Conference System using Finger Braille

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ABSTRACT

In this paper, we propose a conference system using text and finger braille. Finger braille is one of the communication methods for deaf-blind people. Since some of them have serious impairments of the visual and auditory senses, they communicate with others using tactile sensation. We have analyzed the features of finger braille. The functions required for the system were examined and implemented in the conference system. The validity of the functions was ascertained by an evaluation experiment. As a result, the number of utterances of a deaf-blind person was almost the same as that of a sighted-hearing person. The result of a simulated conference confirmed the validity of the proposed system.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Haptic I/O.*

General Terms

Language

Keywords

Finger braille, deaf-blind, conference system, haptic input/output device.

1. INTRODUCTION

People who are both deaf and blind are called “deaf-blind”. They suffer much inconvenience in their everyday lives due to the social handicap. In particular, the deaf-blind with serious impairments are not able to obtain sufficient information necessary for living, something which a hearing and sighted person can do easily. To obtain information for living, they use tactile sensation instead of auditory and visual sensation.

Finger braille is a communication means using tactile sensation. Some deaf-blind people are able to communicate with sighted-hearing people through finger braille interpreters. However, many issues remained to be solved before deaf-blind people can come autonomous and enjoy conversations with others without interpreters.

We focused on a conference system using finger braille as an interactive communication method for deaf-blind people. Using a conference system, deaf-blind people are able to speak with both deaf-blind and sighted-hearing people directly without finger braille interpreters. Moreover, it gives deaf-blind people a chance to converse with others in a group.

Since finger braille is coded similar to Braille, it is easy to apply to digital information devices and equipment. Equipment for finger braille has been proposed [3]. However, there has been no conference system by which deaf-blind and sighted-hearing people can converse. We designed a conference system in which participants use finger braille or text characters. In the system, problems may arise due to language processing through different communication media: text and finger braille. In designing the system, the difference must be taken into account.

In this paper, we describe the features of finger braille, comparing text and speech, in section 2, the design of the conference system in section 3 and the evaluation of the conference system in section 4, and present discussion in section 5, and finally the conclusions and future work in section 6.

2. OVERVIEW OF FINGER BRAILLE

2.1 Communication Methods of Deaf-Blind

Typical communication methods for the deaf-blind are (1) print-on-palm (tracing letters on the palm of the deaf-blind), (2) tactile sign language and finger alphabet, (3) “Bulista”, which prints out braille on tape, and (4) finger braille using a Braille code. In finger braille, the fingers of the deaf-blind are regarded as the keys of a brailler. A person types the Braille code on the fingers of the deaf-blind (Figure 1). Of these methods, finger braille using a Braille code seems appropriate for real-time communication [2].

Figure 1: Typing finger braille

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2.2 Characteristics of Finger Braille

We considered the characteristics of finger braille by comparing speech and text communication.

2.2.1 Coded System

A braille code consists of combinations of six dots. The Japanese braille code system consists of 46 codes which express kana characters (voiceless syllable), and some special codes. It is much easier to process this code using digital devices than print-on-palm or tactile sign language and finger alphabet.

2.2.2 Transmitted Speed

A skilled deaf-blind person is able to receive about 350 characters per minute from a finger braille translator. Compared with oral transmission of 350-400 letters per minute, finger braille is adequate for real-time communication.

2.2.3 One-Dimensional Media

Sensations receive two types of information: information that spreads in two- or three-dimensional space, and one-dimensional information that changes with time. Tactile sensation receives one-dimensional information as dose auditory sensation.

The information transmitted by finger braille is one-dimensional compared with text which has a spatial spread. [1]. For example, in the case of information expressed in a tabular form, in speech, it is necessary to explain the position of text in the table and to provide information in addition to the text information.

2.2.4 Passive Media

Because tactile media expand in time series, a person receives information chronologically. Therefore, deaf-blind people must receive information passively while the information is displayed, whereas sighted-hearing receive visual information actively. Auditory information is also passive.

2.2.5 Volatility

Finger braille is a volatile medium like speech [1]. In the case of speech, since speech disappears simultaneously with an utterance, the listener is required to memorize the contents of the utterance, and must ask for verification. Similarly, in the case of finger braille, only at the moment an interpreter's finger is touching a deaf-blind's hand will the information be apparent, and it will disappear the moment the fingers are withdrawn.

3. SYSTEM DESIGN

3.1 Problems

To design a conference system wherein deaf-blind people are able to participate, we focused on the characteristics of finger braille described in the previous section: “one-dimensional medium”, “passive medium” and “volatility”. We noted the difference in the characteristics of each medium. It may cause the problems which cause a deaf-blind person to miss the opportunity to make utterances and to fall behind in the conversation. In order to establish smooth communication between deaf-blind and sighted-hearing people, we examined each problem, as below.

