

A Caption Presentation System for the Hearing Impaired People Attending Theatrical Performances

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Abstract. This study addresses information support for hearing impaired people who attend theatrical performances. In present Japan, there are a few theaters that employ programs providing captions for hearing impaired people. The few programs that provide captions only show dialogues and sounds (musical note icons). We propose, implement, and evaluate a caption presentation method for hearing impaired people, which includes support for dialogues, sound effects, and audience responses.

1 Introduction

According to government research conducted in 2006, there were 270,000 hearing impaired people in Japan, which was 0.22% of the population. However, hearing often deteriorates with age [5], and the Japanese population is aging faster than any country in the world [1]. In future, the demand for subtitled videos, movies, and theater performances will increase. The Ministry of Internal Affairs and Communications (MIC) in Japan has promoted barrier-free broadcasting. From 30% to 60% of terrestrial broadcasts provide subtitles for hearing impaired persons [10]. In contrast, very few movies or theater performances have subtitles or any form of captioning. Only three of 2,719 titles listed on an internet portal site provide barrier-free subtitles, a mere 0.1% of the theater performances in Tokyo in 2011. It is difficult to produce subtitles in Japanese because it takes four times longer to correct subtitles using the kanjis (Japanese characters) than European or American languages [2].

In this study, we report a subtitle display system that includes audience reaction and discuss the results of an evaluation.

2 Enjoyment of Visiting Theaters

When non-hearing impaired people visit theaters, they enjoy many aspects of the play: the acting, music, sound effects, and stage sets. They also gain enjoyment from participating in a shared experience. Audience reactions, such as laughing, smiling and clapping, are contagious. Individuals respond to the reactions of other members of the audience. These shared reactions are one of the enjoyable elements of the

experience. Tatsumoto et al. [13] showed that while watching videos in a shared environment, the reason for laughing is changed from “something funny makes you laugh” to “laughter makes something funny.” They found that “watching together” increases enjoyment.

An interview to find whether the situation is similar for a theatrical event was conducted with 11 people (3 men, 8 women) in the age range of 20–50. All the people interviewed had attended a play in a theatre. All of them indicated that being part of an audience is an important part of the experience. They gained a sense of reality from the atmosphere in the theater that amplified their enjoyment. We drilled down and explored the initial answers in greater depth to determine what constitutes a sense of reality for people watching a play. The findings are presented in Table 1.

Table 1. Sense of reality during a theatrical performance

| What enhances a sense of reality for audience members in a theater | Types of sensation |
|---|----------------------|
| Air movement when actors move or the audience reacts physically | tactile |
| Audience reactions such as laughter, crying, or other vocal responses | auditory |
| Perceived suspense or tension when the audience is suddenly still or silent | auditory and tactile |

The interviews revealed that audience reaction influences the enjoyment of a theatrical performance. All the interviewees confirmed that tactile and auditory information is important and contributes to the sense of reality.

For the most part, the stage is positioned directly in front of the audience and their attention is focused on the stage in a dark theater. Consequently, it is difficult for an individual to visually sense the audience’s reaction. Vocalizations and the auditory perception of movement from other audience members are thus helpful to enhance the sense of reality. Previous captioning systems only present subtitles for the actors’ spoken words and explain sound effects, but do not include indicators for the audience’s reaction. We believe that presentation of the audiences’ reactions will transform the theater-going experience for hearing impaired persons.

3 Related Works and Previous Technology

In this section, we review related work and describe a proposed captioning system for a theater performance.

3.1 Captioning System for Theater Performances

There are some existing systems for displaying subtitles in theaters. These are not always exclusive for the deaf and hard-of-hearing. A few programs that provide captions for hearing impaired persons only show dialogues and sound effects.

There are two types of systems: open and closed. In the open system, visual aids are displayed or projected onto a screen on the stage. In a closed system, such as the “G-mark portal subtitle system” [7][11], a tablet PC or a personal monitor near the user’s seat displays the subtitles.

