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Toward the Knowledge Circulation between Institutions and Public Audiences with Virtual Agents

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Abstract This paper proposes the CINOVA framework that supports the knowledge circulation between the institutions which possess large amount of knowledge and would like to disseminate it to public audiences. This framework proposes the use of visualized knowledge management systems and virtual agents for knowledge presentations. Two VKMSs and two virtual agent based presentation systems cooperate on the framework with a common contents presentation media, knowledge cards. The prototype system is still being implemented but the two virtual agent based presentation systems are already deployed to our client, NFRI in real-world exhibitions and Web based on-line services.

1 Introduction

Institutions demand an effective way to disseminate their knowledge and information to public audiences. The Ministry of Health wants people to notice the spreading infectious diseases and know how to prevent it, the Meteorological Agency wants people to pay attention to a coming typhoon or understand the mechanism of earthquakes, a science museum wants its visitors to understand and experience the principles of mechanics, research institutes want to introduce their results and make difficult theories easily understandable to the public. At the same time, institutes want to get the feedbacks from the public, what people want to know and what was not clearly conveyed. In a large institution, usually there are many experts who possess specific aspects of knowledge but do not know the others well. The scattered institution knowledge has to be stored, well managed and organized to be useful and can be reused to create new values.

Two essential issues emerged in the knowledge circulation, the first one is how to efficiently store, organize and reuse large amount of knowledge that is scattered among many experts, the second one is how to efficiently disseminate information to and get feedback from public audiences. This paper presents the Circulating

Knowledge with Virtual Agents (CINOVA) Framework that proposes the integration of visualized knowledge management systems (VKMS) and life-like virtual agents for these two issues. The status of the deployment of the prototype systems to our client institute, NFRI (National Food Research Institute) is also presented.

2 The CINOVA Framework

The basic requirements of a knowledge circulation framework is the storage and a common presentation of knowledge. The knowledge representation should be able to describe various principles of knowledge and can be easily accessed by many experts who work on different computer systems and have different preferences on user interfaces. The core of CINOVA framework is a back-end knowledge repository of the whole institution and is shared by all of the experts (Fig. 1). The basic unit of the common knowledge representation stored in the knowledge base and exchanged among the subsystems is so called *knowledge cards*. As proposed in [4], describing pieces of knowledge into card media is an efficient way for one or a group to organize known information and to create new thoughts. A knowledge card in CINOVA is a metaphor of such a card that represents a piece of knowledge and is composed with a fragment of XML text and one image. It is simple but is a general representation of knowledge in any principle and can be processed by various applications on various operating systems. Multiple relevant cards can be further linked sequentially to be a *story* to form a presentation of specific topic.

When the amount of the knowledge contents gets large, they become difficult to be handled and be thoroughly understood. Therefore, information visualization techniques are applied to provide efficient interfaces for the operations like uploading, organizing and authoring of the knowledge repository that may contain many thousands of knowledge cards. Several such visualized knowledge management systems (VKMS) can be connected to the same shared repository and provide different abstract views for the experts' convenience.

These knowledge contents are then presented by life-like virtual agents as the interface toward end public audiences. Life agents are considered particularly effective and intuitive for non-expert public users because no extra training is required and allow people to use daily-life communication skills to interact with them. Two ways of presentations are anticipated, the presentation on the Web which is more limited in functionalities but has broader audiences, on-site presentation in exhibitions which is more interactive and allows the visitors to directly try and experience so that deeper understanding can be expected. There are four user classes in CINOVA framework.

