New Generation Computing, Vol. 20, No. 2, pp. 165-185,
Ohmsha, Ltd. and Springer-Verlag, 2002.

Supporting Cross-Cultural Communication with a Large-Screen System

Masayuki OKAMOTO[†], Katherine ISBISTER[‡], Hideyuki NAKANISHI[†] and Toru ISHIDA[†]

[†]*Department of Social Informatics, Kyoto University*
Yoshida Honmachi, Sakyo-ku, Kyoto 606-8501, JAPAN
okamoto@kuis.kyoto-u.ac.jp,
{nakanishi,ishida}@i.kyoto-u.ac.jp

[‡]*Finali Corporation*
3001 19th Street, San Francisco, CA 94110, USA
kisbister@finali.com

Received 28 February 2000
Revised manuscript received 7 May 2001

Abstract As opportunities for international collaboration and cross-cultural communication among people from heterogeneous cultures increase, the importance of electronic communication support is increasing. To support cross-cultural communication, we believe it is necessary to offer environments in which participants enjoy conversations, which allow them to share one another's background and profile visually.

We believe that the following three functions are important: (1) showing topics based on participants' profiles and cultural background; (2) life-sized, large-screen interface; and, (3) displaying objects which show feelings of identify. In this paper, we discuss the implementation and the empirical evaluation of two systems that were designed to support cross-cultural communication in the real world or between remote locations.

From the empirical evaluation of these systems, we conclude that these systems add new functionality to support conversation contents, which may be especially useful in a cross-cultural context where language skills are an issue, and this type of environment may be especially useful in a pre-collaboration context.

Keywords Cross-Cultural Communication, Community Computing, Large Screen, Social Interaction.

§1 Introduction

Various electronic communication support systems have been studied and developed for supporting collaborations in companies or research activities. The computational aspect of such systems, e.g., system performance, as well as their impact in business offices or laboratories have been discussed extensively (for example, in the groupware research area, this aspect is considered well[14]). However, the cultural aspect, especially in cases where people from heterogeneous cultures interact with each other, and aspects of the process of interpersonal understanding or socialization between co-workers before the actual task, have not been thoroughly examined. The number of the Internet users in East Asia is expected to increase to 300 millions. The Internet brings about great number of cross-cultural communications. This is, especially true in Japan, where many companies advance abroad and many foreign companies enter domestic markets. Therefore, opportunities for international collaboration and cross-cultural communication among people from heterogeneous cultures (e.g., manufacturers which have subsidiaries from different countries doing research and working locally, and research communities at international conferences) increase. Thus, it becomes more important and interesting to consider these aspects of electronic communication support. However, there are few Human-Computer Interaction researches in this area. In these situations, cross-cultural differences must be addressed to enable satisfactory communication and community-formation. We are studying this kind of communication or community-formation, named *communityware* or *community computing*[6][7]. This approach focuses on informal communication and socialization, which are earlier stages of collaboration; while groupware focuses on the collaboration itself. As internationalization in companies or research activities spreads, supporting cross-cultural communication is getting a larger research area in community computing.

There are five factors in community computing[7]:

- Knowing each other
- Sharing preference and knowledge
- Generating consensus
- Supporting everyday life
- Assisting social events

Supporting socialization encourages people to know each other in five factors of community computing.

The research described in this paper adopts the theoretical framework of community computing and extends it into supporting cross-cultural communication. The common concept of this research is "providing an environment which presents shared information or topics to people in the same space and from heterogeneous cultures." Usual community-computing systems provide virtual spaces or interests among users. However, there are few trials which provide both of them.

By implementing the two systems, we aimed to provide the following two supports for users:

1. Support of mutual understandings by providing shared contents
2. Support of a mode of communication nearer to face-to-face communication

To support cross-cultural communication, we believe it is necessary to provide environments in which participants enjoy conversations that allow them to share one another's background and profile visually. To satisfy both of these conditions, we propose systems with large screens that can display information shared by many participants.

This paper describes the design and implementation of two different systems which deal with cross-cultural communication both in the real world and in remote locations, and describes the evaluation of these systems through experimental use of the systems.

Section 2 describes the general features of a communication environment with a large screen. Section 3 describes the design, implementation, and evaluation of Silhouettell[15)16)], which supports cross-cultural communication in the real world, and Section 4 describes Networked Silhouettell, which supports cross-cultural communications between both local and remote places.

§2 Supporting Communication with a Large Screen

There are three general concepts to design communication tools[5)]. They are also needed to design tools for supporting cross-cultural communication.

- Conversational common ground
  Conversational common ground is a process by which conversation partners create a shared awareness of what knowledge and assumptions they have in common.

- Nonverbal cues in social interaction
  Nonverbal cues are signals, which are not in words, that express the emotions of a person, the general qualities such as personalities, the attitude a person has toward the topic other people are speaking, the attitude toward the listener, the relationship with the listener, and so on.
- Situation and role expectations in social interactions
  Characteristics of a situation help people understand its social context, which then helps them determine which actions and roles are relevant and appropriate.

The systems described in this paper enable the concepts above by incorporating the following features:

- Showing shared information based on participants' profiles and cultural background. (common ground)
- A life-sized interface with a large screen. (situation expectations as well as nonverbal cues)
- Displaying participants in the conversation using real images or shadows. (nonverbal cues as well as common ground)

In the next three sections, we will discuss each of these features, and in Section 2.4, we will compare two systems proposed in Section 3 and Section 4.

