Visualizing Real-Time Questionnaire Results to Promote Participation in Interactive Presentations

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***Abstract*—An interactive presentation is intended to support lecturers that need to enhance presentation expressions and gather real-time feedback from audiences while delivering their presentations. Our objective is to improve the efficiency of bi-directional communication between a lecturer and a large audience in presentations using a real-time questionnaire that the result is displayed on a shared screen in real-time while gathering answers. The real-time questionnaire is based on a hybrid interactive presentation system that is collaboration between the traditional presentation supporting system and a web application. To gather feedback from audiences at presentations, our system provides the web application that delivers presentation slides to audiences and provides a feature of creating annotations and answering the questions on delivered presentation slides. The result of an experiment for evaluating performance of our system showed that the features of the real-time questionnaire have high performance scalability.**

I. Introduction

An interactive presentation that includes not just delivering presentations by lecturers, but also sending feedback comments from audiences makes the knowledge exchange more efficient. We propose a hybrid interactive presentation system that consists of a presentation controller extending the traditional presentation supporting system, that is, PowerPoint and a web application for gathering feedback from audiences. Our approach assists easily a real-time questionnaire that the result is displayed on a shared screen in real-time while gathering answers. In this paper, we describe the methodology of implementing the real-time questionnaire and the underlying technologies at length.

We need to develop new functions for easy and quick feedback by using web browsers from audiences to realize the interactive presentation. One of such functions is a real-time questionnaire performing during presentations based on an existing presentation software. The existing presentation softwares (e.g. Microsoft PowerPoint and Apple Keynote) and the presentation web applications (e.g. Google Drive, iCloud, Office 365) do not support the functions for the interactive presentation. We attempt to implement the functionalities as a co-application with PowerPoint for easy deployment.

Our hybrid interactive presentation system provides basic functionality of the real-time questionnaire that counts and shows the result of a questionnaire on a presentation slide in real-time while audiences give replies of the questionnaire. Since questionnaires in presentations are effective for attracting audiences and increasing the depth of understanding of presentations, the feature of questionnaires is a crucial component in the interactive presentations. Furthermore, we discuss the real-time questionnaire from a decision-making supporting tool the point of view.

This paper is organized as follows. We start with discussing related works in Section II. Section III explains a design goal and the interface of the real-time questionnaire. In Section IV, the architecture of the hybrid interactive presentation system that is the foundation of the real-time questionnaire is shown and section V exposes an evaluation for confirming a performance of our approach. After discussing our approach in Section VI, we summarize effects of the real-time questionnaire in the interactive presentation in Section VII and we present conclusions.

II. Related Works

The interactive presentation plays a key role in education. Clicker Assessment and Feedback (CAF) is an instructional assessment and feedback strategy that is incorporated with interactive technologies for higher education, often referred to as clickers. CAF is important as one use for the interactive presentation. Wireless systems that enable professors to ask questions and have students respond using hand-held devices (clickers) are proposed in existing studies [4], [5]. Existing studies of CAF confirm the efficacy of the interactive functionality at presentations in education, but the hand-held devices for gathering feedback from students are hindrance in a large class.

In late years, to avoid the trouble of having to install in specific devices, the software clickers are proposed. Hauswirth et al. proposed a software clicker to teach Java programming for higher education, which allows for much richer types of problems than the traditional multiple-choice questions [3]. The burden of installing devices is certainly removed with the use of the software clickers, but the approach requires setting applications for collecting opinions of audiences before each presentation. The approach Triglianos et al. proposed resolves the problem by an interactive presentation system as a web application [2]. The proposed method lacks flexibility of designing presentations provided in the conventional applications for supporting presentations.

When lecturers deliver presentations in an unexpected context, i.e., the situation such as the place, knowledge of audiences and questions is unexpected, designing presentation

slides and giving a presentation are challenging. To achieve flexible presentations for solving issues in presentations, tangible interfaces based on direct interaction with digitally encoded printed handouts are proposed in previous studies [6], [7]. Our ongoing efforts in Silhouette Effects are dedicated to scaling conventional presentation tools to instant manipulations of slide objects at the presentation mode [1]. While Silhouette Effects supports only the features for delivering presentations, in our work we target the hybrid interactive presentation system that is intended to improve the presentations to have interaction between lecturers and audiences without loss of the flexible presentation functionality. We demonstrate a real-time questionnaire system that is based on the hybrid interactive presentation system and gathers feedback from audiences in presentations with modern web technologies.

