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Reflection Support System with Audience Robots for Presentation Practice

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Abstract: During a presentation, an effective presenter will modify his/her own presentation style by observing the audience's reaction. To hone this skill, we have developed an audience robot that reacts according to the presenter's presentation style. The objective of this study is to propose a system that supports self-reflection after presentation practice with an audience robot. To modify the presentation style, the presenter needs to understand how the audience's psychological state corresponds to each reaction and what presentation style the presenter should adopt to modify the audience's psychological state. In addition, he/she needs to utilize this knowledge at the appropriate time. Therefore, during reflection, the presenter should evaluate whether he/she has such knowledge and whether he/she can utilize it. This study constructs a system that visualizes the presentation data graphically to represent each evaluation item clearly for effective consideration.
Keywords: Presentation support, communication robot, non-verbal expression, reflection

1. Introduction

A presentation is an activity in which a presenter conveys his/her point of view to an audience. Effective communication utilizes non-verbal expressions in addition to verbal expressions. The good usage of non-verbal expressions cannot be defined, as it depends on the audience and the environment. Therefore, it is necessary for a presenter to modify his/her presentation style, such as the usage of non-verbal expressions, by observing the audience's reaction during the presentation. However, reading an audience's reactions, objectively evaluating one's presentation style, and correcting it is not easy.

Many studies support presenters based on predefined good verbal and non-verbal expressions (Tun, Okada, Huang, & Leong, 2023) (Ochoa & Dominguez, 2020) (Kurihara, Goto, Ogata, Matsusaka, & Igarashi, 2007), but these studies do not focus on behavior modification based on the audience's reactions during the presentation. Since it is difficult to predefine an audience's reactions, presenters must learn behavior modification experientially through presentations with various audiences.

We have developed an audience robot that changes its internal state, i.e. emotion, according to the presenter's non-verbal expressions and expresses actions according to that internal state (Kato, Kunori, & Kojiri, 2023). Using this robot, the presenter can practice presentations anytime and anywhere. Although this process allows a presenter to practice and test their presentation, the presenter must still determine whether he/she is able to modify his/her own behavior appropriately. This study supports effective reflection so that the presenter can modify his/her own behavior in response to the audience's reaction.

For productive reflection, the presenter needs to objectively observe their own behavior and accurately judge whether it is appropriate. Ito et al. constructed a robot that mimics the presenter's behavior so that the presenter can observe his/her own behavior objectively (Ito & Kashihara, 2023). This robot merely follows the presenter's actions, so the presenter may not notice some inappropriate or ineffective actions. Some studies cope with this problem by acquiring non-verbal expressions through sensors and visualizing them. Kurihara et al. developed a system that graphically displays the presenter's speaking speed, intonation, slowness, eye contact rate with the audience, and pause on each slide, thus allowing the presenter to analyze the parts in which he/she is not performing well (Kurihara, Goto, Ogata, Matsusaka, & Igarashi, 2007). Chollet et al. developed a system that presents a graph with a time-series of scores calculated from eye contact, facial expressions, and hesitations during the presentation (Chollet, Ghate, Neubauer, & Scherer, 2018). These systems only visualize the information of non-verbal expression during the presentation and do not indicate the points that should be looked at during reflection.

To support reflection, Inazawa et al. prepared a checklist (Inazawa & Kashihara, 2022). This checklist may help the presenter understand good presentation behavior but does not support reflection for modification of the presenter’s performance according to the audience.

To make modifications to their performance, the presenter needs to recognize the audience's internal state toward the presentation based on the audience's reaction, consider how to modify their behavior based on the audience's internal state (this action is referred as "modify-behavior"), and execute the modify-behavior they choose. To do so, the presenter must have the ability to recognize the internal state of the audience (this knowledge is referred to as "Reaction-State knowledge") and the knowledge to modify behavior in relation to the audience's internal state (this knowledge is referred to as "Modify-Behavior knowledge"). In addition, the presenter must know the appropriate time to use this knowledge. Therefore, in reflection, the presenter must consider whether they have the sufficient knowledge and whether they use that knowledge appropriately.

To obtain the Reaction-State knowledge and the Modify-Behavior knowledge, the presenter must know the audience’s internal state, which he/she cannot usually see. Some studies try to externalize the internal states of humans. El Kaliouby et al. developed a system that estimates emotions from facial expressions (el Kaliouby & Robinson, 2005). The system can determine joy, anger, and sadness, but cannot distinguish discomfort or irritation, which is often experienced by audiences. Another study asks the audience themselves to express their emotions by pressing buttons during the presentation (Yumura, Tan, & Lim, 2019). This requires additional work for audiences. In addition, internal states sometimes do not follow non-verbal expression, depending on fatigue and other factors. For the presenter to acquire Reaction-State knowledge from the audience’s reaction, the audience must behave according to that knowledge.

