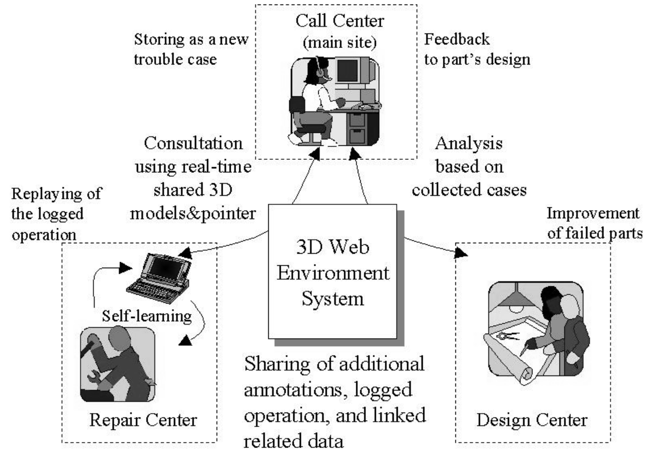

Figure 4: Call center

or 2D images, these conventional systems enable the participants to usefully share a certain page of the document or a certain image. However, if the discussion concerns a 3D object, such as a mock-up model in a design discussion, or a failed part in a troubleshooting discussion between a production group and a design group, it may be hard for them to understand each other, owing to the difficulty of explaining the 3D shape.

The 3D Web Environment system solves this situation by sharing a 3D model virtually among participants. Figure 3 shows a conceptual image of a meeting using a 3D model. Here, we suppose that the original 3D model used in the system is generated as VRML data from scratch by another modeling software system or converted from CAD data to VRML data. At the beginning of the meeting, the participants, in advance, download and share the 3D content for one of the topics to be discussed at the meeting. They can add arrows and text annotations to virtual objects, see them from arbitrary viewpoints by zooming in and out, and add behaviors to the object during the discussion, while using conventional video conference tools. At the end of the meeting, they can store the data, including the added annotations and behaviors, in the database of the 3D Web Environment system. If any people cannot attend the meeting, they can retrieve the data from the database later, understand the minutes precisely by using the 3D model and the related documents, and reflect their comments in the model. In other words, they use the system in a non-realtime, asynchronous way, like a newsgroup, whereas the participants in a real-time discussion use it in a synchronous way.

The VRML format of data in a 3D model can be considered as a multimedia format for Web applications comparable with still images, movies, or formatted documents. Its format is the common and standard file format for 3D objects, so that users can send and receive data without being concerned with the version of the special software that can load and display the data contents; that is to say, users think of utilizing the data not only in one division, where almost all users use the same software and the same data format, but also in other divisions such as purchasing, administrative, or recycling divisions, where it may be very useful to hyperlink the data with related documents and images instead of having the detailed information attached to the data as in the case of CAD data. In such situations, the 3D Web Environment system enables users, who don't have enough technical knowledge of each part from their standpoints of the administration, to intuitively see the 3D model as well as the usual misleading part numbers in the catalogue, with only an ordinary VRML viewer instead of a special CAD data viewer.

Another potential application is at call centers in a maintenance division. In this situation, the 3D Web Environment system is used only in this maintenance division. Figure 4 shows a conceptual image of the call center. A repair person on a satellite repair center ordinarily refers to the repair manual of CD or book. If the failure is different from all the cases shown in the manual, the person contacts the server at the main call center, using the client of the system for consultation about repairs. The repair person and a consultant at the call center discuss the problem, using a 3D shared object to represent the disabled part, in a synchronous usage of the system. After the discussion, at the call center, the motions of the shared objects, including the pointer controlled by both persons and any related documents, are stored in a database as a new trouble case so that the data can be retrieved for later reference. At the satellite site, the repair person can replay again and again the motions of the objects logged during the discussion to learn about the solution. This is an asynchronous usage of the system.

The above situations thus provide examples of the knowledge cycle of collecting, storing, sharing, reusing, and updating knowledge represented by the 3D model. The knowledge created and updated during the synchronous collaboration are stored in the database, and can be retrieved for asynchronous collaboration or further synchronous collaboration.

4 Summary

We have described an application of LivingWorlds in the knowledge management area, along with an overview of a planned system. We believe that this system, which will provide synchronous and asynchronous collaboration functions that can handle 3D models, will be very useful in manufacturing industries that produce 3D objects. We hope that shared-state VRML environments will give all users in the manufacturing area a chance to improve their productivity.

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