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Toward a Real-World Knowledge Medium: Building a Guidance System for Exhibition Tours

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Abstract We propose a notion of a real-world knowledge medium by presenting our ongoing project to build a guidance system for exhibition tours. In order to realize a knowledge medium usable in the real world, we focus on the context-awareness of users and their environments. Our system is a personal mobile assistant that provides visitors touring exhibitions with information based on their spatial/temporal locations and individual interests. We also describe an application of knowledge sharing used in the actual exhibition spaces.

Keywords: Knowledge Medium, Intelligent Agents, Context-awareness, Community Supporting Systems.

§1 Introduction

We propose to build a real-world knowledge medium where people having shared interests externalize, accumulate, exchange, and create knowledge with the help of intelligent systems. "Real-world" is viewed from two aspects: one is the application targets of the system, and another is the orientation of the system usage. Although many works on intelligent systems have been done and some of them perform well, most systems deal with so-called toy problems without even showing practical application targets. To make matters worse, the experimental environments of the systems are isolated from our real life. However, original targets and focal points for our communications are deeply situated in the real world, which should not be limited by computing environments. Therefore, we have to reconsider practical applications of intelligent systems and their usage beyond today's desktop computing.

In order to constructively discuss the proposal and its current status, we describe our Context-aware Mobile Assistant Project (C-MAP).[6] The initial aim of C-MAP was to build a personal mobile assistant that provides visitors touring exhibitions with information based on contexts (spatial/temporal locations and individual interests). We prototyped the first version of the system by using portable computers wirelessly connected and visitor location detection devices. The annual open house of our research laboratories was used as a testbed. Considering an exhibition space augmented by the C-MAP system as a real-world knowledge medium for people involved in the exhibition, we describe services for facilitating new encounters and information sharing among visitors and exhibitors during/after the exhibition tours. By showing the system, we discuss future challenges of intelligent systems such as context-awareness and seamlessness between machine intelligence and real-world application.

§2 Knowledge Media Situated in Real World

Stefik[5] has proposed a notion of a new knowledge medium that is a kind of information network with semiautomatic services for the generation, distribution, and consumption of knowledge among people in society. The knowledge medium greatly differs from existing media, e.g., newspapers and television, in how anyone can be an information provider as well as receiver, and communities having shared interests and the capacity for collaboration can dynamically emerge by the medium. Accordingly, such knowledge media necessitate not only passive tools, e.g., a simple text search engine by keyword matching, but also intelligent systems that autonomously and actively work within human society, e.g., creating knowledge applicable to problems of individuals/organizations by structuring massive information on the net according to subject, finding collaborators, and forming communities for sharing knowledge and interests.

Recent research on intelligent agents[4] and recommender systems[3] have proposed intelligent systems that support creative works on networked computes, such as information gathering, information filtering, decision making, and so on. Network computing with such intelligent systems removes temporal and spatial restrictions from our communications and is indispensable to building the knowledge medium. However, our daily problems and activities are deeply embedded in real-world contexts, and they must not be limited to desktop computing environments. Therefore, in order to build a knowledge medium usable for our real-world activities, we must reconsider the fashion of interactions between humans and the intelligent systems running on real-world computing environments such as mobile, wearable and ubiquitous computing devices. For example, real-world computing systems are not good at input/output based on texts and menus on graphical displays, but they are good at capturing a user's spatial/temporal contextual information since they always function with the user.

In investigating how to create a knowledge medium, we have chosen exhibition-type applications such as museums and open houses for research laboratories. The reason for this approach is that these are places where knowledge is accumulated and/or conveyed by people physically gathering through seeing, touching, and experiencing actual exhibits, and where exhibitors as specialists

provide knowledge to visitors with diverse interests and viewpoints. Conventional exhibitions, however, have many restrictions. The followings are the existing problems and corresponding challenges to prototype a knowledge medium over exhibition-type applications.

- All visitors are provided with the same information prepared beforehand. → *Building a methodology for personalization to provide and present information according to individual contexts*
- Knowledge communication flow is limited to a one-way flow from exhibitors to visitors. → *Building a mechanism for not only exhibitors but also for visitors to provide their thoughts and experiences and to contribute to collaborative knowledge creation*
- Knowledge exchange is limited to certain places and times. → *Providing a digitized world for continuous/open knowledge sharing motivated by and situated in real-world experiences*

§3 C-MAP

3.1 Overview of the C-MAP System

We prototyped the first version of the C-MAP system for an annual two-day open house exhibition held at our research laboratory in November, 1997. The exhibition area for the experiment was on one floor and had 19 sites, including about 70 posters corresponding to research projects. We had about 170 visitors registered to use our mobile assistant during about 10 service hours over the two days.

