

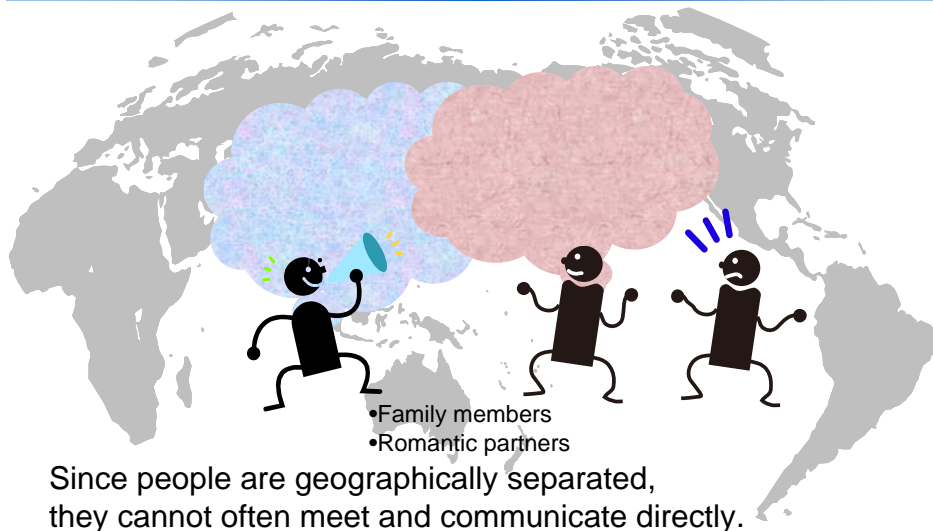
配布資料

## 障子: 雰囲気情報を伝達する コミュニケーション端末

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### Background: Distance between People

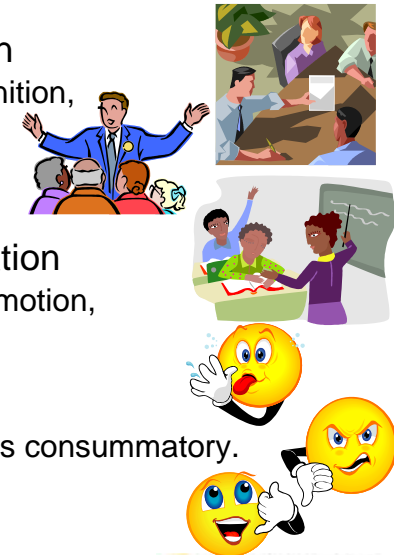


## 第64回学術講演会(ファジィフロント) 講演概要

人と人との対面コミュニケーションにおいては、言語による明示的な情報だけでなく、身振りや感情などの人に関する情報や周囲の環境情報など、いわゆる雰囲気情報が大きな役割を果たしている。一方、遠隔コミュニケーションにおいてはこれが失われがちである。そこで我々は、離れて暮らす親と子世帯を対象に、雰囲気情報の伝達システムを提案している。今回、開発した雰囲気コミュニケーション端末「障子」について紹介する。

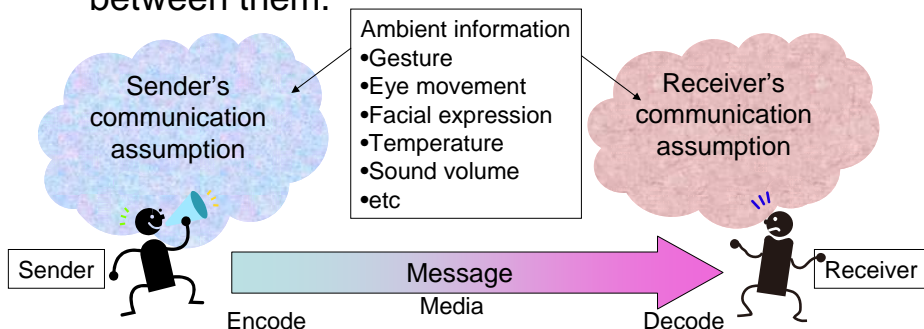
### Background: Human Group Communication

- Instrumental Communication
  - To change the receiver's cognition, emotion, action.
    - Ex. Meeting, speech, lecture.
- Consummatory Communication
  - To share one's experience, emotion, knowledge, opinion.
    - Ex. Joking, complaining, talking about mundane things.
  - Most of daily communication is consummatory.



## Background: Communication Model

- For effective communication, it is necessary **to share communication assumptions** between them.



- Ambient information tends to miss in ordinary media communication.

## Definition: Ambient Information (雰囲気)

- Synthesized information consists of
  - human unconscious information
  - environmental information.

Human Information	Presence
	Motion
	Emotion
Environmental Information	Temperature
	Illumination
	Noise

## Related Works

Family Planter (NTT)	Lovelet (JAIST)	Digital Family Portrait (Georgia Tech)	Lumi Touch (MIT)
<ul style="list-style-type: none"> <li>•Presence</li> <li>•Motion</li> </ul>	<ul style="list-style-type: none"> <li>•Temperature</li> </ul>	<ul style="list-style-type: none"> <li>•Opening/closing doors</li> </ul>	<ul style="list-style-type: none"> <li>•Touch</li> </ul>

We propose expressing various types of ambient information by using a synthesized metaphor rather than focusing on specific information.

