IASDR07
INTERNATIONAL ASSOCIATION OF SOCIETIES OF DESIGN RESEARCH THE HONG KONG POLYTECHNIC UNIVERSITY 12TH TO 15TH NOVEMBER 2007

THE INTERFACE DESIGN OF ROBOT WITH HUMAN EMOTIONAL CHARACTERISTICS

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ABSTRACT:

In Robot design, thinking about human-machine interface design has become important. Robots can show us various emotions: walking, laughing, interacting and many human behaviors. It is not a dream for a human and a robot to live together in everyday life. At that time, we designers should discuss the emotion of robots when the robots interact with us. For example, when we think about the design of a rescue robot, we have to consider that the robot must not create fear for the person waiting for rescue. Creating new emotions for robots will create a new world of interaction between humans and machines.

Our purpose is to explore the possibility of designing the interface of a robot with human emotional characteristics. We tried to design a robot that had “MOE” emotion. Moe is written with the wrong Chinese character for the verb MOERU “to catch fire”. This character now expresses a rarified pseudo-love toward fictitious characters and their related embodiments. And we compared three types of robot models on factor analysis.

In this analysis, we considered: (1) the effect of MOE emotional characteristics and (2) the possibility of using animation techniques.

Keyword: Windows, Word, Technical Report, Template

1. INTRODUCTION

1-1 Personification in Japan

Nowadays, robot studies is prospering in all over the world. In the past, robots meant industrial robots to replace human labor. But in recent years, many kinds of robots have been developed, for example, the human care robot, the disaster relief robot, the animal robot, and so on.
Of all these, the animal robot is the most novel. Humans don't have feelings for ordinary machines such as refrigerators, cleaners, and cars. Why should human beings is treat robots with feelings?

In particular, Japanese people tend to have feelings for humanoid robots. Many Japanese people grow up with the comic character "*Astro Boy*" created by Mr. Osamu TEZUKA. Atom is a dream robot. He can understand human feelings, and he flourishes with a robot's own brute force. Actually, many researchers wish to study robot engineering, because they are fascinated by Atom. But I have another explanation for human fondness of robots.

In Japan, we have thought that everything exists with its own god. Not only living animals and plants, but also non-living things like teacups and chopsticks have their own gods. So Japanese people treat everything as alive. Adopting polytheistic thought like this, Japanese people are inclined to have feelings for artificial things.

1-2 Product Design with Emotional Character

Now, only few Japanese people lead a traditional religions life like this. Today, these are festival events to thank our ancestors for giving us good things in life. But, with mass production of disposable products, people don't pay much special respect to things.

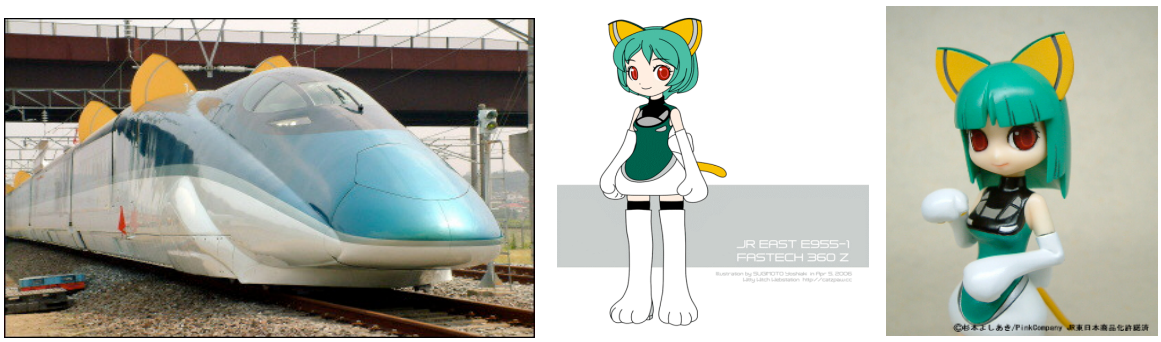

Fig.1 "*FASTECH-TAN*"

However, the effect of this traditional religions thought has spread, in particular in the world of line Internet. Figure1 shows the character "*FASTECH-TAN*", which was modeled on the next-generation Shinkansen test train "*FASTECH360S*" (or "*FASTECH360Z*").

