An Intelligent Agent-Based Framework for Knowledge Management on the Web: A Case Study of A Virtual Team in Designing A Multimedia System

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ABSTRACT

This proposed research will focus on designing, implementing, and evaluating a conceptual framework for intelligent agents that supports processes of managing project-relevant knowledge inside a virtual team in designing a multimedia system over the Internet.

1. INTRODUCTION

Today's organizations are experiencing an extremely competitive and turbulent business environment. In this environment, they are under pressures to react more rapidly and accurately to changes in customer needs and competitor actions. Many organizations have coped with these pressures through radical decentralization of their hierarchical organizational structures (Halal et al., 1996). More recently, the proliferation of personal computers and communication networks has enabled organizations to acquire and retain such distributed organizational structures (Ahuja, 1996; Tapscott, 1995). Using a computer network, geographically distributed people with common goals can communicate, coordinate, and collaborate their work efforts across time and space barriers. These groups of people have been called "virtual teams" (Davidow & Malone, 1993; Geber, 1995). Jessup et al. (1996) define virtual teams as "turbo task forces, with teams forming and disbanding as needed, with team size fluctuating as necessary, and with team members coming and going as they are needed." Because the virtual teams can bring together the right mix of people who have the appropriate set of knowledge, skills, information, and authority to solve difficult problems quickly and easily, they are receiving considerable attention from knowledge workers involved in non-routine, unstructured, and uncertain problems (Jessup et al., 1996; McGuire, 1996). Today such teams can be quite large and they can be distributed around the globe. The quality of their results depends on how well individual knowledge can be communicated among members of a virtual team. The challenge that modern organizations face is to turn the scattered, diverse knowledge

of their knowledge workers who are working in a virtual team into a well-structured knowledge repository (Spek & Spijkervet, 1996; Wiig, 1993). Knowledge Management (KM) is suggested as a methodology for creating, maintaining and exploiting a knowledge repository (Stewart, 1995; Wiig, 1993). KM is defined as the collection of processes that support the creation, dissemination, and utilization of knowledge between appropriate individuals, groups within an organization, and independent organizations (Liebowitz & Wilcox, 1997).

The recent popularity of the World Wide Web (Web) has provided a tremendous opportunity to expedite the dispersement of various knowledge creation/diffusion infrastructures (Chen & Gains, 1997; Ives & Jarvenpaa, 1996). Because the Web enables organizations to create a knowledge repository and to extend the scope of collaboration in an easy and cost-effective manner, it creates the possibility of developing global collaborative KM platforms (Barua et al., 1995; Davenport, 1996). However, the unstructured nature of the Web creates an information overload problem. While the Web allows various kinds of knowledge to be created and disseminated across time and space barriers, it does not support the processes of using and updating the knowledge in a timely manner. Rasmus (1996) and Silverman et al. (1995) suggest the use of intelligent agents as a promising solution for assisting and facilitating these processes. This research will focus on developing a conceptual model for KM and a framework for the roles of intelligent agents in the conceptual KM model. Furthermore, it will implement and evaluate the intelligent agent-based framework on the Web under a collaborative environment for designing a multimedia system.

2. DATA, INFORMATION, VERSUS KNOWLEDGE

Data consists of facts and figures that are relatively meaningless to the user. Information is data that have been shaped or formed by humans into a meaningful and useful form. Knowledge is the stock of conceptual tools and categories used by humans to create, collect, store, and share information. When data is processed, it can be converted into information. Likewise, when information is processed, it can be knowledge. To create knowledge in organizations, managers must manage the processes that transform data into knowledge. Knowledge management includes all of the activities involved in managing the processes. Table 1 shows definitions of data, information, and knowledge in the context of multimedia systems design.

<Table 1: Data, Information, Knowledge, and Knowledge Management in Multimedia Systems Design>

Data	Information	Knowledge	Knowledge Management
Text, Audio, Video, Number, Graphics, etc.	Text, Audio, Video, Number, and Graphics that are closely related to a specific topic.	1) What information should be contained (Content). 2) How the information should be presented (Treatment).	A method for systematically and actively managing and leveraging design ideas and decisions among team members while developing storyboards.