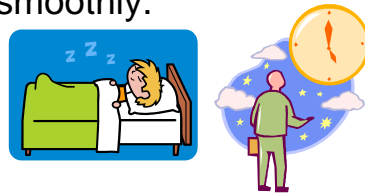
## Target Situation

- Private usage
  - parent and child families
  - husband working at distant location and family
  - hospital patient and family
  - romantic partners
- Public usage
  - head office and distant plant
  - office and teleworker's home



## Technical Functional Requirements

1. To convey various types of ambient information so that they can imagine the other side instinctively.
2. To protect the privacy so that they do not feel uncomfortable.
3. To enable people who have different lifestyles to communicate smoothly.



## Design of Expression Methods

If ambient information is clearly displayed with numerical values, users feel their privacy has been invaded.



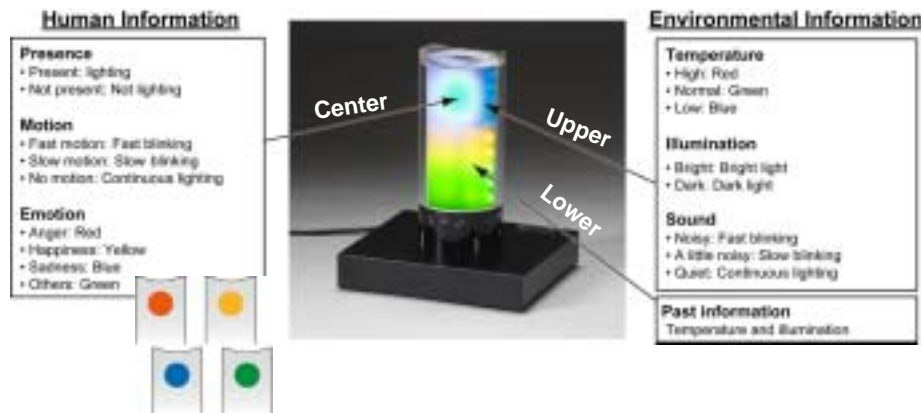
Our approach is to express ambient information in an abstract or sensuous manner.



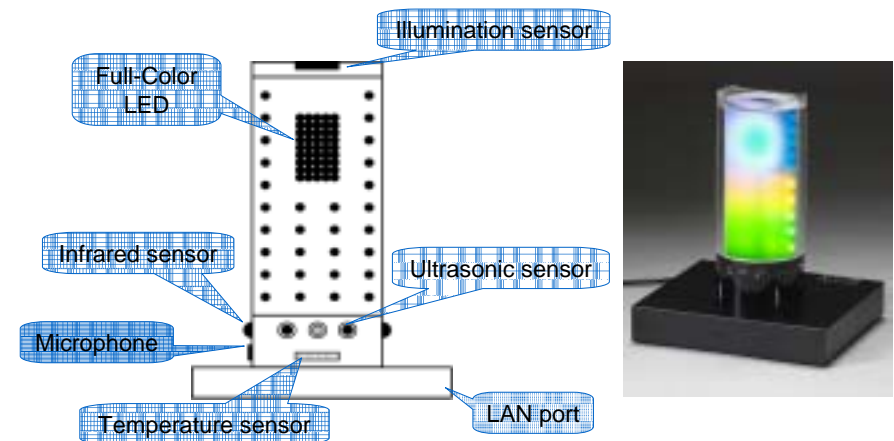
To determine the most appropriate expression method, we conducted a questionnaire survey. Some expression methods of ambient information were tried: using light color, using light shape, using sound, using light brightness and motion.

## Appearance and Expression Methods

Based on the questionnaire survey, we decided how to express ambient information on the device.



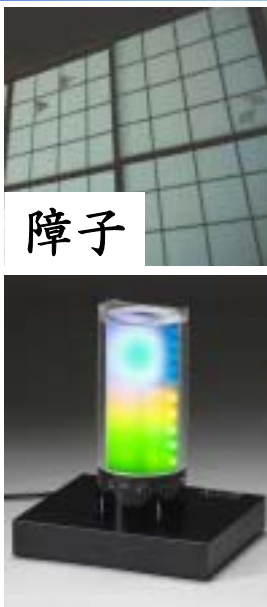
## Prototype Terminal (Hardware system)



Information detected in one terminal is transmitted to the other terminal by internet. The terminal displays received information using full-color LED.

# Communication over *shoji*

- Concept of “**communication over *shoji***” to express ambient information in abstract or sensuous manner.
- *Shoji* is a **semitransparent room divider** that is traditionally used in Japan. One can be aware of ambient information in the next room indirectly from filtering lights or sounds through *shoji* screen.
- Code name: “SHOJI” (Symbolic Hosting Online Jog Instrument)



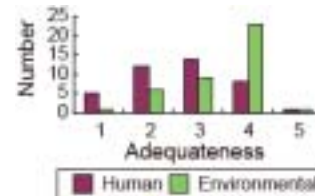
# User Study: Expression Methods

- **Participants**
  - Total 40 = 23 men + 17 women (Young: 16, Middle: 10, Senior: 14)