3.1.1 Slow Receiving Rate

As we described above, finger braille provides one-dimensional information. If the utterances are shown at the same time in text and finger braille, text characters are displayed much earlier than finger braille. Furthermore, a sighted-hearing person might make an utterance before the deaf-blind person finishes reading. Therefore, sufficient time to understand the utterances of others and to prepare for his/her own utterance is not secured for the deaf-blind person. Thus a deaf-blind person’s opportunity to speak may become less than that of sighted-hearing people. In order that all participants may follow the flow of a conference, it is necessary to align the timing to enable understanding.

3.1.2 Alternating Input and Output

In finger braille, both transmitting and receiving information use haptic sensation. Thus, a deaf-blind person is not able to perform input and output operations on the system simultaneously. Deaf-blind people must switch the mode from input to output and *vice versa*. Therefore, it takes more time for the deaf-blind person to make an utterance. Utterance opportunity for the deaf-blind should be secured.

3.1.3 Disappearance of Past Information

Since the information received in finger braille is volatile, the same as in speech, information can be easily lost. Optimizing the presentation speed of utterances will reduce a deaf-blind person's psychological stress related to receiving information.

When it is difficult for a deaf-blind person to read text, they must depend only on the information obtained by finger braille, therefore, a support function for receiving and memorizing the contents is expected.

3.2 Solutions

Here, we propose the functions of the conference system, based on the discussion on the previous subsections.

3.2.1 Selection of Speaker

To provide an opportunity for all participants to speak, the concept of “the speaker” is considered. “The speaker” is the participant who holds a right to speak. Only one participant is able to speak during a conference. In order to realize the idea, the system assigns the right to speak. When a participant wishes to speak, he/she requests his/her turn beforehand and wait until “the speaker” is assigned. “The speaker” right is granted to only one person at a time, and it is held until the person yields it.

In order to give participants an equal opportunity to speak, a different order level of “speaker’s priority” is defined for every participant. A person who has spoken only slightly is given a high priority. When two or more participants request “the speaker” right simultaneously, the participant with the highest priority is given the opportunity to speak.

Moreover, the system has the function that the speaker is presented with the list of names of participants that have made requests to speak so far. Thereby, the speaker can comprehend the condition of other participants.

3.2.2 Aligning Receiving Rate

In order that all participants can follow the flow of a conference, it is necessary to align the timing of understanding. To unify the timing of understanding, the system has two functions. One is the function for aligning the time of the end of an utterance in finger braille with the text. That is, the complete text sentence and the last character of finger braille are displayed at the same time.

Another function is to align the receiving rates of finger braille among deaf-blind people. The receiving rate of finger braille for deaf-blind people is set to the slowest receiver's rate.

3.2.3 History of Utterance

Because of the one-dimensional characteristic and volatility of finger braille, the deaf-blind participant is not able to check his/her previous utterance. To check the previous utterance, the system has the function to show past utterances. Deaf-blind participants are able to request the presentation of past utterances anytime using the function. Therefore, participants are able to gain a better understanding of the whole conference.

3.3 Implementation

The system consists of a server and clients. The client for the deaf-blind participants is connected to the input/output device for finger braille called "Ubitzky" (Figure 2) [4]. The client for sighted-hearing participants is connected to a keyboard and display. We developed a prototype system which was implemented with the functions proposed in the previous section.

Left hand Right hand

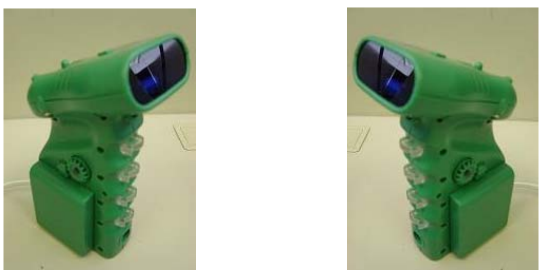

Figure 2: "Ubitzky" (Input/output devices for finger braille)

3.4 Preliminary Experiment

In order to check the functions of the system, a conversation experiment was conducted by four sighted-hearing subjects. Two subjects used a display and keyboard. The other two subjects pretended to be deaf-blind subjects. Since they were not skilled in finger braille, they used a display and keyboard. To reproduce features of finger braille, such as the volatility and one-dimensional characteristic, only one character which corresponded to a braille code was displayed at a time for the dummy deaf-blind subjects. After being displayed for a while, the character disappeared.

The subjects were given 20 minutes to discuss a given subject. The contents of each utterance were recorded during the experiment, and comments on the use of the conference system were recorded.

