Conference assistant system for supporting knowledge sharing in academic communities

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Abstract

This paper describes our ongoing attempts to build a communityware system by presenting a project of providing digital assistants to support participants in an academic conference. We provided participants at the conference with a personal assistant system with mobile and ubiquitous computing technologies and facilitated communication among the participants. We also made online services available via the Web to encourage the participants to continue their relationships even after the conference. In this paper, we show the system we provided for the project and report the results. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Communityware; Conference assistant; Personal agent; Support for new encounters; Knowledge sharing

1. Introduction

Recently, a lot of research has been done on communityware, a software that allows large decentralized groups of people to form communities, share preferences and knowledge, and perform social activities (Ishida et al., 1998). Unlike previous research on groupware, which has mainly supported the collaborative work of already-organized people with shared goals, communityware is for more diverse and amorphous groups of people sharing interests and preferences, and not obvious goals. In communityware, the objectives and benefits of an activity are not centralized, but distributed. The essence of the activities changes from finding solutions to finding issues to be solved. The interests and volunteering mindsets of the participants empower these activities, and not a sense of duty or direct rewards.

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In investigating how to create such a communityware system, we have chosen social events situated in the real-world, such as attending conferences, visiting museums and viewing open house events at research laboratories. The reason for this choice is because these are opportunities where knowledge is accumulated and/or conveyed to people by seeing, touching, and experiencing actual events, and where informants, as specialists, provide knowledge to visitors with diverse interests and viewpoints.

In the last few years, we have prototyped and revised several versions of a personal guidance system for exhibition tours. The system personalizes a tour guidance according to its user's individual context, and facilitates knowledge communication among communities by matchmaking users having shared interests and providing real and/or virtual places for their meetings (Sumi et al., 1998; Sumi and Mase, 2000, 2002).

This paper describes one of our project's practical applications, a project of providing digital assistants to support participants in an academic conference, the 14th Annual Conference of the Japanese Society for Artificial Intelligence (JSAI 2000), which was held at the International Conference Center of Waseda University from July 4th to July 7th, 2000.

The aim of the project, called the JSAI 2001 Digital Assistant Project, was to enhance communication among the JSAI 2000 participants. The events of various societies such as annual conferences give society members an attractive opportunity to experience new encounters and face-to-face knowledge exchanges, and enable them to become informants as well as audience members. However, it is unexpectedly difficult to efficiently exploit this opportunity within the period of a conference: we tend to miss meeting other participants who have shared interests or fail to attend noteworthy presentations. In addition, even if we could meet and have fruitful discussions with other participants at the site of a conference, these relationships would likely terminate after the conference.

We provided JSAI 2000 participants with a personal assistant system with mobile and ubiquitous computing technologies and facilitated communication among the participants. We also made online services available via the Web to encourage the participants to continue their relationships even after the conference. The services of the project extended from paper submission, to online previewing via the Web, personal assistance and information sharing support at the conference site, and Web services after the conference.

In this paper, we present the system that we provided for the project and report the results.

2. Digital services for society events: related works and motivations

With the recent spread of e-mail and Web services, it has become common to use the Web to announce conferences, call for papers, submit papers, and review papers. Such digital data, however, have only been used by conference organizers to manage their conferences, but not to facilitate information sharing among participants to the conferences.

As one of the earliest works on digital services for society events, Salomon (1990) provided CHI'89 participants with conference information, e.g. presentations, participants, and venues, by kiosk terminals located at the conference site. Digital kiosks play an

important role in open spaces, such as conference halls, museums, and town community centers. Their kiosks, however, do not provide individual users with continuous and personalized services. On the other hand, our system aims to personalize its services by integrating kiosk services, which can be casually used at community places, and mobile devices that are highly personalized and continuously accumulate their users' contextual information.

There have been many works on building tour guidance systems for museum visitors and travelers by using mobile and network computing technologies (Nagao and Rekimoto, 1996; Abowd et al., 1997; Feiner et al., 1997; Cheverst et al., 2000). However, almost none of them have focused on the enhancement of information sharing among users. Classroom 2000 (Abowd, 1999) was an attempt to support the sharing of course materials and hand-taken notes by applying ubiquitous computing technologies to a living educational environment. The focus of this work was on the personalization of rich digital documents automatically captured at fully equipped classrooms. Our focus, in contrast, is the enhancement of communication among users by exploiting their nomadic experiences in a larger space, i.e. a conference site.

Meme Tag, an electronic name tag that is capable of exchanging short messages while facing other tags, and Community Mirror, a big screen that visualizes the spread of messages (Borovoy et al., 1998), are interesting efforts at facilitating interaction between people sharing interests at actual party locations. However, the exchanged information among users consists only of short messages, which are insufficient for communities.

Dey et al. (1999) prototyped a mobile assistant system for conference participants by using a position detection technology with RF tags. Their aim included the facilitation of information sharing among conference participants after a conference by using not only digitized papers but also presentation materials. Although their work is of interest to us, the actual workings of their system at conferences have not been reported. One of our motivations to deploy our system as a digital assistant service for actual conference participants is to explore how such technologies are used and evaluated by a practical community.

The most closely related work to ours has been the ICMAS'96 Mobile Assistant Project (Nishibe et al., 1998). They provided portable digital assistants with various services to assist conference participants. The users could use e-mail and online-news services. They were also able to use a service that supported the exchange of information related to the conference with the other users. The characteristics of our project in comparison with theirs are that we combine mobile assistant services with services on kiosk terminals located at the conference site, and we integrate online services via the Web, which can be accessed before/after the conference, with services provided at the conference site.

Members of a community such as an academic society are spatially and temporally distributed. Although network computing, such as the Web, removes the spatial and temporal restrictions from them, it is difficult to maintain effective communication among a community without a focal point situated in the real-world. Society events provide good focal points for their communication. The principle of our system design is a mutual augmentation between online services via the Web and the services provided at the conference site. That is, the online services are expected to reinforce tours at the conference site (real space), and conversely, tours at the conference site are expected to
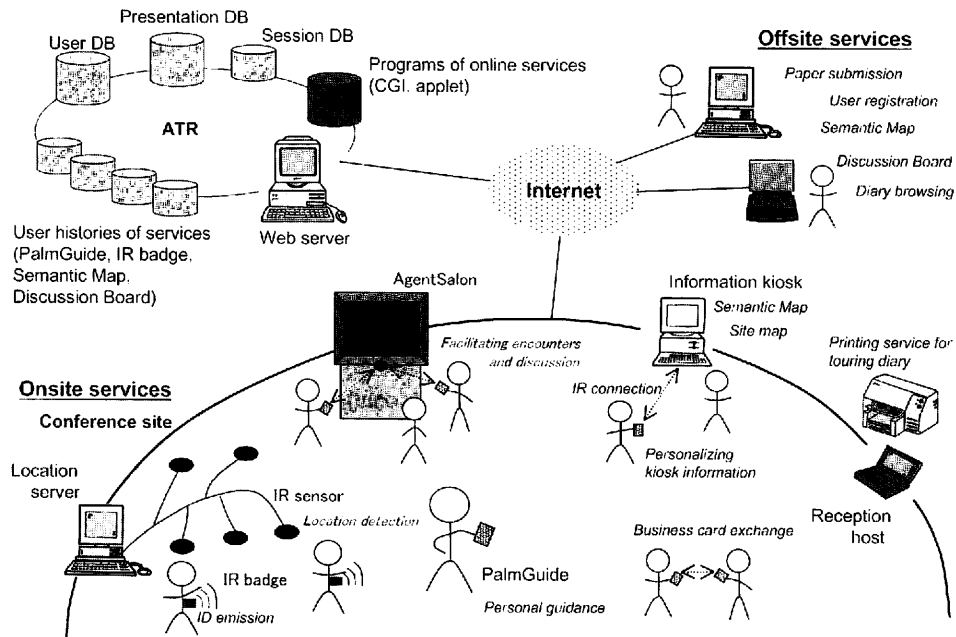
Fig. 1. System overview.

provide users with motivation and focal points for communication beyond the existing temporal and spatial restrictions.