Fig. 1 illustrates the hardware architecture of the system. The system principally consists of servers, which provide exhibit-related information and guide information, and portable PCs connected to the servers by a wireless LAN. For detecting users' locations, we used Olivetti's Active Badge Systems (ABS). ABS infrared sensors mounted on the wall of each exhibit site detect badges worn by users. The ABS server gathers the latest sensor data and updates the

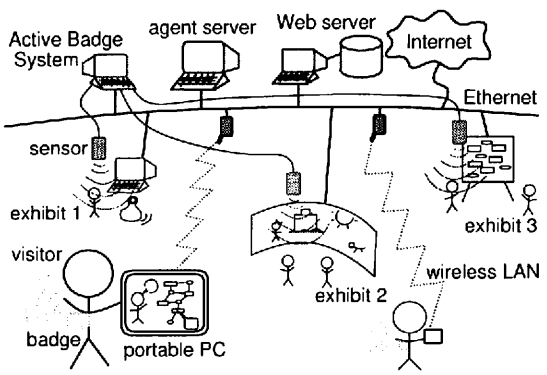

Fig. 1 Schematic Diagram of C-MAP System

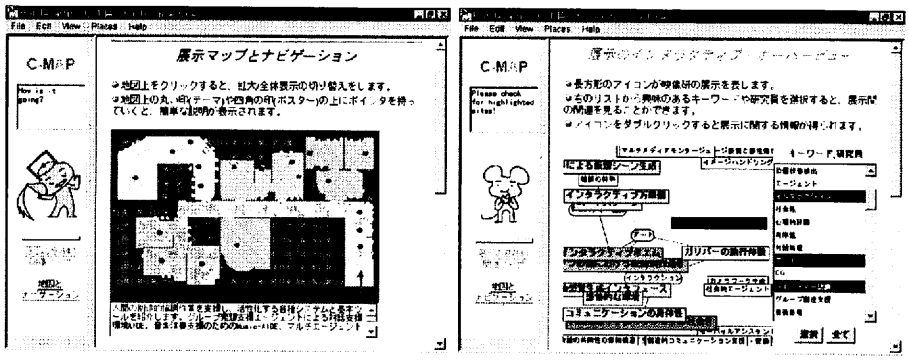

Fig. 2 Screenshots of the Mobile Assistant's Display Showing Physical and Semantic Maps

location data of all badges, i.e., users. The agent server provides personalized guidance during the tours such as route planning and exhibit recommendations by monitoring the ABS information and each user's interaction with the system via the portable PC. The Web server is used as a server of Java applets for the mobile assistant and as a server of exhibit-related information. This server is connected to the Internet and is therefore open to users outside of the exhibition site. This facilitates the seamless provision of offsite services, which are provided through a network before and/or after exhibition visits.

Each portable PC runs the Web browser for the mobile assistant's Java applets to guide the tour, show exhibit-related information, interact with the user, and display animated characters of the guide agents. Examples of a mobile assistant's display are shown in Fig. 2; this display has a main window on the right and a frame on the left. The user obtains visual guidance of the exhibition space in the main window by alternatively viewing a physical map applet (left side of Fig. 2), which displays the geographical layout of the sites and the user's current location, and a semantic map applet (right side of Fig. 2), which visualizes the semantic relationships between the exhibits based on keywords selected by the user. The controlling frame displays links for viewing the two applets and the animated character and message box of the personal guide agent.

The mobile assistant also recommends exhibits based on the contexts of the user and environments, such as the similarity between the selected keywords and each exhibit's keyword vector, the touring history of the user, the geographical distances between exhibit sites and the user location, the exhibit site attendance, and the exhibition's demonstration schedule. The calculation of a recommendation responds to changes in contexts, e.g., the user's selection of keywords on the semantic map and the user's movement to different exhibit sites. Recommended exhibits are indicated to the user by highlighting three icons (with higher scores) on both the physical and semantic maps.

