Face direction control for a guide robot using visual information

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Abstract. Face direction plays an important role in our daily conversation. This paper presents a museum guide robot that moves its face to communicate smoothly with humans. We analyze the behavior of humans when one explains about an exhibit to the other. Then, we develop a robot system that can recognize the human's face direction using vision. The robot moves its face depending on the human's face direction and the contents of utterances. We use the analysis results of human behavior to control the face movements. Experimental results show that it is effective for the guide robot to change its face direction while explaining about exhibits.

Introduction

We are developing a remote-controlled museum guide robot (Kuzuoka et al., 2000). Such a robot should help collaboration between the robot's operator and the visitor currently attended, and that between the visitor and people around him/her. We need proper control of the robot's face direction to improve interaction in both cases since it is well known that face direction plays an important role in our communication (Goodwin, 1981). For example, the robot should turn its face toward the visitor when he/she asks it a question. Such actions help smooth communication between the visitor and the operator. In addition, they let other people know the current interaction status. This makes them easier to collaborate with the visitor to further appreciate the exhibit. They can give their comments at proper timing. However, manual control of the face direction imposes a burden on the operator, especially he/she needs to operate multiple robots. Thus, we have started research on automating the face direction control.

Robot system

First, we performed experiments to observe human behaviors in museum guide situations. We asked an expert to explain an exhibit to a visitor(s). The expert did so four times to a single person and two times to a pair. We recorded the scene with three video cameras. The video analysis shows the followings. The guide tends to look at the visitor(s) after a block of explanation or important keywords. The visitors turn their faces toward the guide when he looks at them. Then, they turn back to look at the exhibit if they do not have any questions. If they have any questions, they keep the face direction toward the guide. If they do so in other occasions, the guide notices this with peripheral vision, then accepting questions.

Next, we have developed a guide robot that moves its head in the same way of the human guide depending on the utterance and the face direction of the visitor obtained from the camera images as shown in Figure 1.

Finally, we performed experiments to evaluate the effectiveness of our method for controlling the face direction. The robot explained an exhibit to a visitor (subject) in one of the following three ways: proposed one (A), the face direction is fixed toward the visitor (B), and that is fixed toward the exhibit (C). These three were randomly adopted. Each subject experienced the three ways of explanation and was asked to give subjective evaluation from 1 to 5 in terms of easiness of explanation (1: difficult, 5: easy). We used five subjects; they were students at our university. Table I shows the results. It indicates the effectiveness of the proposed way of controlling the face direction.

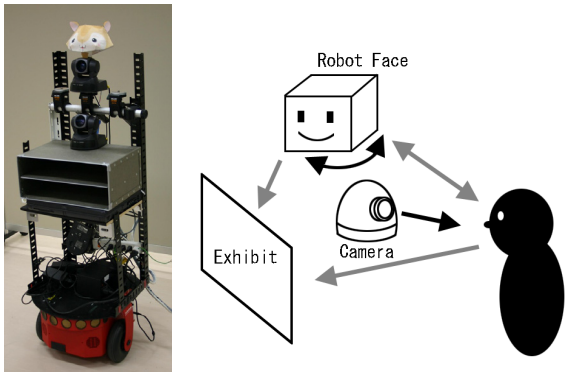

Figure 1. Museum guide robot.

Table I. Evaluation experiment

	Face control		
Evaluation	A	B	C
1: Difficult	0	7	0
2: A little difficult	0	2	4
3: Moderate	1	0	4
4: A little easy	6	0	1
5: Easy	2	0	0
Median	4	1	3
Mean	4.1	1.2	2.7

References

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