3. Overview of the project

3.1. System overview

We provided all participants with services at the conference site (called onsite services) and online services via the Web (called off-site services). The aim of the onsite services was to provide the users with information focusing on 'now', 'here', and 'with who' in order to encourage them to share information with other conference participants while attending presentations and having face-to-face discussions. The aim of the off-site services was to remove tempo-spatial constraints from information services by using the Web.

Fig. 1 shows an overview of our system. The system principally consisted of mobile devices (a portable guidance system called PalmGuide and infrared badges) carried by the users at the conference site and a Web-based online system.

PalmGuide is a portable guidance system for a conference participant. It is not constantly connected to the network, but has an infrared communications port so that it can access network resources by connecting with kiosk terminals located at the conference site.

The kiosk terminals (and AgentSalon, a kind of kiosk) were connected to a local-area network (LAN) at the conference site and used to access, via the Internet, a Web server located at ATR (our laboratory). A location server with several infrared sensors, to detect the IDs emitted by the infrared badges worn by the users, was also connected to the LAN. All of the data collected by the location server were used to show the current locations of the users on the site map, a service available on the kiosks.

The Web server, remotely located at ATR, accumulated the data collected at the conference site, such as the users' records using PalmGuide and the infrared badge, and provided tailored service content based on requests remotely sent from kiosks via CGI. The Web server also continuously provided off-site services for paper submission, user registration, and conference information viewing.

As described above, the system was a combination of various platforms and programming languages, i.e. the Web server with a Java applet and about 40 CGI programs written in Perl, PalmGuide running on PalmOS devices, information kiosks and AgentSalon with JavaScript and Microsoft Agent[3] running on Web browsers and infrared communications components written in C++, and the location server programmed with Java.

3.2. Data preparation

The conference was held for four days and had about 250 presentations (oral presentations and demos) and about 600 participants.

We prepared a Web server to receive paper submissions before the conference. Upon submission, the authors were automatically registered as users of the JSAI 2000 Digital Assistant Project and their IDs and passwords were created.

In order to provide a service enabling the browsing of conference data (papers and authors), we had to quantify these data and the user's intention (interests, preference) somehow. For this purpose, we used keyword vectors. At the time papers were submitted, we received all of the keywords freely attached to the papers: The numbers of keywords was over 650, which was not useful for indexing the papers and the users' interests. Because of this, we prepared a thesaurus to consolidate these keywords into 28 formal keywords.

The data treated by the project included not only the above static data, but also data dynamically captured and updated during/after the conference, such as a user's history of using our system, preferences, and Internet resources (homepage URLs) employed by the user.

4. Services provided

4.1. Portable guidance system: PalmGuide

One of the most important services we wanted to provide conference participants was a

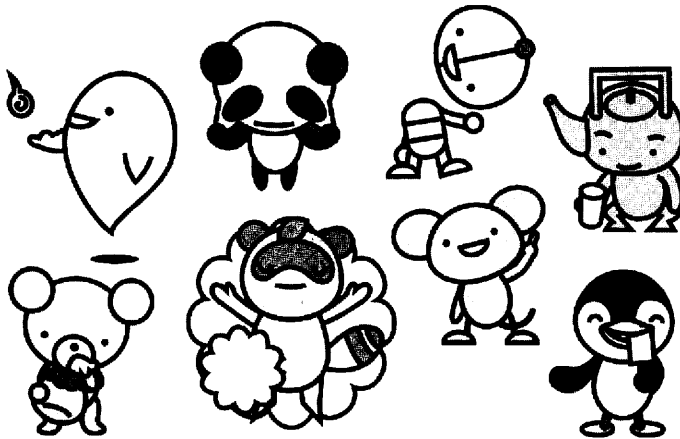---

[3] http://www.microsoft.com/msagent/.

Fig. 2. Eight guide agent characters.

portable guidance system at the conference site. To that end, we prototyped a lightweight tour guidance system good for nomadic usage during tours, called PalmGuide. PalmGuide runs on PalmOS PDAs (Personal Digital Assistants). We prepared 50 PalmOS devices (IBM WorkPads) for the PalmGuide system.

Upon borrowing a device, a user selected an agent character from among eight characters that we prepared beforehand (Fig. 2). The character representation was intended to have the agent increase the believability, consistency, and transparency of services, by having the agent show up on PalmGuide as well as on the kiosk displays and AgentSalon when the user connected his/her PalmGuide to them.
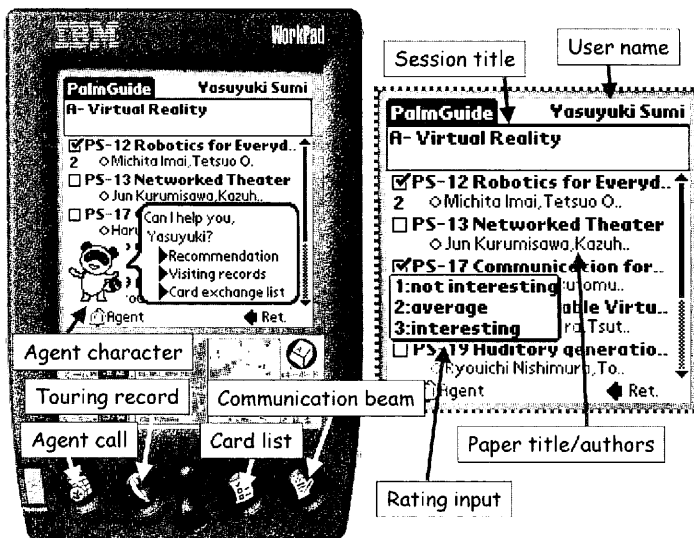

Fig. 3. Displays of PalmGuide.

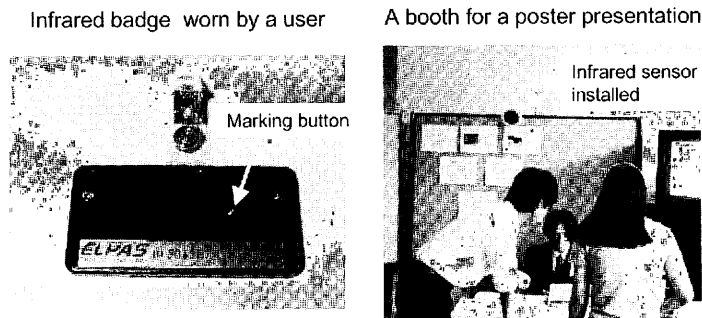Infrared badge worn by a user   A booth for a poster presentation

Fig. 4. Infrared badge and sensor.

Fig. 3 shows example displays of PalmGuide. PalmGuide provided its user with the following four functions.

