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Analyses of Local Mascot Characters and Proposal of Automatic Creation System Using *Kansei*-words

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Abstract: In this paper, first, analyses of local community mascot characters are carried out to obtain knowledge to be the popular ones. Next a mascot characters automatic creation system is proposed using these findings. As for the analyses, we used 200 (top 100 and low 100) local community mascot characters selected from 2,258 characters. Many interesting findings could be obtained such that short limbs or dark-round eyes tend to contribute to be popular as a mascot character. The proposed system utilizing these findings can create a mascot character reflecting a user's image inputted by *Kansei*-words. Many parts having degrees of *Kansei* images are prepared in the proposed system and are combined to form a character using Rough Sets Theory and an Interactive Genetic Algorithm framework. We performed evaluation experiments. Many mascot characters satisfying user's image were created and remarkable results were obtained through subjective evaluations. For example, by using the extracted rules from the analyses and Interactive Genetic Algorithm, the proposed system can create much favorable mascot characters. Moreover, we found some interesting tendencies of the color used to paint characters. One of them is that the *cheerful* characters are often painted in warm colors with high saturation.

Keywords: local mascot characters, automatic creation, Interactive Genetic Algorithm, Rough Sets Theory.

1. INTRODUCTION

There are a variety of mascot characters around us —from commercial characters such as Disney (Disney) and Sanrio (Sanrio) to anime ones such as Pikachu (Pokémon company) and local community ones. The market, as large as 1.6 trillion yen, is said to be invulnerable to recession and to have a promising future (Koshikawa, 2013). Recently, "Kumamon", Kumamoto Prefecture's local mascot community character, has advanced overseas, making one of current topics. The Japanese mascot character business is on the rise, with its goods being sold in Europe,

America and Asia and the articles concerning it have often appeared in major newspapers (W. S. Journal, 2012, December).

A mascot character reflecting the image of a product, a company, or a local community is considered to have a potential to activate the target. Therefore, the design of a mascot character is a crucial issue to effectively convey the image of the target. However, there is little knowledge about the design: in most cases the characters are designed manually or by designers.

There are some researches on analyses of mascot characters. In (Shiizuka, 2012, April) it is reported that mascot characters popular in Japan were mostly expressionless. Ref. (Ito, Yamanaka, et al., 2007, September) reports that characters with short legs are suitable for “healing” that many people nowadays are seeking for in mascot characters (Miyashita, 2001), (Yamada, 2008).

Some researches treated some elements in a character. Ref. (Kiya, Yamanaka, et al., 2009) focuses on the color of a character. Effects for impression and preference by the shape of the eyes are analyzed in ref. (Ito, Yamashita, 2012).

We have proposed a 3D character automatic generation system (Ogura, Hagiwara, 2012). This system, however, aims at creation of only *Kawaii* (cute) girls. As a result, fields of the application are very limited.

This paper treats much more general and popular character, a mascot character. First, many local community mascot characters are collected and analyzed and obtained knowledge or rules concerning popular mascot characters. Second, a mascot characters automatic creation system is proposed using these findings.

This paper is organized as follows. In section 2, analyses of many mascot characters are carried out. Section 3 proposes an automatic creation system using *Kansei*-words. Evaluation experiments and the results are shown in Section 4. Finally, we conclude the paper in section 5.

2. ANALYSES OF MASCOT CHARACTERS AND DETERMINATION OF PARTS

Figure1 shows the flow of the proposed method. First, rules expressing popular mascot characters are extracted by analyses of many mascot characters. Then, *Kansei* space is defined in order to determine *Kansei* words used as the system input. Next, the degree of *Kansei* image for each part to create a mascot character is estimated by preliminary experiment.