If we can observe the internal state of our audience robot, we can determine whether the presenter has the correct Reaction-State knowledge and Modify-Behavior knowledge, and whether he or she can use them appropriately. The audience robot constructed by our laboratory generates reactions corresponding to internal states. Therefore, this study utilizes the internal state and reactions of the audience robot and the behavior of the presenter as targets of reflection. Since the reflection points differ depending on the reflection purposes, this study proposes a system to support effective reflection by visualizing the reflection points according to the reflection purposes.

2. Approach

2.1 Steps for Modifying Presentation Behavior

The steps for generating modify-behavior are shown in ***Figure 1***. To execute modify-behavior, the first step is to recognize the audience's internal state from their reactions (Step 1). Here, we utilize the knowledge of the audience's internal state that the audience's reactions imply (Reaction-State knowledge). Next, modify-behavior is examined based on the internal state recognized in Step 1 (Step 2). At this time, knowledge of behaviors that can change the audience's internal state (Modify-Behavior knowledge) is utilized. Then, the modify-behavior considered in Step 2 is acted upon (Step 3).

Suppose that the presenter has the Reaction-State knowledge and the Modify-Behavior knowledge for the number of eye contacts, as shown in **Table 1**. If the audience is looking away, the presenter recognizes that the audience is disinterested based on Reaction-State knowledge 2. The presenter then determines that the number of eye contacts should be increased when the audience is disinterested based on Modify-Behavior knowledge 1. Therefore, the presenter will look at the audience more often to increase the number of eye contacts.

Figure 1. Steps for Generating Modify-behavior

Table 1. *Knowledge Examples*

Reaction-State knowledge (reaction: internal state)	Modify-Behavior knowledge about the number of eye contacts (internal state: change of eye contacts)
1. Nodding: neutral 2. Looking away: disinterested 3. Tiling the head: bad impression	1. Disinterested: increase 2. Bad impression: increase

2.2 Audience Robots

Figure 2 shows an overview of the audience robot (Kato, Kunori, & Kojiri, 2023) that has been constructed by our laboratory. This robot is created using the functions of Sharp's RoBoHoN. The audience robot has an internal state as an emotion model that represents emotions. The robot generates an emotion model based on the presenter's non-verbal expression acquired by the sensors and represents reactions according to the emotion model. Currently, the robot acquires only eye contact as the nonverbal expression, such as the number of times the robot makes eye contact for every 10 seconds.

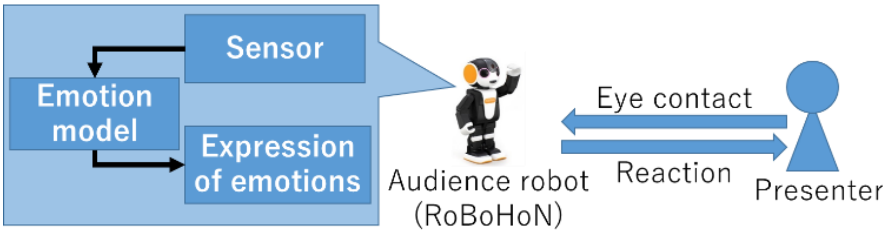

Figure 2. Overview of Audience Robot

The emotion model of the audience robot is shown in ***Figure 3***. The emotion model represents emotions as two elements: interest and impression. In general, an audience who is not interested in the presentation is unlikely to have a strong impression of the presentation, so we define the range of possible impression values to be smaller if the interest in the presentation is low. An impression value bigger than value α_1 is a good impression and α_2 is a very good impression. On the other hand, an impression value smaller than β_1 is a bad impression and β_2 is a very bad impression. When the interest values fall below a certain value γ, the presenter gets disinterested. Equations 1 and 2 are the equations to generate the emotion model.

The number of eye contacts was counted every 10 seconds. n_t is the number of eye contacts that occur for tth counts and i_t is the value of interest after tth counts. v is the amount of change in interest if eye contact occurs at least once and $-v$ if not. p_t is the impression value, which is determined by the previous impression value i_{t-1} and the number of eye contacts n_t. If the number of eye contacts is 1 or if the number of eye contacts is 0 and $i_{t-1} < 0$, the change in impression value p_t is d; if the number of eye contacts is 0 and $i_{t-1} \geq 0$, or if the number of eye contacts is more than 2, the change in impression value p_t is $-d$.