2.1 Showing Shared Information

A common feature shared by most of the current communication systems (including community computing systems[12)19)]) supports conversation by providing a virtual conference room, either on a desktop monitor or a large screen. Desktop systems, such as CU-SeeMe[3)] typically create a conference room by displaying all participants on the screen. FreeWalk[12)] also provides a 3-D virtual space for casual meetings. Large screen systems, such as MAJIC[14)], connect two or more locations to create conference rooms shared by people who are in the remote locations.

Unlike the systems mentioned above, the two systems described in this paper focus on supporting conversation contents. There are two approaches to support them. One is a method to enable users to understand one another directly, using tools such as interpretation. The other is, as we propose, a method to tell "who he[*1] is" by presenting the user's information. These systems provide

[*1] "He," "his," and "him" should be read as "he or she," "his or her," and "him or her" throughout this paper respectively.

additional information about cultural characteristics or differences of users to their conversation partners as shared information, projecting topics related to them on-screen. In particular, it is important to consider the following two effects due to share information related to users:

1. The increase of interaction by knowing common information
   At the early stage of communication, people begin conversations by finding their (many kinds of) common interests. It is more difficult to find cues in cross-cultural communication than in communication among people from the same culture. Thus, showing shared information is important in order to promote their communication.
2. The decrease of misunderstanding by recognizing differences among people
   In an international project including companies or research organizations from countries, people who do not know each other collaborate at the same place or from remote places. In such situations, troubles due to misunderstanding about their features or differences easily happen. Thus, it is important to tell their differences, especially cultural differences, in advance.

2.2 Large-sized Interface with a Large Screen

Using a large screen is more effective for supporting cultural communications than using a CRT monitor for the following reasons:

- Users can move more freely in a wider space
  If the system has a small display, users must use it in a correspondingly narrow physical space. A large screen allows users to play more freely with the system in a wider sphere, without worrying about where they are in relation to the screen.
- Users can be projected life-sized
  A life-sized, large projection space allows us to display information of users on the screen in front of each user. Providing information related to each user's position in the real world is more natural than providing information at one location on the screen, as with a traditional desktop interface. In a large-screen environment, each user can see all participants' information at a glance.
- Shared viewing is easier

A large screen is especially appropriate for shared viewing, because all the participants can easily see the information on the screen. People who are far away from the screen can also see what is going on, which may draw them into joining the conversation.

- Transmitting nonverbal information is easier
  In meetings between remote locations, especially those that require cross-cultural communication, transmitting nonverbal information such as facial expressions or gestures is important. A large-screen system can make gestures and expressions more legible to everyone who is interacting, and create a more effective nonverbal communication.

In recent years, systems which provide people with information using some of above features have been developed. For example, the Campiello Project[4] is aimed at supporting interpersonal interactions using a shared large screen.

2.3 Displaying Participants as Real Images and Shadows

In communication systems supporting meetings between remote locations, it is customary to project both conversation partners' images on the screen. It is clear that showing real images of corresponding participants is useful in this case. We believe that it is also effective to show representations of users in local interactions, in order to attract them to use the system. The implementation form is decided according to the location which a system supports. In the systems discussed in this paper, the following two display methods are used to attract and engage participants.

- Local (face-to-face) system (Sillhouettell): displaying a shadow corresponding to each local participant on the screen in front of him.
- Remote (over-network) system (Networked Silhouettell): displaying only real images of all remote participants on the screen. Local participants see transparent shadows of themselves projected into the same space as remote participants.

A shadow in Silhouettell is a black shadow or silhouette, and a shadow in Networked Silhouetell is a transparent mirror image instead of a black shadow.

We consider that a user representation which is linked to his information is needed. Moreover, only one clear face (which means his "identity") is needed per participant. A shared information is shown on the corresponding user's real image. In the local environment, we can not show the information on the user. Therefore, we use his shadow which is natural representation on the

real life, and the information is presented on the screen with the shadow. On the other hand, in the over-network environment, the information of a user is directly presented on the real video image of him. The implementation of the representation depends on the environment in which the system will be used.

We believe that for local interaction, it is easier for users to understand the use of shadows compared to other representation systems. Chatting systems often use avatars or icons. When using avatars or icons in a real world, however, users may not be able to map which icon relates to themselves and which to their partner—the avatars become a cumbersome additional identity. However, a shadow is a naturally co-present representation of oneself in a physical interaction. Thus, the correspondence between a participant and his shadow is much more natural and intuitive in a local interface. We could of course also simply display mirrored video of all participants. However, users might be uncomfortable about having all other participants "looking" at them all the time. A shadow is more subtle and natural, and does not duplicate the face-to-face interaction already taking place.

In the case of the over-network environment, a black shadow causes the problem that a person cannot see his partner because of overlapping when he stands in front of the partner. Therefore, we decide to use a transparent mirror image instead of a black shadow.

2.4 Silhouettell and Networked Silhouettell

We implemented two systems based on the above common concepts, named Silhouettell and Networked Silhouettell. The two systems are different systems which aim at the same purpose.

There are several differences among these systems.