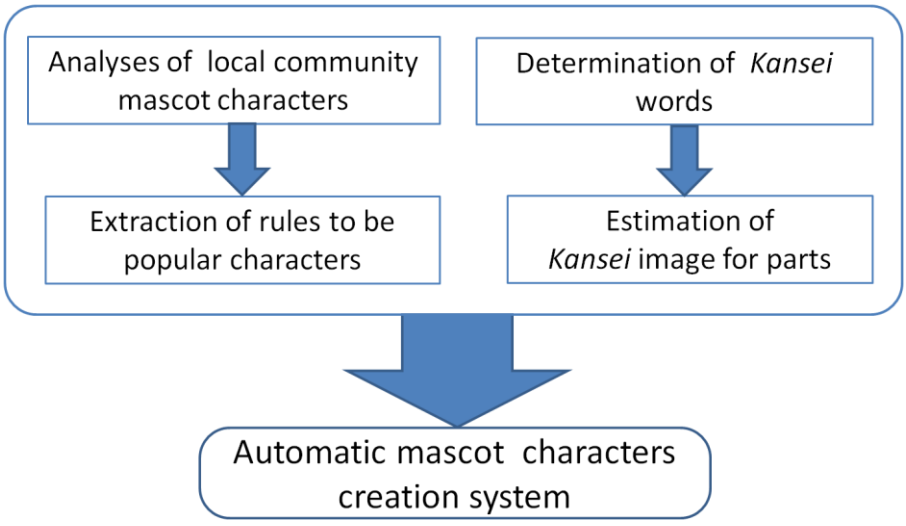


Figure 1: Flow of the proposed method.

2.1. Analyses of mascot characters

We collected and analyzed 200 mascot characters from 2,258 characters in “Catalog of local mascot characters” (TINAMI Co.,Ltd.). Among 200 characters, 100 are top 100 ones, and remaining 100 are low 100 ones in the 2,258 characters. We defined the popularity degree as follows,

$$Popularity = \frac{Number\ of\ \ favorite\ users}{Number\ of\ \ access\ to\ the\ character\ \ page} \quad . \tag{1}$$

Here, $Number\ of\ \ favorite\ users$ means the number of users who registered the character as his or her favorite in “Catalog of local mascot characters” web page (TINAMI Co.,Ltd.). Since the data for the character getting a small number of accesses to the character page are considered to be low reliability, we treated the character obtaining more than 3,000 accesses. Figure 2 shows the elements of analyses and Table 1 shows the elements and their values.

Analyzing item	
Proportion of the head to the body	A
Shape of the body	B
Proportion of the length to the width of the face	C
Shape of the eyes	D
Proportion of the black to the white of the eye	E
Configuration of the black and the white of the eyes	F
Presence or absence of the nose	G
Presence or absence of the cheek	H
Shape of the mouth	I
Presence or absence of the ears	J
Length of arms	K
Length of legs	L
Animal used in the mascot character	M

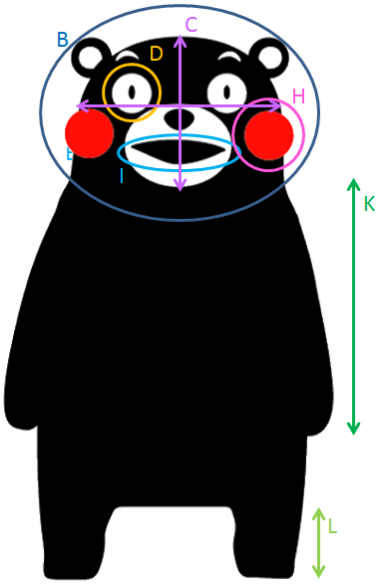


Figure 2: Elements of analyses.

Table 1: Elements of analyses and their values.

Analyzing item	Values
Proportion of the head to the body	positive real values
Shape of the body	circle, ellipse, square, tunnel-like
Proportion of the length to the width of the face	positive real values
Shape of the eyes	circle, vertically long, horizontally long, up-angled eyes, droopy eyes, almond-like, parabola
Proportion of the black to the white of the eye	positive real values
Configuration of the black and the white of the eye	black in white eyes, white in black eyes, black eyes
Presence or absence of the nose	presence of the nose, absence of the nose
Presence or absence of the cheek	presence of the cheek pattern, absence of the cheek pattern
Shape of the mouth	negative, neutral, positive
Presence or absence of the ears	presence of the ears, absence of the ears
Length of arms	absence of arms, short, long
Length of legs	absence of legs, short, long

By observing the data, we found the following tendencies for a popular character.

1) A tunnel-shaped form
2) Black colored eyes without white part
3) Short legs
4) Emotionless mouth rather than smiling mouth

2.2. Rule extraction by Rough Sets Theory

We employed Rough Sets Theory (Inoue, Harada, et al., 2009) to extract rules considering the combinations of several elements. As mentioned above, top 100 and low 100 characters were used for the analyses.

Figure 3 shows an example of rule extraction using Rough Sets Theory. In this case, the shape of the eyes and arrangement of the black part of the eye and white part differ between the character 1 and character 2. As a result, the following rules were extracted.

