An Experimental Live Streaming of an Ice Hockey Game with Enhancement of Mutual Awareness

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Abstract

Internet streaming of live entertainment activities like sports and music performances is now popular. However, the streaming is almost one-way communication. Audience can send texts to the performers, but they can hardly read them during the performance. We are trying to design a live-streaming support system that enhances mutual awareness of performers and audience. In this paper, we give a model of communication structure between performers and audiences and report a trial for an ice hockey game with an experimental system. For downstream awareness, we installed shock sensors around the hockey rink and tried to transmit hard hits of players to the fence. For upstream awareness, we have designed a cheering tool for audience and set a display to show the cheering at the rink side. The experiment was not perfectly successful, but we found some future problems.

1. Introduction

Live streaming applications, such as UStream[1] and NICO NICO LIVE[2], which is well known in Japan, are getting more and more popular. Recently, professional live performances like music or sports are on the streaming service and many remote audiences enjoy such performances.

However, this kind of remote entertainment involves some problems. One important problem is that streaming services threaten the business model of professional performers who gain their income from the admission fee. Second, the audiences can only enjoy worse quality of experience than in-house audiences (we mean the audiences at the live venue, e.g., audiences in concert halls, live houses, or stadiums), because of the quality of audio and video and *lack of awareness*. In this study, we focus on the second problem. We suppose that one of the methods to solve the first problem is to give a good solution to the second problem, because people are more likely to pay for their high quality experiences.

Especially, awareness [1] is an important concept from the viewpoint of CSCW. It is worth considering the awareness in cases of remote live performance.

2. Structure of live streaming communication and awareness

In this section, we consider the structure of communication in case of live streaming services for professional live performance.

Figure 1 illustrates the structure of communication. Three types of parties are in the communication structure: *performers*, *in-house audiences*, and *remote audiences*.

Performers and in-house audiences are at the same place. They already have rich mutual awareness. Although it is an interesting research topic to give richer awareness between them, we leave it as future work in this paper.

Remote audiences, on the other hand, have poor awareness with in-house audiences and other remote audiences. They can hardly know what other in-house or remote audiences are doing during the performance. It is an important problem, because sharing experience with other audiences is one of the essential factors of enjoying live performance. However, we still leave it as future work in this paper.

The remaining problem is mutual awareness between performers and remote audiences. It can be decomposed into two problems: *downstream awareness* (from performers to remote audiences) and *upstream awareness* (from remote audiences to performers).

1 http://www.ustream.tv/
2 http://live.nicovideo.jp/

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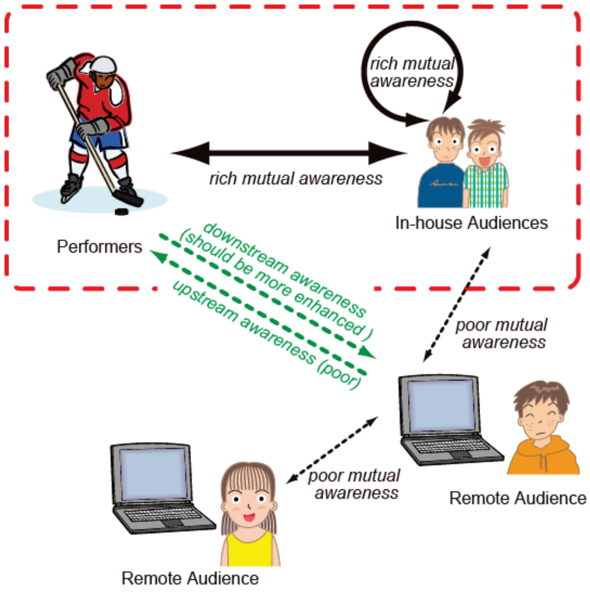

Figure 1. Communication structure between performers and audiences

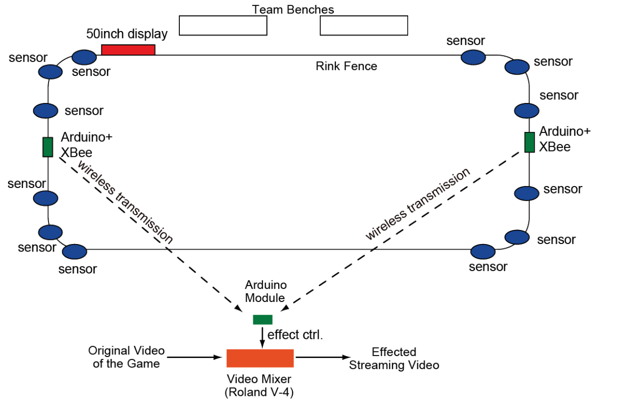

Figure 2. Layout of devices around the rink and video control flow

Of course, service providers are trying to maximize the downstream awareness, as their business. However, it is still possible to enhance it in some cases.

