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8-15-1997

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1. Introduction

Software design is a problem-solving process of translating clients' and end users' underspecified and ambiguous knowledge into a structured description of a computer program that will satisfy their needs (Curtis et al., 1988; Jeffries et al., 1981; Walz et al., 1987). Software design tasks are too complex to be accomplished directly from the design problem statement that clients or users specify. Thus, during a design process a designer decomposes the ill-defined and ill-structured problem into a set of well-defined and well-structured subunits that are manageable and minimally interacting, and combines these design solutions (Jeffries et al., 1981; Simon, 1973). The decomposition and integration processes are central to the success of software design (Jeffries, 1981). Since the kinds of knowledge that may be required for accomplishing both problem decomposition and solution integration processes are practically limitless, individual designers face cognitive difficulties (breakdowns) during design processes. The cognitive breakdowns are likely to produce incorrect design solutions. To reduce the cognitive breakdowns, users, designers, and developers must share their knowledge and skills central to the design of useful software (Sonnenwald, 1995).

Many studies addressing the coordination problems in software design assume that the problems in small or mid-sized projects are not serious (Curtis et al., 1988; Kraut & Streeter, 1995; Walz et al., 1993). However, as the use of interactive multimedia gains its popularity in educational and training software development, even small-sized software development projects involve complex communication and coordination processes. This is because multimedia systems design, compared with text-based systems design, requires deeper and broader application domain and technical knowledge. Multimedia systems design is generally performed by different design participants, such as user, project manager, instructional designer, content expert, media specialist, and so forth (Alber, 1996; England & Finney, 1996; Yang, 1995). Because each of them possesses totally different backgrounds, training, and experiences, communication among them is always problematic. Unifying a design team that is comprised of members from different disciplines, with different skills and different ways of describing multimedia, might be a major problem that project managers must solve in order to complete projects successfully. The major issue in the collaborative design environment is making designers, with their own unique interests and individual perspectives, come to a common understanding of what they are building, sharing information, and coordinating their individual design efforts.

The storyboard facilitates the collaborative design environment for multimedia systems design (Kiddoo, 1992). The storyboard shows how one frame relates to adjacent ones, as well as to the whole concept, and what media are needed to achieve a particular effect (Kiddoo, 1992). Therefore, while developing the storyboard, design team members can explicitly communicate and negotiate how narration, images, text, special effects, and background music are brought together and linked together to form a final presentation. This research attempts to design a knowledge management system that can help design team members to create, exchange, and share their storyboards.

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, Numbers, Graphics, etc.	Text, audio, video, numbers, 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.

The Intelligent Agent-Based Knowledge Management (KM) System

The KM system consist of three intelligent agents: user agent, knowledge manager, and knowledge agent. Each agent has a dialog structure for users and other agents, a rule base, and a database. Its dialog structure and rule base are implemented using Javascript, and its rule base is implemented using Cold Fusion and Microsoft's Access.

User Agent

A user agent records all KM activities of users and dynamically organizes agenda lists. A user agent observes the user's KM activities and the current state of a knowledge repository to deduce what actions are to be performed and how to perform these actions.

3.2 Knowledge Manager

As the size and complexity of a knowledge repository increases, the roles of a knowledge manager becomes important. To enhance KM activities, a knowledge manager needs to perform three important functions. First, a knowledge manager should have a high level of knowledge about a knowledge repository. Therefore, when a knowledge manager receives a request from users, it can determine a plan to perform the service. Second, a knowledge manager needs to monitor and record changes that occurred in a knowledge repository. Collaborative design process is fundamentally a learning process. Design team members can come to a working understanding about a system by continually learning from each other. The gap between the continually changing design knowledge can hinder effective design. Therefore, the mutual awareness is an important issue for supporting collaboration among team members. Third, a knowledge manager needs to know general design principles about multimedia systems design. While users design storyboards, a knowledge manager reminds users of some design principles in order to prevent errors and to enhance creativity.

Knowledge Agent

A knowledge agent provides intelligent access to storyboards, feedback messages, and libraries for images and audio in a knowledge repository. Its primary goal is to maintain the integrity, accuracy, and quality of a

knowledge repository. By employing a content-based indexing mechanism, a knowledge agent identifies and promotes the most useful knowledge and filters useless, outdated, or incorrect knowledge from a knowledge repository. Whenever changes occur in a knowledge repository, a knowledge agent dynamically indexes existing knowledge to integrate the changes. The knowledge (heuristics) about a content-based indexing mechanism is acquired through a series of meetings with a domain expert.

Conclusion

This research designs an intelligent agent-based KM system that supports KM activities for a virtual team designing a multimedia system 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). The system is designed for supporting and streamlining all KM activities. As many organizations use internet/intranet technology to support knowledge communication and sharing between clients and designers and among design team members, the research is expected to provide guidelines for building a knowledge repository with internet/intranet technology

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