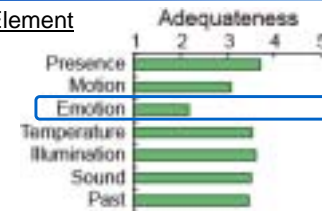
## • Overall adequateness



## • Human / Environmental



## • Element

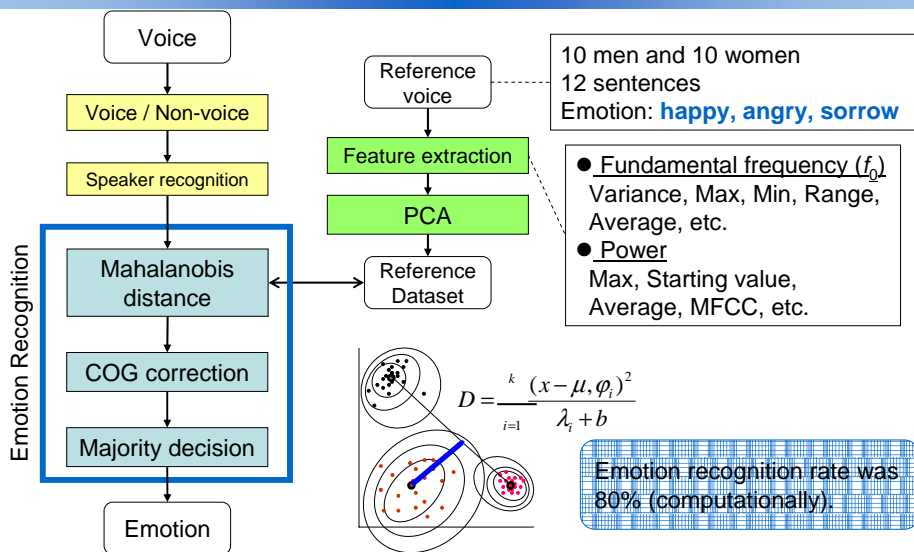


## • Wishing list

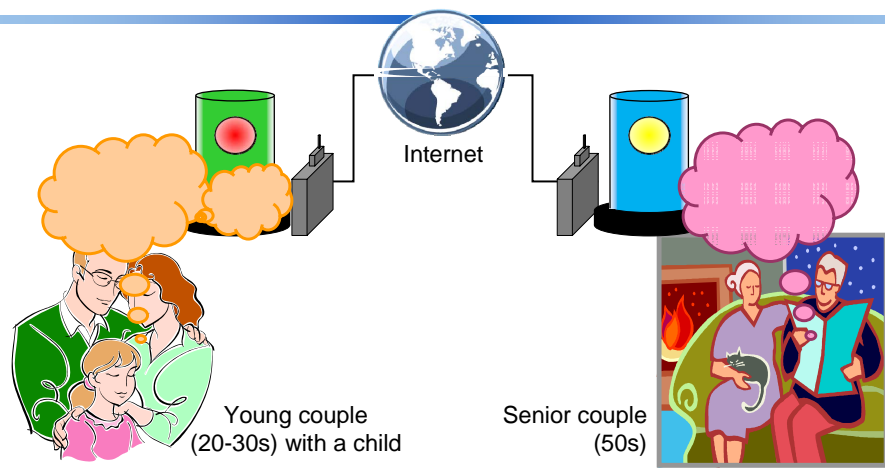


Still wanted emotion

# Emotion Extraction from Voice



# Field Experiment using “SHOJI”



Evaluation of consummatory communication by “SHOJI.”



## Q. How was the effect on consummatory communication by “SHOJI”?

(from young)

- A1. Since “SHOJI” informed us of the presence of my parents, I could easily contact them. In contrast, my contact occasion decreased because I could imagine the condition of the other side by watching “SHOJI”,
- A2. During our family dinner, we often talked not only about my family’s events but also about the events of the other side.

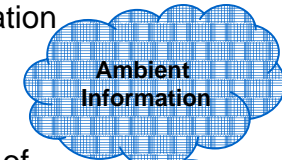
(from senior)

- A3. “SHOJI” increased the frequency to imagine the other side. Although “SHOJI” was a “machine,” I could feel connected to the other side.
- A4. The communication frequency increased. My wife sometimes made a phone call to her daughter while watching “SHOJI”.

Experiments to be continued.

## Conclusions

- “SHOJI” conveys ambient information to promote fluent consummatory communication.
- “SHOJI” expresses various types of ambient information such as presence, motion, emotion, temperature, illumination, and noise.
- Although the emotion recognition rate should be improved, some participants judged that ambient information was sufficiently expressed. It indicates that “SHOJI” is useful for exchanging communication assumption.



## 本研究に関する主な研究発表

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- 山田 一郎, “雰囲気コミュニケーション,” 感覚・感情とロボット (社団法人 日本機械学会編), pp. 173-181, 2008.
- Masaki Shuzo, Makoto Shimura, Jean-Jacques Delaunay, Ichiro Yamada, “SHOJI: A communication terminal for sending and receiving ambient information,” 2009 ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, San Diego, USA, August 30-September 2, 2009.



