Comparative Culture Research on the Emotional Impact of Humanoid Robots

Comparing Japanese and other-nationalities participant responses to humanoid robot motion

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Abstract

"Communication Robots" are expected to become a best partner for human. However the motion designs of the robots are mechanical, and not friendly for human. To solve the problem, we created a new robot with an expansion and contraction body to express many emotions from the acting methods of the Japanese "Bunraku" puppeteer. Puppet stage Bunraku has established attractive acting method, these had been quantitatively scrutinized from about 400 years ago. From these, the structure of it has a completely different from human. The reason is because it is a structure to attract audiences. We had some experiments to evaluate the effect of the robot, these results were good from subjective evaluation and objective evaluation (measuring the brain waves). The expansion and contraction body robot was highly praised in those evaluations. However, there were distinct differences of evaluation for robot between Japanese experimenters and foreign nationality experimenters. Foreign nationalities tended to not accept the exaggerated motion of the expansion and contraction body robot. From these results of motion experiments of robot, we confirmed that there is a different how to feel and viewpoint for Robots between Japanese and foreign nationalities. And we understood the influence of different cultures greatly affects the preference of the nation people.

Keywords: robot design, motion design, comparative design

1 Introduction

Humanoid service robots are expected as communication robot widely now, however in each culture and each country, the view of robot and acceptability of robot are different. Especially Japanese tend to prefer and accept robots. So we had an experiment, it was about the motion. For the humanoid service robots, the motion is important factors when humans communicate to robot. These are important functions for people to determine the evaluation of the robot.

The experiment of robot motion used a new robot with an expansion and contraction body to express many emotions from the acting methods of the Japanese "Bunraku" puppeteer (hereinafter called Bunraku Robot experiment). Those were experimented between Japanese and foreign nationalities as experimenters.

2 Experiment of Robot Motion Design

"Communication Robots" are expected to become a best partner for human. However the motion designs of the robots are mechanical, and the motion of the emotion is not friendly for human. For example, when a pet animal made a careless mistake, human allowed it for the emotional motion. However, when industrial products made a careless mistake, human almost could not allow it. Because human recognizes that industrial products do work without mistake. So a robot which is an industrial product is needed emotional motion. Recently, elderly patients don't hope to be cared by robots. As the

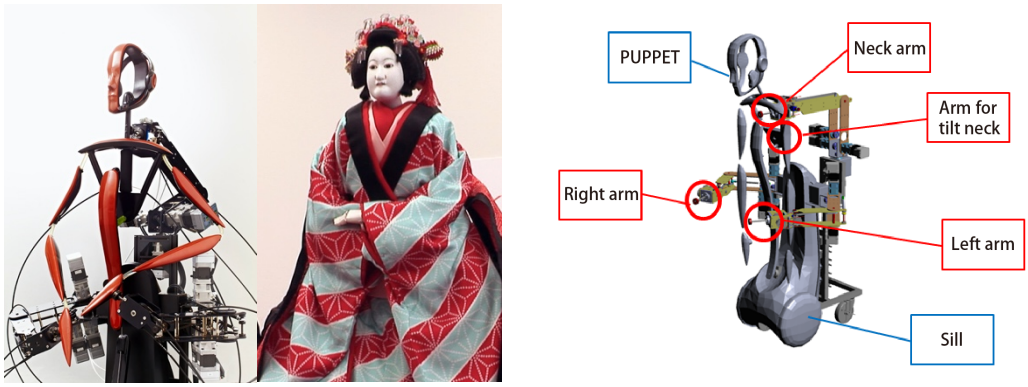


Fig. 1 Bunraku Robot and Bunraku Puppet and Configuration of Bunraku Robot

reason for that, they latently hate to be treated like things by robots. Robots must be designed emotional that it will be contributed to enhancing and protecting human dignity.

To solve these motion design problems of robots, H.Ishiguro and A.Takanishi had developed emotional robots. These structures were designed in reference to a bone of human body. However we had a sense of discomfort with emotional expression of these robots, so we had extracted the method of expressing emotions from the motion of the Japanese "Bunraku" puppeteer. "Bunraku" is the traditional puppet play of Japan.