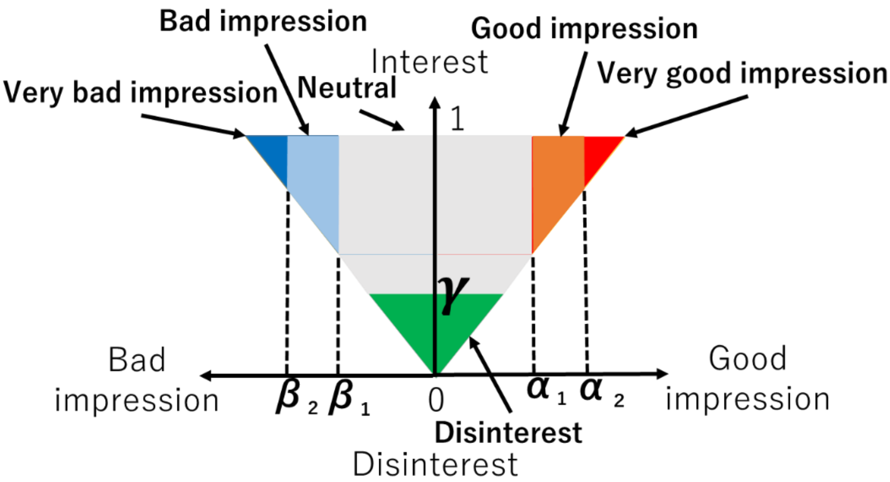

Figure 3. Emotion Model

$$i_t = i_{t-1} + \begin{cases} v \ (n_t > 0) \\ -v \ (n_t = 0) \end{cases} \tag{1}$$

$$p_t = p_{t-1} + i_{t-1} \times \begin{cases} d \ (n_t = 1 \ or \ n_t = 0 \text{ and } i_{t-1} < 0) \\ -d \ (n_t = 2 \ or \ n_t = 0 \ and \ i_{t-1} \geq 0) \end{cases} \tag{2}$$

The audience robot moves according to the internal state determined by the emotion model. The robot nods when the emotion model is good impression and nods twice when it is very good impression. The robot does not move when it is neutral. The robot turns its head to the side when the emotion model is disinterest, tilts its head when it is bad impression, and shakes its head when it is very bad impression.

2.3 Overview of Reflection Support System

The reflection support system provides the internal state and reaction of the audience robot with the presenter's behavior. ***Figure 4*** shows the system configuration. The audience database stores the video of the user's presentation (presenter), the number of eye contacts made by the user, and the internal state and the reaction of the audience robot. The knowledge database stores the Reaction-State knowledge and Modify-Behavior knowledge input from the user. The reflection point determination function selects the data to be observed according to the user's reflection purposes.

The user is asked to input Reaction-State knowledge and Modify-Behavior knowledge as prior knowledge before reflection. The presentation data is then shown to the user. When the user selects the purpose he/she wants to reflect on, the system selects that part of the data as reflect points. The user inputs the reflection results by looking at the presented reflection points. As reflection purposes, our system provides whether the user has acquired enough Reaction-State knowledge and Modify-Behavior knowledge, and whether the user applied the Modify-Behavior knowledge appropriately.