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### SHOJI: A COMMUNICATION TERMINAL FOR SENDING AND RECEIVING AMBIENT INFORMATION

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#### ABSTRACT

In modern Japan, increased human mobility has resulted in many people being geographically separated from their families and friends. There thus exists a need for communication devices that provide a link between geographically separated family members and friends. Although there are two types of communication, instrumental and consummatory, few studies have been conducted on the latter. We have developed a communication terminal that uses the exchange of ambient information as a means to promote consummatory communication. A concept for effectively communicating ambient information was derived from data collected from questionnaires. This concept was used to develop a communication terminal called "Shoji" that can send and receive ambient information such as the temperature, illumination, light color temperature, and noise level as well as information about the presence or absence of individuals, their movements, and their emotions. We evaluated it experimentally. The participants were parents and children living apart. They judged that the information was sufficiently expressed, which indicates that the terminal is useful for exchanging ambient information.

#### 1 INTRODUCTION

In modern Japan, many people live apart from those with whom they have a close relationship, such as family members and romantic partners. Since they are geographically separated, they cannot often meet and communicate directly. Although computer network-mediated media communication tools will enable people living apart to interact more frequently, there

are various obstacles to efficient media communication. One goal of media communication is to realize kansai communication, which conveys human emotions and/or the ambience of their locations.

Human group communication is often classified as either instrumental or consummatory communication [1]. The purpose of instrumental communication is to change the receiver's cognition, emotion, and/or action by communication. Examples of instrumental communication are providing knowledge to others, persuading others, and changing others' action. The purpose of consummatory communication is communication itself, namely, to share one's experiences, emotions, knowledge, and/or opinions. Examples of consummatory communication are joking, complaining, and talking about mundane things. It is said that most daily communication is consummatory [2].

For both instrumental and consummatory communication to be effective, it is necessary to share communication assumptions between the two parties (Figure 1). However, most media communication does not convey nonverbal information such as gestures, eye movement, and facial expression and social information such as age, gender, and job. Most previous studies have focused on instrumental communication; few have focused on ambient information such as human unconscious information and environmental information. To convey the ambient information that tends to miss in ordinary media communication would be an effective way to improve consummatory communication, which often requires the expression of emotion.

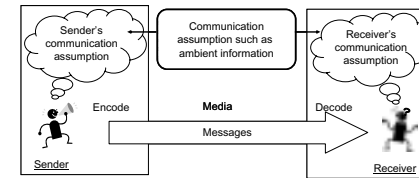


Figure 1. Communication model.

## 2 AMBIENT INFORMATION

### 2.1 Definition:

In this paper, ambient information is defined as synthetic information consists of human unconscious information and environmental information. We classify information related to consummatory communication as either explicit or ambient. Explicit information is the information that the communication sender consciously wants to share with the receiver in consummatory communication. Contents, the way to speak, and gestures used when joking are examples of explicit information. Ambient information, on the other hand, is implicit information that the communication sender does not want to consciously share with the receiver, for example, casual air and soliloquy. Moreover, environmental information such as the balmy sunshine and bird's twittering in the morning is also included in the ambient information.

We have investigated the effectiveness of ambient information in supporting consummatory communication. One reason we focused on ambient information is that it is often and easily lost in media communication. The language contents of explicit information are easily conveyed by telephone or e-mail. Nonverbal information such as gestures and facial expressions can be conveyed by using video chat. On the other, the motions without conscious intention and soliloquy cannot be conveyed because the sender does not have the intention to do so. In addition, ambient information has rarely been conveyed because conventional media communication tools cannot sufficiently convey this information.

Another reason we focused on ambient information is that it is an extremely effective way to share communication assumptions. On the one hand, explicit information is conveyed only when the sender consciously conveys it. On the other, since ambient information involves many kinds of information that is automatically shared when the sender and receiver are in the same place, people unconsciously send and share such ambient information. This information promotes the sharing of communication assumptions. When most communication assumptions are shared, the communication is more effective. Thus, we assume that the sharing of ambient information is useful for smooth consummatory communication.

### 2.2 Related works:

We can classify related works of the ambient information in two ways: "information that people unconsciously produce" such as emotion, presence, and motion and "environmental information" such as temperature, illumination, and noise.

One of the previous studies related to ambient information focused on tsunagari communication [3], which is "aimed at fostering a feeling of connection between people living away and maintaining their social relationships." To validate the concept of tsunagari communication, a prototype "Family Planter" terminal was developed. It uses an infrared sensor, an ultrasonic sensor, and a touch sensor to detect users' presence and motion information. These detected information is conveyed to other Family Planter terminals. Although the effectiveness of tsunagari communication had already examined in experiments with family members and students as participants, the information conveyed was only human presence and motion information.

There have been previous studies in which ambient information other than presence and motion information was communicated. Lovelet [4] communicated human temperature information. Digital Family Portrait [5] conveyed information regarding human activities (e.g. opening or closing doors). Lumi Touch [6] transmitted information regarding human touch. Peak-A-Drawer [7] is a virtual shared drawer across distant locations. Lover's cup [8] is a coffee cup and exchanges water level. Meeting pot [9] is a coffee maker and expresses coffee aroma.

Other studies have focused on emotion, which is the important communication assumption for consummatory communication. They, however, treated emotional information separated from other ambient information. ComSlipper [10] is a pair of slippers with sensors and expresses the emotion of the other side. TCON [11] is a tactile facial form and expresses the emotion of the other side. These studies communicated only a small portion of the various kinds of ambient information.