We humans have human characteristics that we do not want to see human-type products behave like human beings. So motion design of Bunraku puppet includes exaggerated expression like illusion. By effectively using these motions included exaggeration and omission, Bunraku puppet look like emotional creature. We constructed a new robot with an expansion and contraction body for expressing many emotions and evaluated the effect of robot. The mechanism of this robot is same Bunraku puppet. By the Bunraku puppeteer, Bunraku puppet is operated the expansion and contraction of the neck and body and arm. So we had confirmed the emotional expression motions using body languages from Bunraku. The emotional expression is the same as the facial emotional expression of Paul Ekman. Bunraku robot is in Fig. 1. It can play the same act (expands and contracts) as the emotional expressions of Bunraku puppet. This robot has a new mechanism to express the emotions unlike conventional robot.

2.1 Mechanism of Bunraku Robot

In Bunraku, three puppeteers manipulate one Bunraku puppet. Bunraku robot was designed with the same operating system. Exterior parts and operating parts are separated shown in Fig.1. The operating system consists of exterior parts to be controlled passively and operating parts to manipulate the exterior parts. So the body expands and contracts. The operating parts include right hand arm, left hand arm, neck and body arm for body in Fig. 1. This operating system looks just like Bunraku. Active controller is the operating parts and passive controller is the exterior parts. In addition, the robot has the function of teaching for playback control. And it is built by a high speed multiple-axis motor control device. By using this technology, Bunraku puppeteer had taught his motion this robot for experiments.

2.1.1 Specification of Bunraku Robot

Total actuators: 19-degree-of-freedom actuators. Right hand arm, left hand arm and neck and body arm: 6-degree-of-freedom, Tilt neck: 1-degree-of-freedom. Movable range of arm: degree-of-freedom ±90°. Motor：Cool Muscle CM1-17L. Program：C++ on Windows7 platform and Real time dynamic extensions module RTX platform.

2.1.2 Control Method of Bunraku Robot

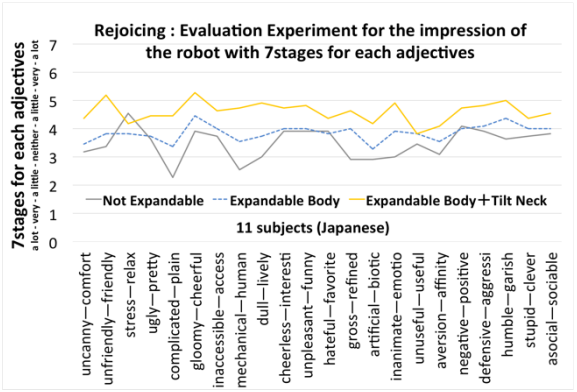
Communication hardware: Ether CAT plate substrate×6, Positional information for controls: 2ms, Detection information of each motor error：2ms. Puppet control: each part position (x, y, z) and posture (roll, pitch, yaw shaft). Two arms control：Wire driving by motors in the still.

2.2 Experiment

We had experimented to verify the impressions of experimenters (including foreign nationality students) of this emotional new robot. Because Christian nations tend to despise Robots from the factors of their religious idea or work ethic, we verified the comparative culture about the view of their Robots between Japanese and foreign nationalities. Especially Europeans tend to hate humanity in the Robot, and they tend to like better mechanical Robots because of their Christianity view. We wanted to verify these views of differences for this new expandable Robot.

2.2.1 Method

For each motion, experimenters were measured their brain waves for objective evaluation before and after the robot motion. Brain wave of relax can be evaluated the average ratios of αwave / βwave, because measurement of brain wave is high dispersion. So we measured the relax degree (acceptance) from variation of αwave and βwave of experimenters. θwave: 4-7Hz light sleep state, αwave: 8-13Hz relax state, βwave: 14-40Hz brain is strained and excited. Experimental device was Brain wave measuring support tool "BrainPro FM-929" made by FUTEK ELECTRONICS. These experiments had done along the rules of procedure for Mie University the department of technology ethics committee. And after that, they wrote their subjective evaluation. The sheets were free description type and questionnaire type. They consist of 7 stages and 22 pairs of adjective. For these adjective pairs, we selected words that biological, human, and measuring impression.