It is professed by many people on the Internet that a thing exists only as a thing and not a living thing essentially. When people regard a thing as an idol, the things comes to be a god. This is similar to making an idol in religion.

In this section, I picked up "*FASTECH-TAN*" as an example of impersonation.
Actually many things are impersonated, for example, food, vehicle, computer, computer operating system, website, and social networking service.

Personification is not a rare phenomenon, and is not a phenomenon of recent years. But characters having unique Japanese emotions have been impersonated in recent years. Its emergence and popularization is related to the Internet.
In the case of "*FASTECH-TAN*", the character is developed at one time, regardless of when "*FASTECH-TAN*" was created by Mr. Yoshiaki SUGIURA.

The character was impersonated more widely, but it was under-known. One reason is more less exposure for the medium. On the other hand, the most important reason is that the character was not developed for someone. Impersonated characters discover unique Japanese emotions within themselves, and people care for these characters.

The reason that Japanese people have empathy for robots is camaraderie through personification expressed as a longing for robots.

1-3 The Problem of Uncanny Valley in a Robot

The Uncanny Valley is a hypothesis in robotics concerning the emotional response of humans to robots and other non-human entities. It was introduced by Japanese roboticist Masahiro MORI in 1970.

This hypothesis states that as a robot is made more humanlike in its appearance and motion, the emotional response from a human being to the robot will become increasingly positive and empathic, until a point is reached beyond which the response quickly becomes that of strong repulsion. However, as the robot's appearance and motion continue to become less distinguishable from a human being's, the emotional response becomes positive once more and

approaches human-human empathy levels (Fig.2).

This area of repulsive response aroused by a robot with its appearance and motion being between a "barely-human" quality and a "fully human" one is called the Uncanny Valley. The name captures the idea that a robot which is "almost human" will seem overly "strange" to a human being and thus will fail to evoke the empathetic response required for productive human-robot interaction.

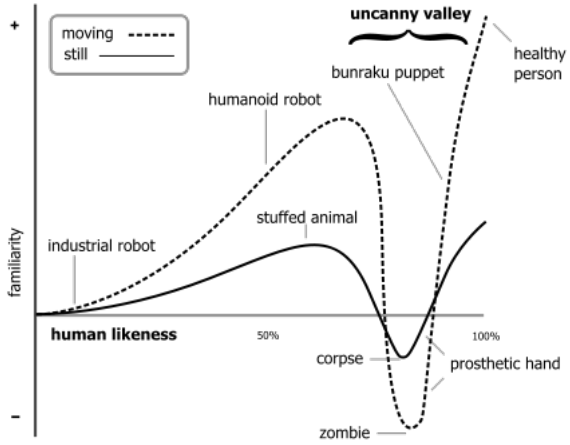

Fig.2 The uncanny valley

Figure 2 compares non-moving things (dolls, rag dolls, etc) with moving things (robots). The dolls and rag dolls do not cause, the uncanny valley easily. Mr. Mori talks about this point, “if you want to relieve or conquer of the uncanny valley, you should aim the summit and its environs that stands left of the uncanny valley.”

On the basis of this thought, I made a doll-like robot. In other words, doll-likeness is the most human likeness. Moreover, I aim to relieve and conquer the uncanny valley and to control human feeling through reflection on signs (Fig.3).