III. The Real-Time Questionnaire

Our system provides the real-time questionnaire allowing the lecturer to grasp intelligibility of audiences at presentations by gathering feedback. In this section, we discuss the requirements and the methodology of the real-time questionnaire.

A. Requirements

We aim at offering a simple method to have the real-time questionnaire, i.e., the type of the questionnaire in which the result is displayed on a shared screen in real-time during the implementation of presentations. The real-time questionnaire in presentations helps to maintain focus on presentations and to comprehend and increase the depth of understanding of presentations. In the conventional researches, the specific devices are needed to gather the answers from audiences. Our approach requires that the answers are collected using the web application, and then simplifies the operation of performing the real-time questionnaire.

We have an objective that our system provides seamless questionnaires in the interactive presentation easily. Therefore, the real-time questionnaire system should be independent of troublesome specific coded communication channels and authentication mechanisms for ensuring safety and anonymity in questionnaires. We take no thought of challenges of the web questionnaire system, that is, cheating such as multiple responses and assurance of anonymity. Even if the problems are out of consideration, our approach has the efficacy of the decision-making at a certain scale of meetings in enterprises and organizations. As you want to perform the questionnaires that the problems of safety should be considerable, we implement a new questionnaire mode for tackling the problems with existing approaches [8].

We suppose that the real-time questionnaire is used in the situation that a lecturer and audiences are in the same location and there is a few dozens or hundreds of audiences. Hence, we consider the scalability of the real-time questionnaire because an increase of audiences leads to occur the network congestion and the high processing load, that is, reason for the time delay of displaying the results of the questionnaires in real-time. Moreover, because of the requirements of the specific devices expressed in the approaches of the previous studies, the scale of the effort to carry out questionnaires is vast in cases where a number of audiences is large, and then the system does not scale well.

B. Design Goal

The critical goal of our study is to make it an open possibility to provide the real-time questionnaire at the interactive presentation easily in the situation that a lecturer and audiences are in the same location. We set the following concrete objectives:

- Interoperability: The approach should be independent of special devices and applications for collecting opinions of audiences, i.e., audiences should answer the questionnaires using the personal devices without reference to the type and OS of devices.
- Interactive Functionality: A lecturer and audiences should share presentation slides and the results of the questionnaires in real-time when delivering a presentation. Audiences should send feedback of the questionnaires at presentations to improve the communication among participants in the real-time questionnaire.
- Scalability: The approach should absolutely perform summary of a questionnaire and display the result in real-time in cases where there is a large audience at a presentation.

To attain interoperability, we implement a user interface for audiences as the web application. The specific devices and applications for collecting comments from audiences are not required, and personal devices such as notebooks, smart phones and tablet computers are used in our system.

Our system supports interactive functionality that ensures the communication between a lecturer and audiences in the real-time questionnaire. The results of the questionnaires are displayed on a shared screen while submitting answers from audiences using the graph provided by Microsoft Excel. When updating the result on the presentation slide in accordance with the received answers, audiences share presentation slides in real-time using the web application operating with general web browsers. Concretely, audiences submit handwrite memo and text comments as feedback of presentations. Submitted handwritten memo and comments are sent to the device of a lecturer and reflected on presentation slides. The communication mechanism can be crucial to improvement of the consensus of opinions. Our system supports real-time information presenting for lecturers and the features of feedback posting from audiences.

The approach of the web application contributes the scalability of our system by reason of independence from the specific devices for gathering feedback. Besides, to avoid the network congestion and the high processing load, we design the mechanism of the interactive presentation that is based on the tallying server to handle the crush of demand. To confirm the efficacy of the mechanism, we performed an experiment of the time delay of sharing the results of the questionnaires among a lecturer and audiences.

C. Display of The Real-Time Questionnaire Result

Fig. 1 indicates the screenshot of displaying the questionnaire result on the device of the lecturer. The icons located in the left and right lower angles are a presentation controller for supporting the lecturers to give a presentation effectively with