- Location
  While Silhouettell supports only local communications, Networked Silhouettell supports both local and remote communications.
- Shared information
  Silhouettell uses web pages including common topics for shared information among users. Networked Silhouettell uses users' cultural experience. In designing our two systems, we decided each content on the large screen based on two aspects described in Section 2.1. That is, we used common topics in Silhouettell because we believe a common topic is the most fundamental factor in community. In Networked Silhouettell, we tried

to decrease misunderstandings by showing each user's backgrounds and differences among users.

- Representation of shadow
  We implemented a shadow as a black silhouette in Silhouettell, and as a transparent image in Networked Silhouettell. The detailed description is shown in Section 2.3.
- Selecting on-screen information
  In Networked Silhouettell, the selecting operation for on-screen information is supported, while this operation is not supported in Silhouettell.

The comparison of these two systems is shown in Table 1.

Table 1 Comparison between Silhouettell and Networked Silhouettell

	Silhouettell	Networked Silhouettell
Locations of users	local (face-to-face)	remote (over network)
Representation	black shadows of all the participants	transparent images for the local users and video images for others
Shared information	web pages including common topics	each user's cultural experience
Selection of information	not supported	supported

In the next two sections, we try to confirm the effects from these points of view empirically through these systems.

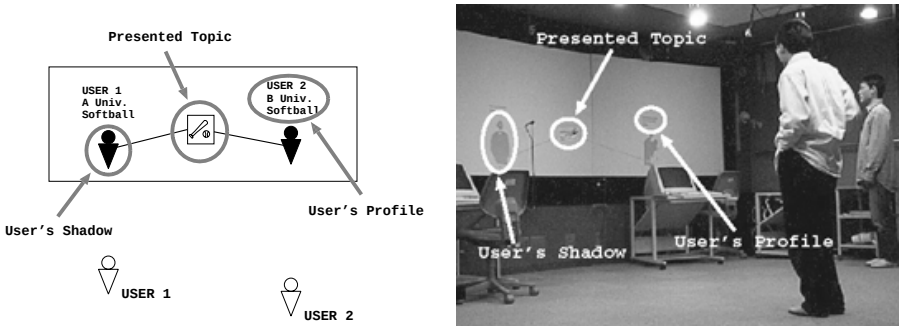
§3 Supporting Cross-Cultural Communication in the Real World

This section describes Silhouettell[15)16)], a system that finds topics common to conversation participants, and displays web pages related to those topics on the large screen along with the participants' shadows. The system provides awareness support, which augments the real world, to enable users to become aware of other users who have common interests and to make communities.

3.1 Design of Silhouettell

We believe that the following features are important for supporting and augmenting real-world communication:

Silhouettell uses a large screen to display users, their profiles and common interests. Figure 1(a) shows the concept of Silhouettell, and Figure 1(b) shows Silhouettell in use.



(a) Concept (b) Actual Use

Fig. 1 Silhouettell

Silhouettell displays the shadows of the participants as objects on the screen with their profiles above their shadows so that they can identify one another. The system also enriches encounters and encourages conversation by presenting web pages as common topics. The connection lines between each topic and the shadows show groups interested in the same topic.

3.2 Implementation of Silhouettell

Figure 2 shows the system configuration of Silhouettell. It consists of two computers, an SGI ONYX and an SGI INDY, connected via Ethernet. The ONYX is connected to a large graphics screen. The INDY is connected to the output of a video camera.

Images from the video camera are processed by the Video Process in the INDY, and the results are sent to the Main Process in the ONYX. The Main Process generates the screen image from the profile stored in the Profile File, web pages, and the data from the Video Process.

The system works as follows. It generates the shadow of a user by comparing the current image to the background image, and distinguishes participants using their clothing color. It averages the value of the pixels corresponding to the user's chest area and identifies the participants by the stored values (they are input at first use). The system also uses each user's movement computed from two continuous frames. The use of both color and location reduces misidentification[*2]. When a user is recognized, the system reads his profile (name, birthplace,

[*2] Though we used this method for the experimental prototype system, it is not sufficient for real-world applications (for example, if people change clothes, the system does not work well). We think that some kind of tag-based small device, such as Active Badge system[1)] or Meme tags[2)], would be useful for more robust user-recognition in future versions.

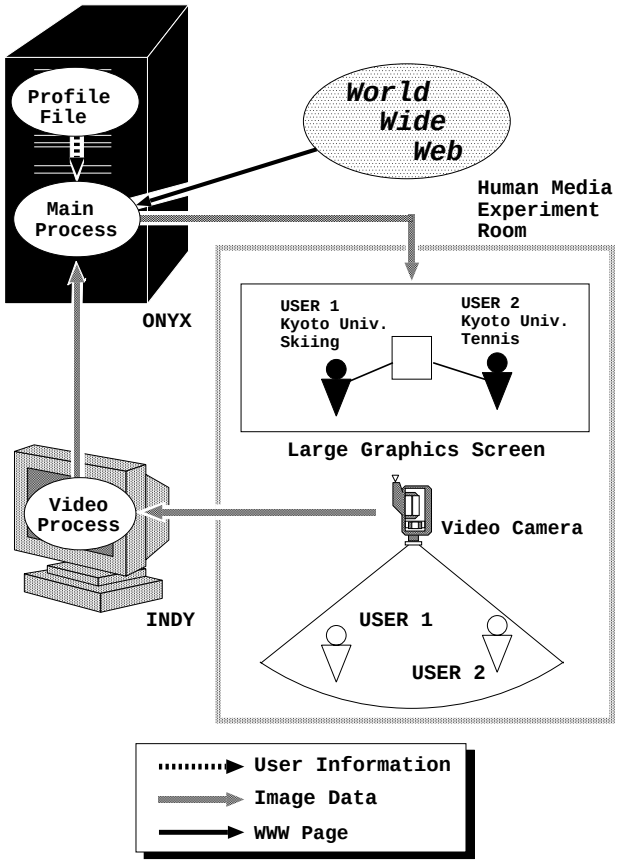


Fig. 2 Silhouettell system configuration

and interests), which is registered in advance.