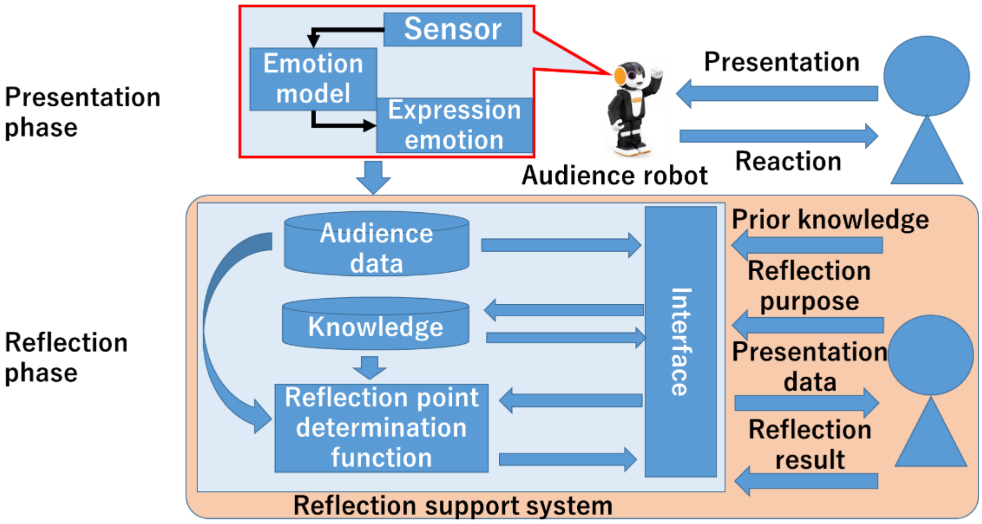

Figure 4. System Configuration

3. Reflection Point Determination Function

The reflection point determination function indicates the data to look at for each reflection purpose.

Table 2 summarizes the types of data that should be viewed when considering each reflection purpose. The correctness of the Reaction-State knowledge can be grasped by comparing the audience's internal state, reaction, and the presenter's Reaction-State knowledge. The correctness of the Modify-Behavior knowledge can be determined by whether the change in the state of the audience in response to the user's actions is the same as the Modify-Behavior knowledge. The appropriateness of applying the Modify-Behavior knowledge can be evaluated by checking whether the presenter acts according to the Modify-Behavior knowledge. The function compares the knowledge with these data according to the purpose and shows the parts where the user can observe the insufficiency of his/her knowledge or inappropriateness in applying the knowledge.

Table 2. *Data to be Used for Reflection Purposes*

Reflection purposes	Audience robot		User (Presenter)		
	Internal state	Reaction	Action	Reaction-State knowledge	Modify-Behavior knowledge
State of Reaction-State knowledge	Y	Y		Y	
State of Modify-Behavior knowledge	Y		Y		Y
Application of Modify-Behavior knowledge	Y		Y		Y

Figure 5 shows an example. The internal model that the user assumes by his/her Reaction-State knowledge is shown as the "Assumed internal model." For the purpose of reflecting on the state of Reaction-State knowledge, the function shows the parts where the internal state of the audience robot and assumed internal model are different. For the purpose of reflecting on the state of Modify-Behavior knowledge, the parts where the change of the internal model and the number of eye contacts do not correspond to the Modify-Behavior knowledge are displayed. To consider the application of the Modify-Behavior knowledge, the function shows the parts where the user's action does not follow his/her Modify-Behavior knowledge.