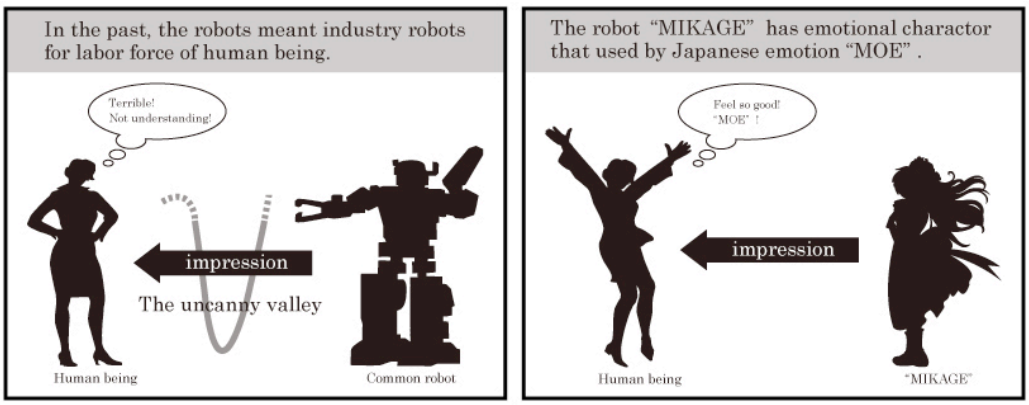

Fig.3 The robots and Japanese peculiar emotion

2.PROCESS OF ROBOT MAKE

2-1 Select Model of Robot

I want to relieve the uncanny valley with unique Japanese emotion. So I made a woman robot. General by speaking, Japanese people's emotion is aroused by woman robots.

2-2 Decide of Robot size

I decided to downsize this study robot, because I had limited funds. I bought a robot kit for hobbyists that was 35 centimeter in size. And I improved it. The body of the robot has to be small and light for it to be moved by a small motor. Therefore, I decided to make a half-size robot of a human being.

The limbs of human beings change in size with age. Internet investigation revealed the fact that the ideal average age was 16 years old for an object of unique Japanese emotion. But a 16-year-old woman robot's arm is too thin to sheathe motor. Then, I used a 7-year-old-woman robot in this study.

2-3 About robot name

The name of the robot is important to give it character. The secret of unique Japanese emotion is the religious icon within one's self. The icon is beautiful, but it has no entity. So, this study robot is named "*MIKAGE*". "*MIKAGE*" means embodiment of icon.

2-4 Make Body of "MIKAGE"

In this section, I talk about the method to make the body of *MIKAGE* (Fig.4).
01) I made a paper pattern.
02) I shaped expanded polystyrene.
03) I made the shape of *MIKAGE*'s body with paper clay.
04) I gave 03) a coat of fand.
05) I folded up thin vinyl for to 04).
06) I papier-mache with Japanese paper.
07) I gave 06) a coat of fand.

08) I removed 07) from an archetype.

09) I cut the parts that no I did not want.

10) I applied resin to the back of the body parts.

11) I putty the outside.

12) I polished the surfaces of the body parts.

13) I bore some holes for screws, and fitted some nuts.

14) I coated the body parts with paint.

Fig.4

2-5 Input of Motion

The sign includes motion. So the robot should have good motion to thrill people's heart. Then, I programmed "*MIKAGE*" to have three motions (Fig.5).

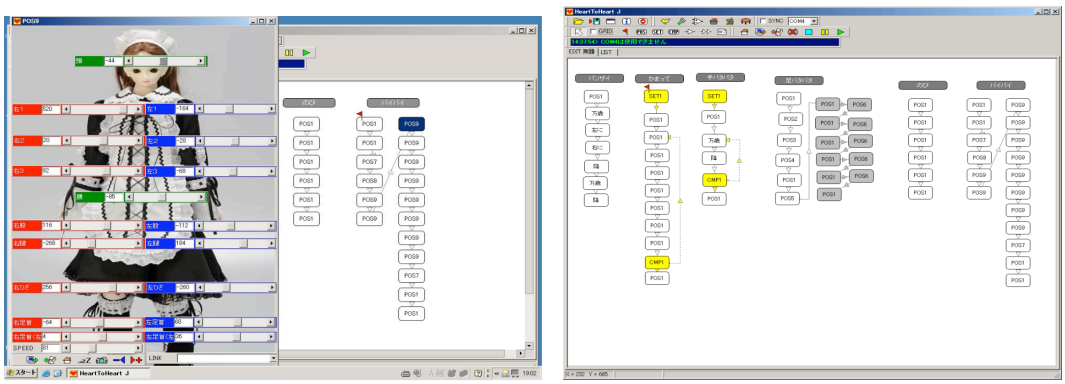

Fig.5

3. INVESTIGATION AND ANALYSIS

In this part of the study, I inquire into whether "*MIKAGE*" can ease up the uncanny valley or not. In 3.1, I talk about taking a picture to be used in the survey. In 3.2, I surveyed on "*MIKAGE*" using the semantic differential method.
In 3.3, I talk about the result of the survey.