3.2 Personalization of Exhibits

We can easily combine the C-MAP guidance system with exhibit applications by allowing the applications to use the user information accumulated in

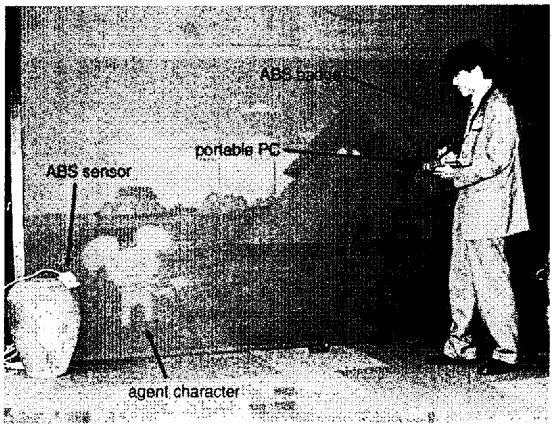

Fig. 3 Guide Character Appearing in an Exhibit Application

the agent server. Fig. 3 shows an example of this combination in an exhibit application where a user's personal guide agent character appears. In this example, once a user's badge is detected by a sensor located in the demonstration area, the agent character residing in his/her mobile assistant automatically appears and leads the user through the virtual space of the exhibit application. For a combination of exhibit applications with the mobile assistant, various directions are expected, such as exhibit guidance personalization based on the individual interests and knowledge of the user inferred by his/her previous touring records. In this example, the user's frequency in using the mobile assistant was used to quantify the activity and (based on this value) to automatically switch the demonstration courses.[1] This personalization is a simple but effective way to increase user satisfaction in experience-based exhibits.

Currently, we are developing a general architecture to personalize exhibit displays according to a user's context by using palm-size PDAs (Personal Digital Assistants) such as 3Com's PalmIII, which can communicate, by infrared, with exhibit displays ubiquitously mounted on the walls of the exhibition site. The PDA keeps its user's personal profile and touring records, which are conveyed to the exhibit displays when the user turns the PDA to these. The individual exhibit displays are then personalized for presentation based on the user's context (individual profile and touring records). This architecture is more practical than the first prototype, which used heavier portable PCs, and facilitates the protection of the user's privacy and the maintenance of the exhibitor's preparation because the individual user data and exhibit-information can be distributed.

3.3 Offsite Services

Since the user data that can be obtained by the guidance system during an actual tour is limited, obtaining detailed user data such as user interests and areas of expertise by online services would be very beneficial. The user interface of the C-MAP system is built with Java applets to enable it to be used on Web browsers in remote sites as well as at the actual exhibition site. For example,

the semantic map will allow potential visitors to preview of the exhibition and to extend their knowledge space through Web-surfing by starting from the semantic map, which will be restructured according to the individual user's interests.

We have also developed an online viewing system based on question-and-answer interaction, which personally directs a user in exploring the information space of exhibitions.[2] The user can select some interesting keywords from an outline text of an exhibit and ask questions about the keywords for getting detailed information from the system. This helps the user to access deeper knowledge based on his/her interests. According to the user's interests and knowledge, the system recommends other exhibit information and predictively presents the answering windows showing potentially attractive keywords when the user encounters related exhibit information. To do this, the system gradually improves the user's interest model by monitoring the user's selection of keywords and their related questions and his/her evaluation to given answers ("interesting" or "uninteresting"); the system then uses that information for the recommendation and the predictive presentation of answering windows.

These obtained user data by online services certainly help in the advance preparation of the personalized guide agents and in improving the exhibit. They can also be exploited to model the user for the community-supporting systems described next.

§4 From Personal Touring Assistant to Community Support

So far we have mainly shown the C-MAP functions for personalizing individual touring assistants. Although the main objective of C-MAP is to encourage mutual communication among people involved in exhibitions, the personal touring assistant only supports a one-way flow of knowledge from exhibitors to visitors. In order to allow visitors to actively participate in knowledge creation as information providers, we aim to support the formation of communities and the exchange of personal knowledge/experiences among visitors/exhibitors sharing interests in the exhibits.

As a first step toward this goal, we developed a method to structure the records of users of our guidance system to provide them with visualized community networks.[6] The community network's structure is a graph whose nodes represent visitors, exhibitors, and exhibits. Connections are also shown in the graph between people having shared interests in the exhibition. It is hoped that these community networks can be used to encourage further communications between people by providing services, such as proposing possible new communities, and offering a forum for information exchange between individual exhibitors and visitors.

Fig. 4 shows our scenario of knowledge communications flowing within exhibition tours using the context-aware guidance system. Individual visitors' tours in the exhibition site are situated in their own contexts. That is, although seeing exhibits, speaking with somebody, and recording picture and voice memos with the help of our system are only independent/disconnected functions, the visitors' contexts (temporal/spatial touring records, quantified interests, and so

on) captured by our system automatically index the individual data along with the contextual data. Therefore, the system can connect their touring experiences in the actual space to a digitized information space by using the contextual indices. For example, the system can easily generate personal touring diaries of individual visitors that show visited exhibits and their experiences such as picture/voice memos, as shown in the lower-right side of Fig. 4, by capturing the individual user's temporal/spatial contexts.

