Evaluation of a Sign Language Support System for Viewing Sports Programs

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ABSTRACT
As information support to deaf and hard of hearing people who are viewing sports programs, we have developed a sign language support system. The system automatically generates Japanese Sign Language (JSL) computer graphics (CG) animation and subtitles from prepared templates of JSL phrases corresponding to fixed format game data. To verify the system's performance, we carried out demonstration experiments on the generation and displaying of contents using real-time match data from actual games. From the experiment results we concluded that the automatically generated JSL CG is practical enough for understanding the information. We also found that among several display methods, the one providing game video and JSL CG on a single tablet screen was most preferred in this small-scale experiment.

Author Keywords
Japanese Sign Language; JSL; Accessibility Technology;

INTRODUCTION
In Japan, deaf and hard of hearing people are coming to increasingly expect the benefits of sign language services. Although Japanese Sign Language (JSL) contents should be provided by human signers, this is difficult due to the limited availability of interpreters. To deal with this problem, various studies about the automatic generation of sign language information using computer graphics (CG) animation have been conducted [3, 8, 9]. The system is suitable for sports programs in particular since signed contents availability is scarce for such programs. Several previous studies tried to generate sign language CG animations based on sports game data [1, 4]. However, since these studies did not consider synchronizing with main game videos, the sign language CG animations were completely independent. The appropriate sign language support for deaf and hard of hearing people should reflect the content accurately without disturbing the viewers. To address these issues, we have developed a prototype support system that helps deaf people watch sports programs through real-time provision of JSL CG animation [10]. In this paper, we report the prototype system's operation during actual games and evaluation experiment results obtained for the system that were based on automatically generated contents.

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IMPLEMENTATION & DEMONSTRATION EXPERIMENT

System Overview
To generate JSL CG animation automatically, we applied a system that analyses fixed-pattern game metadata distributed during sports events. Extracted data such as players' names, times, scores, and penalties was inserted into prepared templates of JSL sentences. After this, JSL CG animation was generated automatically from completed sentences and pre-recorded JSL motion capture data by a real-time CG rendering system. Figure 1 shows the system overview.

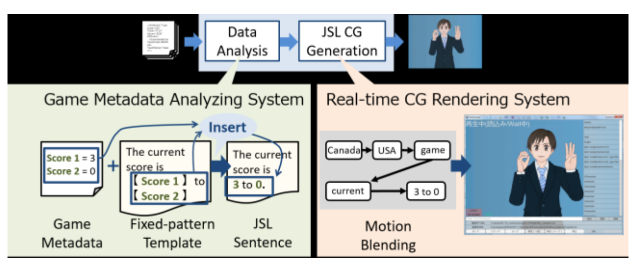

Figure 1. Overview of automatic generation system.

Operation in Actual Games
We applied the automatic generation system to actual winter sports games (ice hockey and curling) to verify the performance of real-time contents generation. The generated JSL CG animation included the current score, the elapsed time, types of penalties (for ice hockey), types of shots (for curling) and so on. The average delay time from

event occurrence to JSL CG animation display was 25 seconds for ice hockey and 31 seconds for curling. The cause of the delay is primarily the time needed to generate the videos and the time it takes to receive the event metadata. Except for the delay, it was confirmed that JSL CG animation can be automatically generated in real time as the game progresses.

EVALUATION & RESULTS

We conducted an evaluation experiment using the contents automatically generated from actual game metadata. The purpose was to verify the users' understanding of the information provided by the JSL CG animation, ascertain the most desirable display method, and acquire deaf users' opinions. Other than JSL videos, the generated contents included subtitles in Japanese, visualizations of audio contents, tablet vibration or a whistle icon when a penalty occurred, and score information. The participants were three deaf signers (one male and two females) ranging from 20 to 40 years in age. Two participants had used JSL as their mother tongue since birth and the other had used it since becoming a teenager. All participants were familiar with how to use a smartphone and/or tablet.

Evaluation 1: Understandability of the CG animation

Some studies have proposed a method of measuring the understandability of CG animation [7]. We adopted the simple method that the participants viewed short JSL video clips and then answered multiple-choice questions. There were three types of JSL video clips: clips showing real human, manually produced animation clips, and automatically produced animation clips. The thirty questions comprised five about videos of the human signer, five about videos of the CG avatar that manually reproduced the motions of the human signer, and twenty about the automatically generated CG animation videos. The manually produced animation clips were generated by arranging motion capture data in word order corresponding to human signers and combining them using linear interpolation. Each clip was played two times for each question and the participants were required to answer within 10 seconds. The results obtained by checking whether the participants had correctly answered the multiple-choice questions showed that the accuracy rate of the three participants was 100% for both the CG avatar and human signer. This demonstrates that the automatically generated JSL CG animation was as understandable as an actual human signer for fixed-pattern JSL sentences. We need to assess the acceptance of signing avatars as in prior evaluation studies, e.g., [2, 6].

Evaluation 2: Evaluation of the display systems

We designed and implemented three types of display systems, shown in Figure 2 as Web browser (a), Tablet App (b), and Tablet & TV (c), and evaluated the usability of each system. The participants tried using each system and then evaluated the need for JSL videos, subtitles, and other text or image information using a 9-point rating scale in 0.5 increments (1: not effective – 5: very effective).

Figure 2. Implemented display systems.

The displayed game video was a five-minute summary of an ice hockey game. We displayed the JSL CG animations and the subtitles at the time the creation of the game metadata was completed in the actual game. Figure 3 shows the obtained evaluation experiment results. 'Game situation' and 'Rule commentary' provide information about the game with JSL animations. We found that the effectiveness of the information for each display system varied. Support information such as the rule commentary in JSL, the subtitles, the tablet vibration, and the score information were highly evaluated for all systems.

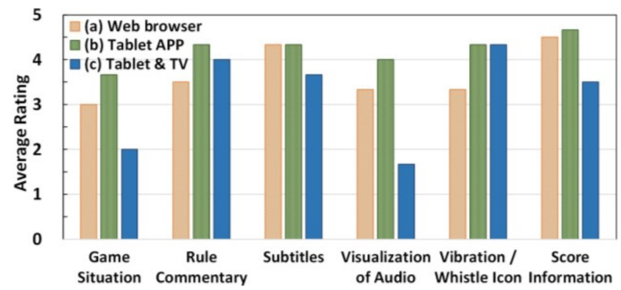

Figure 3. Information effectiveness results.

Evaluation 3: Questionnaire

The participants gave their opinions about the systems by answering the questionnaire. The answers show that the Tablet App (b) received the highest evaluation. It can be considered that the reason for this is that for this system there was little eye movement between the game video and the JSL CG animation and it did not mask the game video area. Furthermore, all contents were completed with one easy-to-use tablet in hand. However, the system was not evaluated highly in terms of delay time and eye-movement fatigue. To alleviate eye-movement fatigue, we will need to improve the user interface by finding a layout that minimizes eye-movement. We will also consider implementing customizable functions and other notification functions that have been reported to be useful [5, 11].

CONCLUSION

We have developed and evaluated a sign language support system to assist deaf and hard of hearing people in viewing sports programs. A real-time operation experiment on actual sports games showed that the support contents could be automatically generated and that the generated JSL animations were useful for understanding the information. The results of an evaluation experiment indicate that the preferable method for viewing displayed game video and support contents is to view them together on the same tablet device. In the future, we will continue to improve its accuracy and usability through evaluation experiments with more participants.

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