Auditory Effect for Human Friendly Interaction in Robotic Feeding

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1. Introduction

In recent years, there have been growing expectations for assistance robots in supporting the independence of people with disabilities. Previous studies have proposed a method in which a robot automatically recognizes food and a user and brings the food to the user's mouth(1). However, when a robot is moving at a distance close enough to be easily touched by a human being during meal assistance, psychological resistance may be felt(2). In order to enable people with disabilities to eat with peace of mind, it is necessary to analyze the movements of the robot that cause psychological resistance. In this study, we evaluate the effect of psychological resistance to the approaching motion of the arm by measuring the changes in facial and body states of the user while presenting the approaching motion of the arm and the corresponding sound.

2. Method

This measurement system quantitatively determines the sense of resistance by measuring the body's reaction to psychological resistance. As shown in Fig. 1(a), we measure the movements of the eyelids, eyes, eyebrows, and mouth in 10 locations. Using MediaPipe's facial landmark detection function, we measure the distance between the landmarks at the measurement points. In addition to MediaPipe, colored markers are used to measure the body more precisely than each individual marker. Fig. 1(b) shows the body measurement.

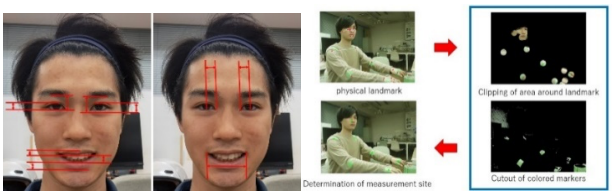


Fig. 1. (a) Face measurements (left) and (b) Body measurements (right).

Landmarks on the upper body are detected and pixels around the landmarks are clipped. At the same time, colored markers are attached to the measurement points, and the marker areas are clipped out by color extraction. From the clipped landmarks and colored markers, the colored marker areas around the landmarks are extracted. The center of gravity of the extracted pixels is used as the body measurement area, and the 3D coordinates are detected by the RGBD camera. For head detection, however, we do not use markers, but use the average coordinates of 11 landmarks on the face as the measurement points. For the hand detection, the average pixel of three landmarks (pinky finger, index finger, and wrist) is used as the measurement location.

3. Experiment

The experiment investigated the effects of sound on subjects' learning of the correspondence between sound and action. The experimental method was to measure physical changes when the arm approached the subject's mouth. Fig. 2 shows the robot "Mani" used in the experiment. The arm approach motion was performed 100 times in succession, and a high tone (1000 Hz) or a low tone (440 Hz) was presented for 1

second just before the motion. In the first 50 trials, when the high tone is presented, the robot always stops at 10 cm from the mouth, and when the low tone is presented, the robot always stops at 30 cm from the mouth. In the subsequent 50 times, the movements are basically the same as in the first 50 times, but in 10% of the cases, the correspondence between the sound and the movement is reversed. In addition, before the first arm movement, a 10-second measurement was taken to measure normal physical changes. Fig. 3 shows the movement rate compared to the normal condition for each measurement condition for each subject. The movement rate is the average of the percentage of body change for each measurement condition divided by the average of the percentage of body change under normal conditions. In conditions 1 and 2 and conditions 3 and 4, movement was greater when the correspondence was off, suggesting that the prediction of movement by sound was related to psychological resistance. In conditions 5 and 6, the number of movements decreased with the number of times, suggesting that habituation occurred. In addition, from conditions 4 and 6, it is thought that not only the reduction of movements due to habituation caused by the number of times, but also the ability to predict movements through learning reduces movements.



Fig. 2. Mani, a feeding robot

test subject	A	B	C	D	average	dispersion
1. Stops near 1-50 times	96%	111%	117%	126%	112%	0.016
2. Stops 1-50 times far	90%	120%	110%	131%	112%	0.031
3. tops near 51-100 times, sound and motion reversed	84%	102%	105%	183%	119%	0.193
4. Stops near 51-100 times, sound and motion in sequence	89%	119%	97%	157%	115%	0.092
5. Stops near 1-50 times, 5 times from the beginning	101%	107%	113%	126%	112%	0.011
6. Stops near 1-50 times,5 times from the end	89%	116%	105%	119%	107%	0.018

Fig. 3. Experimental results

4. Conclusion.

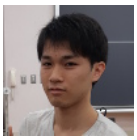
In this study, physical movements in situations of psychological strain were measured with the created system. It was also suggested that the system could reduce physical movements by being able to predict movements through acoustic presentation. As a future prospect, we intend to verify psychological resistance in actual meal support movements by the robot.

Reference

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Biography



Akira Matsuda is a master course student at Kanagawa Institute of Technology. His research interest includes robotic feeding.



Ryo Saegusa is an associate professor at Kanagawa Institute of Technology. His research interest includes symbiotic interaction between human and machines towards coevolution