Impact of Sign Language Movie and Text Layout on the Readout Time

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Abstract. In an emergency such as an earthquake, it is important to give information in different formats that permit everyone to realize rapid assimilation. In public spaces, information is presented to the hearing impaired in text as well as sign language movies. In this case, it is considered that the readout time and impression of the information depend on the layout of sign language movies and text used. However, there are no comprehensive guidelines on the proper layout of sign language movies and text. This paper focuses on optimizing the layout of text and sign language movies to decrease the readout time of the hearing impaired and the normal hearing. Tests show that the optimal spatial separation between the text and its accompanying sign language movie depends on their relative position. They also indicate that the readout time depends on the separation between the line head of text and the center line of the translator in the sign language movie.

Keywords: Public Space, Sign Language, Layout, Emergency message.

1 Introduction

In emergencies such as an earthquake, it is important for people to get information they need to deal with the emergency as soon as possible. Therefore, it is necessary to display information in the form the people can acquire easily and quickly. Also, these days, people's awareness of information displays that cater for the widest range of abilities has been rising. Especially in public spaces, text and sign language displays are being increasingly used side by side.

If we set the text and sign language movie too close together, it is possible that both will become hard to assimilate; that is, it may take more time to assimilate the message due to the collision of the disparate visual modalities. We must be carefully, however, not to separate the text and sign language movie by too much distance because this would decrease the size at which the movie and text could be displayed, and take more time for hearing impaired people to look from text to sign language movie. This suggests that when displaying emergency information by using text and sign language displays in public spaces, we need to determine that optimal separation. Unfortunately, no guidelines directly address this issue.

In this study, we assume emergencies in public spaces, and focus on optimizing the layout of text and sign language to provide the hearing impaired and the normal

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hearing with more rapid assimilation. In this paper, we use the example of trains as the public space. This is for the following two reasons;

1. Almost all subjects can imagine the scene, because many users take trains frequently, and most people have experienced emergencies, such as delay and suspension.
2. The chance of emergency information being displayed will increase, because more trains are being equipped with these displays.

Tests show that we have to vary the spatial separation between text and its accompanying sign language movie according to their relative position. Tests also suggest the readout time depends on the separation between the line head of text and the center line of the translator in the sign language movie.

2 Previous Studies

The assimilation of textual signs has been studied for a long time. The viewing area in which vision is effective is called the "effective visual field". Ikeda et al. measured the effective visual fields of Japanese reading sentences written in Japanese [1]. They showed that the effective visual field is about 10[deg]. Osaka studied the difference in eye movements when reading easy and difficult sentences, and between English and Japanese sentences; the subjects were Japanese students [2]. The results show that there are significant differences between languages but not between the different levels of difficulty.

The impact of the display style of sign language movies on message understanding has been studied. Kamata et al. conducted an experiment on sign language communication using an ISDN64kb/s TV telephone system [3]. They showed that the refresh rate of the movie has a larger influence on message understanding than display resolution. Kamata el al. showed that both display resolution and refresh rate influence message understanding but to different extents according to the image quality [4]. Shionome et al. studied the relation between display size and the take up of sign language messages [5]. They investigated the understanding and readability of sign language messages displayed using 1[inch] to 6[inch] size screens. The results show that 1 and 2[inch] screens yielded much lower take up rates than the other sizes. Screens less than 3[inch] had different levels of understanding and readability from those more than 3[inch].

No study has, however, fully examined the relation between the take up time and the layout of a display that places a sign language movie and text on the same “page”. Miyamoto et al. investigated the differences in the number of stationary gazes and eye scan strategies among hearing impaired people, sign language translators, and people in an early stage of learning a sign language [6]. They also showed that hearing impaired people look from text to sign language movie to better assimilate the message. Miyamoto et al. examined how the subjective readability of a message varies with the separation of text and sign language movie, and two text locations (test is set to the right or the bottom of the movie) [7][8]. However, for the emergency situations assumed in this study, assimilating the message quickly is more important than its subjective readability.