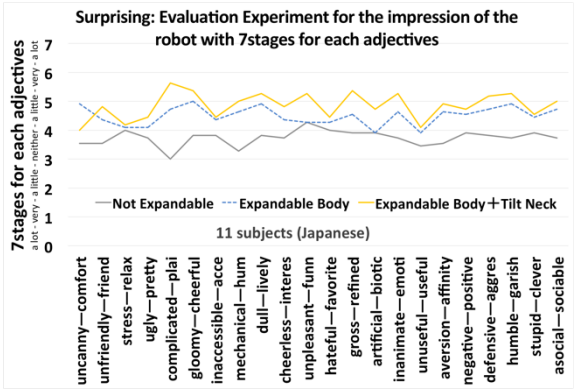
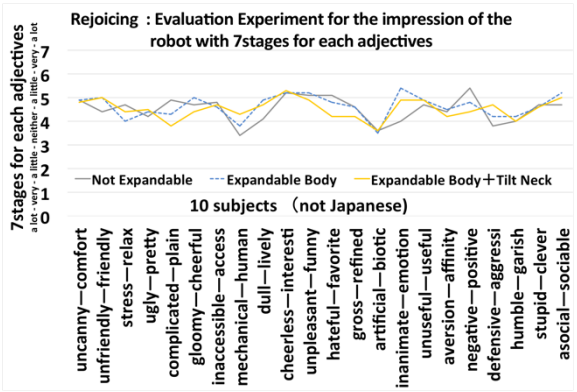


Fig.2 Result of Subjective evaluation (Rejoicing, Japanese) Fig.3 Result of Subjective evaluation (Surprising, Japanese)



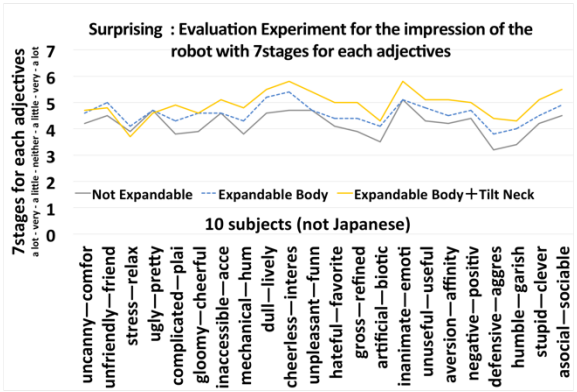


Fig.4 Result of Subjective evaluation (Rejoicing, Not Japanese) Fig.5 Result of Subjective evaluation (Surprising, Not Japanese)

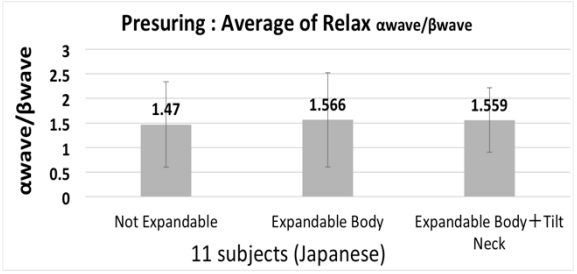
2.3 Result

We show the comparison results of Japanese experimenters (11, mail:5, femail:6) and foreign nationality experimenters (10, mail:4, female:6) for each experiment. They were American:2, Russian:3, French:1, German:1, Chinese:2, Swedish:1. Fig.2 and Fig.4 show the results of subjective evaluation (rejoicing motion). Fig.3 and Fig.5 show the results of subjective evaluation (surprising motion). Fig.2 and Fig.3 are the results of Japanese subjects, and Fig.4 and Fig.5 are

the results of foreign nationality experimenters.

Among the three motion patterns, the motion pattern in which the Bunraku robot expands and contracts and the neck tilts (hereinafter called expandable body and tilt neck) got the highest evaluation. Next, the evaluation that was high was the motion pattern in which the Bunraku robot expands and contracts (hereinafter called expandable body). And other motion pattern is that the Bunraku robot does not expand and contract (hereinafter called not-expandable body). In Fig.2 and Fig.3, the motion patterns in which the Bunraku robot expand body and tilt neck got high evaluation in 21 items out of the evaluation item 22. High evaluation here means that the Bunraku robot is biological and humanly and good impression. Especially, the motion pattern in which the Bunraku robot expand body and tilt neck was evaluated highly in these pairs of adjective, plain-complicated, cheerful- gloomy, humanity-mechanical, lively-dull, biotic-artificial, emotional-inanimate.