We use web pages for various topics. If there are common keywords among several users (they are found by string matching), the system searches web pages for selected keywords and displays the resulting pages between corresponding users on the screen (The system first searches pages registered by the system manager in advance and next searches using a general search engine). In addition, the system changes the size of the topic display windows to reflect the physical distance between users. When they are far from each other, the topic windows are quite small in size. As they approach each other, the topic windows increase in size. This is to encourage users to approach each other with the idea of confirming the topics listed.

3.3 Experimental Evaluation of Silhouettell

We observed actual use of Silhouettell by people from various countries. This section describes the experiment and our observations and analysis about what happened.

Thirteen people participated in our experiment: eight from Japan and five from the United States, Canada, and France. One of them was an industry researcher, and the rest were graduate and undergraduate students. Seven of the Japanese did not have much experience in English conversation. In each session, two persons talked to each other for fifteen minutes with the scenario that they were students of the same department of a university. We paired up the participants in advance (some participants were involved in more than one experiment condition) and prepared common topics (about sports, music, food, and books) for each pair from pre-test questionnaires. We used two to three web pages to represent a single common topic for each pair for the experiment. We also used each participant's own web page as a topic if he had one. Name, birthplace, and the chosen common topic were used as the user's on-screen profile.

We obtained the following feedback from the questionnaire administered after the experiment. The items reported here were rated on a seven-point scale by twelve of the thirteen participants (Figure 3).

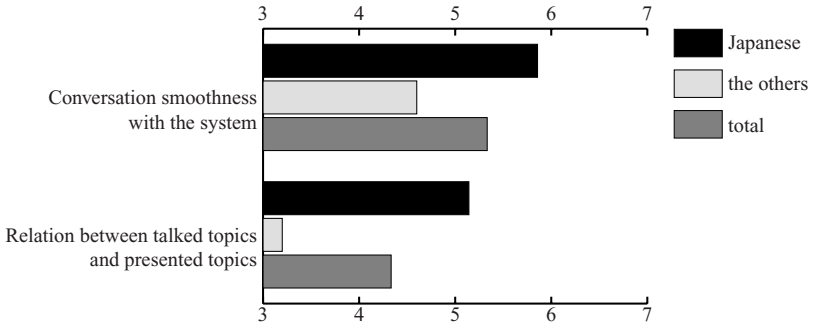


Fig. 3 Questionnaire about using Silhouettell (7 highest, 1 lowest ranking)

From Figure 3, we found:

- Almost all users answered that they could talk smoothly.
- There is a difference between topics that users actually talked about and topics that the system presented. While Japanese users related their own topics to on-screen topics, the others did not do so.

We also observed and analyzed the video record of all conversations

to help us understand when and how differently Silhouettell might be used in cross-cultural encounters.

The following examples were collected from the video logs:

- At the beginning of the conversation, both users checked their partners' profile using the screen. Both participants always faced the screen and did not turn to face each other (two users from Japan).
- Conversations related to the screen contents occurred first, and the pair later extended it to include various other topics (two users from Japan).
- Participants who could hardly communicate (mainly due to language problems) sometimes talked only about the profile and the web pages shown by the system. In such cases, the pair faced the screen and talked with each other with their face to their partner and frequently turning their face back to the screen. However, when they talked about a topic for a long time, their bodies would also turn toward each other (observed in a pair from Japan and the United States, and a pair from Japan and France).

In every case where a person's own home page appeared on-screen, there was a strong positive reaction from the individual user, and conversation about the page ensued. Moreover, users moved around in many cases.

Through these investigations, we confirmed the following features of cross-cultural communication in the Silhouettell environment.

- Information directly related to participants, such as their own home pages, plays a helpful role in initiating conversation.
- On-screen topics are frequently referred when there is a language barrier between conversation partners. We think this is because using the displayed information as a topic allows them to concentrate on talking itself, instead of having to do the additional work of starting new and appropriate topics.
- We could not find the apparent effect of shadows.

Based on our observations and short questionnaire to participants, areas for future work include:

- Expanding the range of what is displayed on-screen to include general topics such as news to help expand conversation support.
- Allowing users to give feedback to the system about what is displayed during conversations.

§4 Supporting Cross-Cultural Communication between Remote Locations

In this section, we describe a system called Networked Silhouettell.

The video technology used in Networked Silhouettell is similar to what is used in other meeting systems[3)18)]. However, we use a large-screen environment, which makes nonverbal information such as eye gaze and expression, facial expression, and gestures easier to read. Also, the life-size representation of the participants helps to mitigate the demonstrated effects of screen size on perception of one's conversation partner[17)].