### 2.3 Our approach:

We propose expressing various types of ambient information by using a unified metaphor rather than focusing on specific portions of ambient information. We develop a method for expressing ambient information that helps the two parties communicating to intuitively understand the situation of the other party. They can select the portion of ambient information to be transmitted depending on the time and circumstances. This method is expected to protect each party's privacy due to the use of a metaphor.

We have now developed a communication terminal for conveying various types of ambient information that we call "Shoji (symbolic hosting online jog instrument)."

## 3 TARGET USAGE

Shoji can be used for both private and public communication.

Private communication between

- family and husband or wife working at distant location
- parent and child families
- hospital patient and family
- romantic partners

Public communication between

- head office and distant plant
- office and home of teleworker

\* These authors also belong to Japan Science and Technology Agency, Core Research for Evolutional Science and Technology (JST-CREST).

Private communication is mainly between people who are relationally close and cannot communicate easily due to their physical separation. For example, when a husband or wife assigned to work at a distant location returns to his or her temporary residence after work, he or she might imagine the living situation back home. Such ambient information might lead him or her to feel at ease or to pick up the phone and call home.

In public communication use, people who work at a distant location use ambient information to maintain their relationship. Since most communication in work situations is instrumental communication, people contact those working at distant locations by telephone, e-mail, or video conference only when necessary. However, to perform their jobs effectively, it is important for work group members to maintain their relationships by conducting a moderate amount of consummatory communication. Thus, creating communication cues is an important function for a terminal designed to communicate ambient information.

#### 4 TECHNICAL FUNCTIONAL REQUIREMENTS

Given the situations discussed above, we identified three technical functional requirements:

- 1 The ability to convey various types of ambient information that are effective in enabling each party to imagine the environment, motion, and state of mind of the other party.
- 2 The ability to protect the privacy of each party so that they do not feel uncomfortable.
- 3 The ability to enable people who have different lifestyles to communicate smoothly.

To meet the first technical functional requirement, we use the information that is communication assumption. This includes information about humans and their environments. Since the ambient information communication terminal is for use in daily life situations, the information about the humans should be detectable without imposing any physical restrictions on them. We thus use human presence and motion information. In addition, we attempt to detect emotion, which better represents the ambient information.

To detect emotion without physical restriction, we analyze the voice characteristics from voice information obtained by a microphone and extract the emotion. There are two reasons for detecting only emotion and not voice information itself. The first is to protect privacy. Although it is possible to communicate the voice information obtained from the microphone, users would certainly feel uncomfortable if they thought their privacy was being invaded.

The second reason is that all the voice information is not always necessary for smooth consummatory communication. It is possible that conveying all the voice information would be bothersome for the users. In addition, one of the features of consummatory communication is sharing emotion. This means that extracting and conveying only the emotional information rather than all the voice information is more effective for consummatory communication.

In the architectural field, there have been several studies on the effect of environmental information, which is room color and illumination. On the basis of these findings, we use

the apparent temperature (compound function of temperature and humidity), illumination, noise, and color temperature. These kinds of environmental information are easy to detect, and change in a few hours for users to help to imagine the other side. Table 1 lists the information detected by the Shoji ambient information communication terminal.

Our solution to the second technical functional requirement, privacy protection, is to enable bi-directional communication of ambient information in an abstract manner. Since the digital expression of acquired information can lead users to feel that their privacy is being invaded, we express the acquired ambient information in a sensuous manner using light and color.

The third technical functional requirement is that people who have different lifestyles can communicate smoothly. One of the potentially disruptive factors in telecommunication is the difference in lifestyles between the two parties. People in remote locations may not spend much time in front of a communication terminal, so they may feel and appear uncomfortable. Thus, the communication terminals must cope with differences in lifestyles.

Our solution is to express not only present ambient information but also previous ambient information. This means that even though one party may have already gone to bed, the other party can better understand his or her situation from the previous illumination and temperature information.

**Table 1.** Information detected with the Shoji terminal.

Information	Type
Environment	Temperature
	Illumination
	Noise
Human	Color temperature (light color)
	Presence
	Motion
	Emotion (extracted from voice)

#### 5 QUESTIONNAIRE

##### 5.1 Overview:

As mentioned above, the ambient information sent using the communication terminal should be expressed so that the users do not feel that their privacy has been invaded. Our approach is to express information in an abstract and sensuous manner by using light and color.

To determine the most appropriate expression method, we conducted a questionnaire survey. We considered four methods for expressing ambient information: using light form, using light color, using light brightness and motion. For each type of information, we asked about the validity of each method. The participants in the first survey were 63 adults (33 men and 30 women). They completed the questionnaire while watching demonstrations of a number of expression methods.

The participants were first told to "Please imagine a situation in which the terminal is placed in your living room and that your parents (or your child) are living apart. An identical terminal is placed in their living room. The terminals

detect each room's environmental information such as room temperature, noise level, and illumination level and information about the human in the room such as their entering/leaving and emotions. The terminals exchange these information." They completed the questionnaire without further information about the terminal.