Knowledge contents providers. They are the experts in the institution who possess specific knowledge in their minds and are willing to contribute it to the others in the institute or to disseminate it to the public. For example, in the case of NFRI, they are the researchers of food science. One provider may describe a piece of knowledge as

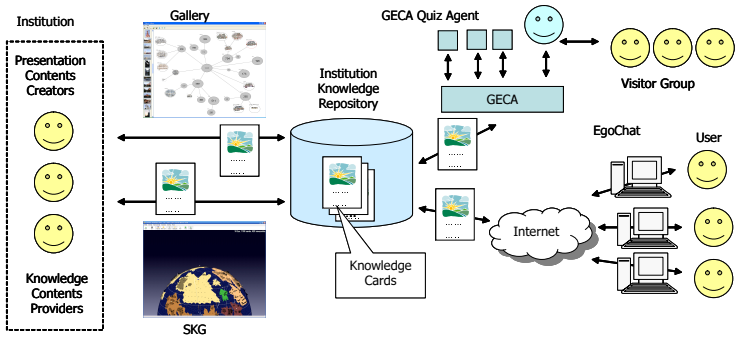

Fig. 1 The concept diagram of the CINOVA Framework

a knowledge card and upload it to the shared knowledge base by using one of the VKMSs.

Presentation contents creators. They are the people who belong to the institution and create agent presentation contents (stories) by authoring the knowledge cards stored in the shared knowledge base by using one of the VKMSs. Depending on the target presentation agent system, the knowledge of how to compose expressive and natural non-verbal behaviors of the agent is required, they may be or may not be the knowledge contents providers.

Grouped exhibition visitors. They are the users who actually visited the exhibitions of the institution or the museum. From our observations in NFRI, the visitors go to exhibitions are usually in groups like students in the same class, friends, couples or families. In the CINOVA framework, we meant to provide these visitors immersive and multi-modal interactions with the knowledge presenting virtual agents. The setting of sensor devices, microphones or cameras that capture the activities of the visitors and 3D graphics that required high-end machine are possible.

Individual Web visitors. They are the people who access the Web site of the institution remotely. In the Web environment, the setting of sensor devices and the timing control of the agent's behaviors are not practical and thus the agent's functionalities are more suppressed.

These users exchange, share and acquire knowledge via knowledge card media through the CINOVA framework. The experts provide their knowledge to the knowledge base, the creators author the cards to presentation contents (stories), the knowledge is then presented by virtual agent systems instead of the staff of the institution. The knowledge consumers (visitors on-site or from remote) acquire their demand knowledge via the interactions with the virtual agents who are never tired and can serve queries in all aspects as long as the answers can be found in the knowledge repository rather than a human exhibitor who is usually only an expert of certain area. This forms a circulation of knowledge and is considered to be able to facilitate the communication between the institution and the public audience. The knowledge is made actionable and can also facilitate the institution to create new knowledge.

3 Visualized Knowledge Management and Agent Presentation Subsystems

There are two knowledge card based and visualized knowledge management subsystems implemented in CINOVA framework up to now, a zoomable 2D implementation, Gallery [3] and a 3D implementation Sustainable Knowledge Globe (SKG) [6]. Both of the two system share the basic ideas of utilizing zooming user interface for browsing large image collections and humans' spatial memory, that is, the human ability to remember the location of a stored item.

Gallery presents its contents on a smoothly zoomable 2D surface forming a memory space. It has virtually unlimited size and comprises concept nodes that represent the user's thoughts while knowledge cards are displayed as image thumbnails within a node. New concept node are created by dragging the mouse cursor out from an existing node and entering a filter string. Gallery uses this string to match keywords, annotations, the file path, and date of the items in the parent node. Items coinciding with the filtering string will then become the contents of the newly created node. The user retrieves information from the memory space and places newly generated nodes repeatedly and then a logically organized tree structure of the user's view over the whole repository will finally be constructed.

SKG is a 3D implementation of CINOVA compatible VKMSs and features the metaphor of a planet. Knowledge cards are represented as image thumbnails on the surface of the planet and are organized to tree structures by the user's direct manipulation. Virtual landscape with mountains and islands is used as the abstract representation of knowledge cards clusters. Because the surface of a sphere is limited, the sphere will expand to make space for accommodating new cards when there is no space (sea) left.