Upstream awareness is an important problem. It is almost impossible for performers to perceive what remote performers are doing or how they are enjoying the performance. One solution is showing twitter or chat text logs written by remote audiences to performers. For example, Ustream includes twitter or other social communication services within the streaming service user interface to encourage remote audiences to write in. NICO NICO LIVE is more positively encouraging remote audiences. The typed-in texts are overlaid on the streaming video and shown to all audiences (and possibly to the performers). However, an important problem of this design is that performers can hardly read texts because they have to concentrate on their performance.

We have designed a system to enhance upstream and downstream awareness for an ice hockey game. We will describe the design and result of an experiment.

3. Our trial: ice hockey game

3.1. Why ice hockey?

We selected ice hockey as the first example of our trial. We did not have any research-oriented reason for this selection. The reason was just the team (Kagawa Ice Fellows[3]) wanted to cooperate with us because of their business background.

3 http://kagawa-icefellows.com/

In our city, ice hockey is not a major sport. We do not have a big ice arena and the in-house audiences can watch a game closely at the rink side. The capacity of arena is small. The team requested us to use live streaming so that more people would be able to watch the game.

3.2. Design for downstream awareness

To enhance downstream awareness, we decided to transmit more information of the hard hit by players. By watching games at the rink side, we found that the hitting sound and shocks are important factors of game awareness for in-house audiences.

To transmit the shock of hitting against the rink fence, we installed 12 shock sensors on the fence. We had two sets of Arduino and XBee modules to realize wireless transmission of shock information. Each set of the module handled six sensors.

The number of sensors (=12) was decided because of administrative reasons such as human resources. If more number of sensors had been installed, it would have been better. We selected corners and fences behind the goals as the places to install sensors. Hitting is more likely to happen at these places of fence.

The transmitted signals of shocks were received by another Arduino module, which made effects on the video signal for streaming the game. When a shock was detected by a sensor, the video was reversed five times, to give a shocking feeling to remote audiences. (Figure 2)

3.3. Design for upstream awareness

For the upstream awareness, our design goals for this time were: (1) to enable remote audiences to cheer a team, and (2) to show the cheering by remote audience to players during the game.

For the first goal, we designed a cheering tool, within which a Ustream panel was embedded (Figure 3). A

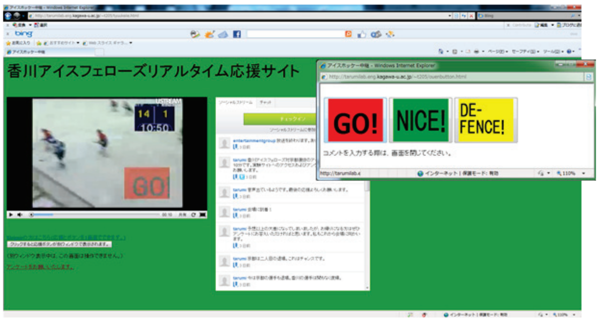

Figure 3. Cheering tool

Figure 4. A 50 inch display at the rink side

remote audience can click buttons of “GO!”, “NICE!”, and “DE-FENCE!”. “GO!” button is for encouraging a team, “NICE!” is for praising, and “DE-FENCE!” is used for cheering defending plays. Logs of button-pushing actions were stored in a database.

For the second goal, we set a 50 inch size LCD display at the rink side. For players to be able to recognize remote cheering, the displayed messages were simply designed --- same as the cheering buttons. The displayed message was designed to be same as the last data stored in the database mentioned above, and it was refreshed every second. Background colors were also selected to give striking impression to players and to be easy to recognize --- red, yellow, and green (Figure 4).

For remote audiences to be able to perceive that their cheering was shown to players, a copy of the displayed image was embedded in the streaming video. For example, in Figure 3, “GO!” with red background is embedded.

We did not use any audio output devices like speakers in the rink for remote cheering. It is simply because it would disturb in-house audiences.