3-1 Take a Picture

I took photographs and movies to use in the survey. The photograph location was a photo studio in my university. And the movie location was in my university.

3-2 Survey

The survey questionnaire has 10 key words organized in 50 pairs. The panelists looked at a movie of the three robots, and evaluated each robot in terms of the 50 pairs of pair of adjectives. The three Robots are "*FT*", "*MIKAGE*", and "*ACTROID-DER2* " (Fig.6). "*FT*" was made by Robogarage Company. "*ACTROID-DER2*" was made by Kokoro Campany.

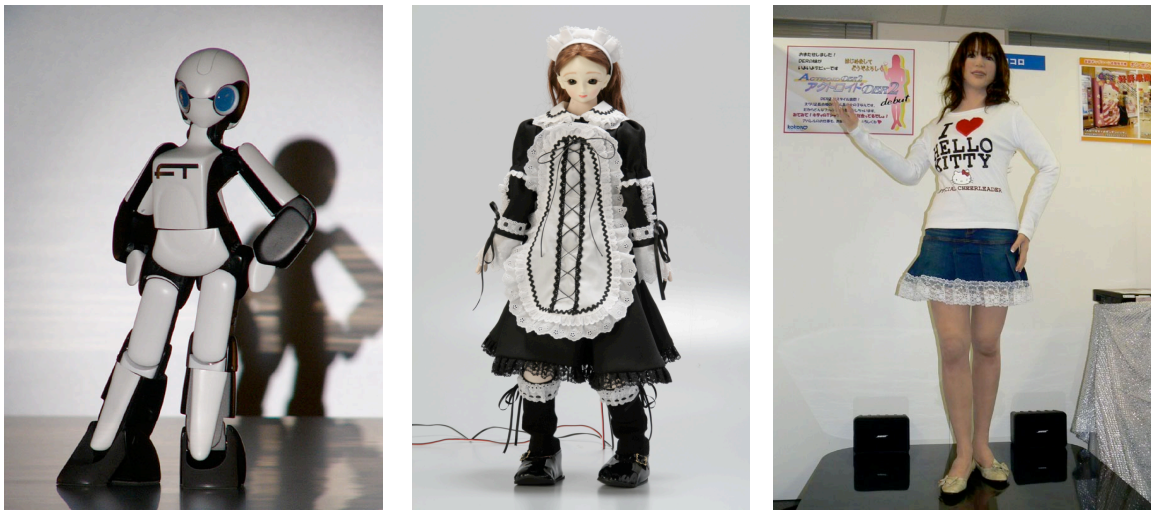

Fig.6
(left: "*FT*", center: "*MIKAGE*", right: "*ACTROID-DER2*")

In 2007 on January 15th, I surveyed. Before the survey, I explained the plan of my study to the panelists. I got 110 responses from university students.

3-3 Results of Survey

About "*FT*":

The pairs of adjectives that many panelists responded to strongly were "white-black", "old-new", and "dirty-pretty" (Graph 1). So, "*FT*" seems to be household by panelists. Many people connect it with existing robot images, that was made unconscious by humans self. In a word, people have knowledge this robot is more of a moving thing a common robot.

About "*MIKAGE*":

The pairs of adjectives that many panelists responded to strongly were "nice-hard", "agreeable-not agreeable", "funny-obnoxious", and "favorite-dislike"(Graph 2). So the panelists responted without making a comparison between "*MIKAGE*" and the other robots. In other words, I guess the panelists responded with their sensibility. I guess this is related to the high scores they gave only the "*MIKAGE*".

About "*ACTROID-DER2*":

The pairs of adjectives that many panelists responded to strongly were "quick-late", "correct-incorrect", "pointless-acute" and so on (Graph 3). So the panelists compared "*ACTROID-DER2*" with human beings. Or, they thought robots compared favorably or unfavorably with human beings. On the other hand, people connect this robot with existenting robot images.