There are other large-screen communication environments that have recently been developed. For example, MAJIC[14)] is aimed at supporting gaze awareness, which is useful and important, but users need special equipment, and the system cannot really be used by many people at once. HyperMirror[10)] is another large-screen communication system that projects both local and remote users onto the same screen using video transmitted with chroma key. Networked Silhouettell uses HyperMirror-like display technology, but also augments the display with information about users' cultural backgrounds.

Below, we will describe the design and implementation of Networked Silhouettell, and we will also describe the results of experimental use of the system by students from Japan and the United States.

4.1 Design of Networked Silhouettell

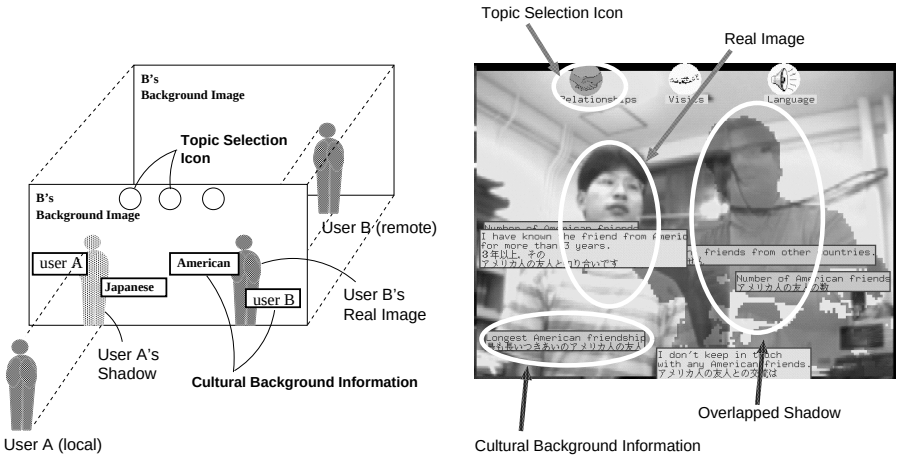
Figure 4(a) shows the concept of Networked Silhouettell, and Figure 4(b) shows on-screen image of the system in use. Figure 5 is an example of actual use.

The key features of the system, shared view and cross-cultural experience information, will be discussed in the next two sections:

- *Shared View*

  In the Networked Silhouettell system, the images of remote users are displayed on a large screen, and the images of local users are overlapped on the same screen as transparent mirror images.

  This style of representation in the communication environment has the following benefits. Since participants from both places are mapped onto the same screen, they can have a greater sense of sharing an environment compared to users of traditional, multiple-box video conference displays, and they can indicate with their gestures what they are referring to on



(a) Concept (b) On-screen Image

Fig. 4 Networked Silhouettell

Fig. 5 Actual use of Networked Silhouettell

the screen. Particularly in cross-cultural communications where verbal communication may be difficult, nonverbal information is an important component for a successful conversation. The life-sized display helps make nonverbal cues more legible, enhancing that aspect of communication. HyperMirror also uses the same kind of displaying technologies. However, it suffers from a problem due to its implementation—sometimes a person cannot see his partner because of overlapping when he stands in front of the partner. Using Networked Silhouettell, on the other hand, participants can still see the behavior of their partners even when he is in front of them, because their own image is transparent.

- *Cross-Cultural Experience Information*

Users of Networked Silhouettell can more easily develop a rapport with their conversation partner, by looking at or touching information about his background that is readily available on-screen. We display the following three kinds of information about each user's cultural background:

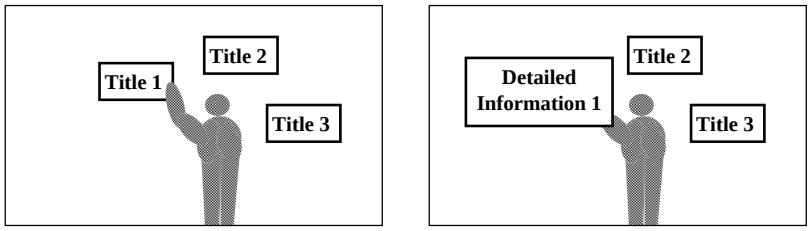
Language knowledge This includes language training and confidence in the partner's native language as well as any other foreign language (e.g., How many years have you studied the language? How confident are you about your speaking ability?).
Culture literacy and experience This includes any experience in living in any other culture and warmth toward and/or understanding of that culture's ways (e.g., How long were you immersed the culture?).
Culture affinity and ties This includes information about friends from other cultures, and other ties to the culture (e.g., How many friends from these other countries do you have?).

All information were entered by each user using a web form before they started using the system.
The cultural information is shown on-screen arrayed around the corresponding participant both in the participant's native language and in his partners' language, and each person's information is displayed by a characteristic color. Thus, all participants can easily map information to users based on location as well as color.
Each item is selected by gesturing at the screen with a special device, which is a plate which can be simply recognized by colors[*3]. At first, each item in a given category is shown as a title (Figure 6(a)). When a user selects an item, its more detailed version appears (Figure 6(b)). By observing changes in the display, a participant can understand what the other participant finds interesting about their background. For example, a participant who sees Figure 7 easily understands that the remote participant is trying to change the kind of information displayed on the screen.

4.2 Implementation of Networked Silhouettell

This section describes the implementation of the Networked Silhouettell system. Figure 8 shows the system configuration.

[*3] This device should be changed to some more robust devices in general applications.