An advantage of the open system is that the subtitles appear on the stage. People who would benefit from the assistance do not have to divert their attention to a secondary device. The open system does not require special individual equipment. A disadvantage is that people who do not need the assistance provided by the subtitles may find them distracting. In a closed system, audience members can choose to use or not use the device and can select the type of subtitles presented; for example, English subtitles for foreigners, Japanese subtitles for hearing impaired persons, and no subtitles for people who do not require any assistance. However, audience members who must refer to a tablet or monitor will occasionally miss either a part of the performance or a subtitle because they must alternatively look at the stage and the device.

Recently, some systems using a head-mounted display (HMD) instead of personal monitors have been developed [4][12]. However, similar to 3D glasses, HMDs are difficult to wear for an extended period of time. HMDs also require a constant change in focal length. The users have to adjust their focus between the stage and the subtitles on the HMD. This is particularly distracting and tiring in a play where the actors move frequently. However, HMDs have potential and continue to be developed. They have advantages and disadvantages. Perhaps the biggest disadvantage is that they are tiring and consequently distract the users enjoyment of the performance.

3.2 Subtitle Display Method in a Related Field

There is a similar study to our proposed system in another field. Fujii et al. [3] demonstrated subtitles in a balloon field as a support system for the deaf and hard-of-hearing participating in a video conference. They compared two types of subtitle displays: balloon and linear. The balloon display was determined to be preferable to the linear display in terms of enjoyment, user-friendliness, and affording realistic sensations. Because many people in Japan are familiar with Manga, most are aware that a balloon tail indicates the position of the speaker.

However, in its present state, this system would be difficult to use for a play because it was developed for video conferencing where the attendees, unlike actors in a play, do not move very much.

4 Problems

There are various problems associated with the existing subtitle systems for theatrical performances: missing a subtitle or an action on stage, difficulty locating a particular speaker, and difficulty sensing the audience’s reaction. Each of these problems is discussed in the following sections.

4.1 Problems Associated with Subtitles

To understand the plot of a play, an audience member needs to know who is speaking as well as what is being said. Subtitles should provide both pieces of information. When non-hearing impaired persons watch a play, they recognize who is speaking by the movement of a speaker's lips, the direction of the voice, and the quality of the voice, e.g., they can immediately determine if the speaker is male or female. By contrast, when hearing impaired persons watch a play with subtitles, they recognize who is speaking because the subtitles identify the role (e.g., Hamlet, Macbeth) and provide the text of the speech. In an open subtitle system, which allows the audience to keep their attention on the stage, they may also rely on the movement of the speakers' lips. A proficient lip reader could understand the story without subtitles. However, if there are many actors on stage, it would still be difficult to locate the speaker. This difficulty would be compounded if the actors are constantly moving on the stage. In addition, it may not always be possible to identify the speaker by role because the electronic display of an open system is limited to one or two lines of text. A closed system is more confusing than an open system because the user must constantly move between the personal monitor and the stage.

4.2 Problems Associated with Perceiving Audience Reactions

As mentioned in Section 2, awareness of audience reaction is important to a person's enjoyment of a play. However, the subtitles presented in the existing systems (dialogue and sound effects) do not indicate the audience's reactions, for example smiling, laughing, and clapping. In a well-attended small theater where the spectators are seated close together, it is possible to sense the audience reactions. However, in larger venues, where an individual may be seated at some distance from other audience members, this becomes more difficult. Moreover, audience reactions may be very subtle because Japanese people tend to not express strong feelings in public. This is a distinct disadvantage for hearing impaired people in terms of their ability to perceive audience reactions.

5 Our Approach and Implementation

To solve the problems described in Section 4, we propose a new open subtitle system. Because an open system is not entirely suitable for non-impaired people, we attempted to integrate the subtitle screen in such a way that it has minimal distraction.

We divided a screen area into two parts. One part displays dialog and sound effects, and the other displays the audience's reactions. Fig. 1 and Fig. 2 illustrate how subtitles would be displayed. Fig. 3 shows the layout of the stage.

A projector is positioned in the center of the stage. Subtitles are projected on the screen. An operator responsible for providing information about subtitles and the audience reaction is seated near the boundary between the stage and the auditorium.