- *Browsing of the conference program* (left side of Fig. 3). The user could hierarchically browse dates, sessions, individual presentations, and their abstracts and authors.
- *Recommendation of presentations.* Presentation recommendations for the next participation were calculated based on the current time and the user's ratings for the presentations that he/she had earlier attended.
- *Management of touring records.* The user could mark the presentations that he/she had earlier attended (right side of Fig. 3). A dialogue box for the user to give a rating (1: not interesting, 2: average, 3: interesting) automatically popped-up when he/she marked the box beside the corresponding presentation title.
- *Exchange of virtual business cards.* All PalmGuide users could exchange 'virtual business cards' by turning their PDAs towards others.

4.2. Infrared badge

For users who prefer an easier device, we prepared infrared badges for location detection. As wearable devices, they were more casual than PalmGuide. Each badge was used as a name tag as well.

We used the EIRIS system by ELPAS (Fig. 4).[4] With this system, a badge emits a unique ID every 4s and the nearest sensor detects it. All detected data is collected at the location server, which updates a table of the current location of every wearer. The table can be referenced by other machines on the LAN, allowing the site map on the kiosks to show the wearers' current locations.

As can be seen in Fig. 4, an EIRIS badge has a button on its back. Pushing the button emits a signal with its ID. We used this button as a 'marking button'. That is, the badge user could mark an interesting presentation by pushing the button while attending the presentation. The data collected by the location server was used to create the user's touring diary.

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[4] http://www.elpas.com.

Fig. 5. Information kiosk located at the conference site.

We installed the infrared sensors of the EIRIS system at three halls for oral sessions, at eight booths for poster demonstration sessions, and at AgentSalon.

4.3. Information kiosks

We did not intend for all participants at the conference site to carry PalmGuide devices or wear the infrared badges. Another important service we wanted to provide was one that all participants could use without any special devices. Also, we wanted to make it exploit online resources for showing the conference participants the present activities of a community to which they belong. To that end, we placed four sets of information kiosks at the conference site. As can be seen in Fig. 5, each kiosk terminal was a Windows PC with an LCD touch panel.
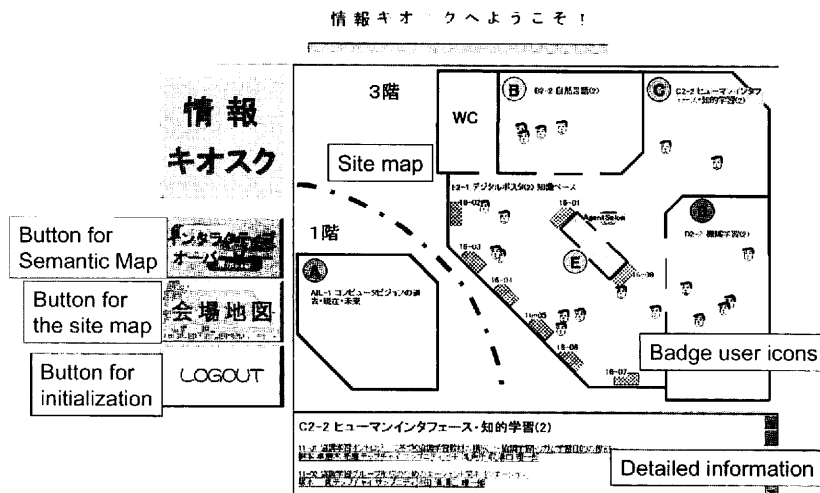
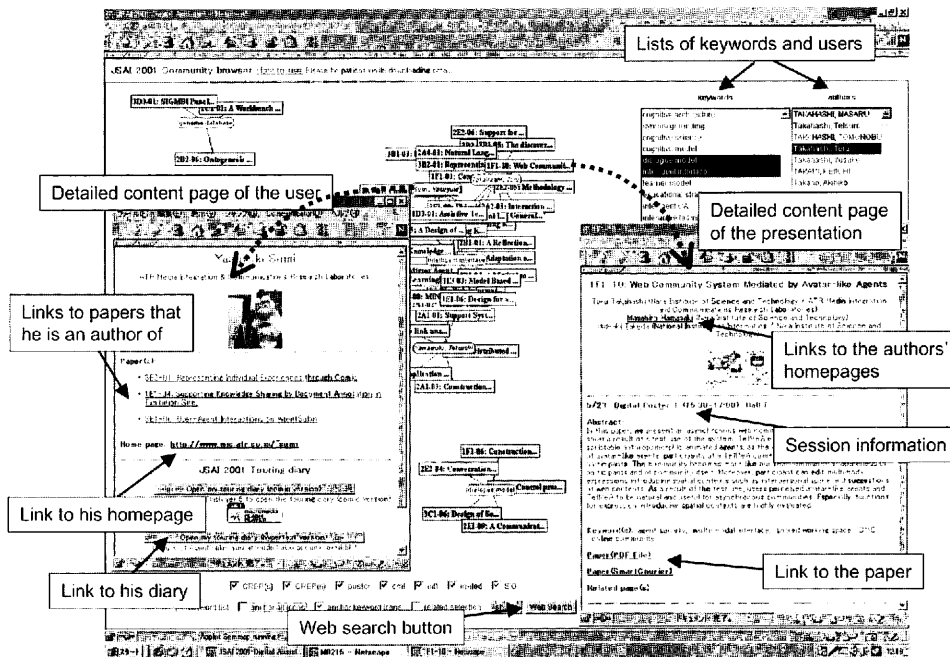

Fig. 6. Example display of an information kiosk.

Fig. 7. Semantic Map interface.

We provided the following services on the kiosk.

- *Site map.* The user could browse the titles and abstracts of ongoing presentations by touching the displayed map. The locations of badge users were also shown on the map, so the viewer could immediately know the popularity levels of the current presentations (Fig. 6).
- *Semantic Map.* The user could browse the semantic relationships between the presented papers, topic keywords, and participants.
- Since the kiosk was connected to the Internet, the user could access Internet resources from the site map and Semantic Map, such as other participants' Web pages.

Although the kiosk could be used without PalmGuide, the services on the kiosk could be personalized by connecting PalmGuide. By connecting PalmGuide, the agent character on PalmGuide would migrate to the kiosk display and guide the user on the use of the kiosk. Semantic Map could also be personalized by filtering displayed information based on the user's touring history and preferences.