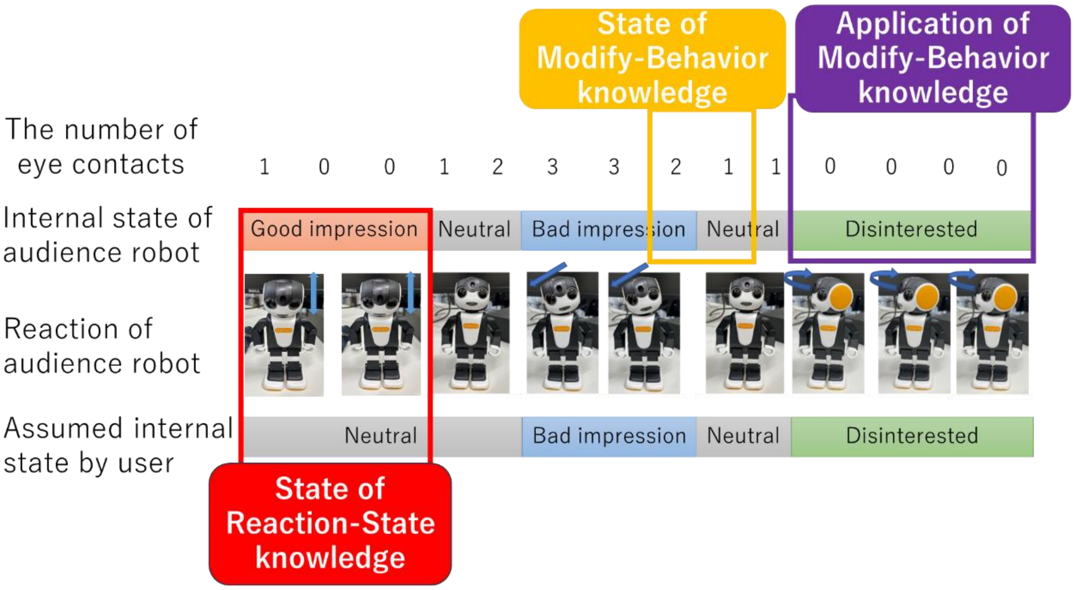

Figure 5. Example of Data Shown for Each Reflection Purpose

4. Prototype System

We developed the prototype system to support reflection of modify-behavior. When the system starts, the prior knowledge input interface shown in ***Figure 6*** is displayed. The "Reaction-State knowledge input area" allows the user to enter their known Reaction-State knowledge by entering the internal state for each reaction. Since it is difficult to discriminate Very good and Good, they are both set as good impression. Similarly, good impression is assigned for both Very bad impression and Bad impression. The possible internal states of RoBoHoN are presented in the emotion model display area. In the Modify-Behavior knowledge input area, the internal state of the audience and the reaction to be taken at that state are input by selecting from the list of candidates. Since the current system only handles eye contact as non-verbal expression, modify-behavior is either “increase” or “decrease” the number of eye contacts. The user can select one of them from the combo box. When all the knowledge has been inputted, pressing the "End Input" button will take the user to the reflection interface.

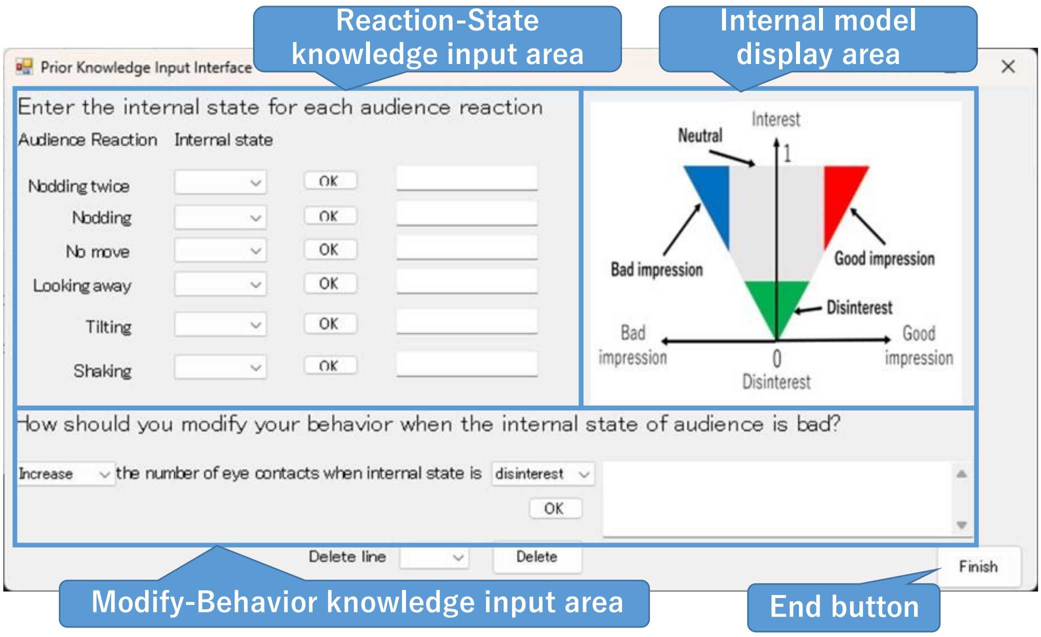

Figure 6. Prior Knowledge Input Interface

The reflection interface first asks to select the presentation video and the data of the audience robot's presentation. When each file is selected, the interface of ***Figure 7*** emerges. The presentation video display area displays the selected presentation video. In the Modify-Behavior knowledge display area, the Modify-Behavior knowledge entered in the prior knowledge input interface is displayed. In the presentation data display area, log data consisting of the internal state and reaction of the audience robot, the number of times the user makes eye contact, and the internal state of the audience robot that the user would recognize based on the Reaction-State knowledge entered in the prior knowledge input interface are displayed for every 10 seconds. The internal state of the audience robot and that estimated by the user are colored the same color in the emotion model display area. The "Reflection Point" button is provided for each reflection purpose and, when the button is pressed, only the data that should be viewed is displayed in the presentation data display area. *Figure 8* shows an example of the presentation data display area when pressing the button for reflecting the state of the Reaction-State knowledge. The time periods where the internal states of the audience robot and those estimated by the user differ are displayed.

When the “Knowledge Construction” button is pressed, the Knowledge Construction interface shown in ***Figure 9*** is displayed, allowing the user to enter what was learned from the Reflection interface. Clicking the "Exit" button closes the reflection system.