Balloon subtitle on a screen

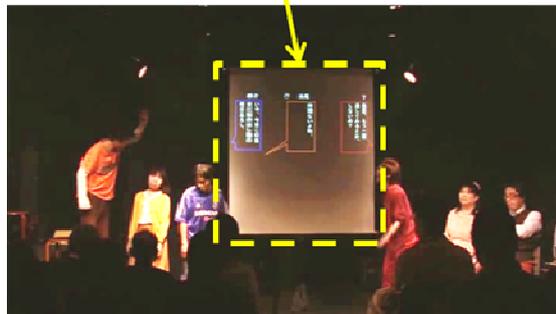


Fig. 1. The entire stage

Acting near the screen balloon tail direction toward the actor.



Fig. 2. Actors in front of the subtitle screen

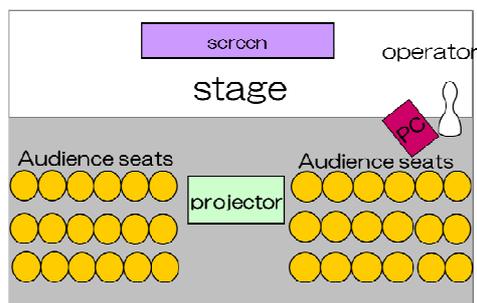


Fig. 3. Layout of the stage

5.1 Subtitle Display Area

Our system uses 80% of the total screen area to display subtitles and audience reaction, as shown in Fig. 1 and Fig. 2. From this total subtitle display area, 80% displays subtitles and the remaining 20% of the displays audience reaction icons, as shown in Fig. 4. The system has five display functions: dialog balloons, dialog balloon border colors, hand signs, music, and stage properties.

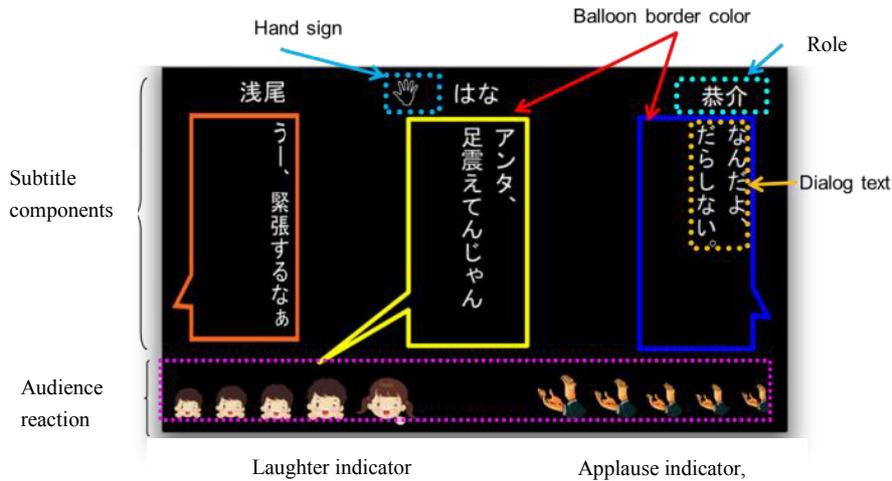


Fig. 4. Overview of the system interface

Balloon-Shaped Dialog Area

As shown in Fig. 4, the system displays dialogue text in a balloon and identifies the actor's role above the balloon. There can be a maximum of three lines in one balloon; each line can contain nine characters.

Line breaks can be inserted for readability. Hearing impaired audience members would be able to follow complicated, fast-moving dialogue. The direction of the balloon tail indicates the actor who is speaking. When actors perform in front of the screen, the balloon tails are shortened and positioned on the outside edges of the screen, as shown in Fig. 5.

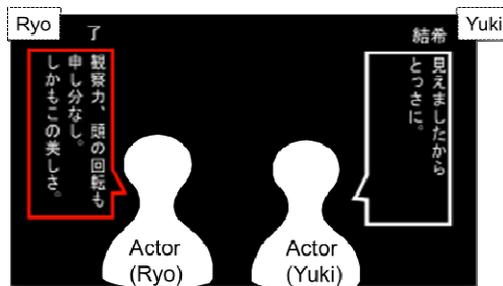


Fig. 5. Action in front of the screen. Balloon tail direction indicates the actor.