(a) Selecting a title (b) The detailed information appears

Fig. 6 Contents selection

Fig. 7 Changing the kind of information on the screen

The system works as follows. In a client machine, the Video Process sends the input images to the other client, and draws the image from the other client and the local client on the screen. The image from the other client is displayed as it is. In the case of the local image, the system detects the difference of the image from the background image recorded in advance, cuts it out, creates a mirrored image, makes it transparent, and overlays it on the screen. The Voice Process simply sends the input voice and outputs the voice from the other client. As for the server machine, the Server Process gets users' information from the Cultural Background Data File, and sends it to each client. It also synchronizes on-screen contents of both clients with Video Processes.

The Cultural-Background-Data Processing Component semi-automatically converts each user's cultural information which is obtained from the web-based form into the data of the system, where some items are manually converted. The contents are displayed in both Japanese and English. Each piece of information is shown near the corresponding participant. The location and contents are sent to the server first, collected, then sent to both clients.

When a user wants to select a kind of cultural information or a specific piece of information, he uses a pointing device. In this implementation, the user

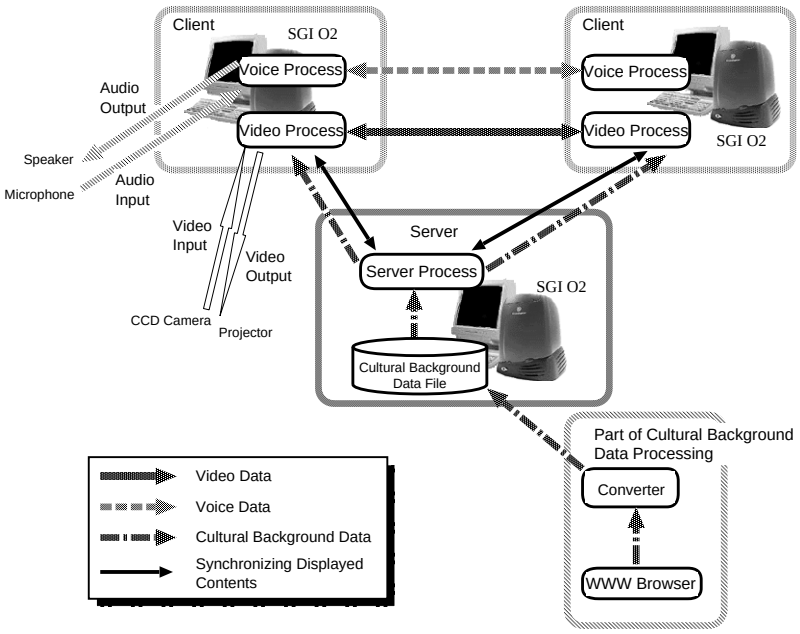


Fig. 8 System configuration

holds up a flat plate of a particular color, and the system detects its location using the input image from a CCD camera. If the detected point is at the same place on the screen as an icon, the system changes the kind of cultural information displayed. In the same way, if the point is in the same location as a particular piece of information, the system pops up the detailed information for that item.

As for user identification, we did not use any special technique of user identification but used a simple method in which a user selects his own name in the user menu, because we assumed one-to-one experimental use in this implementation.

The client and the server run on Silicon Graphics O2.

4.3 Experimental Evaluation of Networked Silhouettell

We evaluated the system by observing actual conversations among undergraduate students from Japan and the United States.

Method Seven pairs of students participated. Each pair consisted of a student from Japan and a student from the United States. The students from Japan had

all been to other countries or studied conversation in English. The students from the United States were taking classes in Japan and had studied Japanese for a few months. We had participants enter cultural information using a web form, before the experiment began. Since the Networked Silhouettell system is a tool for supporting the users knowing each other, we also instructed them to do a task together after using the Networked Silhouettell system for evaluating the system. The participants were told that their task was to work together to make a mini-guide to their own university for students from their partner's university, and that they were to use the Networked Silhouettell system for twenty minutes before the task[*4].

Result We obtained the following opinions from the questionnaire administered after the experiment. The items reported here were rated on an eight-point scale by eight or more of the fourteen participants (Figure 9).

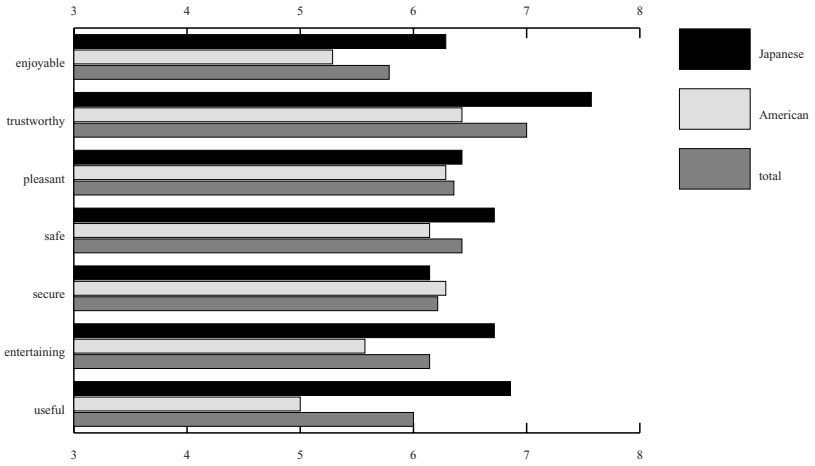


Fig. 9 Questionnaire Evaluation of Networked Silhouettell (8 highest, 1 lowest ranking)

- Impressions of the conversation partner and the Networked Silhouettell system

  The conversation partner was rated 'trustworthy,' and the system was rated 'pleasant,' 'safe,' 'secure,' and 'entertaining.'