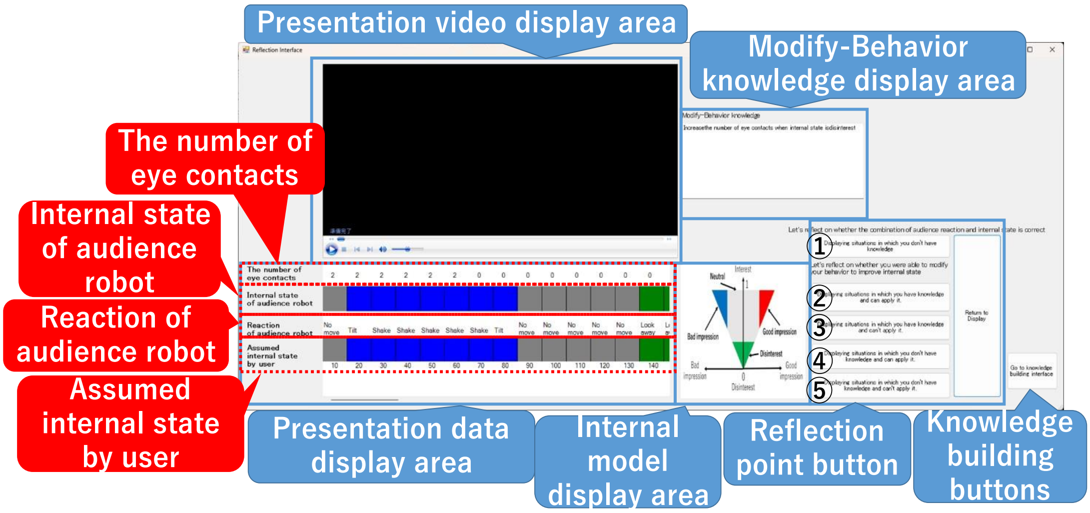

Figure 7. Reflection Interface

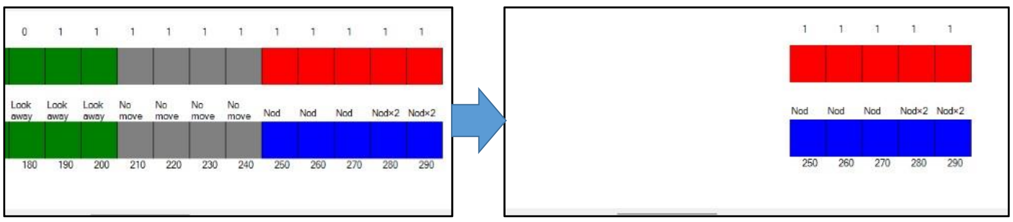

Figure 8. Example of Pushing the Button for Reflecting Reaction-State Knowledge

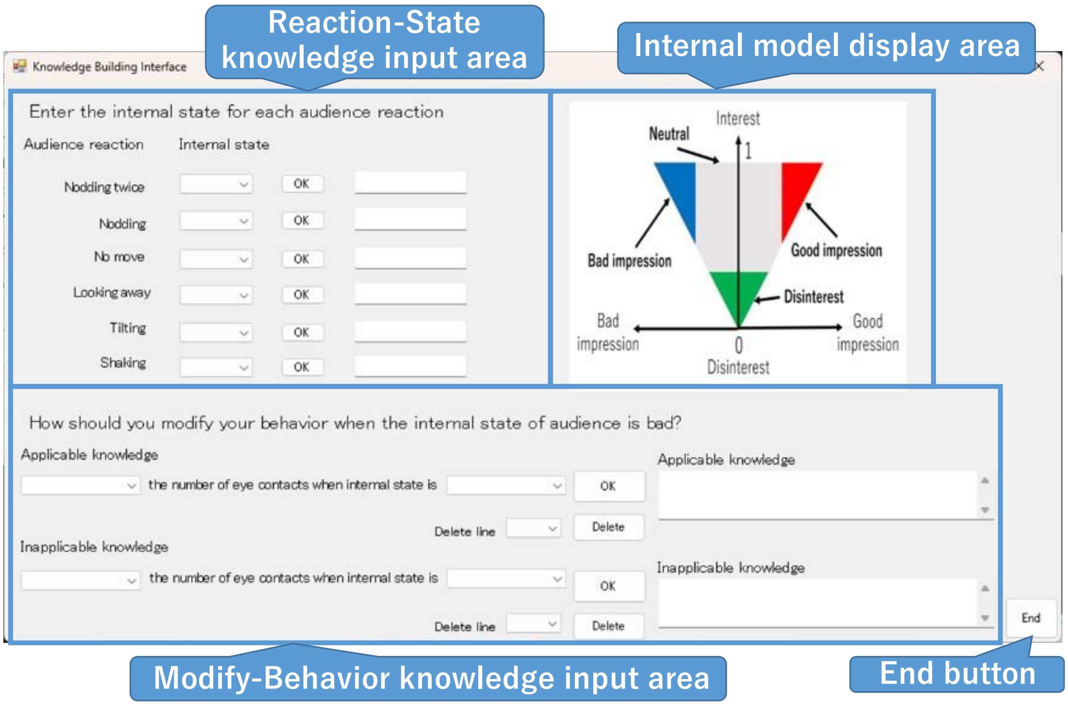

Figure 9. Knowledge Building Interface

5. Evaluation Experiment

5.1 *Overview*

An evaluation experiment was conducted to evaluate the effectiveness of the proposed reflection system. The experiment was conducted with 10 undergraduate and graduate students (A-J).

The experimental procedure is described below.

1. Give presentation using an audience robot.
2. Input the prior knowledge input interface.
3. Reflect on the presentation using only the presentation video.
4. Reflect on the presentation using the reflection system WITHOUT the reflection point determination function.
5. Reflect on the presentation using the reflection system WITH the reflection point determination function.
6. Answer the questionnaire.

In Step 1, the participants were asked to give a presentation to an audience robot. Slides and dialogue for the presentation were prepared in advance. The presentation themes and the number of slides used in the experiment are shown in

Table **3**. We prepared themes that would not change in quality depending on the level of understanding of the content. The lengths of the slides were about 3 to 4 minutes. Five participants were asked to use Theme 1 and the other five were asked to present Theme 2. Slides and dialogue were given to the participants before the presentation to ensure that they understood the content, but they were allowed to change the dialogue. We informed the participants that the audience robot evaluates the presentation by the number of eye contacts and expresses reactions, and we instructed the participants to change the number of eye contacts when they felt that the audience robot's reaction was not good. During the presentation, we set a video camera next to the audience robot to record the presenter’s behavior.

Table 3. *Presentation Theme and the Number of Slides*

Presentation theme	Number of slides
1: Introduction of Kansai University	7
2: What is Chat GPT?	6

The questionnaire items are shown in **Table 4**. In Q1, participants were asked to indicate what information was used for reflection. In Q2, they were asked about the usability of the system.