Gallery is 2D and is implemented in OS independent Java language while SKG is 3D and is implemented in Microsoft Windows' native API. This caused major difference of the possibilities of the two systems. Despite the argument on infinite 2D surface or 3D is better which is out of the scope of this paper, Gallery can be run virtually anywhere including the browsers but SKG is bounded to Microsoft Windows. Gallery is also light-weighted and can hold larger scale of contents. On the other hand, SKG's interface is much more fancy and rich. It can also deal with OS dependent contents like Word, PowerPoint files or multimedia clips while Gallery only accepts most simple knowledge cards with text fragments and images. They provide the varieties of choices and allow the users to pick their favorite one depending on their environments and needs.

Two virtual agent presentation subsystems are the front-end of the knowledge repository of the institution toward public visitors either from the Internet or in an exhibition.

EgoChat [5] is a Web based avatar presentation system. One or two avatars stand for the contents creator and present the stories composed with knowledge cards. A Q&A module is also attached and allow the contents user to feedback a question when there is something that they do not understand. An answer will be selected

from a Q&A stories related to the channel of that story. If there is no appropriate answer found, an answer request will be sent to the contents creator via an e-mail.

Life-like virtual agents who can do real-time and multi-modal face-to-face interactions with human users involve many research disciplines and are very difficult to develop. Our previously proposed Generic Embodied Conversational Agent (GECA) framework [1] introduced the concept to distribute agent functionalities like sensor data processing, deliberation or character animator to simple, general purpose and reusable standalone modules that are connected with a common platform. In the reference implementation, the possible user-agent interactions are defined as stimulus-reaction pair based script language. One knowledge card is converted to one scene of a GSML script and the image of the knowledge card is associated to the background image of that scene.

EgoChat agents and GECA based agents have obviously different usages. Limited to the Web environment and remote access nature, EgoChat agents have suppressed GUI but it can have very broad audiences. As a contrast, the GECA agents are displayed on-site and user activity information from sensor devices are possible. They thus can aim high-degree multi-modal interactions with user groups.

4 Deployment Status

The National Food Research Institute (NFRI) is one of the typical institutions seeking for the solutions of the knowledge disseminating channel with public audiences. It is executing research programs that contribute to secure supply of safe food, and technical innovation in agriculture and food industries. It stands for the Japanese government and bears the responsibility to be the source of dispatching food related information and arouse the public's awareness on food safety.

Among the four introduced subsystems, the two virtual agent presentation systems are already deployed to NFRI in real uses. EgoChat is being used as a poster presenting agent since an exhibition in November 2006. It is reported by the staff of NFRI that the presentation done by the avatar agent is more understandable and more efficient to convey information to the audiences in short time period than presenting by themselves. By using EgoChat agents, they also don't need to worry about failures. It is also used for on-line quiz and in the homepage of certain working groups of the institute. The average page views per month in last year was 1,543 with a peak in May (3,943) This probably came from the effect of the open lab event held at the end of April.

This preliminary version of the GECA based quiz agent kiosk is equipped with a touch panel user interface and equips an emotion dynamics module changing the background melodies. This kiosk was displayed in four NFRI open lab exhibitions from April 2007. Each time there are totally around 2,000 people visited these events and averagely 250 (78 groups) of them played with the quiz kiosk. The typical visitors of NFRI exhibitions were the people who live in the neighborhood or teenage students come from nearby high schools. Almost during the whole day, there were

dozens of visitors waiting for playing the game. Therefore, we considered that the basic idea was very successful in attracting the visitors. Besides, from questionnaire investigation, most of the visitors reported that they enjoyed the game and felt the knowledge explained by the agent is more trustable.

5 Conclusions

The four subsystems were developed with keeping knowledge card / story concepts in mind, but due to the fairly heterogeneous natures of them. The needs of knowledge representation are different one to one. For example, in the highly interactive GECA tour guide agent, the user can point to a specific area and ask the agent to introduce that place, the coordinates of areas on the background image is essential to the GECA agent but is meaningless to the present only EgoChat agent. Therefore, a clear definition of ontology of knowledge card mediated systems is required. The GECA based quiz agent is the current research focus in our group. We are trying to improve it to be aware of the status of user groups via video and audio information. The rough idea and preliminary results have been presented in [2].

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