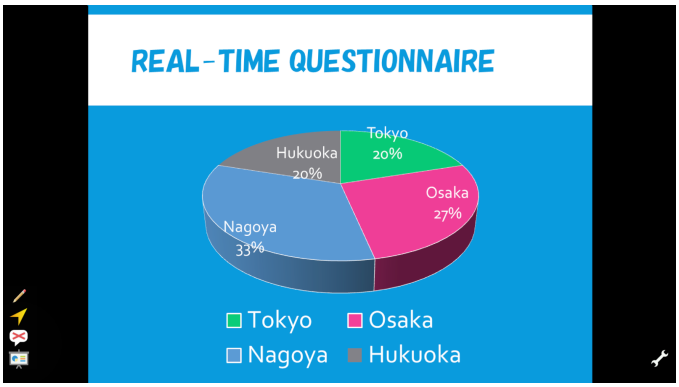

Fig. 1. Screenshot of Displaying The Questionnaire Result

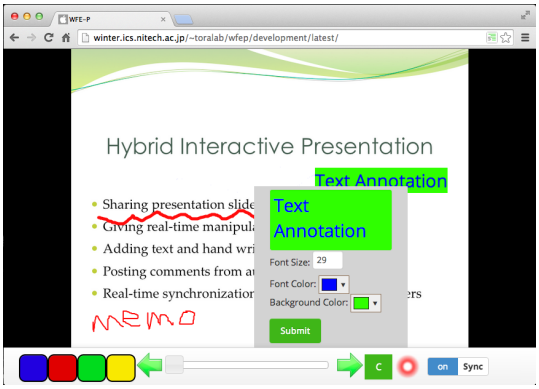

Fig. 2. Screenshot of The Web Application for Audiences

the proposed method Silhouette Effects [1]. Silhouette Effects expands the methods for utilization of Microsoft PowerPoint to modify slide objects, such as text, graphs and figures, at the presentation mode. The presentation controller based on Silhouette Effects is a PowerPoint supporting tool that provides the presentation supporting features and sends the information of sharing presentation slides. The lecturers run the presentation controller together with PowerPoint.

The presentation controller allows lecturers to begin a questionnaire at any time during presentations. Since our real-time questionnaire supports a type of survey that there are alternatives up to four, the lecturer configures the alternatives using the presentation controller. Then, a graph like Fig. 1 is generated for displaying the result of the questionnaire in real-time. The presentation controller inputs the lecture's configuration of the alternatives to a Microsoft Excel spreadsheet and visualizes the configuration as a graph object. The graph object in Excel gets copied to the PowerPoint presentation. When receiving the result of questionnaires from the counting server in our system that tallies answers from audiences, the presentation controller passes the result to the Excel spreadsheet that runs in the presentation background and the graph object visualizes the result. When receiving the second and subsequent results, the presentation controller rewrites the data in the Excel spreadsheet and then the graph object is updated in real-time.

The presentation controller saves the result of the questionnaires to a presentation file as PowerPoint graphs. In general conference, the results need to be recorded in the conference note for future reference. The real-time questionnaire system avoids the trouble of recording by automatic saving.

D. The Interface of Submitting Feedback for Audiences

Fig. 2 shows the interface of the web application for submitting feedback from audiences. To participate in the interactive presentation, audiences open the web application. The web application runs on common web browsers and devices to achieve the interoperability that audiences send feedback with respective devices. Since the web application assumes a crucial role in the interactive presentation, we describe the user interface in detail.

Audiences need to enter an ID in the window when opening the web application to get into the interactive presentation. The counting server in the real-time questionnaire, that gathers answers from audiences and tallies the real-time questionnaire, manages answers from audiences with the IDs. The web application associates the answers of the questionnaires with the entered ID and sends them to the counting server. Then the counting server keeps a correct tally in cases of receiving multiple answers from the same web application. The ID is also sent to the presentation controller through the WebSocket server when entering the ID. The presentation controller enumerates the number of audiences that submits the ID. The number of audiences is displayed on the screen in presentations for the duration of having a questionnaire. If the number of entrants of the questionnaire is apparent, the lecturer compares the actual number of entrants with the displayed number, thus helping the lecture to determine whether there is a repeater that votes answers with multiple web applications or not.

The lower bar of the screen has the four-color buttons for answering questionnaires, the controller of page transitions, the comment-posting button, the mode switch and the synchronization switch. As audiences give a reply to the questionnaire using the four-color buttons, the web application sends the answer to the counting server. The dialogue for inputting comments is displayed when clicking the comment-posting button. The comments is sent to the presentation controller on a device of a lecturer and saved in presentation slides. After presentations, the lecturers check submitted comments as audiences' feedback. The users define the behavior of press-and-holding the mouse button and drag by the mode switcher, i.e., users select the pointer mode or the handwritten mode. The synchronization on/off button configures whether other users' manipulations are synchronized in real-time or not. When the synchronization is off, the manipulations of a lecturer and other audiences are not synchronized. The button allows that the users genuinely browse the presentation slides.