However, Fig.4 and Fig.5 show that the high evaluation was not same Fig.2 and Fig.3. Especially, Fig.4 was different from the results of Japanese experimenters Fig.2 and Fig.3. Fig.4 shows that foreign nationality experimenters evaluated these 3 motion patterns of the robot almost the same. The number of a pairs of adjective evaluated highest was / not-expandable body: 10 / expandable body: 10 / expandable body and tilt neck: 7. Their evaluations on this were divided. And Fig.5 shows that the motion pattern of expandable body and tilt neck got the highest evaluation. However, compared with the Japanese results in Fig.2 and Fig.3, the amount of difference between the highest evaluation and the lowest one in Fig.5 were smaller than these. So Japanese experimenters tended to prefer exaggerated motion of the robot, foreign nationalities were not same.



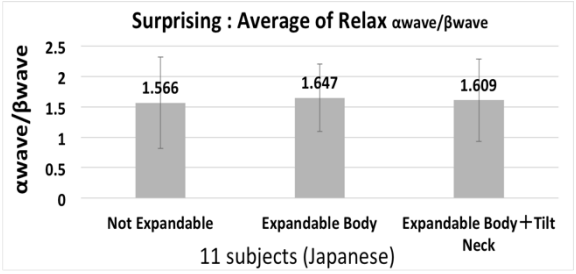
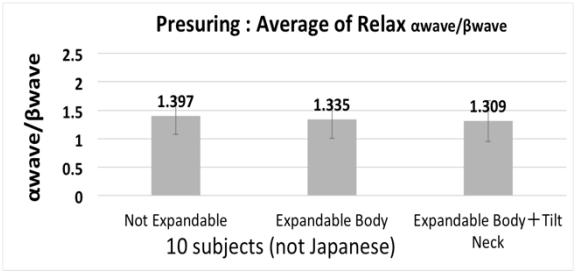


Fig.6 Average Brain wave (Rejoicing, Japanese) Fig.7 Average Brain wave (Surprising, Japanese)



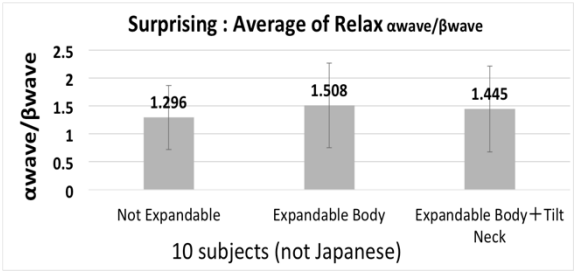
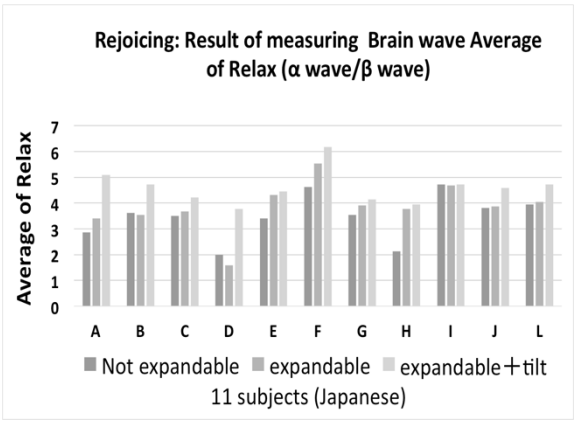


Fig.8 Average Brain wave (Rejoicing, Not Japanese) Fig.9 Average Brain wave (Surprising, Not Japanese)

Fig.6 and Fig.8 show the results of Experiment (rejoicing motion) that are the average ratios of αwave/βwave for each three moving patterns of robot. Fig.7 and Fig.9 show the results of Experiment (surprising motion). The experimenter of Fig.6 and Fig.7 are Japanese, Fig.8 and Fig.9 are foreign nationalities.From these results in Fig.6 and Fig.8 (rejoicing motion), the highest evaluation of the Japanese average is the expandable body (average ratio: 1.56, standard deviation: 1.44). The second highest is the expandable body and tilt neck (1.55, 1.30), and the third highest is the not-expandable body (1.47, 1.73). However, the highest evaluation of the foreign nationalities is the not-expandable body (average ratio: 1.39, standard deviation: 1.30). The second highest is the expandable body (1.33, 1.44), and the third highest is the expandable body and tilt neck (1.30, 1.73). These results are quite in the opposite direction.