Community networks structure and visualize the relationships among exhibits, exhibitors and visitors based on the touring records of certain users (visitors). They can be provided via the Internet as an offsite service. At the same time, we are interested in serving them with active community boards set at community squares in the exhibit site for facilitating actual meeting and information sharing in the real world.

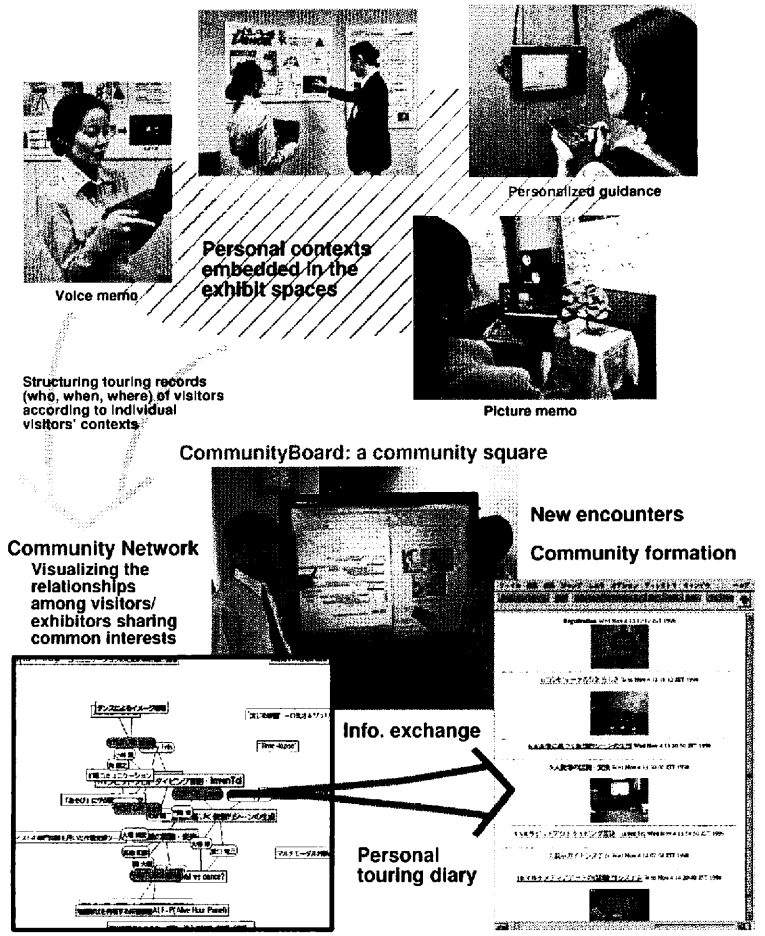

Fig. 4 Knowledge Communications Embedded in Exhibition Spaces

For real-world applications with mobile/wearable interfaces, we cannot rely on text input with keyboards and direct manipulation of information presented on graphical displays, so we need a more intuitive and natural input/output interface. Therefore, we are planning to complete and currently partially implementing a new interface based on audio/visual graffiti for easily and collaboratively inputting/browsing audio/visual notes during exhibition tours.

§5 Conclusion

We proposed a notion of a real-world knowledge medium by presenting our ongoing project of a guidance system for exhibition tours. In order to realize a knowledge medium usable in the real world, we have focused on context-awareness, which has two aspects, i.e., comparatively short-term context-awareness in the exhibition site and long-term context-awareness involving offsite services (before and after exhibitions). Since onsite services are more deeply embedded in the contexts of the real world, we have been developing context-sensitive applications having rich real-world interactions by making the environment sensitive.

We believe that building a context-aware personal guide agent will lead to facilitating community formation based on shared interests and knowledge exchange within the communities. It might appear that our current C-MAP system only gives opportunities to exchange knowledge between people having shared interests. However, knowledge exchange in a digitized world, even one which has rich information, will not be effective without such a condition. To effectively exploit existing intelligent systems of digitized worlds in a real-world knowledge medium, we must connect the digitized and real worlds.

Finally, the following issues remain to be solved before achieving a real-world knowledge medium:

- We need to create personal agents that can capture the user's context and information from every possible digitized data that daily involves the user.
- We have to continuously work on finding solutions to social issues such as authorization and privacy of exchanged information.
- A knowledge medium allowing asynchronous/distributed communications will depend on agent mediation. Accordingly, we need a method for externalization, communication, and presentation of the agents' knowledge with multi-goal scripts so that they can semi-automatically interact with each other on behalf of the users.

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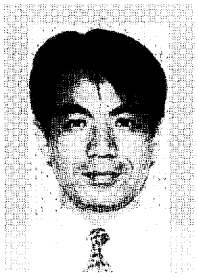

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