When audiences press-and-hold the mouse button and drag, a pointer or handwritten memo is displayed on a presentation slide, and audiences indicate a slide object when delivering feedback. Right clicking on presentation slides displays the dialogue for adding an annotation like Fig. 2. The annotation consists of DOM elements that have a handler of the user's operation, so the user edits and drags the created annotation.

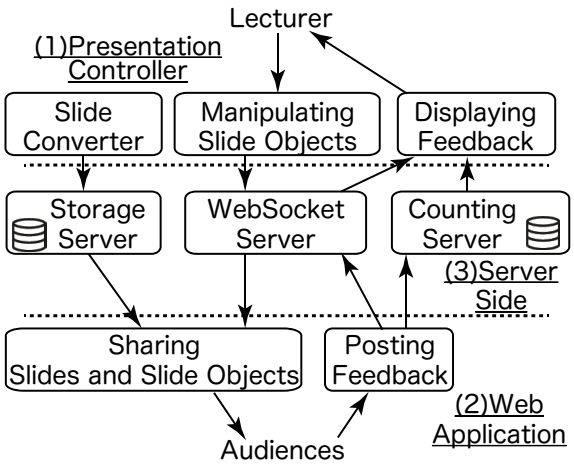

Fig. 3. Architecture of The Hybrid Interactive Presentation System

IV. The Hybrid Interactive Presentation System

We propose the hybrid interactive presentation system that connects the traditional presentation supporting tool and the web application for the feedback gathering of audiences. The hybrid interactive presentation system occupies an important role as the basis of the real-time questionnaire system. In this section, we describe the methodology of achieving our hybrid interactive presentation system.

A. Architecture

The architecture of the hybrid interactive presentation system shown in Fig. 3 consists of three main parts: (1) the presentation controller, (2) the web application and (3) the server for managing the interactive presentation. (1) The presentation controller is a PowerPoint supporting tool that provides the presentation supporting features and sends the information of sharing presentation slides. The slide objects such as text and figures can be moved, zoomed, modified and removed using the presentation controller at the presentation mode of PowerPoint. Moreover, lecturers start a questionnaire at any time in presentations. While audiences submit the answers of the questionnaire, the result of the questionnaire is visualized using Excel graphs in real-time on a presentation slide.

To share presentation slides and submit opinions of audiences, we develop (2) the web application that provides the user interface for displaying presentation slides and adding annotations and handwritten memo on shared slides. The web application consists of two layers, i.e., a layer to recreate presentation slides and to share feedback from audiences in real-time. The first layer recreates presentations made of presentation slides that are converted into images. The approach performs reliably and accurately since converting presentation slides to images is used commonly by achieving web conferences in a previous research [9]. On the second layer on the front of the web application, audiences generate annotations and handwritten memo that are composed of DOM elements for sending opinions and feedback to a lecturer.

(3) The server of managing the interactive presentation is divided into three internal subsystems. The first subsystem is a storage server keeping presentation slides converted into images. When lecturers start presentations or manipulate the slide objects in presentations, the presentation controller converts the presentation slides into images and uploads the images to the storage server. The function of the storage server is to issue the URL of each uploaded image.

The presentation controller sends the URLs of the images to the second subsystem that is a WebSocket server for a real-time communication among lecturers and audiences. The WebSocket server pushes received data in real-time. The presentation controller and the web application communicate through the WebSocket server. The web application serializes and sends the created annotations and handwritten memo to the WebSocket server. The presentation controller deserializes the received data and generates the slide objects. Then, the feedback from audiences is displayed on the presentation slides in real-time.

The third subsystem is the counting server that tallies answers of the real-time questionnaire. The count process consists of the following three steps. First, the system notifies an issue of a questionnaire by the lecturer to the client web applications via the WebSocket server, then the web applications start a questionnaire mode and the feature of voting answers. Second, the clients send the answer selected by their users to the counting server, and then the server tallies the answers and saves the result to the storage. Finally, the counting server sends the results of the questionnaires to the presentation controller at regular intervals.

B. The Mechanism of The Real-Time Questionnaire

The hybrid interactive presentation shares presentation slides, manipulations in presentations and feedback from audiences in real-time. The presentation controller on the device of the lecturer and the web application for audiences communicate through the intermediately of the counting server in the real-time questionnaire.

The web application sends the answers of questionnaires as JSON data that contain the color selected using the four-color button, the ID for identifying the users and a token for identifying the questionnaires to the counting server. The counting server deserializes the received data and tallies the selected answers with the respect to the token.