4.4. Semantic Map

Because our system provides a large quantity of conference information, conference participants need a tool for easily and effectively browsing and exploring the information. Therefore, we provided a system called Semantic Map (Sumi and Mase, 2000), a visual
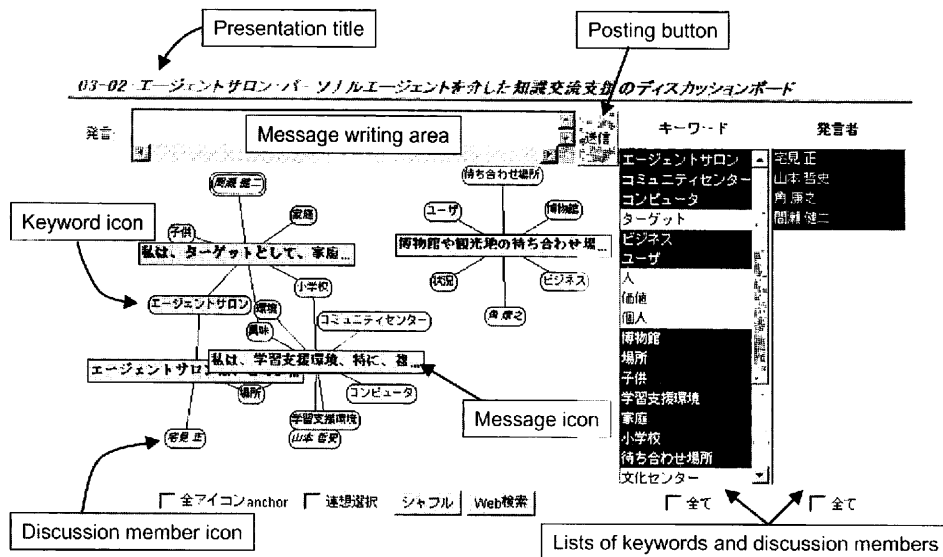
Fig. 8. Example display of Discussion Board.

interface for browsing conference information. The conference information includes not only information about the papers presented at the conference, but also community-like information about their authors and the conference participants. Semantic Map is implemented by a Java applet, so a user could seamlessly use it as a front-end interface for the kiosk services at the conference site and off-site services via the Web.

Fig. 7 shows a screen shot of Semantic Map being used as the user interface for the Web online service.[5] Semantic Map shows a graph consisting of presentation icons (rectangular icons), keyword icons (oval blue icons), and author icons (oval green icons). The user can select interesting keywords and/or participants from the lists on the right side of the applet. By selecting them, the displayed icons are filtered: This shows the user's personal viewpoint.

On the graph, the icons of PalmGuide users (oval pink icons) are also displayed and linked to presentation icons according to the users' ratings: That is, if a user evaluates a presentation as 'interesting', his/her icon is linked to the presentation icon.

There is a 'Web Search' button at the bottom of the applet. Pushing the button opens a window showing a list of related Web pages searched by a search engine (currently, Google), using keywords currently selected on Semantic Map. This means that Semantic Map enhances the user's exploration not only within the community information collected by our servers but also among the open resources on the Web.

Double-clicking presentation icons and participant icons open their pages, which include paper abstracts and links. Semantic Map also functions as a portal for our other online services, such as our Discussion Board and touring diary services.

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[5] Note that the example was captured from the newer version in 2001 because the version in 2000 did not support English.
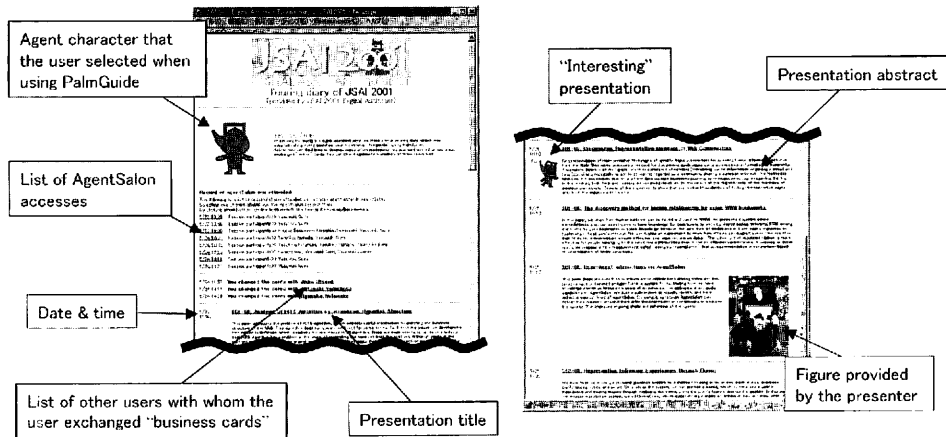
Fig. 9. Example of a touring diary.

4.5. Discussion Board

To encourage deeper interaction between presenters and audience members without tempo-spatial restrictions, we provided Discussion Board, an online discussion system. Discussion Board was provided for individual presentations and was accessible from the detailed content page of the presentation. We intend for it to be used as a way of sending questions about a paper before a conference so that its authors can improve the presentation of the paper at the conference, as well as discussing and reporting updated information after the conference.

Fig. 8 shows an example display of Discussion Board. Although its interface is very similar to that of Semantic Map, Discussion Board visualizes relationships between posted messages and their writers. In the case of Discussion Board, the displayed keywords are automatically extracted from posted messages by using a Japanese parser, called Chasen, developed by NAIST.[6]

4.6. Touring diary

By using PalmGuide and infrared badges, the electronic 'footprints' of the individual users were accumulated in the Web server. We provided the users with automatically created touring diaries by using this data.

Fig. 9 shows an example of a touring diary. The figure shows a list of other PalmGuide users with whom the user has exchanged virtual business cards and a list of the presentations he/she had attended. Since the diary was provided as a Web page, the user could use the diary as a portal for the Web pages of presentations and people he/she had met at the conference.

We intended that they facilitate the users' further exploring of online resources after the

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[6] http://cl.aist-nara.ac.jp/lab/nlt/chasen/.
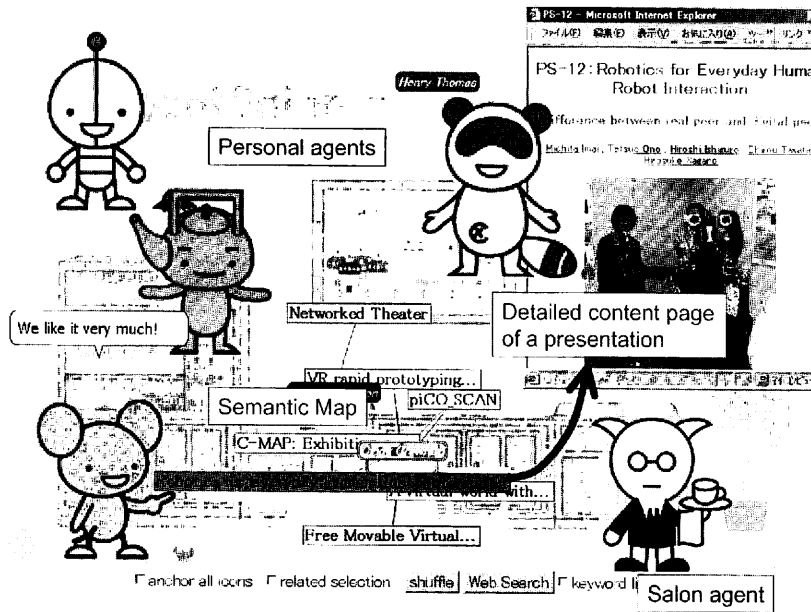
(1) Display of AgentSalon.
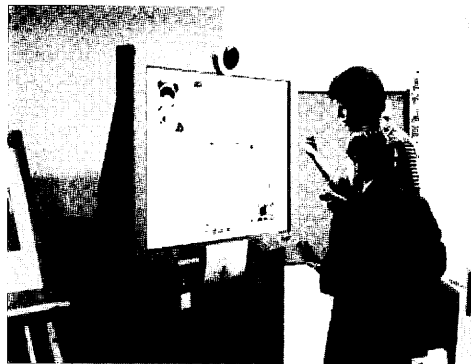
(2) AgentSalon being used by two people.

Fig. 10. AgentSalon. (1) Display of AgentSalon. (2) AgentSalon being used by two people.

conference and enhance the chances of new collaborations among the users who have interacted during the conference.