Border Color of Balloons

The balloon border color can be set to coincide with the color of the actor’s costume. Because it is difficult to differentiate between some colors, such as red and orange, and because colors can be altered by stage lighting, additional help is provided by identifying the role above the dialogue balloon.

Hand Signs

When this system is employed, it is desirable that the actors perform as near to the screen as possible. However, if an actor on stage is at some distance from the screen and raises his/her hand, a hand sign is displayed near the balloon displaying the text for his/her dialogue, as shown in Fig. 6.

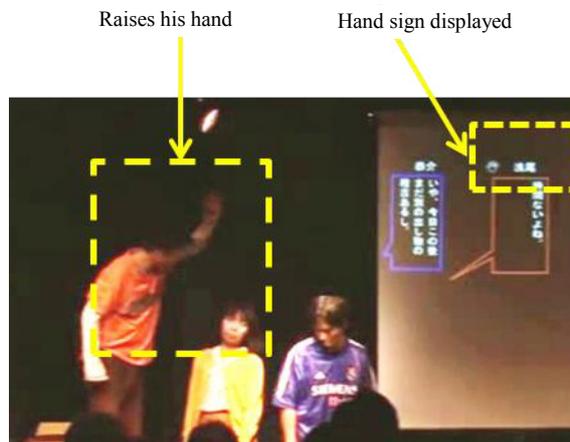
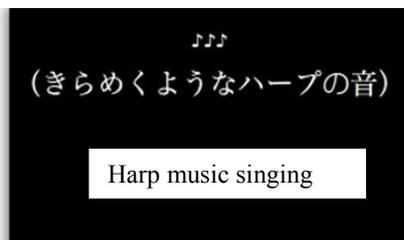


Fig. 6. Case of a distance between the screen and an actor; an actor raises his hand

Displaying Indicators for Background Music and Stage Properties

Background music and staging are important aspects of a theatrical production. As shown in Fig. 7 (left), a musical note icon could be used to indicate music. This icon is often used in the subtitles that accompany television program. Including notations



Musical notes indicate background sounds



Screen used to indicate set decoration

Fig. 7. Optional use case of the interface. Musical notes indicate background sounds. Text describes the sound (left). Screen used to indicate the set decoration (right).

to explain onomatopoeia has also been considered. Moreover, as shown in Fig. 7 (right), the screen can be used to clarify the importance of particular stage settings that relate to the action of the dialogue. In recent years, techniques for projecting background images to enhance the stage settings have improved [9] and in many cases it is not necessary to install a screen for a subtitle

5.2 Audience Reaction Displaying

An audience's reaction is displayed on the lower 1/5th of the area for a subtitle display. This is a better position of sight when reading subtitles, under the restriction of the screen. From the interviews, we learned that auditory information, particularly laughter and applause, are important aspects of the audience response. Icons for these two elements have been created. The size of the icon can be controlled to indicate intensity. Five different sizes are available. The intensity of the laughter or applause is determined by a human operator who controls the display. Although there are costs associated with a human operator, the operator's response may be more representative of the entire audience's response than that of an automated sensor. An example is shown in Fig. 8.

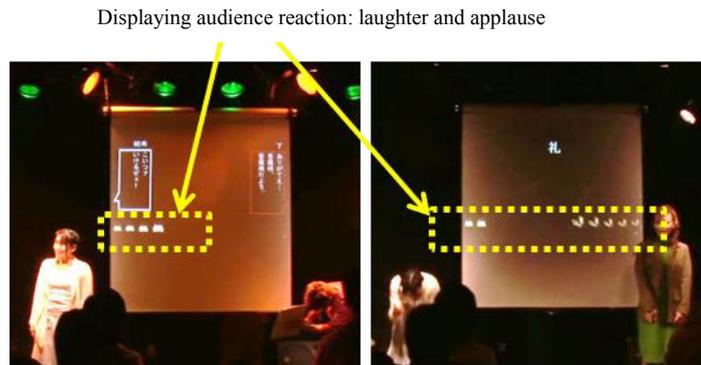


Fig. 8. Pictures of audience reaction indicators

6 Evaluation

We evaluated the system in two situations. The first was at a dress rehearsal and the second was at an actual theatrical performance that held two performances a day and a total of eight performances. The system was placed on the stage, as shown in Fig. 3. A projector was positioned in the center of the stage. Subtitles were projected onto the screen. The evaluation experiment was conducted over four days for performances on November 10–13, 2011. The theater had a capacity of approximately 50 people. The barrier-free performance, which was a comedy with eight actors, lasted approximately 85 min.