The result is sent to the presentation controller at an interval of two seconds. Although the counting is accomplished in the way that the web application sends answers to the presentation controller directly and the presentation controller compiles the total amount, the device of the lecturer and the network have a heavy processing load. The heavy processing load can be hindrance to the interactive presentation. Our approach reduces the load by counting results of questionnaires in the external server and sending the results to the lecturer's device at intervals of two seconds. We consider the chances of keeping on changing an answer at intervals of less than two seconds are low. Thus, our approach gets out of providing real-time information about the questionnaires.

Using the synchronization mechanism of presentation slides as follows, the results of the questionnaires on presentation slides are shared in real-time on the web application for

audiences. When receiving a questionnaire result, the presentation controller updates a graph for displaying the result using Excel. Then, the presentation controller uploads the image of the updated presentation slide and broadcasts the image URL as JSON data to the web application for audiences through the WebSocket server. After the web application updates the image on the first layer that displays presentation slides with the received image, the result of the questionnaire is shared in real-time.

V. Evaluation

We are concerned with achieving the interactive presentation without troublesome specific devices to collect the opinions of the users and propose the web application for the interface submitting feedback from audiences. In this section, we confirm that the methodology of collecting feedback with the use of the web application functions effectively in a large group and organization by a suitable experiment.

A. Experimental Protocol and Environment

Our approach provides the web application for audiences in the interactive presentation and personal devices such as notebooks, smart phones and tablet computers are used to share presentation slides and post feedback from audiences. To indicate that the web application works adequately for the real-time interaction between a lecturer and audiences in presentations, we measured the delay time in the real-time questionnaire system. The time refers to a period of time from the point when the answers are sent from the web applications to the point when the result of the questionnaire is displayed on the presentation slides of the lecturer. When increasing the number of users virtually, we indicated that the delay time was sufficiently small.

We installed one server device and two client devices for running the presentation controller and the web applications. The roles of the server device installed in a wide area network are data passing and the tally of questionnaires in the real-time questionnaire system. While the spec of one of the client devices that was used as the lecture's device, hereinafter referred to as the client device A, was composed of Intel Core i3 1.8Ghz, 4GB of RAM, Windows 8.1, that of another client device that was used as the audiences' device, hereinafter referred to as the client device B, was composed of Intel Core i5 2.7Ghz, 8GB of RAM, Mac OS X. The client devices were installed in local area network. To virtually lay out a situation in which there are multiple users in a presentation, we launched 20 web applications on the client device B. The network delay time between the server device and the client devices that is measured by 100 pings was about 22ms.

B. Experimental Procedure

We repeatedly performed the following three steps to measure the delay time of submitting answers in the real-time questionnaire system. In first step, we activated a PowerPoint file and the presentation controller on the client device A and started the real-time questionnaire. Second, we launched 20 web browsers on the client device B and opened the web application on all web browsers. In this experiment, the web application submitted automatically 50 data of answers to the counting server at a regular interval that can be configured arbitrarily. The data of answers consisted of random answer of a questionnaire, time stamp information right before submitting data, sequence number and an ID for the identifier of each web application. The counting server transferred the data to the presentation controller when sending the result of the questionnaire at an interval of two seconds. After drawing the graph for displaying the result, the presentation controller broadcasted the received data of answers to all web applications through the WebSocket server. If the ID in the data of answers matches up with the ID of a received web application, the web application recorded the delay time using time stamp information in the data of answers on the browser console together with the sequence number of the answer. Finally, we calculated the average of the recorded delay time and checked packet loss and sequencing using the recorded sequence numbers.

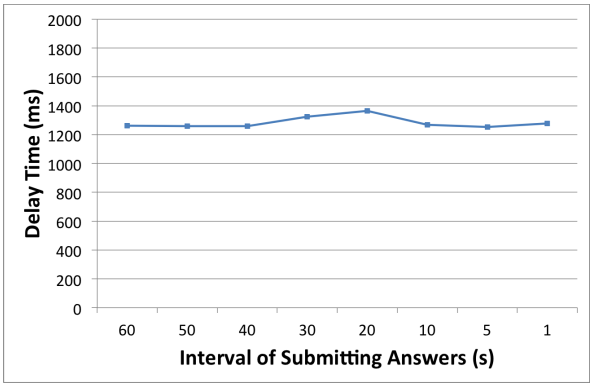

Fig. 4. Evaluation Result

To increase virtually the number of users, the above steps were performed as we reduced the interval of submitting answers in the web application. We consider audiences submit multiple answers to fix, and assume that the actual interval is about 30 seconds. The virtual number of users is inversely proportional to the interval of submitting answers. In this experiment, we set the interval to 60, 50, 40, 30, 20, 10, 5 and 1 second. If the interval is 1 second, we confirm the performance of our system in the severest situations, i.e., the situation in which 600 users submit answers.