3 Policy for Layout

In order to give as much information to as many people as possible in public spaces at the same time, bigger and many displays are often installed. Such displays fall into three types:

A) One (big) display (ex. Fig.1)
B) Many displays working as one big display (ex. Fig.2)
C) Many displays working individually (ex. Fig.3)

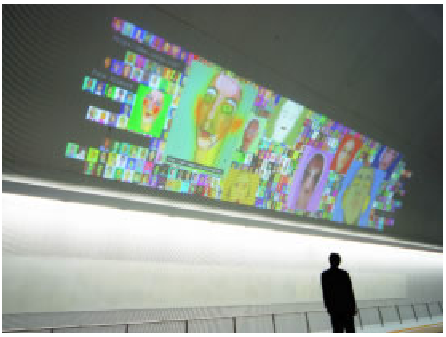

Fig. 1. Example of one (big) display

Fig. 2. Example of many displays working as one big display

Fig. 3. Example of many displays working individually

If one screen shows both text and a sign language movie simultaneously, maximizing the font size and movie size means that the separation between the two modalities is minimized. This may not be effective since there is a possibility that it will take more time to read out the message due to collision of the visual modalities. One solution is to display the text and movie on different displays, but this raises the possibility that the two messages will not be associated with each other; i.e. there is a possibility that it takes more time for hearing impaired people to look from text to sign language movie.

We examine here the case wherein a text message and corresponding sign language movie are shown on the same display at the same time; we assess the impact of

- Spatial separation of text and sign language
- Relative position of text and sign language

  on the readability of the message, in particular the readout time of the message.

It is considered that this time also depends on font type, size, and color of text, size and quality of sign language movie etc. In this study, we assume that the modalities are clearly readable in their own right to focus on their interaction.

4 Experiment

4.1 Subjects

The 14 evaluators consisted of 7 Japanese men and women with ages from 26 to 45. All were hearing impaired and use sign language as the dominant communication method. The remaining 7 were Japanese men and women who had normal hearing and did not understand any sign languages.

4.2 Method of Experiment

Each message, an example is shown in Fig.4 (Left), was composed of text and the corresponding sign language movie. We used alert messages produced by Japanese railway companies. A sign language translator converted the message into sign language and his actions were videotaped. We examined eight arrangements as shown in Fig.4 (Right). We defined the center of text as the center of the minimum rectangle that bounded all text, and the center of the sign language movie as the center of the minimum rectangle that bounded the translator. Fig.5 shows the four arrangements with the text to the left of the movie. For the 8 arrangements, we measured the time taken to read each message.

- Position: Left or Right
- Separation: 22.6[deg], 11.5[deg], 8.4[deg] or 5.8[deg]
  (in terms of subject's view angle)

  *With separations of 8.4[deg] and 5.8[deg], some text overlapped the sign language translator.

The 432[mm] * 324[mm] display used had a resolution of 1600[pixel] * 1200[pixel]. The display was placed 500[mm] from the subject. Each subject was challenged once per arrangement. The sign language movie showed the translator from the waist up [9], and movie size was adjusted so that the translator's shoulder width was 8.2[deg]. The movie was edited to show 1 second periods before and after the sign language representation, and it was played repeatedly. The screen background color was gray, i.e. no hue. The background color of the sign language movie was also gray. The text message used the font "HG-SOEIKAKU Gothic UB" and font size was 27[pixel] (0.81[deg]). Considering the occlusion of text and movie, we set the font color to aqua, a color not present in the movie. Moreover, in order to improve text visibility, we gave each character a 3[pixel] wide black drop shadow. Text language was Japanese written from left to right. Line length was set to 10 characters per line (8.6[deg]). If a text statement had more than 10 characters, the characters beyond 10 were placed on a new line.

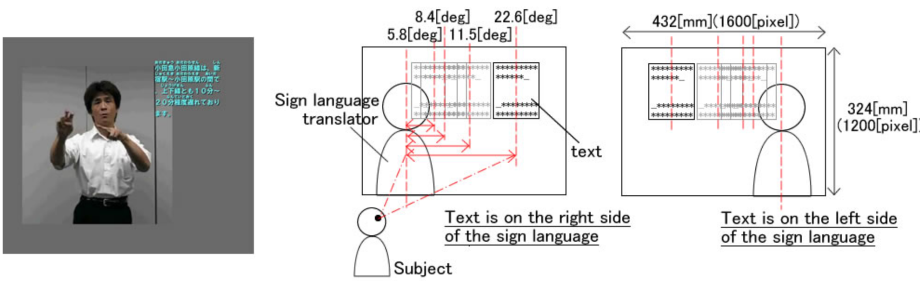

Fig. 4. Displayed message (Left), Layout pattern (Right)

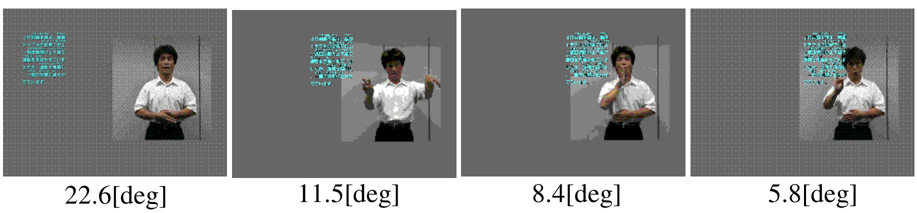

Fig. 5. Examples of layout (Case text is arranged at movie's left side)