  There were also some positive comments, "bilingual information was easy to use," "I can easily know my partner's feeling with gesture," and "transparent display is easy to use." As an interesting comment, a user wrote

[*4] The time twenty minutes is not so long for introducing themselves.

that this interface would be more appropriate for n-to-n communication than 1-to-1 communication.

- Comparison between Japanese and American
  In almost all items, Japanese students answered more positively than American students. We think it is because Japanese students had less experience of cross-cultural communications than American students.

We also observed the video log of this experiment.

The typical flow of conversation with the Networked Silhouettell system was as follows. First, participants talked about their own affiliations. They enjoyed talking about each others' birthplaces and travel experiences to each others' countries. Then, topics about the current environment where the participants lived (living, part-time job, and so on) began.

The following patterns were also observed in use of the cultural information.

- First, a participant read all of the information on the screen. Once the conversation began, however, he concentrated only on speaking.
- A participant talked while staring at the information.

In both cases, there were not any cases in which a participant related the information to the conversation topic directly. We did observe that sometimes, once a participant began to change the contents on the screen, the other participant would also begin to do so. As to the use of gestures, some were observed. For example, an American student showed three fingers to his Japanese partner while speaking, when the partner could not hear his sentence 'Are you in your third degree?' Interestingly, there were some bilingual conversations in which participants each spoke the other's language (the Japanese student spoke English, while the American student spoke Japanese).

For the system performance, since the system has a problem of image latency (0.6 second) due to system resolution and machine speed, there were complaints about system performance.

Through the whole experiment, we confirmed the following features of cross-cultural communication in the Networked Silhouettell environment.

- The non-native users (Japanese) in conversation rated the system more positively.
- Users use gestures in this environment without any special attention to the system.
- The transparent shadow is helpful for the users to understand the pointing

function, while we could not find the apparent effect of the feeling of existence.

§5 Discussion

In this paper, we have described factors needed to support cross-cultural socialization, both in the real world and between remote locations, and discussed the design, implementation, and evaluation of two systems designed to support this kind of socialization.

From the actual use of two systems, we empirically confirmed the following effects of the systems:

Shared information On-screen common topics are frequently referred when there is a language barrier. That is, users who do not have much experience of cross-cultural communication or is not non-native frequently referred common topics. The apparent effects of cultural backgrounds are not found.

Large-sized interface Each user's movement and gestures were done without any special attention to the systems. Therefore, when we develop a system which aims at a natural mode of communication, the nonverbal functionalities should be designed to be enable without any operation as verbal functionalities, e.g., the voice communication.

Displaying shadows We believe shadow is useful to handle information on-screen. In the experiment of Networked Silhouettell, we got opinions that the shadow is helpful in using the pointing devices. We could not find out whether this interface provides the feeling of existence or effects in identifying users.

We also confirmed the importance of response speed in an interactive system. There was no feedback about image latency from users of Silhouettell, which does not incorporate user feedback into the display. However, there were many complaints about image latency from users of Networked Silhouettell, which allows users to make changes on-screen with a pointing device. Thus, latency seems like a larger problem in a system which incorporates user feedback.

We could not find some effects, i.e., the effects of cultural backgrounds, the feeling of existence or effects from shadows. We think it is because the systems are not task-oriented and the conversations in each experiment includes only two persons. We have to consider these points in future works.

§6 Conclusion

In this paper, we discussed the importance of tools to support early socialization in cross-cultural collaboration. We proposed two support systems, which present shared information based on each participant's profile and cultural background by both using a life-sized interface with a large screen and representing participants in intuitive and natural ways on-screen during the interaction. We also discussed experimental evaluation of both systems.

Silhouettell is a system which supports real-world communications by presenting web pages related to common interests of participants located in the same place. The system shows shadows on a large screen, which attract participants and displays common topic web pages based on users' profiles. Through observations of the actual use of the system, we found that (1) information directly related to participants is referred in initiating conversation, and (2) participants frequently refer to the contents on the screen in a situation whereby it is hard to communicate to each other because of difference in participants' native language.

Networked Silhouettell is a remote communication tool, which gives participants a sense of a shared environment by displaying them on the same screen. It encourages understanding among users by showing each user's cultural experience and background information on-screen. A participant can select and examine detailed information about his partner's background using gestures with a pointing device. We found out that (1) The non-native users used the system more positively, and (2) the transparent shadow is helpful with the pointing function.

As a result of both studies, we empirically confirmed that: shared information is referred in situations where it is hard to communicate because of differences in the participants' native language; and users use movement and gestures naturally in the large-sized interface.

There are also several projects or systems supporting collaboration or communication among users.

AIDE[9] and CoMeMo-Community[13] promotes discussion or knowledge sharing by structuring or visualizing each user's topics or knowledge; while our systems provide cues to know each other by showing each user's profile or interests, which is described in section 2.1.