6.1 Interview and Result

Two hearing impaired students were interviewed after the dress rehearsal. The interviewee asked questions about four items, as shown in Table 2.

Table 2. Evaluation questionnaire

| No | Confirmation item | Questionnaire |
|----|---------------------------|---|
| 1 | Enjoyment of a play | Did you enjoy the play with subtitles? |
| 2 | Matching speaker | Effect of color Did the balloons' colored borders help you find the speaker? |
| 3 | | Effect of balloon shape Did the balloon tails help you find speaker? |
| 4 | Audience reaction display | Did the audience reaction icons enhance your enjoyment of the play? |

Two hearing impaired students and three non-hearing impaired students attended a dress rehearsal, which was virtually the same as the public performance, and all five participants were able to enjoy themselves. In response to question 2, the hearing impaired subjects said they were able to recognize a speaker because the actor's clothes were of the same color as the dialogue balloon's border. Although they said that it was hard to distinguish red from orange, having the actor's role positioned near the dialogue balloon helped them to determine which actor was speaking. In response to question 3, they felt that the direction of the balloon tails was helpful and made it easier to connect "the movement of lips with the direction of the tail" and thus to "identify the speaker." The hearing impaired participants indicated that the hand sign, which appears when the actors making a gesture are positioned at a distance from the screen, was also helpful. For question 4, opinions were divided because there were only five people in the audience during the rehearsal. One hearing impaired participant said that it was an important feature even though there was not a great deal of noticeable audience response at this particular performance. The other said that it was unnecessary information because he was absorbed in the play.

6.2 A Questionnaire about the Theater Experience

A questionnaire was administered to 97 audience members after watching a public performance. The audience included two hearing impaired and four visually impaired participants. Ninety-one audience members had neither visual nor hearing impairments. Before the performance, the captioning systems was explained to ensure that the participants understood that the subtitles would be displayed on the screen placed in the center of the stage center and that laughter and applause icons would be displayed in the lower 1/5th of the display area. The questionnaire was comprised of the questions listed in Table 2. The participants could select from four options (agree,

somewhat agree, somewhat disagree, Disagree). A free entry column for written responses was included.

6.3 Survey Result

The responses of all 97 participants were similar. The overall results are shown in Fig. 9. With regard to enjoyment of the play, 89% of the subjects choose “Agree” or “Somewhat agree.” For the questions about the balloon tail indicating the position of the speaker and the coordination of the color of the balloon border with the actor’s costume, approximately 80% of subjects selected positive options. For the enhancement of the sense of reality from displaying the audience reaction, 64% of the subjects had a positive response. The responses from the hearing impaired participants are presented in Table 3.

The two hearing impaired persons selected “Agree” for the first three questions and “Somewhat agree” for the question about whether the sense of reality was enhanced by the audience reaction icons.

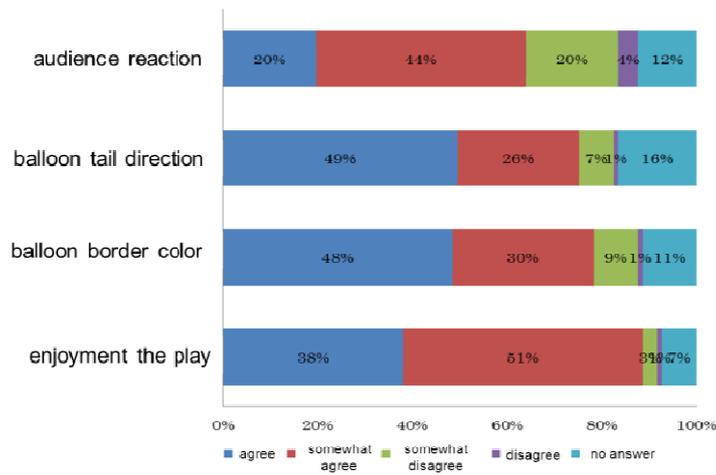


Fig. 9. Results of audience questionnaires (n = 97)