4.3 Method of Evaluation

We explained the assumed situation and how to proceed. Next, in a training phase, the subjects could read messages and answer quizzes about the messages repeatedly until they felt comfortable with the process. In the task, at first, the message, such as Fig.4 (Left), was shown to the subject. The subject read the message and then indicated the completion of reading/assimilation. At that time we stopped playing the message. Three seconds later a quiz about the displayed message was shown, and the subject answered one question. Each subject repeated this process 8 times to cover the 8 arrangements; a different message was used in each trial. The order of arrangements displayed was randomized for each subject.

Subjects were told to imagine that the train they were taking had stopped suddenly and the message was shown on a display inside the train. Moreover, we told them to read the message as quickly as possible while still understanding it. We recorded the readout time of the message and their answer to the question.

5 Result

There were differences between the amount of information in each message and the ability of each subject. Based on the number of characters in each displayed message and each subject's average readout time calculated for all 8 trials, we normalized the readout time (called hereafter "readout rate"). The readout rate of the j th message shown to subject i is given by the following expression (1).

$$R_{ij} = \frac{r_{ij} / c_{ij}}{8 \cdot \sum_{j=1}^{8} (r_{ij} / c_{ij})} \quad (1)$$

c_{ij} : The number of characters in the j th message shown to subject i

r_{ij} : The readout time for the j th message shown to subject i

Fig.6 and Fig.7 plot the readout rates for the hearing impaired and aurally competent subjects, respectively. In each graph, the horizontal axis is the spatial separation between the text and the movie, and the vertical axis is average readout rate.

We subjected results to ANOVA (Table.1). We found significant differences in the average readout rates of the hearing impaired. When the text was set to the left of the movie, there were significant differences at the 5% level between 22.6[deg] and 11.5[deg], and between 22.6[deg] and 5.8[deg]. When the text was set to the right, there ware significant differences at the 5% level between 22.6[deg] and 11.5[deg], and between 22.6[deg] and 5.8[deg]. We did not find any significant difference in the results of the aurally competent subjects at the 5% level.