4.7. AgentSalon

The aim of our digital assistant service was not only personalized tour guidance but also facilitating (face-to-face) interactions among users by providing them with a social space. To that end, we provided a specialized kiosk at the conference site, called AgentSalon
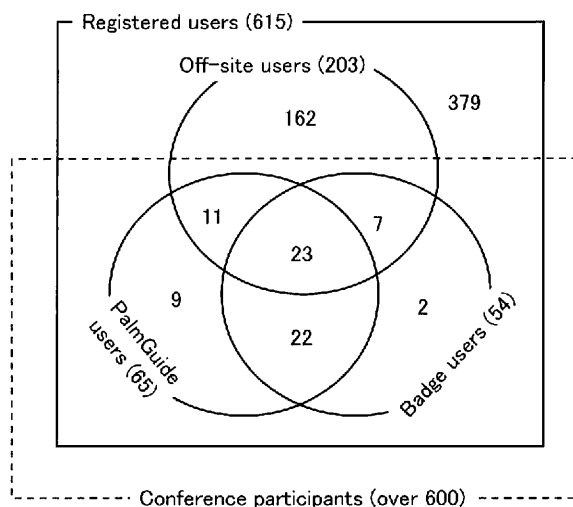
Fig. 11. Distribution of user types.

(Sumi and Mase, 2001), as a chatting space for the participants. AgentSalon has a large display for use by two to five users simultaneously.

We intended for AgentSalon to facilitate new encounters and face-to-face discussions between conference participants by orchestrating chats between their personal agents, which stored information on their interests and experiences. The personal agents would migrate from PalmGuide to AgentSalon by infrared connection.

The chatting by the agents was dynamically created according to the touring records of the agents' users, i.e. presentations they had attended up to that point and the personal ratings they gave to them. When the users shared many presentations in their touring records, their agents mutually recommended the presentations that were not shared by them, and/or exchanged their users' opinions about each shared presentation. We expected that such chatting by the agents would provide timely topics and stimulate the users' discussions.

Fig. 10 shows an example display of AgentSalon and its usage at the conference. Semantic Map was displayed behind the animations of the agents and showed the touring records of the current users. The users could touch the icons of Semantic Map and browse their detailed information.

5. Results of users' data

In this section, we analyze our system users' data and describe the lessons we learned.

5.1. Distribution of user types

The users of our systems can be classified into the types described below. Note that only identifiable users were classified.

Table 1
Number of users who logged in to off-site services

	User (persons)	Login (persons)	Login ratio (%)
Auto-registered users	479	87	18.16
Signed-up users	136	116	85.29
Total	615	203	33.01

- *Registered users.* All users registered for the project. This type consists of users who were automatically registered when they submitted a paper and users who signed-up themselves.
- *PalmGuide users.* Users who carried the PalmGuide device at the conference site.
- *Badge users.* Users who wore an infrared badge at the conference site.
- *Off-site service users.* Users who logged-in to our off-site services at least once.

The number of users in these groups naturally overlapped. Fig. 11 shows the numbers and distribution of the groups' members. From the diagram, we can make the following observations.

- Over half of the users who used PalmGuide and/or the badge at the conference site logged-in to the off-site services.
- Of the 203 off-site service users, 162 utilized only the off-site services.
- Over 60% of registered users did not use PalmGuide, the badge, or off-site services. Most of them are assumed to be auto-registered participants who submitted papers, so they did not have enough motivation to use our systems. Note that there is no way to count the users who only used the kiosk service, so we cannot say how many users never used any services.
- There is considerable overlap between users of PalmGuide and the badge. We intended these two services to be used as alternatives, but most of the active users were interested in using both of them.

We prepared 50 PDAs to lend out for use with the PalmGuide system. Since most of them were used by one person during the entire conference, the total number of PalmGuide users was 65. Among them, five people used their own PalmOS devices. We expect that we will not have to prepare such PDA devices for lending out in the near future.

We prepared 100 infrared badges, but the number of users was small. We expected that a site map effect would be displayed on the kiosks (Fig. 6), depending on the number of worn badges; however, this effect was not achieved. Such badges should be distributed to all participants like name tags for effective usage; this would also make user registration easier. However, the EIRIS badge we used is too expensive to give to all participants. Considering how to use cheaper RF tags or IC cards for this purpose is a future topic.

We registered 479 presenters as users of our system beforehand. In addition to these users, 136 people signed up for our services in the 2-month period after we started our online service. Even now, the number of signed-up users continues to increase. As shown in Table 1, while the ratio of auto-registered users logging into our online service was only
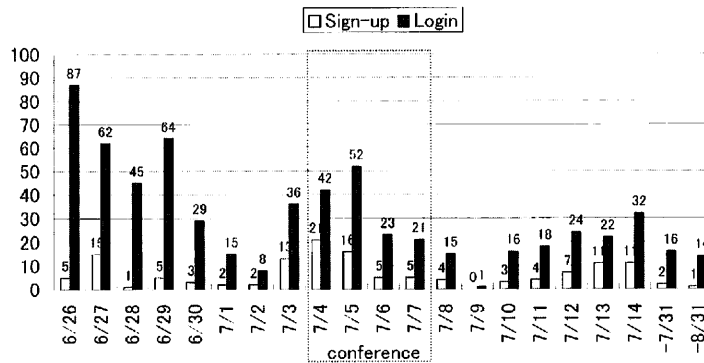
Fig. 12. User sign-up and login to our off-site services.

18.16%, the ratio of signed-up users was over 85%. This seems reasonable considering that signed-up users are generally more motivated.

5.2. Utilization of off-site services

Fig. 12 shows the overall activities of our off-site services. The *x*-axis indicates the date, and the *y*-axis indicates the number of user sign-ups and logins. Note that the login count before the conference is larger than that during the conference; this indicates that online services provided by the Web offer great potential as 'warming-up' activities among participants before society events.

Fig. 13 shows the utilization of individual off-site services. Semantic Map was constantly accessed; which implies that it functioned as a browser for the pre/post viewing of conference information. While Discussion Board was launched more than a few times, its posting numbers were very low. We think the reason for this is that the posted messages could be read anonymously but the people posting messages had to use their names. In the future, we need to find a way to motivate users to join the discussions. Touring diaries were viewed after the conference, but not very much. Although we expected the touring diaries to be effective for continuously connecting users after the conference, the synergistic effect remained low among the utilization of PalmGuide (or the badge), the amount of information provided by users, and the touring diaries.

5.3. Utilization of onsite services

In order to analyze the utilization of services at the conference site, we tracked the daily utilization of the information kiosks, which was the most casual service. Fig. 14 shows the access numbers for four kiosks (with and without PalmGuide) and one AgentSalon system. Kiosk use without PalmGuide was consistently the most popular.