From these results in Fig.7 and Fig.9 (surprising motion). These bar graph show meanings same as Fig.6. From these results, the highest evaluation of the Japanese average is the expandable body (average ratio: 1.64, standard deviation: 1.30). The second highest is the expandable body and tilt neck (1.60, 1.44), and the third highest is the not-expandable body (1.56, 1.73). And, the highest evaluation of the foreign nationality is the expandable body (average ratio: 1.50, standard deviation: 1.30). The second highest is the expandable body and tilt neck (1.44, 1.44), and the third highest is the not-expandable body (1.29, 1.73). In this case, both evaluated same pattern.



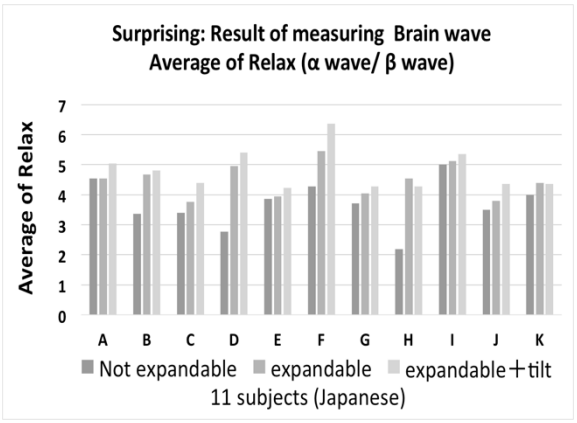
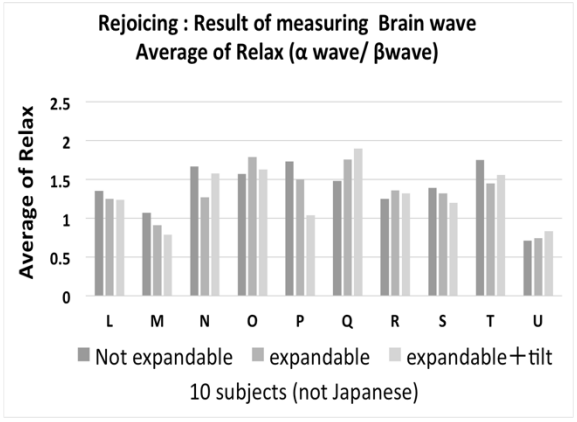


Fig.10 Result of Each Brain wave (Rejoicing, Japanese) Fig.11 Result of Each Brain wave (Surprising, Japanese)



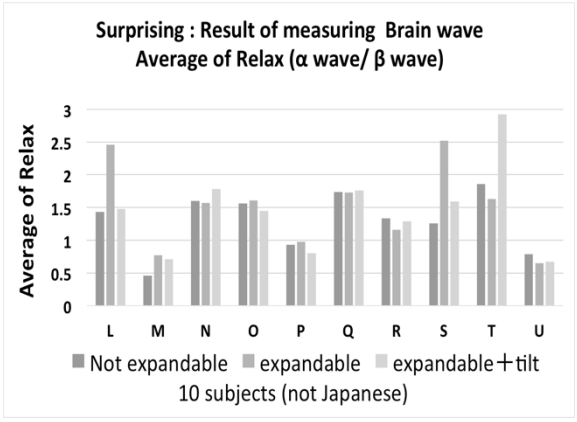


Fig.12 Result of Each Brain wave (Rejoicing, Not Japanese) Fig.13 Result of Each Brain wave (Surprising, Not Japanese)

Fig.10 and Fig.11 show the average ratios of each Japanese subject for each experiment of three motion patterns of the robot. The both highest evaluations were the expandable body and tilt neck. In Fig.10, all 11 experimenters selected it, and in Fig.11, all 11 experimenters selected it, too. The second evaluation was the expandable body, the third evaluation was the not-expandable body. From these results, we confirmed that Japanese experimenters tend to prefer exaggerated emotional motion of the robot like Bunraku puppet.

