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Effect of Displaying a Remote Operator's Face on a Media Robot

Hideaki Kuzuoka[1], Yosuke Furusawa[2], Naritoshi Kobayashi[3] and Keiichi Yamazaki[4]

[1]Graduate School of Systems and Information Engineering, University of Tsukuba, Ibaraki, Japan
(Tel : +81-298-53-5258; E-mail: kuzuoka@iit.tsukuba.ac.jp)
[2]Graduate School of Systems and Information Engineering, University of Tsukuba, Ibaraki, Japan
(Tel : +81-298-53-6187; E-mail: furusawa@krystal.esys.tsukuba.ac.jp)
[3]Japan Science Foundation, Tokyo, Japan
(Tel : +81-3-3212-8481; E-mail: kobayasi@jsf.or.jp)
[4]Department of Liberal Arts, Saitama University, Saitama, Japan
(Tel : +81-48-858-9232; E-mail: byi06561@nifty.com)

Abstract: Person's body and head orientations are important resources to infer/anticipate the person's intention. To support these resources for tele-communication, we have been developing a remote control robot that mediates communication. The robot's head motion is synchronized with the remote operator's head motion, and his/her face is shown on the robot's chest display. We compared the effect of the robot's head and the chest display and the result showed that there is no difference in the effect on anticipation but the chest display is preferred in terms of affinity.

Keywords: Tele-communication, robot, museum.

1. INTRODUCTION

We have been developing a robot that mediate human-to-human communication, i.e. media robot. Especially we are interested in how bodily actions of a robot affect communication. For example, we have been studying how the robot's head, body, and arm should be controlled so that they can effectively support reference to physical objects and anticipation [4], [5].

It is known that bodily orientation enables inference and anticipation during conversation[7]. For example, when a helper is giving instruction on a physical task [3] such as building a kit of KD furniture to a learner, body orientation of the helper enables learner to infer which object is currently being explained. Also, change in head orientation of the helper enables the learner to anticipate which part is going to be used next. By carefully designing the robot, we were able to support this kind of inference/anticipation between geographically distributed participants [5].

Another important issue on human-robot interaction is the psychological aspect. It is very important to understand how robots should be designed so that they can widely be accepted by human.

Some of the recent media robots starting to have displays that show the video images of remote operators' head [1], [6], [8]. The remote operator's video image is considered effective because gaze and head orientation are assumed to be effective in inference/anticipation and affinity. Therefore, it is important to understand how facial image of the remote operator affect these factors. For this purpose, we developed a new communication robot and tested at the Science Museum in Tokyo.

In the next section, we briefly explain some related works. Then introduce our robot system named GestureMan–3.5 and explain about the remote guidance experiment that was conducted at the Science Museum in Tokyo. Finally, we discuss the results.

2. RELATED STUDIES

Kanda et al. clarified that a people has good impression on an autonomous robot when its gaze is appropriately controlled[2]. In this paper, we are interested in people's impression on a remote control robot. Especially, we want to compare between a robot's head and a remote operator's live image.

Some robotic communication systems are equipped with displays in which the live video image of a remote operator's face is shown [1], [6], [8]. These systems, however, have not compared the difference between the physical robot head and the live video of the remote operator.

3. GESTUREMAN–3.5

GestureMan–3.5 (Fig. 1) has three camera units on its body so that its horizontal field of view is about 180 degrees in total. On the remote control operator's side, the image of the camera unit is displayed on three horizontal screens (Fig. 2). Since the robot's head motion and a remote controller's head motion are synchronized, the remote controller's natural head motion when he or she scans the three-display units is reflected in the robot's head motion. Recently, we have added a display on the robot's chest to display a remote controller's face. When this robot is used for museums, we expect that visitors will be able to anticipate a remote operator's intention both through the robot's head movement and the remote operator's face displayed on the robot's chest.

4. EXPERIMENT AT THE MUSEUM

We have conducted the experiment to compare the effect of the robot's head and the chest display on tele-communication.

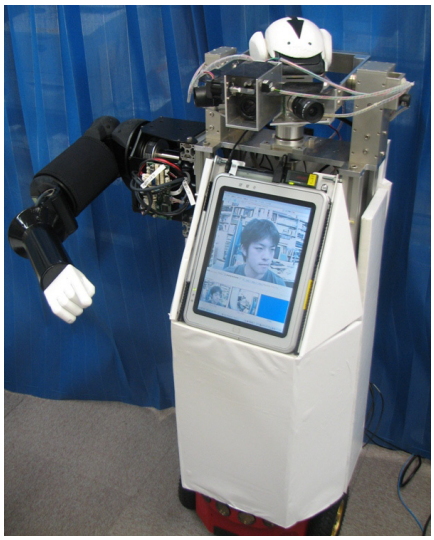

Fig. 1 GestureMan-3.5

Fig. 2 Controller's site

4.1 Set up

The robot was settled in one of the exhibition rooms at the Science Museum in Tokyo. An experimenter served as a remote guide (hereafter "guide"). He controlled the robot from the different floor in the same building and explained about some of the exhibits to subjects.

Subjects were chosen from visitors to the museum. The number of subjects for each session ranged from one to three. Each session took about fifteen minutes and it was recorded by three video cameras for later analysis. After the session, subjects were asked to filled out the questionnaire.

We compared following three cases for the experiment;

case 1 The guide's face was not shown on the chest display.

case 2 The robot's head was not synchronized with the guide's head motion.

case 3 Both the robot's head and chest display were fully functioned.

Our assumptions were as follows. In term of affinity, chest display is more effective than the robot's head. In terms of inference/anticipation, robot's three-dimensional head motion is superior to the two-dimensional head motion in the chest display. Furthermore, we assumed that the robot's head is superior because the chest display cannot be seen when subjects are behind the robot.