Table 4. *Questionnaire Items*

Q1	From which information could you reflect on the acquisition of knowledge and the application of that knowledge?
Q2	Please describe the good and bad points of the system.

By comparing the reflection results in Steps 3 and 4, we evaluated the effectiveness of visualizing the internal state and reaction of the audience robot, the presenter's eye contacts, and the internal state of the audience robot estimated by the presenter. By comparing the reflection results of Steps 4 and 5, we evaluated the effectiveness of the recommendation of the reflection point.

5.2 *Results*

Let's discuss the effectiveness of the system for acquiring Reaction-State knowledge. Three participants did not have Reaction-State knowledge for the robot's reaction "did nothing" and two participants did not have Reaction-State knowledge for "titling the head" before Step 4. All participants acquired the knowledge during Steps 4 or 5. **Table 5** shows the number of participants for each step that acquired such knowledge. For Reaction-State knowledge, all participants acquired the correct knowledge in Step 4. The fact that a participant answered "I was able to acquire knowledge by reflection on the data of the audience robot" in Q1 of the questionnaire indicates that visualization of the internal state and reaction of the audience robot is effective for recognizing the correct Reaction-State knowledge.

Table 5. *Number of Participants Who Acquired State-Reaction Knowledge in Steps 4 and 5*

Audience robot's reaction	Step 4	Step 5
Did nothing	3	0
Tilting the head	2	0

Next, we evaluate the effectiveness of the system for acquiring Modify-Behavior knowledge. Five participants did not have the knowledge "decrease eye contact when the audience has bad impression" but all of them acquired this knowledge during Steps 4 or 5. **Table 6** shows the steps in which the participants acquired such knowledge. In Step 4, only one participant was able to acquire the knowledge while in Step 5 all four participants were able to acquire it. Two of them answered, "I could understand where my knowledge increased by using the reflection point button." This suggests that showing the internal state of the audience robot and the presenter's own behavior is not enough to acquire the knowledge and indicates that the reflection point is effective.