Fig. 15 shows the utilization of individual services on the kiosks and AgentSalon. The number of accesses to Semantic Map was significantly higher than the other services since it was launched as the default display. Interestingly, the accessing frequency of the touring diaries increased from the beginning to the latter part of the conference. This seems
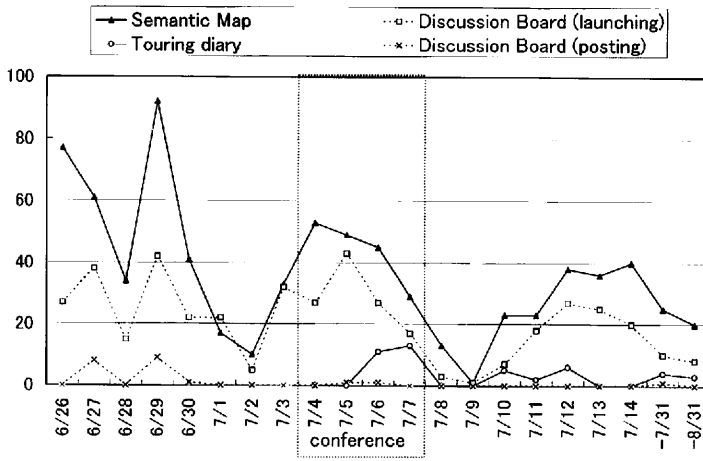
Fig. 13. Utilization of off-site services.

reasonable because the value of the diary increased with the utilization of PalmGuide and the infrared badge.

5.4. User distribution of PalmGuide utilization

Thus far, we have only discussed the aggregated results of all users. Now, we will discuss the trends of system utilization by individual users.

Fig. 16 shows the user distribution for PalmGuide functions. Concerning the number of kiosk accesses and 'business card' exchanges, people who never used these services were the majority, and the user numbers generally tended to decrease with the increase in
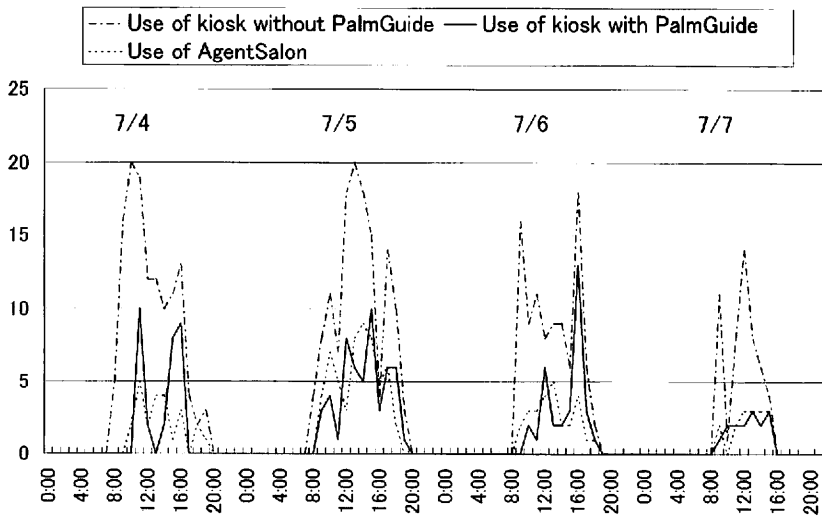

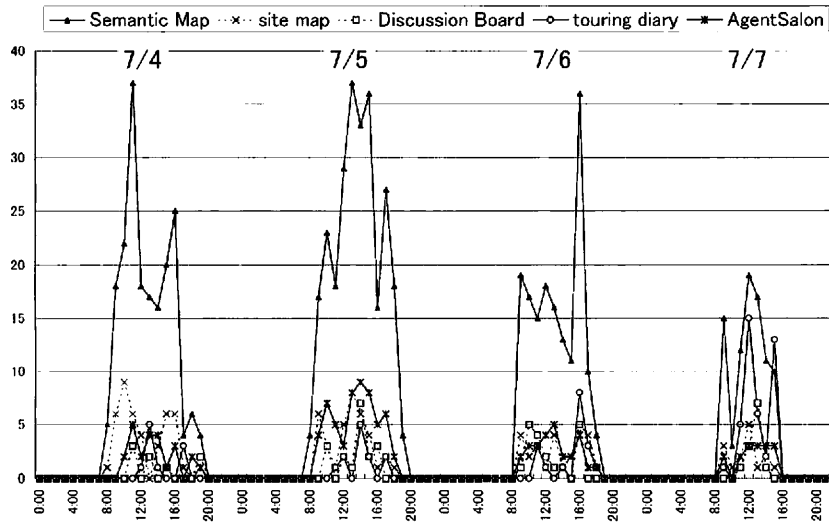Fig. 14. Utilization of kiosks located at the conference site.

Fig. 15. Utilization of onsite services on kiosks.

utilization numbers. On the other hand, the utilization of the presentation marking function was completely different depending on the users. Over half of the PalmGuide users marked over 10 presentations for attendance, and there were 11 users who marked more than 30. Such a distribution of the marking number seems to correspond to the diversity of individual users' activities at the conference site. This implies that PalmGuide was correctly understood and used by most users as a casual interface during conference attendance.

The number of kiosk accesses and business card exchanges is apparently lower than the presentation marking function. A common characteristic between the two functions is that they need users to interact with other devices (kiosk terminals) or other PalmGuide users. Naturally, interaction frequency depends greatly on the size of the system components (human members and devices). We think the number of PalmGuide users and kiosk terminals was, unfortunately, too small to motivate the users to actively interact with each other.

5.5. User distribution of off-site service utilization

Fig. 17 shows the utilization of our off-site services. Fig. 17(1) shows the user distribution of logins to the off-site services. While about half of the users logged in only once, some of them logged in about 40 times over 2 months. The most utilized off-site service was Semantic Map for browsing conference information such as papers and presenters. Fig. 17(2) shows the utilization of Semantic Map. Most of the users launched Semantic Map a few times. Surprisingly, there were a few users who launched it more than 30 times over the 2-month period.
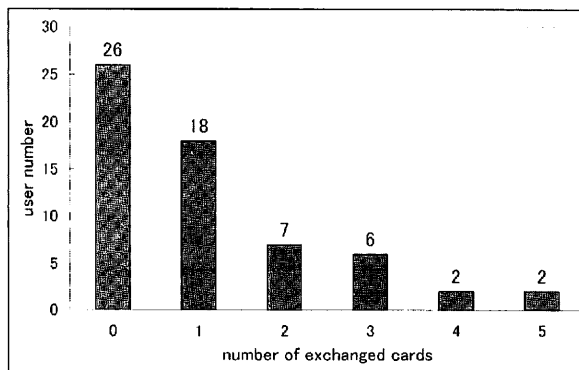
In order to gain a better understanding of this utilization of Semantic Map. let us look at the number of keyword selections on Semantic Map in Fig. 17(3). On Semantic Map, a
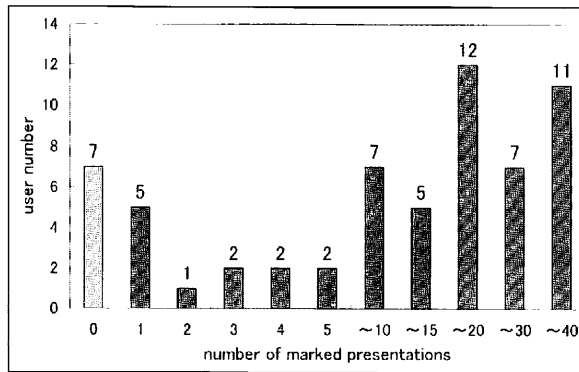
(1) Presentations marked
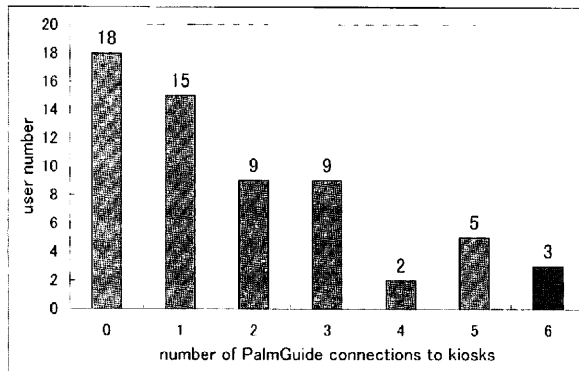
(2) Accessing kiosks with PalmGuide