Table 1 Five pairs of adjectives for SD

Question	negative adjective	positive adjective
Q1	bad	good
Q2	scary	gentle
Q3	hateful	cute
Q4	boring	fun
Q5	dislikable	likable

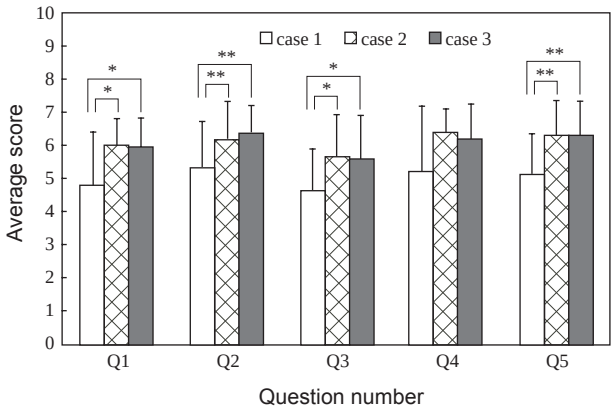

Fig. 3 Result of the question Q1 to Q5($*p < .1, **p < .05$)

As part of the questionnaire we used five seven-point SD (Semantic Differential) scales to evaluate the impression on the robot. Five pairs of adjectives are shown in table 1. We set the scale so that the positive adjectives get higher scores. In respect to inference/anticipation, the subjects answered the following two questions and we used 5 point scales for these questions.

Q6 Was it easy to recognize to which exhibit the explanation is given?

Q7 Was it easy to recognize where the guide was looking at?

We conducted 25 sessions and in total 51 subjects were participated. Among 25 sessions, 8 were case 1, 8 were case 2, and 9 were case 3.

4.2 Results

The average score for SD test is shown in figure 3. Kruskal-Wallis test showed that, for Q1 and Q3, case 1 is likely to be less preferred compared to both case 2 and case 3. For Q2 and Q5, case 1 was rated significantly lower than both case 2 and case 3. These results indicate that the remote guide's face on the chest display gave positive impression to the subjects.

In terms of inference/anticipation, the scores for Q6 and Q7 did not show any significant difference between 3 cases (fig. 4).

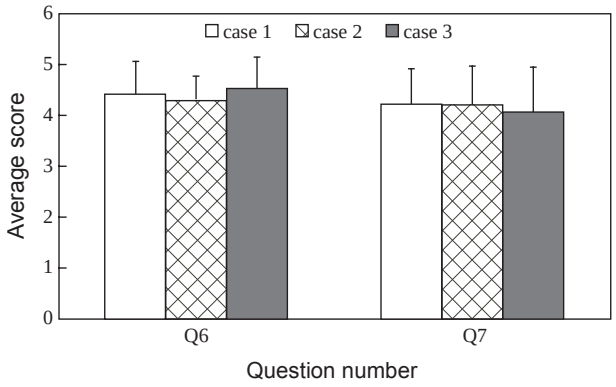

Fig. 4 Result of the question Q6 and Q7

5. DISCUSSIONS

From the results of Q1 to Q5, it was shown that remote guide's face on the robot has positive impact on the subjects' impression on the robot. From the video observation, we compared the time ratio that the subjects situated themselves in front of the robot (fig. 5). LSD test showed that there the subjects of case 1 stayed in front of the robot significantly shorter than case2 and case 3. This result shows that the subjects were willing to see the remote guide's face when it is displayed on the robot's chest display.

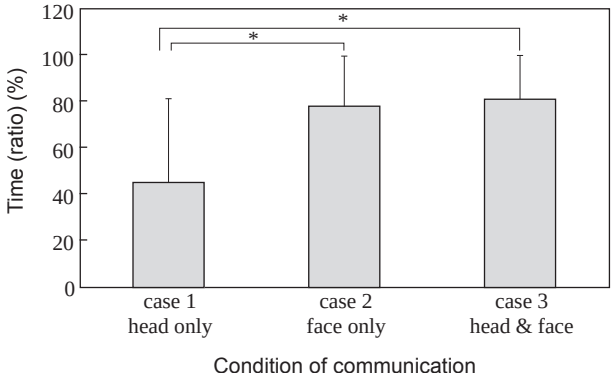

Fig. 5 Time ratio that the subjects situated themselves in front of the robot ($*p < .05$)

Figure 6 is a typical scene that was observed during case 1. When the guide's face was not shown on the chest display, the subjects tend to stand behind the robot. When the guide's face was shown on the chest display, on the other hand, the subjects tend to stand face-to-face to the robot and look at the chest display to talk with the guide.

In terms of inference/anticipation, however, the average scores of Q6 and Q7 showed no difference between three conditions. It is interesting to know that the average scores for three cases are relatively high. During this experiment, whenever the remote guide changed the objects to be explained, he turned the robot's body toward the designated object. It can be assumed that compared to the robot's head orientation, the robot's body orientation had stronger effect on the answers to these questions than head orientation had. Although we expected that the robot's head have more effect on inference/anticipation, it was not proved in this experiment.


Fig. 6 An example that the subjects stood behind the robot


Fig. 7 An example that a subject stood face-to-face to the robot

According to the interviews to the subjects, some of them appreciated the robot's head movement. Thus in order to clarify the effect of head orientation on anticipation, we need further studies with different settings and metrics.

6. CONCLUSIONS

We compared the effect of physical head that synchronized with the remote guide's head and the chest display that showed guide's face. The result showed that chest display had positive effect in terms of affinity. The effect of robot's head on anticipation was unexpectedly low. In the future, we have to consider more about the appropriate place and size for the display that shows the guide's head.

7. ACKNOWLEDGEMENTS

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