Table 6. *Number of Participants Who Acquired Modify-Behavior Knowledge in Steps 4 and 5*

	Step 4	Step 5
Bad impression -> Decrease eye contact	1	4

Next, we evaluate the effectiveness of reflection on the application of the Modify-Behavior knowledge. In reflection, it is necessary to grasp whether the participant applied the knowledge that he/she has. During the presentation, one participant failed to apply the knowledge of "increase eye contact when the audience is disinterested" and six participants failed to apply "decrease eye contact when the audience has bad impression." Among them,

Table 7 shows the number of participants who reflected on the application of the knowledge in Steps 4 and 5. All participants were able to correctly grasp their own situation in Step 5, therefore indicating that reflection points are needed to reflect on the application of the knowledge.

Table 7. *Number of Participants Who Correctly Identified the Status of Application of Modify-Behavior Knowledge*

	Step 4	Step 5
Disinterested -> Increase eye contact	0	1
Bad impression -> Decrease eye contact	0	6

Finally, we discuss the usability of the system. According to the results of Q2 of the questionnaire, comments on the good points of the interface included "we can see the change of the internal state of the audience according to the number of eye contacts" and "it was easy to see at a glance which parts of the presentation data needed to be reflected on." No bad points of the reflection system were submitted. From this, we can say that the reflection support system was easy to use.

6. Conclusion

In this study, we proposed a reflection support system for modifying presenter behavior in reaction to audience reaction. Modification requires Reaction-State knowledge to recognize the audience's internal state from their reactions and Modify-Behavior knowledge to modify one's own behavior according to the audience's internal state. To facilitate reflection on the existence and application of this knowledge, we proposed a reflection support system that shows the presentation data of the presentation to an audience robot and indicates the reflection points. The evaluation experiments suggest that visualization of the internal state of the audience robot is effective for acquiring Reaction-State knowledge and that presentation of the reflection points is effective for acquiring and applying Modify-Behavior knowledge.

The current reflection support system focuses only on eye contact, but non-verbal expression is not only eye contact but also other information such as gestures and intonation. When multiple non-verbal expressions are visualized, it is difficult to identify which expression is related to the audience's reactions. Therefore, it is necessary to clarify the relations among non-verbal information with the audience's reactions and propose a reflection support system that visualizes the information to facilitate reflection appropriately.

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References

Chollet, M., Ghate, P., Neubauer, C., & Scherer, S. (2018). Influence of Individual Differences When Training Public Speaking with Virtual Audiences. *Proceedings of the 18th International Conference on Intelligent Virtual Agents*, pp.1-7.

el Kaliouby, R., & Robinson, P. (2005). Real-Time Inference of Complex Mental States from Facial Expressions and Head Gestures. *Kisačanin, B., Pavlović, V., Huang, T.S. (eds), Real-Time Vision for Human-Computer Interaction. Springer, Boston, MA*, pp.181-200.

Inazawa, K., & Kashihara, A. (2022). Designing and Evaluating Presentation Avatar for Promoting Self-review. *IEICE Transaction on Information and Systems*, Vol.E105-D No.9 pp.1546-1556.

Ito, K., & Kashihara, A. (2023). Authoring Robot Presentation Behavior for Promoting Self-review. *Proceedings of the International Conference on Human-Computer Interaction,Cham: Springer Nature Switzerland*, pp.316-326.

Kato, S., Kunori, K., & Kojiri, T. (2023). Development of Audience Robot for Supporting Presentation Rehearsal. *IEICE Technical Report*, Vol. ET 2022-70,pp.65-72 (in Japanese).

Kurihara, K., Goto, M., Ogata, J., Matsusaka, Y., & Igarashi, T. (2007). Presentation Sensei: A Presentation Training System Using Speech and Image Processing. *Proceedings of the 9th International Conference on Multimodal Interfaces*, pp.358-365.

Ochoa, X., & Dominguez, F. (2020). Controlled Evaluation of a Multimodal System to Improve Oral Presentation Skills in a Real Learning Setting. *British Journal of Educational Technology*, Vol.51, No.5, pp.1615-1630.

Tun, S. S.Y., Okada, S., Huang, H.-H., & Leong, C. W. (2023). Multimodal Transfer Learning for Oral Presentation Assessment. *IEEE Access*(11), pp.84013-84026.

Yumura, T., Tan, Y., & Lim, Y. (2019). PICALA: An Interactive Presentation System to Share Reaction of Audiences with Light Color. *Proceedings of Asian CHI Symposium 2019: Emerging HCI Research Collection*, pp.46-52.