##### 5.2 Results:

First, the participants answered questions about the adequateness of four expression methods representing seven types of ambient information. The description of the human presence information was "a measurement that represents whether a person is in the other living room", that of human motion information was "a measurement that represents the speed of human motion in the other living room", and that of emotional information was "a measurement that represents the emotional status of the person in the other living room." The participants then chose the detail of the expression about the expression method that they rated "appropriate".

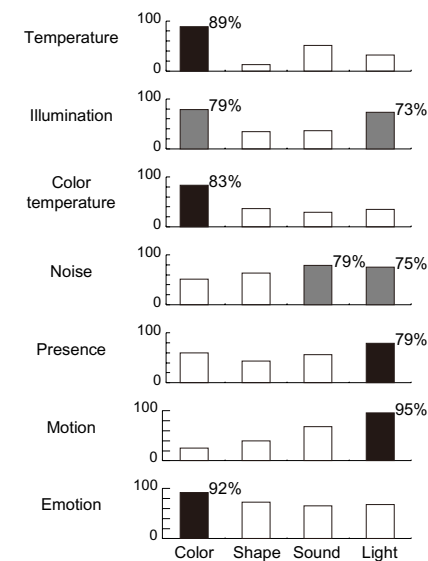
The questions about appropriateness had a 7-point scale from "not appropriate" to "appropriate." We consider a score from 5 to 7 as "appropriate." The participants answered the questions about the detail of the expression if they gave a score of from 5 to 7.

Figure 2 shows the percentage of respondents who answered "appropriate" for each type of information. The results showed that it was appropriate to express temperature, color temperature, and emotion using color and that it was appropriate to express presence and motion information using light brightness and motion. Color expression was judged appropriate for illumination information by 79% of the participants. Light brightness and motion expression were judged appropriate for illumination information by 73% of them. There was thus little difference between the two expression methods. There was also little difference between using sound (79%) and light brightness and motion (75%) for noise information.

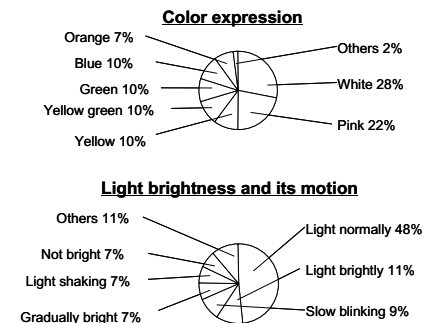
Next we describe the details of each expression method. The result of information for which only one expression method was judged appropriate, such as temperature, color temperature, presence, motion, and emotion showed the explicit direction in the detail of each type of information detail. Thus, we determined the detail of the expression following to the result.

The results for illumination and noise information were more complex. Figure 3 shows the results for color and light and its motion expression methods about the illumination information in "average brightness." 48% of the participants answered "bright normally" for light brightness and motion expression. In contrast, explicit direction was not observed for color expression. Thus, we decided to express illumination information using light brightness and motion. In the same way, since we could observe more explicit direction in light and its motion than sound, we expressed noise by using light brightness and motion.

In addition, some participants also stated that the expression of noise information by sound is troublesome for daily life. We thus decided not to use sound to express noise information.



**Figure 2.** Percentage of respondents who answer "appropriate."



**Figure 3.** Representation methods of illumination information.



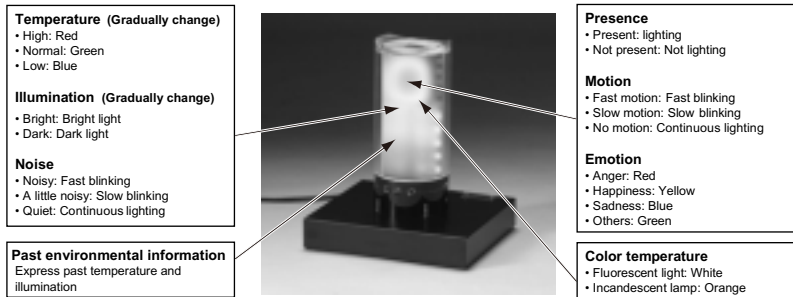


Figure 4. Appearance of the developed terminal “Shoji” and adequate representation methods found in questionnaires.

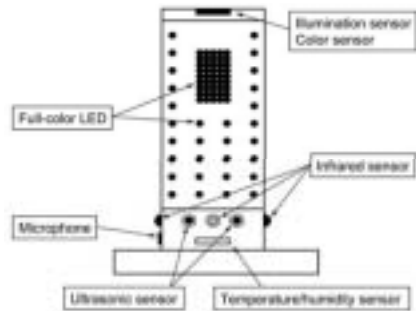


Figure 5. Schematic of the Shoji terminal.

## 6 PROTOTYPE TERMINAL

To validate the concept of ambient information communication in which users can feel close to the other party, we developed an experimental terminal. The terminal concept to express ambient information in ambient and sensuous ways is “communication over *shoji*.” A *shoji* is a semitransparent room divider that is used in Japan traditionally. People can be aware of the ambient information in the next room indirectly from the lights and sounds filtering through the *shoji* screen.

The *shoji* metaphor offers two advantages. The first is that it can be an effective way for people to comprehend an ensemble of information. Since the *shoji* is a common room divider in Japan, we assume that people will intuitively understand the *shoji* metaphor, i.e., a person on one side of the divider being aware of the environment and activities on the other side.