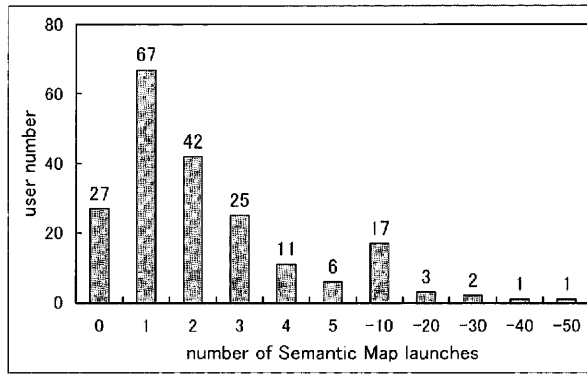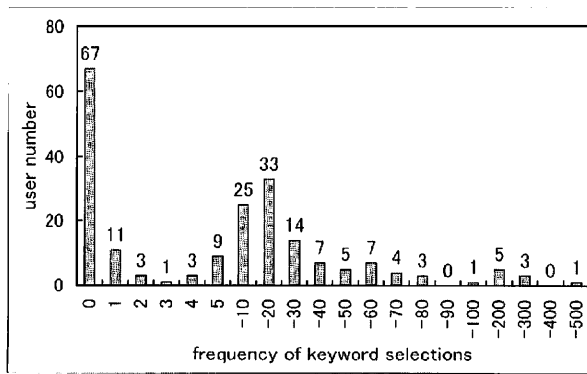(3) "Virtual business card" exchanges

Fig. 16. User distribution of PalmGuide utilization. (1) Presentation marked. (2) Accessing kiosks with PalmGuide. (3) Virtual business card exchanges.
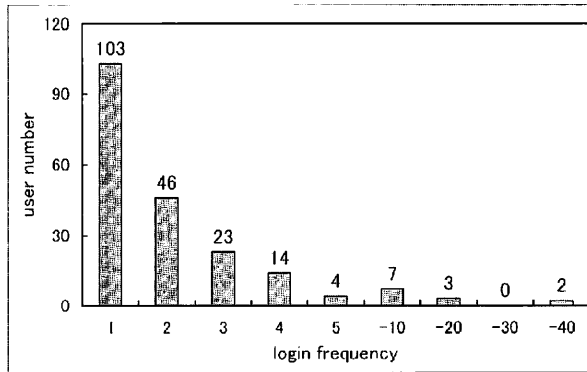
(1) Login

(2) Launching Semantic Map

(3) Keyword selection on Semantic Map

Fig. 17. User distribution of off-site service utilization. (1) Login. (2) Launching Semantic Map. (3) Keyword selection on Semantic Map.

Table 2
Correlation between the utilization of various services by PalmGuide users

	Kiosk	Record	Card	Login (1)	Login (2)	Login (3)	Login (t)	Semmap	Discuss	Diary
Kiosk	1									
Record	0.2605	1								
Card	0.0926	0.2716	1							
Login (1)	-0.1853	-0.0520	-0.0014	1						
Login (2)	-0.0410	0.0868	0.0030	-0.0785	1					
Login (3)	-0.0102	0.2878	-0.0249	-0.0359	-0.0821	1				
Login (t)	-0.1914	0.0493	-0.0076	**0.9388**	0.1332	0.2223	1			
Semmap	-0.1920	0.0576	-0.0039	**0.6668**	0.3514	0.1474	**0.7669**	1		
Discuss	0.0532	0.3783	0.1080	0.0296	0.1075	0.3567	0.1521	0.1215	1	
Diary	0.0502	0.1928	0.0062	-0.0733	0.3778	0.0000	0.0167	**0.4245**	0.3617	1

Kiosk: kiosk access with PalmGuide; Record: presentation marked; Card: business card exchange; Login (1,2,3,t): off-site service login (before, during, after conference, total). Semmap: Semantic Map; Discussion: Discussion Board; Diary: touring diary.

Table 3
User evaluations of individual services

Service	Used or noticed			Effective			
	Yes	No	No answer	Yes	No	Undecidable	No answer
PalmGuide							
Browsing of conference program	33	1	1	28	2	1	4
Recommendation of presentation	30	4	1	13	8	8	6
Management of touring records	25	9	1	16	3	11	5
Exchange of virtual business cards	19	16	0	7	6	11	11
Information kiosk							
Agents' migration from PalmGuide	29	6	0	17	0	9	9
Semantic Map	21	14	0	14	5	6	10
The site map	23	12	0	15	2	6	12
Links to Web pages	14	21	0	8	3	9	15
AgentSalon							
Chats by agents	25	10	0	11	2	10	12
Semantic Map displayed behind the agents	25	10	0	18	1	4	12
Online preview services							
Semantic Map	13	22	0	8	3	7	17
Discussion Board	9	26	0	2	3	9	21

user can select keywords to explore conference information. Therefore, the frequency of keyword selections can be regarded as the user's activity while using Semantic Map. In our case, since one-third of all users never selected a keyword, we can assume that quite a few users launched Semantic Map without any aim. On the other hand, we can also see a gentle peak around 20 times, indicating that most of the users understood and actually used Semantic Map. Some very active users made more than 100 keyword selections. According to our records, the most active person used Semantic Map before the conference (for only 8 days). This implies that Semantic Map functioned as a way to preview the conference.

5.6. Correlation between the utilization of services

In a more detailed analysis, Table 2 shows the correlation between the utilization of various services (PalmGuide functions and off-site services) by PalmGuide users. We assumed a positive correlation between two services having a correlation factor of more than 0.4, which is indicated with bold print in the table.

A very strong correlation appears between off-site service login before the conference and total off-site service login, which means the most logins were done before the conference. Additionally, there was a positive correlation between Semantic Map utilization and off-site service login. Therefore, we can assume that such active users, who used PalmGuide at the conference site, were highly motivated by our service before the conference. A positive correlation also appears between diary browsing and Semantic Map utilization. This means that Semantic Map functioned as a portal for personal diaries and Internet resources related to the presentations and participants of the conference.

6. User evaluations

We asked onsite service users to fill out a questionnaire when they returned the PDAs and/or the badge. We received answers from 35 users.

6.1. Subjective evaluations of individual services

Our questionnaire asked whether the user had used individual functions on PalmGuide, information kiosks, and AgentSalon, and if so, whether they were effective. At the same time, we also asked about off-site services for previewing the conference. Table 3 shows the results. The numbers in the table show the number of users.

The following is a summary of the results.

- All functions of PalmGuide except business card exchanging were used (or noticed) by most of the PalmGuide users without the need for detailed instructions, and their effectiveness was acknowledged.
- The migration of agent characters from PalmGuide to kiosks was easily understood and used with pleasure.
- Although some authors registered links to their personal Web pages for the detailed content pages of their papers, most users were not aware of these. The major reason was thought to be the fact that the number of linked pages was very small.
- We employed the same Semantic Map applet for the kiosk displays and the AgentSalon's background. In spite of this, the Semantic Map on AgentSalon was regarded as more effective. We believe that conference participants may prefer collaborative Web browsing on a large screen over single use with a kiosk terminal.