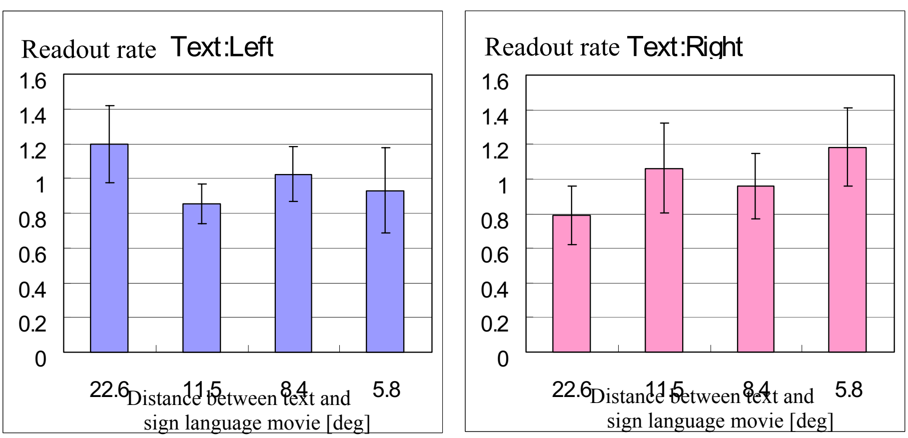

Fig. 6. Result of 7 hearing impaired subjects

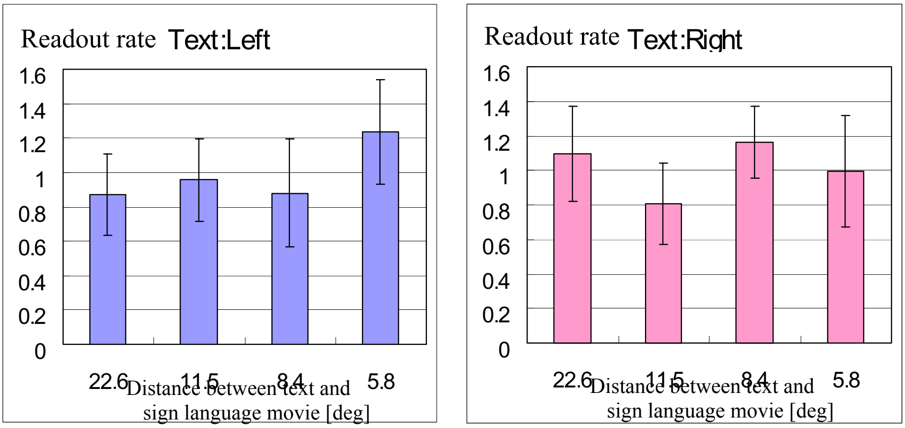

Fig. 7. Result of 7 aurally competent subjects

Table 1. Difference between average readout rates

	Hearing impaired subjects		Hearing subjects	
Text position	Left	Right	Left	Right
F-measure	3.59 (p=0.028)	3.67 (p=0.026)	2.30 (p=0.103)	2.03 (p=0.136)
5.8[deg]- 8.4[deg]	p=0.407	p=0.079		
5.8[deg]-11.5[deg]	p=0.501	p=0.329		
5.8[deg]-22.6[deg]	p=0.023	p=0.004		
8.4[deg]-11.5[deg]	p=0.140	p=0.410		
8.4[deg]-22.6[deg]	p=0.128	p=0.185		
11.5[deg]-22.6[deg]	p=0.005	p=0.037		

When the text was set to the left of the movie, 11.5[deg] and 5.8[deg] were better than 22.6[deg]. However, when the text was set to the right, 22.6[deg] was better. In order to provide information we can read quickly, we have to vary the spatial separation between the text and sign language movie according to their relative position.

6 Discussion

The trials showed that the optimal separation of text message and sign language depends on their relative position. After the experiment, we interviewed hearing impaired subjects; 3 subjects said “placing the text to the right of the movie was better,” 2 subjects had no preference. It seems that text messages are subjectively easier to read if they are set to the right of the sign language movie. We confirmed this by analyzing the trial results. For the message left arrangement, the average readout rate was 1.002 (SD = 0.2306), for the message right arrangement, the average was 0.998 (SD = 0.2584). We subjected these results to a t-test yielding p=0.97(>0.05), and this showed that relative position itself did not influence the readout time.

We read Japanese written horizontally from left to right and it seems logical to assume that one factor determining the readability of a message is the ability to rapidly identify the line head of the text. We focused on the separation between the line head of text box and the center of the translator. Fig.8 shows the relation between 7 hearing impaired subjects' average readout rate and the separation as defined above. From 1.5[deg] to 18.4[deg], as the separation became larger, the average readout time decreased. However, when the separation was 26.7[deg], the average readout time became longer. This result suggests the readout time depends on this separation and there is an optimum separation.

In this experiment, we investigated the readout time from the aspect of the separation between the center of the text and the center of the sign language movie. This implies that data is missing from 18.4[deg] to 26.7[deg], and more than 26.7[deg]. Therefore, we need to perform more detailed tests. Another task is to examine the effect of writing the Japanese text vertically.

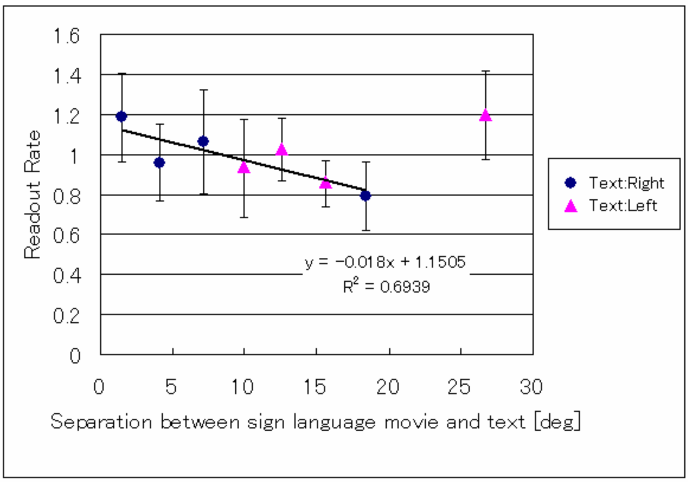

Fig. 8. 7 hearing impaired people's average readout rate from aspect of separation between line head of text and center of sign language translator

7 Conclusion

This paper focused on emergencies in public spaces, and on optimizing the layout of text and sign language movies to decrease the readout time of the hearing impaired and the normal hearing. Tests showed that we have to vary the spatial separation between text and its accompanying sign language movie according to their relative position. They also indicated that the readout time depends on the separation between the line head of text and the center line of the translator, and there is an optimum separation that minimizes the readout time.

Future work includes investigating the readout time for separations not examined in this study, and investigating the influence of the text overlapping a part of sign language translator.

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