C. Experimental Result

The evaluation result shows that our system provides the interactive presentation without loss of usability when a sizable audience gains a place. Fig. 4 shows the delay time associated with changing the interval of submitting answers from the web applications. The horizontal axis is the interval we configured, while the vertical axis is the average of the delay time recorded on 20 web browsers. Even where the interval is shortened, i.e., increasing the number of the audience virtually, the delay time of submitting answers in the real-time questionnaire system. The difference between the maximal time and the minimum time is 141ms, and the value is vanishingly small. Besides, the rate of packet loss is calculated at approximately 0% in each interval. We may, therefore, reasonably conclude that our approach provides the stable interactive presentation since the real-time questionnaire system adequately counts the answers in cases where the users are increased heavily.

VI. Discussion

In this section, we discuss the usability and the application of our approach. We confirm that the usability of the real-time questionnaire and we entertain the progressive approach for use from the decision-making methods point of view.

A. Usability of The Real-Time questionnaire

The hybrid interactive presentation system allows that the lecturer and audiences communicate using the presentation supporting system that extends the traditional system (i.e., PowerPoint) and the simple web application. Our approach reduces the time and expense associated with learning and running the interactive presentation system. The lecturers only have to know the use of commonly-used tools and audiences submit their feedback with the user-friendly interface that is illustrated in Fig. 2.

The result of the questionnaire is visualized using the Excel spreadsheet. Now, the type of the graph object for displaying the results is only the pie chart, but the type of visual effects is expanded easily by the simple expansion of the presentation controller. When the extended presentation controller allows the users to draw a huge variety of graphs, the expressive faculty of the results is improved. Our approach can handle the complex data by the functions of Excel. The users are able to perform more complex questionnaires, i.e., not only the type that the answer has a certain number of choices, but the type that the answerer makes multiple selections and selects answers from a number of choices. The approach that incorporates presentations and the existing data-handling system contributes to non-trivial extensions of functions of presentations.

B. Application to Decision-Making

In previous researches, the approaches to implementing real-time questionnaires in education are properly validated. The experimental result ensures that the performance of the real-time questionnaire has efficacy as the feedback mechanism at a large conference. We discuss the effect of applying the real-time questionnaire system to the ordinary conferences in enterprises and organizations.

Let us discuss the system from the application as the decision-making system point of view. The decision-making system supports the method of decision-making such as Brainstorming and KJ-Technique that the participants offer opinions on the same plane and organize the opinions using each procedure. The posting feedback feature of our system allows for collecting the opinions of the users and the data assuming a key role, and then the submitted opinions and data are arranged on the shared plane that is the screen of the presentation. Using the real-time questionnaire system, furthermore, the users perform the decision-making techniques and forge a convergence of opinion effectively.

The function of adding annotations allows the users to offer opinions and compiled data on the shared presentation slide. Dragging annotations and handwritten memo are synchronized in real-time and the features are supportive of the method of decision-making such as grouping opinions in KJ-Technique. The operations are performed on the shared screen and users deal with the operations cooperatively.

In the step of gathering and organizing opinions, the real-time questionnaire is available to summarize options and reach an agreement. The real-time visualization of the questionnaire results has the potential to have an impact on the process of decision-making, i.e., the users can be influenced by other people's opinion. The real-time questionnaire can prompt the users to defer to or to deprecate the answers voted by others. The approach that integrates the real-time questionnaire into the traditional decision-making methods can develop a new methodology of decision-making.

Compared with the traditional system of supporting decision-making, our system widens the scope of participants, i.e., the method based on the interactive presentation functions successfully in a large group. Then, since functions for submitting opinions give anonymity, the users submit opinions at ease and our approach simulates the discussions. The real-time questionnaire that is lacked in the existing applications improves to form an opinion about the discussions.

VII. Conclusion

We proposed the hybrid interactive presentation system and have demonstrated the real-time questionnaire system. Our proposed method allowed for performing the interactive presentation with no use of specific hand-held devices and applications for gathering feedback from audiences. The experiment result showed that the scalability of the real-time questionnaire is high performance, and our system operates effectively at a large conference in organizations and class in education. The approach to the real-time questionnaire based on the hybrid interactive presentation system compensates for the lacks of current systems and contributes to establish a new type of presentation.

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