Fig.12 and Fig.13 show the average ratios of each foreign nationality experimenter for each experiment of three motion patterns of the robot. These results are quite different from the Japanese. In Fig.12, the highest evaluations are the not-expandable body. In Fig.13, the highest evaluations are the expandable body and tilt neck. These are quite opposite. In Fig.12, 6 experimenters (L,M,N,P,S,T) selected that the not-expandable body, 2 experimenters (O,R) selected that the expandable body, and 2 experimenters (Q,U) selected that the expandable body and tilt neck. In Fig.13, 2 experimenters (R,U) selected that the not-expandable body, 5 experimenters (L,M,O,P,S) selected that the expandable body, and 3 experimenters (N,Q,T) selected that the expandable body and tilt neck. From these differentiated results, we confirmed that foreign nationality experimenters do not tend to prefer exaggerated emotional motion of the robot like Japanese.

2.4 Discussion

From these results, Japanese experimenters preferred exaggerated emotional motion of the robot. However, foreign nationality experimenters did not tend to accept perfectly the exaggerated emotional motion of the robot like expandable body and tilt neck. There were distinct differences of evaluation for robot between Japanese and foreign nationality. Japanese tend to accept exaggerated emotional motion of humanoid robots favorably, but foreigners do not tend to accept it, and calmly evaluate humanoid robots.

In the two motion of the robot used in this experiment, rejoicing motion was not perfect. So we speculate as follows. Foreign nationalities consider the robot as an industrial product and if the motion is not good, they tend to lower the evaluation. On the other hand, Japanese accept the whole thing just by saying a robot.

3 Conclusion

In this study, we conducted an impression evaluation experiments on viewpoints and feelings from comparative culture to motion design and robot facial design in humanoid robot.

The experiment of robot motion used a new Bunraku robot with expandable body. In this experiment, 3 motion patterns of the robot (not-expandable body, expandable body, expandable body and tilt neck) were used. The experimenters were Japanese and foreign nationalities. These experiments were subjective evaluation and objective evaluation (measuring brain wave) to this Bunraku robot.

From the result of subjective evaluation, Japanese evaluated in the following order, 1. expandable body and tilt neck, 2. expandable body, 3. not-expandable body. However foreign nationality evaluated differently from Japanese, and there were no significant difference as compared with Japanese in the 3 motion patterns. From the result of objective evaluation, Japanese evaluated in the following order, 1. expandable body, 2. expandable body and tilt neck, 3. not-expandable body. However foreign nationalities evaluated differently from Japanese. From these results, Japanese prefer exaggerated emotional motion of the robot. However, foreign nationality did not tend to accept perfectly the exaggerated emotional motion of the robot. In one experiment, contrary to the Japanese results of experiment, the highest evaluation is the not-expandable body. There were distinct differences of evaluation for robot between Japanese and foreign nationalities. Japanese accept favorably humanoid robots, but foreigners do not necessarily accept humanoid robots positively, understand calmly, and tend to grasp negatively. Even Chinese and Japanese who live in the same Asian region, there were different evaluations for Bunraku robots with exaggerated expression behavior.

From these results of this comparative culture research, it was understood that humanoid robots developed for Japanese are not necessarily accepted by other nationality. And foreign nationalities did not necessarily accept humanoid robots. They are watching calmly them at a distance, and some are negatively watching them.

Based on the above experimental results, it was suggested that there is a tendency to be different for cultures between Japan and other nationalities for humanoid robot motion. Especially, Japanese tend to positively accept humanoid robot. This reason is why the influence of robot animation that has been airing in Japan since the 1960s and the influence of animism culture. Animism is to think that the soul lives in things and creatures. On the other hand, foreign nationalities except Japanese including Chinese in Asia do not necessarily tend to positively accept humanoid robot. It was supposed that values of robots from European and American religious perspectives and labor perspectives were reflected in these results of experiments. Though low-precision robot motion, Japanese tended to positively accept it. However foreign nationalities except Japanese did not necessarily tend to positively accept it. It was supposed that foreign nationalities except Japanese consider the robot as an industrial product and calmly evaluate its performance. On the other hand, Japanese accept the whole thing just by saying a robot.

These themes have issues to be tried quantitaely by increasing the number of experimenters. In research and developing of future robots, based on changes in environmental information, there is a need to optimize for each culture.

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