The second advantage concerns the invasion of privacy. Exchanging large volumes of mundane information often invades a personal privacy. This often occurs when the transmitted information is one-sided or blatant. Since a *shoji* screen is semitransparent when seen from either side, the exchange of information is reciprocal, and information is transmitted naturally, without any specific effort to do so.

On the basis of this discussion, we developed our experimental communication terminal, “Shoji (symbolic hosting online jog instrument)”, which is shown in Figure 4. The figure also shows how emotional and other cue information is expressed by the terminal. Figure 5 shows a schematic of the terminal. It has a microphone, a temperature and humidity sensor, an illumination sensor, three infrared sensors, and an ultrasonic sensor. The terminal is connected to the network through a local area network port. The detected information is transmitted to a predesignated terminal that displays the received information using full-color light-emitting diodes (LEDs). The lights in the center of the terminal present the information about human activities. The lights in the upper portion of the terminal present information about the environment, and the lights in the lower portion show previous information.

## 7 EMOTION EXTRACTION FROM VOICE

In this part, we describe an algorithm for emotion extraction under real environment. The proposed algorithm consists of serial three recognition processes: voice/non-voice recognition, speaker recognition, and emotion recognition.

### 7.1 Voice/non-voice recognition process:

Since the sounds from the microphone include various kinds of voice, noise, and environmental sounds, the determination of voice/non-voice is necessary prior to the emotion recognition. For the voice/non-voice recognition analysis, we used three datasets (one for voice, two for non-voice). The first dataset was voice data from 10 adult men and 10 adult women. The second dataset was domestic sounds database [12]. The third dataset was the Real World Computer Partnership (RWCP) sound scene database in real acoustic environments [13].

In the discriminant analysis, the discrimination function with the modified Mahalanobis distance ( $b=2$ ) was used [14]. As sound feature values, fundamental frequency ( $f_0$ ), variance and starting value of power, average and variance of 12-dimension mel-frequency cepstrum coefficient (MFCC) were selected. Figure 6 shows the computed Mahalanobis distance between voice and non-voice data. This result suggests that voice data can be discriminated from non-voice data by a distance larger than 80.

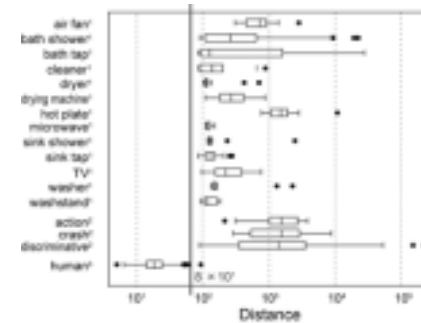


Figure 6. Mahalanobis distance between voice and non-voice data (1: database of domestic sounds (AIST, JIS TR S 0001: 2002), 2: sound scene database (RWCP, <http://tosa.mri.co.jp/sounddb/indexe.htm>, 2005), 3: human voice data).

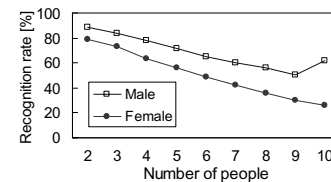


Figure 7. Speaker recognition rate obtained by cluster analysis as a function of the number of people.

### 7.2 Speaker recognition process:

Since voice features show large natural variations among individuals, it is difficult to recognize an emotion of a specific person from several people speaking simultaneously. Thus, speaker recognition is also necessary to achieve the emotion recognition with a high accuracy. Under real environment, any prior reference data of a speaker’s voice is not obtained. So the standard discrimination analysis that requires reference data is not appropriate method.

In this process, to discriminate between different speakers, we implemented a hierarchical cluster analysis method to accumulate and keep a dataset as reference data up-to-date. We used the Ward’s method for clustering analysis with the cosine distance. The voice data and feature values were same as in the previous process. The results of clustering for up-to 10 men or 10 women were shown in Figure 7. This result suggests that the recognition rate is about 80% when the number of speakers is three or fewer which is reasonable in general family room.

### 7.3 Emotion recognition process:

Consequently, emotion recognition is conducted. The voice data from the 20 adults (10 men and 10 women) mentioned above was treated as the reference data. Each person spoke 12 types of sentences with three types of

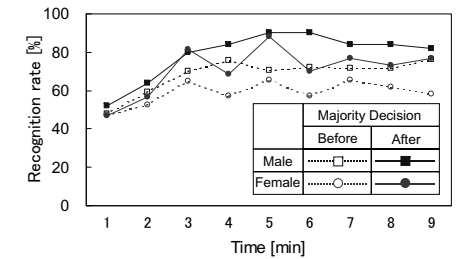


Figure 8. Emotion recognition rate by discriminant analysis with majority decision and COG compensation.



Figure 9. Sample photo of the Shoji terminal in a living room used for the field experiment.

emotions (happy, angry, and sorrow). Three minutes of continuous voice data spoken by other 11 adults (five men and six women) was treated as target data.

In this process, the discrimination function with the modified Mahalanobis distance ( $b=2$ ) was also used. The fundamental frequency and power was used as feature values. As a result, the emotion recognition rate was about 70% for men, and about 40% for women (data not shown).