Graph 1

The examples of the pairs of adjectives and these the first factors (***FT***)

Amount of factor load: After it rotates (Raw varimax method)				
The pairs of adjectives (Variable identifier)	Factor ①	Factor ②	Factor ③	Factor ④
pure-impure	0.638	0.190	0.115	0.019
dirty-pretty	-0.625	0.155	0.119	-0.088
bad-good	-0.592	0.184	-0.156	-0.023
nice-hard	0.571	-0.312	0.109	-0.040
agreeable-not agreeable	0.557	-0.317	0.390	-0.107
funny-obnoxious	0.555	-0.340	0.271	-0.043
favorite-dislike	0.552	-0.336	0.082	-0.192
young-aged	0.546	-0.001	0.253	0.056
mistaken-right	-0.536	0.173	-0.266	0.271
annoying-kind	-0.515	0.190	-0.002	0.311
dangerous-safe	-0.483	-0.069	-0.481	-0.017
horrible-gentle	-0.483	0.028	-0.331	0.382
beautiful-ugly	0.482	-0.172	0.004	-0.073
old-new	-0.480	0.282	0.075	0.104
white-black	0.391	0.125	0.097	0.073
contradiction-consistent	-0.302	-0.134	-0.228	-0.054
deep-shallow	0.289	-0.279	-0.247	-0.241
slow-rapid	-0.099	0.622	-0.139	0.045
poor-splendid	-0.291	0.568	0.139	0.011
inferior-excellent	-0.387	0.562	-0.080	0.288
point less-acute	-0.094	0.560	-0.130	0.112
negative-positive	-0.288	0.554	-0.045	0.022
lively-dull	0.351	-0.553	0.280	-0.111
quick-late	-0.040	-0.534	0.136	-0.344
feeble-strong	-0.088	0.521	0.286	0.152
reliable-unreliable	0.266	-0.488	-0.211	-0.191
stupid-clear	-0.379	0.487	-0.177	-0.287
bustling-lonely	0.224	-0.483	0.252	0.021
inconvenient-convenient	-0.245	0.423	-0.056	0.395
violent-calm	-0.207	-0.400	-0.217	-0.267
correct-incorrect	0.365	-0.392	0.083	-0.138
low-high	0.032	0.381	-0.065	0.258
complate-incomplate	0.271	-0.374	-0.206	-0.186
not dominant-dominant	0.096	0.373	0.171	-0.165
quiet-noisy	0.196	0.311	0.169	0.013
narrow-broad	0.004	0.285	-0.118	0.253
long-short	-0.040	-0.211	-0.136	-0.284
light-heavy	0.036	-0.046	0.557	-0.121
difficult-easy	-0.212	-0.056	-0.516	-0.074
gloomy-cheerful	-0.411	0.434	-0.489	-0.011
constraint-free	-0.148	0.450	-0.487	0.304
simple-complicated	-0.056	0.289	0.460	0.222
bright-dark	0.442	-0.354	0.445	0.009
square-round	-0.059	0.064	-0.384	-0.010
unhappy-happy	-0.286	0.155	-0.288	0.187
manlike-womanlike	-0.054	-0.028	-0.158	-0.156
small-big	-0.027	-0.056	0.094	0.484
hot-cold	-0.103	-0.220	0.006	-0.480
soft-tough	0.192	-0.111	0.220	-0.354
near-far	0.221	0.011	0.013	-0.309
Contribution rate	12.4%	11.7%	6.5%	4.5%
Accumulation contribution rate	12.4%	24.2%	30.7%	35.2%

Graph 2

The examples of the pairs of adjectives and these the first factors (***MIKAGE***)