3.4 Experiment

On January 21st, 2012, we applied our system to a real ice hockey game at Tresta Shirayama (ice hockey arena), in Sanuki-city, Kagawa, Japan. Here, *real* means that it was a scheduled season game of “J Ice West League” and was the most important game within the season, for Kagawa Ice Fellows. The number of in-house audiences for the game had been estimated as the maximum number within the season.

The game started at 18:00. According to the regulation of the league, the game has three periods, each of which is 15 min. The streaming site was visited 141 times.

We encountered some troubles during the live game streaming. One was in the audio part of the streaming system. No voice signal was transmitted during the first and second periods of the game. Another trouble was at the shock sensors. The game had more in-house audiences including young children than we had expected. Many people standing around the rink fence made unexpected sensor signals, which caused unnecessary reverse effects on the video signal. This had not been anticipated although we had tested the sensors at two rehearsal games.

Unfortunately, the game was one-sided and did not have enough tension. At the end of the first period, Kagawa Ice Fellows, the home team, leaded the game by 5-0; the final score was 14-1.

3.5 Results

We evaluated the system by interviews to players and questionnaire to remote audiences electronically submitted through a web interface.

The interview was taken from three hockey players of different positions, FW, DF, and GK, just after the end of game. All of them stated that they had been able to recognize the remote cheering displayed on the 50 inch LCD even during the game, and appreciated the remote cheering. We did not find any serious problems at the players’ side, in this time.

Nine responses to the questionnaire were received. Most of the respondents lived in the local area, but two responses were from other areas of Japan.

The results of questionnaire were not good because of some reasons:

1. The usability of the cheering tool was under the satisfactory level. Instructions were not enough and it made troubles on some PCs of remote users.
2. Due to the many in-house audiences, sensors made incorrect shock detection and caused unnecessary reversing effects on the video, especially in the third period of the game. Moreover, to reverse the video five times for each shock was too many.
3. A copy image of 50 inch display at the rink side was embedded in the Ustream video image. However, it was not understood by remote

audiences as identical with the image shown to players.

However, five of the respondents commented that they appreciate the function of remote cheering. One of them also commented that recognizing other remote audience's cheering (i.e., awareness between remote audiences) was interesting.

Hence, totally, our conclusions are that the experiment at this time was not perfectly successful due to some system troubles and inappropriate details of design, but the concept of remote cheering and improvement of awareness between players and remote audiences are highly expected by both players and remote audiences.

4. Related work

We did not find research papers on systems that enhance awareness between sports players and remote audiences.

Aigner, et al. reported on an interesting system related to awareness between players and in-house audiences [2]. It was an application for figure skating, which tried to detect audiences' activities like hand clapping and voice for cheering, and to use them for voting, influencing on the judged score.

Yoshida and Miyashita's challenge can be categorized as a system enhancing awareness between remote audiences for music performance [3]. However, it is mainly for the stored video, not for live streaming.

Takahashi, et al. have developed a hardware hand-clapping machine for remote users, which can be used with live streaming of entertainment performances [4]. It is a special hardware device and just supports hand clapping.

5. Conclusion and future work

In this paper, we gave an awareness model in the applications of live streaming of entertainment performances, showed a experimental system for ice hockey games, and reported the experimental results.

The experiment was not perfectly successful, but we can conclude that enhancement of awareness between performers and remote audiences is highly expected.

For downstream awareness, the experiment was not totally successful. However, video-reversing effect seemed to be effective at least in the first period of the game. We should refine the system and try another experiment.

For upstream awareness, the experiment was neither totally successful. However, at least the players appreciated the system, and remote audiences also expected more elaborated functions. We should also refine the system.

In case of ice hockey, one of the problems to apply this kind of systems is that the game is too speedy. For example, even if one team is attacking to the opponent's goal, it is likely that the team is defending two seconds later. However, the feedback cycle of streaming and cheering involve some seconds of delay. Remote cheering would more fit to games with slower mode changes, such as baseball.

For other future work, improvement of other kind of awareness in Figure 1 should be considered, and systems to enhance these elements of awareness are expected to be implemented. Applications to other kind of sports and other entertainments, such as music and play, are also expected.

Method of cheering varies depending on the kind of sport games, teams, cultures, and other factors. We are not expecting that only one universal cheering tool apply to all sport games. Analysis of cheering culture should also be considered for design.

Acknowledgements

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