Table 3. Hearing impaired participants’ questionnaire responses

| | Q1 | Q2 | Q3 | Q4 | Free Written Responses |
|------|-------|-------|-------|----------------|---|
| No 1 | Agree | Agree | Agree | Somewhat agree | A larger subtitle is better because of presbyopia |
| No 2 | Agree | Agree | Agree | Somewhat agree | Showing the conversation tone is better. |

6.4 Discussion

We were able to draw some conclusions from the results of the interviews and questionnaires. The participants' responses to our questions about the ability to find a speaker and displaying audience reactions were noteworthy and are discussed in the following sections.

Finding the Speaker

Various aspects of the system were designed to help hearing impaired individuals identify a speaker. These included matching the speaker with the subtitle, indicating the position of the speaker by the direction of the balloon's tail, coordinating the color of the balloon's border with the actor's costume, and providing a hand icon to indicate gestures when an actor was at some distance from the screen. The hearing impaired participants indicated that such additional information were helpful. Moreover, the questionnaire results show that the system is not a distraction for non-impaired audience members and does not interfere with their enjoyment of the performance and in fact, in some cases, it was helpful. For example, "it was convenient when it was hard to catch what was said" was a response from both non-impaired and hearing impaired members of the audience. Another comment was that "subtitles on TV programs may be obstructive, but this has a good feel, like a manga comic." These comments were made in the free entry area of the questionnaire.

We also found that both impaired and non-impaired individuals potentially found our system beneficial. For example, because it may be difficult to control volume levels in a theater, subtitles can be useful when actors speak very quietly. Our system is analogous to *telop*, a television opaque projecting device used in television to broadcast an image without the use of a camera. *Telop* is most frequently used to superimpose text, such as captions, subtitles, or credit scrolls, and is beneficial for both hearing impaired and non-impaired viewers.

Displaying Audience Reactions

Our system displays indicators for the sounds of laughter and applause from the audience on the bottom of the subtitle display area. It is designed to allow hearing impaired people to sense how other members of the audience react to a performance. Because of the limited number of participants, we could not draw firm conclusions from the post-dress-rehearsal interview. In this evaluation, we did not have sufficient responses from hearing impaired individuals. Majority of the questionnaire responses came from non-impaired individuals. However, the comments in the free entry area of the questionnaire were helpful. Some participants suggested that audience response icons created a sense of community or unity with other audience members. Others felt that the audience response icons caused them to exaggerate their reaction in order to contribute to the prevailing atmosphere. We found that there is a tendency for an impaired person and a non-impaired person to collaborate when watching a theatrical performance. Although the effectiveness of displaying audience reactions was recognized by the audience, the presentation needs to be refined and elaborated.

7 Summary and Future Work

We proposed a caption presentation method that uses dialogue balloons and audience reaction indicators to enhance the experience of hearing impaired individuals attending theatrical performances. The design features includes a directional balloon tail and color coordinated balloon borders to help the hearing impaired persons locate the speaker more easily. The system also displays indicators for the sound of laughter and applause from the audience at the bottom of the subtitle display area. This feature is designed to help the hearing impaired people sense the audience's reaction. Evaluation experiments were conducted and good results were obtained from a small number of hearing impaired individuals. Although the audience reaction display did not heighten the enjoyment as much as expected, the subtitles enhanced the audience's enjoyment of the play and enabled them to find the speaker. Opinions about displaying audience reactions were divided. In general, our results showed a tendency of impaired and non-impaired individuals to collaborate in the effort to enjoy a play.

In future, we will implement a sensor to automatically register the audience reaction. We need to acknowledge that the screen, which is installed in the center of the stage, limits the actual performance area. We will investigate methods to display captions that allow the performance area to be increased. Because our results indicate that all people can benefit from the captioning system, we will consider improvements that take into account both hearing impaired and non-impaired individuals.

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