3. AN INTELLIGENT AGENT-BASED FRAMEWORK FOR KM

To develop the framework of intelligent agents for KM, a series of analysis steps is conducted: 1) build a conceptual model for KM in order to discover problems and opportunities for intelligent agents; 2) specify how intelligent agents perform the tasks identified in the previous step; and 3) finally model how the intelligent agents cooperate in order to assist KM activities.

3.1 A Conceptual Model of KM in Designing A Multimedia System

Spek and Spijkervet (1996) identify three basic activities necessary to build a well-structured knowledge repository: creating knowledge, securing/combining knowledge, and distributing/retrieving knowledge.

3.1.1 Creating Knowledge

When designing a multimedia system, designers, developers and users, with their own unique group and individual perspectives, create one or more design solutions consistent with the user requirements. Whenever design participants gain a new understanding about user requirements, they develop new design knowledge. The design knowledge is refined continually by other group members throughout a design process. A highly expressive, precisely defined set of attributes for design knowledge representation can facilitate the ability to create new knowledge in a knowledge repository.

3.1.2 Securing/Combining Knowledge

Since multimedia systems design is multi-disciplinary, enhancing team collaboration is extremely important in the design process. It can be achieved only when all team members share the same knowledge, understand it clearly, and freely integrate their knowledge into existing knowledge. All these can happen by storing and indexing knowledge properly. Throughout a process of multimedia systems design, partially or completely specified new design knowledge should be evaluated by checking whether or not it is consistent and specifying how it should be integrated with the knowledge already stored in a knowledge repository. By constructing a well-designed ontology that specifies at a high level what kinds of terminology are frequently used and what their general properties are in multimedia systems design, design participants can properly integrate their knowledge into an existing knowledge repository.

3.1.3 Distributing/Retrieving Knowledge

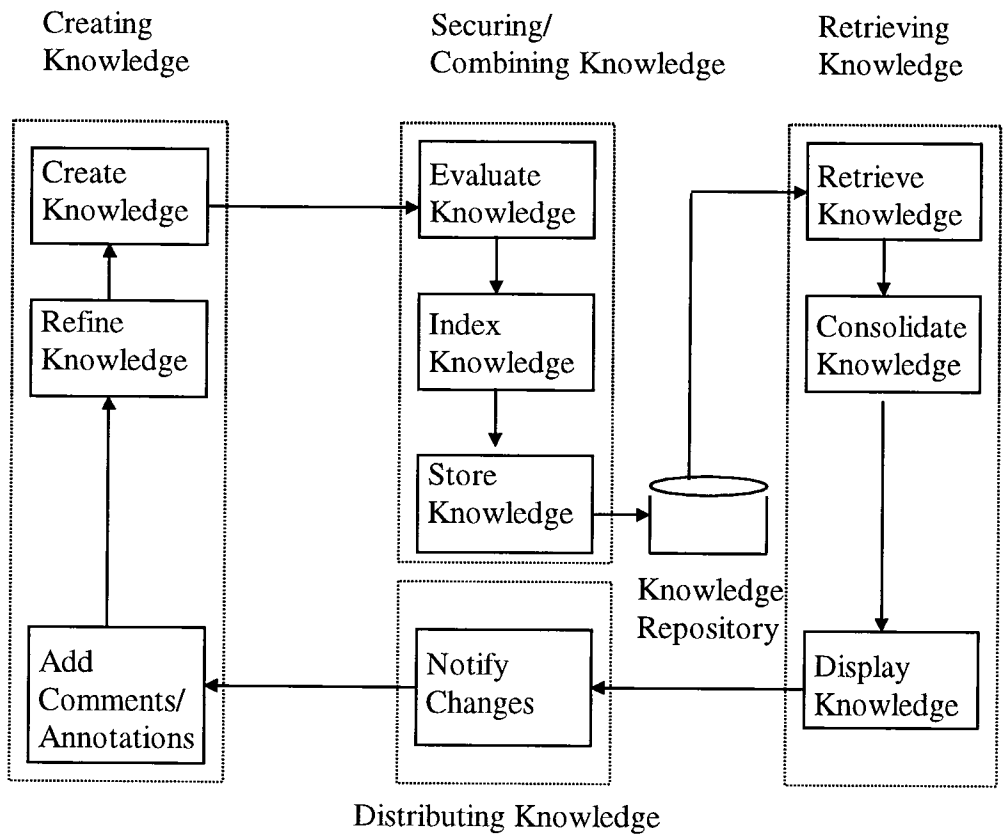
Collaborative design process is fundamentally a learning process. Design team members can come to a working understanding about a multimedia system by continually learning from each other. To support the collaborative learning for design, there needs to be open, flexible, and reactive communication channels to distribute knowledge. The gap

between the evolving and continually changing, design knowledge can hinder effective collaborative learning.