Amount of factor load: After it rotates (Raw varimax method)				
The pairs of adjectives (Variable identifier)	Factor ①	Factor ②	Factor ③	Factor ④
gloomy-cheerful	0.811	0.157	−0.025	−0.058
bright-dark	−0.760	−0.108	−0.208	−0.040
nice-hard	−0.752	−0.281	−0.112	0.035
unhappy-happy	0.703	0.184	−0.032	0.132
funny-obnoxious	−0.691	−0.208	−0.288	0.171
horrible-gentle	0.683	0.095	0.263	0.140
agreeable-not agreeable	−0.668	−0.047	−0.241	0.230
favorite-dislike	−0.651	−0.203	−0.242	0.190
annoying-kind	0.609	0.083	0.191	−0.244
mistaken-right	0.584	0.150	0.181	−0.198
lively-dull	−0.578	−0.478	−0.072	0.116
bad-good	0.576	0.139	0.305	−0.327
negative-positive	0.556	0.421	−0.191	−0.191
dangerous-safe	0.553	−0.084	0.469	0.095
inconvenient-convenient	0.508	0.371	0.042	−0.143
old-new	0.506	0.089	0.176	−0.042
bustling-lonely	−0.486	−0.243	−0.016	0.106
difficult-easy	0.482	−0.012	0.032	0.068
pure-impure	−0.460	0.075	−0.341	0.258
white-black	−0.460	0.077	−0.388	0.087
complate-incomplate	−0.460	−0.301	−0.062	0.254
constraint-free	0.429	0.278	0.029	0.232
hot-cold	−0.416	−0.282	0.068	−0.173
near-far	−0.404	−0.269	−0.277	−0.059
correct-incorrect	−0.399	−0.061	−0.149	0.387
beautiful-ugly	−0.356	0.064	−0.305	0.490
slow-rapid	0.130	0.744	0.206	0.015
quick-late	−0.099	−0.706	−0.145	0.004
point less-acute	−0.030	0.621	−0.113	−0.096
reliable-unreliable	−0.349	−0.620	0.124	0.075
low-high	0.322	0.597	−0.102	−0.206
feeble-strong	0.177	0.530	−0.171	−0.022
poor-splendid	0.412	0.523	−0.053	−0.153
narrow-broad	0.218	0.494	0.132	0.114
inferior-excellent	0.437	0.464	0.048	−0.320
small-big	−0.041	0.463	0.032	0.126
stupid-clear	0.220	0.449	0.149	−0.184
not dominant-dominant	0.093	0.351	0.012	−0.010
simple-complicated	−0.076	0.334	0.144	−0.482
quiet-noisy	0.103	0.302	−0.052	0.273
long-short	0.050	−0.198	0.139	0.074
square-round	0.190	−0.021	0.613	0.092
soft-tough	−0.061	−0.132	−0.554	0.033
young-aged	−0.156	−0.046	−0.408	0.076
violent-calm	−0.015	−0.308	0.400	−0.098
manlike-womanlike	0.000	−0.134	0.385	−0.308
contradiction-consistent	0.266	0.076	0.356	−0.019
dirty-pretty	0.359	−0.030	0.318	−0.406
light-heavy	−0.102	0.008	−0.342	−0.378
deep-shallow	−0.129	−0.089	0.106	0.372
Contribution rate	19.2%	10.7%	6.0%	4.4%
Accumulation contribution rate	19.2%	29.9%	35.9%	40.3%

Graph 3

The examples of the pairs of adjectives and these the first factors (***ACTROID-DER2***)