Since generally human emotions do not change in short time, the majority decision process can be applied to that discriminant analysis output. Also, since the center of gravity (COG) in the voice feature space is different for each individual, it is effective to correct the COG every 1-minute in that discriminant analysis process. Even if the initial rate was low, the emotion recognition rate was improved after a few minutes by majority decision process and COG correction, resulting in about 80% for both men and women (Figure 8).

## 8 FIELD EXPERIMENT

### 8.1 Method:

To examine the effectiveness of the concept, we conducted a field experiment using the Shoji terminal (Figure 9). The participants were a married young couple in their 20s and 30s and a senior couple in their 50s who were parents of the young wife. The senior couple lived on their own, and the

young couple lived with their daughter, who was six years old. The distance between the living place of the young couple and senior couple was about 30 minutes by train. We set one terminal in each couple's house and conducted a field experiment for a week. The terminal was set in the living room where they mainly lived. They were instructed not to be particularly conscious of the terminal and to live as usual.

The interviews were conducted before and after the experiment. In the pre-survey interview, they were asked about their lifestyles and communication frequency with the corresponding couple. In the post-survey interview, they were asked to evaluate the design of the terminal and the appropriateness of the ambient information expression method. They also answered questions about its effect on consummatory communication.

## 8.2 Results:

Since the two couples did not live near each other, they did not meet frequently. The telephone was the most commonly used communication tool, and they talked around five hours per month by telephone. Most communication was conducted by the two wives.

The evaluation of the design of the terminal and the appropriateness of the ambient information expression method in the post-survey interview are summarized below in the form of responses.

- I could grasp an overview of the ambient information without close attention to the terminal.
- Although at first I could not understand the color expression of emotional information, with a day or so I could figure out the meanings. The expression of temperature information was intuitively easy to understand. Seven types of information were not too much for understanding.
- About the ambient information expressed on the terminal, once I become accustomed to the terminal, I figured out the information at once. However, in the current circumstances, I often forgot the expression method.
- The expression by LED was good. The size of the terminal was appropriate. If the display region was smaller, the expression would be harder to understand.
- The light of the terminal was too bright at night. I sometimes mistakenly thought that I had forgotten to turn off a light. It would be better to control the light volume of the terminal at night by detecting the illumination of the room.
- The terminal was interesting because it was like andon (Japanese indirect illumination made from washi paper, a wooden frame, and a candle). The color was so beautiful. Washi was good because it was like a night-light.
- The change in emotional information was a useful cue to talk with my daughter about the condition of her grandparents.

Although the young couple could easily understand the method for expressing ambient information, the senior couple pointed out that there was too much information expressed on the terminal. Thus, the evaluation of the amount of ambient

information was affected by the participant's age. Most participants evaluated each type of ambient information as easy to understand. The design of the terminal was also favorably evaluated. The participants focused on various types of information depending on the situation. In one instance, they paid attention to temperature information, and in another, they took notice of the emotional information.

The evaluation of the effect on consummatory communication is summarized below in the form of responses.

- The terminal increased the chance to imagine the other side. Though the terminal was a "machine," I could feel connected to the other side.
- The chances to communicate increased. My wife sometimes made a phone call to her mother when she watched the terminal.
- Since the terminal informed us of the presence of the other side, I could easily contact them. In contrast, since I could judge the condition of my parents by watching the terminal, the number of times we contacted them to determine their condition decreased.
- Since I could determine whether they were present, it was easy to contact. When I had to contact them, the information on the terminal helped me decide when to phone.
- When our family ate dinner, we often talked about the other side. Since the terminal gave us information about them, we could not only talk about my family's events but also about the events of the other side.
- I felt uncomfortable that the other side knew when I got up late. Additionally, I didn't want to convey information when my family was upset in the morning.

All the participants favorably evaluated the effect of the information sharing, which is the purpose of consummatory communication. In particular, the results of the interview showed several advantages, such as "it helps me to contact them by providing information about the situation of the other side," "ambient information leads users to imagine the other side," and "by watching the information on the terminal, users can carry on a pleasant conversation about the other side."

About the frequency of communication, the effect of the terminal was ambiguous. On the one hand, thinking about the situation of the other side leads to contacting to them. On the other hand, since users can know the condition of the other side, they may not bother contacting them. Nevertheless, the result also says that the communication itself became smooth even if the frequency of communication decreased.

Though the information that users want to convey increased communication effectiveness, there were some problems caused by sending information that users did not want to convey. An increase in the information conveyed inevitably leads to an increase in not only the information that they want to convey but also in that they do not want to convey. This issue requires further examination.

## 9 CONCLUSION

We have developed a communication terminal called "Shoji" that conveys ambient information for the purpose of promoting fluent consummatory communication. The concept on which it is based was derived from data collected from questionnaires. Shoji can send and receive such ambient information as the temperature, illumination, light color temperature, and noise level as well as information about the presence or absence of individuals, their movements, and their emotions. The participants in an experimental evaluation judged that the information was sufficiently expressed, which indicates that the terminal is useful for exchanging ambient information.

We plan to conduct a longitudinal field experiment based on the knowledge acquired in this study. In addition, on the basis of an evaluation of the effectiveness of each type of information, we will identify the information that is most effective for conveying ambient information.

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