HyperDialog[11] as well as Silhouettell supports face-to-face communications. However, there are differences in the supporting methods. HyperDialog

uses mobile agents whereby information is managed in each user's mobile computer and is displayed personally. Silhouettell displays and shares all information on the large screen, so that all users have a feeling of sharing information together. These approaches are not in opposition to each other. It is an interesting approach to combine them, i.e., we can use mobile computers for handling private information and a large screen for handling shared or public information.

Let's browse[8] shares the same purposes with Silhouettell. There are, however, some differences between them. Silhouettell uses profiles entered by users in advance, while Let's browse extracts profiles from users' own web pages. The biggest difference is the handling of multi-user movement. Silhouettell allows users to move freely in conversations, and each shared web page related to users follows corresponding users.

Acknowledgment We would like to thank Stanford Japan Center for the cooperation in our experiments. We also thank the students who participated in the experiments and filled out our questionnaires.

References

1) AT&T Laboratories Cambridge, "The Active Badge System," `http://www.cam-orl.co.uk/ab.html`, 1999.
2) Borovoy, R., Martin, F., Vemuri, S., Resnick, M., Silverman, B. and Hancock, C., "Meme Tags and Community Mirrors: Moving from Conferences to Collaboration," in *Proceedings of the International Conference on Computer Supported Cooperative Work (CSCW-98)*, pp. 159–168, 1998.
3) CUseeMe Networks, `http://www.cuseeme.com/`, 2000.
4) Grasso, A., Koch, M. and Snowdon, D., "Campiello – New User Interface Approaches for Community Networks," in *Proceedings of Workshop Designing Across Borders: The Community Design of Community Networks at CSCW-98*, 1998.
5) Isbister, K., "Designing for Social Interaction in Cyberspace," *IPSJ Magazine*, Vol. 40, No. 6, pp. 569–574, 1999 (in Japanese).
6) Ishida, T., "Towards Communityware," *New Generation Computing*, Vol. 16, No. 1, pp. 5–21, 1998 (also appeared in *International Conference and Exhibition on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM-97)*, pp. 7–21, 1997).
7) Ishida, T. (ed.), *Community Computing: Collaboration over Global Information Networks*, John Wiley and Sons, 1998.
8) Lieberman, H., Dyke, N. V. and Vivacqua, A., "Let's browse: A Collaborative Browsing Agent," *Knowledge-Based Systems*, Vol. 12, pp. 427–431, 1999.
9) Mase, K., Sumi, Y. and Nishimoto, K., "Informal Conversation Environment for Collaborative Concept Formation," Ishida, T. (ed.), *Community Computing:*

Collaboration over Global Information Networks, John Wiley & Sons, pp. 165–205, 1998.

10) Morikawa, O. and Maesako, T., "HyperMirror: Toward Pleasant-to-use Video Mediated Communication System," in *Proceedings of the International Conference on Computer Supported Cooperative Work (CSCW-98)*, pp. 149–158, 1998.

11) Nagao, K. and Katsuno, Y., "Agent Augmented Community: Human-to-Human and Human-to-Environment Interactions Enhanced by Situation-Aware Personalized Mobile Agents," in Ishida, T. (ed.), *Community Computing and Support Systems*, Lecture Notes in Computer Science 1519, Springer-Verlag, pp. 342–358, 1998.

12) Nakanishi, H., Yoshida, C., Nishimura T. and Ishida, T., "FreeWalk: Supporting Casual Meetings in a Network," in *Proceedings of International Conference on Computer Supported Cooperative Work (CSCW-96)*, pp. 308–314, 1996.

13) Nishida, T., Hirata, T. and Maeda, H., "CoMeMo-Community: A System for Supporting Community Knowledge Evolution," in Ishida, T. (ed.), *Community Computing and Support Systems*, Lecture Notes in Computer Science 1519, Springer-Verlag, pp. 183–200, 1998.

14) Okada, K., Maeda, F., Ichikawa Y. and Matsushita, Y., "Multiparty Videoconferencing at Virtual Social Distance: MAJIC Design," in *Proceedings of International Conference on Computer Supported Cooperative Work (CSCW-94)*, pp. 385–393, 1994.

15) Okamoto, M., Isbister, K., Nakanishi H. and Ishida, T., "Supporting Cross-Cultural Communication in Real-World Encounters," in *Proceedings of International Conference on Human-Computer Interaction (HCI-99)*, Volume 2, pp. 442–446, 1999.

16) Okamoto, M., Nakanishi, H., Nishimura T. and Ishida, T., "Silhouettell: Awareness Support for Real-World Encounter," in Ishida, T. (ed.), *Community Computing and Support Systems*, Lecture Notes in Computer Science 1519, Springer-Verlag, pp. 317–330, 1998.

17) Reeves, B. and Nass, C., *The Media Equation*, Cambridge University Press, 1996.

18) Watabe, K., Sakata, S., Maeno, K., Fukuoka, H. and Ohmori, T., "Distributed Multiparty Desktop Conferencing System: MERMAID," in *Proceedings of International Conference on Computer Supported Cooperative Work (CSCW-90)*, pp. 27–38, 1990.

19) Yamaki, H., Kajihara, M., Tanaka, G., Nishimura, T., Ishiguro, H. and Ishida, T., "Socia: Non-Committed Meeting Scheduling with Desktop Vision Agents," in *Proceedings of International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM-96)*, pp. 727–742, 1996.