From the results of the preliminary experiment, we obtained the following conclusion and points for improvement. A dummy deaf-blind subject became anxious because there was no feedback to what he had transmitted. Because simultaneous transmission and reception are difficult with finger braille, the contents of the utterance cannot be checked by a deaf-blind person during an utterance. This problem could be solved by using a function that enables the contents of an utterance to be displayed at any time, and one that sends a vibration signal to indicate that the transmission of utterance from the deaf-blind person is complete.

Moreover, a subject wished to see the reservation status of "the speaker" even when he was not making an utterance. When we designed the system, we considered that some deaf-blind people might become overloaded with too much information were the reservation status to be displayed, which might increase the psychological stress on a deaf-blind person. Therefore, we had designed the system so that the deaf-blind person received the minimum necessary information for understanding an utterance. However, it seems that always providing additional information is indispensable in the conference situation.

The result of the preliminary experiment confirmed the importance of this additional information. Also, it is necessary to incorporate a function which allowed a deaf-blind person to acquire information actively.

4. EVALUATION EXPERIMENT

In the evaluation experiment, we checked the validity of the functions supporting the understanding and utterance of deaf-blind people in the proposed system.

The subjects were one deaf-blind person and two sighted-hearing people, who had approximately 20 minutes to talk about a plan for traveling abroad. Start and end times, the speaker's name, and the contents of the utterance were recorded for each utterance. Moreover, the number of reservations and the duration of "the speaker" were also measured for each subject.

The utterance results are shown in Table 1. The rate of "the speaker" acquisition is expressed as the number of "the speaker" acquisitions divided by the number of reservations. The results of the questionnaire after the experiment are shown in Table 2.

Table 1: Results of the experiment

	D.B.*	S.H. ** 1	S.H.** 2	mean value
Num. of utterances	3	3	3	3
Num. of "the speaker" reservations	4	5	4	4.67
Rate of "the speaker" acquisitions	75%	60%	75%	70%
Duration of "the speaker" (sec)	580	191	334	368
Num. of Characters	508	56	193	252

* Deaf-blind person

** Sighted-hearing person

Table 2: Results of questionnaire*

	D.B.	mean value among S.H.
1. Could you keep up with the flow of the conversation?	5	5
2. Could you understand the conversation?	5	5
3. Were you irritated not to have chance to speak?	3	1.5
4. Were you irritated because the conversation was interrupted often?	1	1.5

*The responses were given on a scale of one to five.

5. DISCUSSION

The number of utterances was not different between the deaf-blind person and sighted-hearing people. All participants were able to speak at almost the same ratio. Since the opportunity and priority of an utterance were secured, the participants were able to speak regardless of their receiving and transmitting speeds.

The deaf-blind person had a long duration of utterances and had a large number of text characters in utterances. This means that participants were fully able to participate in the conversation. In particularly, since interruptions by sighted-hearing people did not occur while deaf-blind subject was making an utterance, 508 characters were recorded in three utterances. From this result, it is considered that sufficient utterance time was fully secured for the deaf-blind subject.

Both the deaf-blind and sighted-hearing subjects were satisfied with the flow of conversation, as shown in Table 2. Before the experiment, we had expected the evaluations of question 3 and question 4 to be low since sighted-hearing participants would not be able to speak freely due to “the speaker” function. However, the result unexpectedly indicated a high degree of satisfaction among sighted-hearing participants. The reason was that the sighted-hearing participants knew who was speaking even if there had been no utterance. Consequently, the sighted-hearing people knew that the speaker had the intention to utter, and they could wait for the deaf-blind person’s utterance without any sense of annoyance, not being annoyed.

After the experiment, the deaf-blind subject mentioned that she was satisfied about being able to present her opinions fully. We to speak that she felt comfortable to having ample opportunities for making utterances without being interrupted by others' utterance, as a result of “the speaker” the function.

Smooth conversation between deaf-blind and sighted-hearing people was achieved with our conference system.

6. CONCLUSION

In this study, we considered the functions in a conference system. We designed the system to help a deaf-blind person to understand and to speak in a conversation, by considering the difference between tactile media and visual media based on their volatility and one-dimensionality. In the evaluation experiments using the proposed system, a deaf-blind person attained almost the same number of utterance as did sighted-hearing people, and even exceeded the number of utterance characters in an utterance. Therefore, the feasibility of the proposed system was confirmed from the result that satisfactory conversation with other participants was achieved.

In the future, we will focus on the prosody of finger braille that had been analyzed in our previous work [2]. Implementing prosody information will aid deaf-blind people to better understand the utterances of other participants.

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