6.2. User requirements for digital services

To the question of whether digital assistant services will be necessary in future conferences, 27 of the 35 users answered that they will be necessary, and nobody answered that they would be unnecessary. On the other hand, with regard to distribution of PDAs and/or digital badges, there were 19 users who answered that they should be distributed only to whose who request them while there were 10 users who answered that they should be distributed to all participants.

To the question of which style of services is desired, 29 respondents chose a portable PDA, 10 chose a badge, 10 chose a kiosk, and only three chose a portable PC.

6.3. Users' comments

We also collected free comments from the questionnaire respondents. The following are some of these.

- *Because the PDA is not good for browsing or operating, I hope that a PC card that includes service software and data will be provided at the conference site so I can use my own portable PC.* Although most PalmGuide users did not desire portable PCs as

mobile devices for future digital assistants, one of the most important challenges is to accept the diversity of user preferences.

- *AgentSalon was attractive for enhancing face-to-face meetings with friends, but I want more proactive services, such as an automatic coordination of meetings with people who share interests with me.* It was impossible to proactively push information, such as meeting coordination, to our users with PalmGuide, because it was not constantly connected with the network. Therefore, we directed users to gather by providing AgentSalon as a meeting place. Future work will include meeting coordination among users by AgentSalon and kiosk displays.

- *The rating data for individual papers entered by PalmGuides and the infrared badges should be fed back to their authors.* Ratings of 'interesting' could be revealed in Semantic Map, however, not only for the concerned persons but for all users. Automatic summarization and delivery of collected community-like information for individual users is an important future topic.

- *Discussion Board would be a good tool for facilitating mutual interactions between presenters and audiences if there were a better way to encourage people to use and notice it.* As we mentioned before, while Discussion Board was launched more than a few times, its posting numbers were very low. We think that increasing the level of awareness on posting and reading within Discussion Board between users is a key issue. We also have to investigate anonymous posting.

- *I would like to see scheduler and alarm functions added to the PalmGuide.* We think that the realization of such functions depends mostly on the employed device and its OS. We will continuously redesign our system with other technologies.

- *I want an electronic version of papers on the digital assistant.* In fact, the new version of our digital assistant in 2001 provided electronic files of papers on kiosks and off-site services. The current issue is its portability.

- *The touring diary is helpful.* We think that a major motivation for participants to attend conferences is to collect and summarize information related to their research interests. Also, when they go back to their offices or schools, they report to their colleagues on what they saw at the conference and investigate further information related to the papers presented at the conference. In such situations, our touring diary will be helpful because it collects the individual user's attendance record at the conference, automatically connects the record with online resources, and is accessible via the Web.

7. Conclusions

We reported on the implementation and experimental results of a digital assistant system for conference participants. A major characteristic of our system was a mutual augmentation between onsite services with mobile and ubiquitous computing technologies and Web services for continuous support of the pre/post conference. The result indicates that the Web services offer great potential as warming-up activities among participants before the conference. However, the influence of the user's activity with our onsite services at the conference site upon the usage of Web services after the conference could not be observed than expected.

We assume that our system is still at an early stage because the services provided were not sufficiently mature and the participants were typically not used to such services. We believe that online services for pre/post conferences and onsite services for enhancing face-to-face meetings at a conference site are mutually compensable and synergetic. Therefore, it is important to continue such services so that they will eventually be firmly rooted in the conference operations of academic communities.

Online services using users' data collected by PalmGuide devices and infrared badges, such as the touring diary and the display of users' activities on Semantic Map and the site map, depend greatly on the number of people using PalmGuide and the badge. In this sense, employing PalmOS devices, which are familiar to many people, as a platform for the PalmGuide is thought to be reasonable. We think that we should prepare and release PalmGuide software as an online service before the next conference trial. Also, we will investigate the possibility of providing all participants with an electronic badge (for collecting users' behavior) like an ordinary name tag.

Future topics also include increasing the awareness of various services and users' behaviors (e.g. posting in Discussion Board) within the community, and developing more casual interfaces suited for daily and nomad use.

Acknowledgments

References

Abowd, G.D., 1999. Classroom 2000: An experiment with the instrumentation of a living educational environment. IBM Systems Journal 38 (4), 508–530.
Abowd, G.D., Atkeson, C.G., Hong, J., Long, S., Kooper, R., Pinkerton, M., 1997. Cyberguide: A mobile context-aware tour guide. Wireless Networks 3 (5), 421–433.
Borovoy, R., Martin, F., Vemuri, S., Resnick, M., Silverman, B., Hancock, C., 1998. Meme Tags and Community Mirrors: Moving from conferences to collaboration. Proceedings of CSCW'98, ACM, New York, pp. 159–168.
Cheverst, K., Davies, N., Mitchell, K., Friday, A., Efstratiou, C., 2000. Developing a context-aware electronic tourist guide: Some issues and experiences. Proceedings of CHI 2000, ACM, New York, pp. 17–24.
Dey, A.K., Salber, D., Abowd, G.D., Futakawa, M., 1999. The conference assistant: Combining context-awareness with wearable computing. The Third International Symposium on Wearable Computers, IEEE, New York, pp. 21–28.
Feiner, S., MacIntyre, B., Höllerer, T., Webster, A., 1997. A touring machine: Prototyping 3D

mobile augmented reality systems for exploring the urban environment. The First International Symposium on Wearable Computers, IEEE, New York, pp. 74–81.

Ishida, T., Nishida, T., Hattori, F., 1998. Overview of community computing. In: Ishida, T., (Ed.), Community Computing: Collaboration over Global Information Networks, Wiley, New York, pp. 1–11, Chapter 1.

Nagao, K., Rekimoto, J., 1996. Agent augmented reality: A software agent meets the real world. ICMAS-96, AAAI Press, pp. 228–235.

Nishibe, Y., Waki, H., Morihara, I., Hattori, F., Ishida, T., Nishimura, T., Yamaki, H., Komura, T., Itoh, N., Gotoh, T., Nishida, T., Takeda, H., Sawada, A., Maeda, H., Kajihara, M., Adachi, H., 1998. Mobile digital assistants for community support. AI Magazine 19 (2), 31–49.

Salomon, G.B., 1990. Designing casual-use hypertext: The CHI'89 InfoBooth. Proceedings of CHI'90, ACM, New York, pp. 451–458.

Sumi, Y., Etani, T., Fels, S., Simonet, N., Kobayashi, K., Mase, K., 1998. C-MAP: building a context-aware mobile assistant for exhibition tours. In: Ishida, T., (Ed.), Community Computing and Support Systems, Lecture Notes in Computer Science, vol. 1519. Springer, Berlin, pp. 137–154.

Sumi, Y., Mase, K., 2000. Communityware situated in real-world contexts: Knowledge media augmented by context-aware personal agents. Proceedings of the Fifth International Conference and Exhibition on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM 2000), pp. 311–326.

Sumi, Y., Mase, M., 2001. AgentSalon: Facilitating face-to-face knowledge exchange through conversations among personal agents. Proceedings of Agents 2001, ACM, New York, pp. 393–400.

Sumi, Y., Mase, K., 2002. Supporting the awareness of shared interests and experiences in communities. International Journal of Human–Computer Studies 56 (1), 127–146.