A knowledge retrieving activity can be executed when a designer seeks pieces of knowledge that are required to perform one's tasks. Normally, a knowledge retrieving activity is based on one or more keywords. In a rapidly changing environment, such as an environment for designing a multimedia system, keyword-based knowledge retrieving is no longer productive. The dynamic nature of such an environment requires content-based, context-based knowledge retrieving. A well-designed ontology enables designers to do content-based and context-based knowledge retrieving.

Heijst et al. (1996) state that by streamlining these processes an organization can implement KM successfully. Especially, in the case of designing a multimedia system which requires multi-disciplinary, ill-structured, highly creative knowledge, the continuous streamlining of the three KM processes is important. Figure 1 shows a conceptual model of KM in designing a multimedia system.

<Figure 1: An Overview of KM Process>



3.2 KM Agents

To enhance knowledge flow in a conceptual KM model, three intelligent agents are specified: user agent, a knowledge manager, and knowledge agent. Table 2 summarizes the major roles of three intelligent agents in supporting KM.

<Table 2: Roles of Intelligent Agents in Supporting KM>

KM Activities	Needs	Intelligent Agent (IA)	Major Functions of IA
Creating Knowledge	By specifying attributes in a knowledge submission form, users must be able to represent their knowledge fully.	User Agent	• Help users to create knowledge and formulate queries. • Remember all KM activities of users. • Dynamically organize a person's agenda.
Securing/ Combining Knowledge	Users need to have the ability to assemble, customize, and extend attributes and their values defined in a knowledge repository.	Knowledge Agent	• Index knowledge. • Detect inconsistency. • Save, retrieve, and update knowledge from a knowledge repository.
Distributing Knowledge	Users need to be aware dynamic changes occurred in a knowledge repository.	Knowledge Manager	• Monitor all changes that occurred in a knowledge repository and forward them to the user agent.
Retrieving Knowledge	Users need to search knowledge in a knowledge repository based on attributes (or context) and contents.	Knowledge Manager	• Reformulate queries based on an ontology. • Determine the most favored alternative based on preference weighting and ranking.

4. IMPLEMENTATION

KM agents consist of three major components: dialog structure, inference engine, and knowledge base. Their dialog structures and inference engines are implemented using Javascript. And, their knowledge bases are implemented using Cold Fusion and Microsoft's Access. The KM agents run on a Window NT server. Table 3 summarizes structures of the KM agents.

<Table 3: Structures of KM Agents>

	Dialog Structure	Inference Engine	Knowledge Base
User Agent	Interface for Users and Knowledge Manager	Backward-Chaining	• Knowledge about users
Knowledge Manager	Interfaces for User Agent and Knowledge Agent	Meta-Knowledge/ Control Knowledge	• Ontology for design knowledge
Knowledge Agent	Interface for Knowledge Manager	Exhaustive Search and Rating	• Knowledge about storyboards

5. CONCLUSION AND FUTURE WORK

This research proposes an intelligent agent-based framework for supporting KM on the Web. Many intelligent agents have been developed for assisting users to retrieve knowledge from the Web. However, few intelligent agents have been developed for supporting other KM activities (i.e., knowledge creating, knowledge distributing, and knowledge securing, and knowledge combing). The framework proposed in this research is designed for supporting and streamlining all KM activities.

The next goal of this research is to validate the framework in a real-world setting. More specifically, by using an exploratory research methodology the research investigates how effective the Web, intelligent agent-based KM system can assist KM activities in designing a multimedia system. The case study will be conducted in a multimedia company. During the case study, the Web, intelligent agent-based KM system will be implemented and used for supporting a virtual team engaged in designing a mid-sized, educational multimedia system. The system will be used mainly for communicating and sharing key ideas and design decisions among team members while developing storyboards. The storyboard - a frame-by-frame matching of hand-drawn images and pencil-in text - is essential for each member of the team to bind together all the individual design efforts (Kiddoo, 1992). The system will help design team members to create, exchange, and share their storyboards in a virtual team.

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