Amount of factor load: After it rotates (Raw varimax method)				
The pairs of adjectives (Variable identifier)	Factor ①	Factor ②	Factor ③	Factor ④
quick-late	0.645	0.099	−0.041	0.198
correct-incorrect	0.634	0.127	−0.274	−0.021
slow-rapid	−0.581	0.046	0.205	−0.193
funny-obnoxious	0.568	0.544	−0.096	0.143
poor-splendid	−0.561	−0.121	0.171	−0.206
deep-shallow	0.559	−0.003	−0.223	0.036
inconvenient-convenient	−0.553	−0.371	0.275	0.097
bad-good	−0.546	−0.382	0.329	0.057
point less-acute	−0.524	−0.061	−0.136	−0.173
bright-dark	0.514	0.330	−0.247	0.258
complate-incomplate	0.489	0.238	−0.161	0.112
bustling-lonely	0.479	0.294	−0.188	0.321
beautiful-ugly	0.473	0.313	−0.377	−0.126
gloomy-cheerful	−0.464	−0.402	0.154	−0.325
constraint-free	−0.456	−0.364	0.037	−0.169
soft-tough	0.448	0.173	−0.104	−0.093
narrow-broad	−0.420	−0.222	0.200	−0.006
near-far	0.392	0.267	−0.248	0.099
square-round	−0.353	−0.070	0.158	−0.024
favorite-dislike	0.273	0.703	−0.120	0.182
agreeable-not agreeable	0.398	0.692	0.001	−0.090
horrible-gentle	−0.065	−0.661	−0.020	0.021
dangerous-safe	−0.025	−0.600	0.083	0.030
mistaken-right	−0.299	−0.575	0.224	−0.143
nice-hard	0.519	0.557	−0.186	0.170
pure-impure	−0.009	0.525	0.025	0.001
unhappy-happy	−0.434	−0.485	0.336	−0.170
annoying-kind	−0.402	−0.435	0.270	0.196
white-black	0.227	0.382	−0.054	−0.135
contradiction-consistent	−0.332	−0.371	0.268	−0.179
difficult-easy	−0.156	−0.350	−0.313	−0.054
feeble-strong	−0.311	0.036	0.132	−0.553
manlike-womanlike	−0.146	−0.139	0.610	−0.097
inferior-excellent	−0.340	−0.269	0.601	−0.017
small-big	−0.067	0.041	0.600	−0.050
low-high	−0.300	0.036	0.589	−0.074
stupid-clear	−0.119	−0.108	0.566	−0.175
young-aged	0.359	0.296	−0.509	−0.006
simple-complicated	−0.339	0.145	0.484	−0.144
dirty-pretty	−0.459	−0.230	0.480	0.063
long-short	0.140	0.058	−0.473	0.015
light-heavy	0.328	0.132	0.399	−0.084
old-new	−0.313	−0.232	0.384	−0.056
violent-calm	0.074	−0.140	0.078	0.627
lively-dull	0.202	0.238	−0.280	0.564
quiet-noisy	0.053	0.075	−0.024	−0.538
hot-cold	−0.111	0.259	−0.084	0.382
negative-positive	−0.190	−0.190	0.283	−0.374
reliable-unreliable	0.304	0.246	−0.232	0.307
not dominant-dominant	−0.145	0.156	0.061	−0.179
Contribution rate	14.8%	11.1%	9.1%	5.1%
Accumulation contribution rate	14.8%	25.9%	35.0%	40.1%

4. CONCLUSION

I learn three things as a result of the study. First, it is impossible to make a shape that expresses emotional character, so long as we make it just with a basic robot kit. Second, the uniform of the waitress is effective as a design to arouse Japanese people's emotion. Third, the emotional characteristics of a robot can have an influence on the impression that we have about the robot.

The term robot at present is inaccurate, because it includes many things for many uses. What is the difference point between a doll and a robot? For example, is a moving doll a robot? And is a still robot doll? I can't answer these questions clearly. But the boundary between robots and dolls is obscure. It means robots are similar to dolls.

Then, what do you think about humans and robots? Now, human beings can't regard robots as human beings. Because now the technique is not perfect. But in the future, when robots will be more human-like as a result of technical innovation, how will we feel? There will surely be more little differences left.

A humanoid robot can't be made with only a technique. Making a complete humanoid robot requires many techniques to arouse human feeling and sense with its shape and movement. So, I think of the idea of adding Japanese emotion to the robot. Then, I will find a powerful sign that controls human feeling, especially unique Japanese emotion that controls love affairs. I think, if I use it for robots, they will be liberated from their present limits.

If you are interested in robot design through my study, and if you understand the possibility of product design with unique Japanese emotion, it is my pleasure.

APPENDIX:

"*MIKAGE*" can make half size, because I have inadequate technique and small fund. Suppose I try a full-dress verification, I must make a new robot of the same scale of human being. And "*MIKAGE*" have no countenance. Countenance is very important to feel expression. If she can move her eyes or her mouth, she will be able to express more feeling.

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