We obtained many rules and extracted 30 rules having higher C.I. (Covering Index) values. C.I. expresses the degree of contribution for the rule in Rough Sets Theory. These rules are used in the proposed automatic creation system. The followings are some examples:

If (form is tunnel-shaped) *and* (eyes are black color only) *and* (legs are short) *then* popular.

If (eyes are circular) *and* (no cheeks) *and* (mouth is neutral) *then* popular.

If (form is square) *and* (white pupil in the black iris) *then* unpopular.

2.3. Selection of *Kansei* words for the input of the proposed system

Selection of words is one of the important elements in the proposed automatic creation system, because they are used as the system input.

First, we defined a *Kansei* space for words. To be more precise, 180 *Kansei* words in the Language Image Scale (NIPPON COLOR & DESIGN RESEARCH INSTITUTE INC.) were vectorized and mapped into the space as follows:

1) 19 axes used in *Kansei* expression database (Takahashi, Asano, et al., 2009) were used. Table 2 shows them.

	Shape of the body	Shape of the eyes	Configuration of the iris and the white of the eye	Evaluation
1	tunnel-shaped	circle	black	popular
2	tunnel-shaped	vertically long	white in black eyes	not popular
3	squre	circle	white in black eyes	not popular

If {(eyes are circular) *or* (eyes are black only)} *and* {(form is tunnel-shaped) *or* (configuration of the black and the white of the eyes is black only) *then* popular.

==> *If* (eyes are circular) *or* {(eyes are circular) *and* (form is tunnel-shaped)} *then* popular.

Figure 3: An example of rule extraction using Rough Sets Theory.

2) *Kansei* value for each axis was calculated using the relatedness value considering common attributes (Araki, Okumura, et al., 2007, October), (Watanabe, Okumura, et al., 2006). Using these values, 180 Kansei words were expressed by 19-dimensional vector.

3) Principal component analysis was applied and 19-dimension was reduced to 3-dimension. Here we obtained the following three components.
   1st component: since the relations "new-old" and "dynamic-static" are dominant, this component can be considered as "cheerfulness".
   2nd component: "beautiful-ugly" and "gaudy-plain" are dominant, this component can be considered as "gaudy".
   3rd component: "warm-cool" and "soft-hard" are dominant, this component can be considered as "softness".

4) Log-scale was used because the range of the relatedness value was very large.

5) *K*-means algorithm (MacQUEEN, 2008) was applied for clustering and 180 *Kansei* words were formed 8 clusters.

6) We performed a preliminary experiment to collect *Kansei* words suitable to express the impression of the characters.

7) Considering the number of *Kansei* words in a cluster, we selected following 9 *Kansei* words shown in Figure 4. They are used for the input of the automatic creation system.

2.4. Structure of a character

Here we explain the structure of a character. Table 3 shows a list of elements to construct a character and their variations. Figure 5 shows some examples of elements to construct a character.

In the proposed system, coloring is carried out manually by the user. This is because effect of color is considered to be very large. For example, the impression of a character would be changed largely if coloring is different.

Each part is attached 9-dimensional *Kansei* words shown in Figure 4 based on the preliminary experiment.

cheerful, simple, amiable, humorous, gentle, innocent, cute, gorgeous, carefree

Figure 4: Selected 9 *Kansei* words.

Table 2: 19 axes of *Kansei* expression.

	(+) Polar expression (-)		(+) Polar expression (-)
1	beautiful <--> ugly	11	simple <--> complicated
2	amiable <--> not amiable	12	dynamic <--> static
3	quiet <--> noisy	13	stable <--> unstable
4	new <--> old	14	soft <--> hard
5	artificial <--> natural	15	thick <--> thin
6	open <--> closed	16	feminal <--> manlike
7	safe <--> dangerous	17	warm <--> cold
8	strong <--> weak	18	light <--> heavy
9	big <--> small	19	blight <--> dark
10	showy <--> plain		

Table 3: A list of elements to construct a character and their variations.

Parts	Values
Shape of the body	55
Shape of the eyes	21
Size of the eyes	5 (20*20, 22*22, ... , 28*28 [px])
Distance between eyes	16*16, 18*18, 20*20, 22*22, 24*24 [px]
Mouth	12
Size of the mouth	6 (35*35, 38*38, ... , 50*50 [px])
Hight of the mouth	16*16, 18*18, 20*20, 22*22, 24*24 [px]
Pattern of the cheeks	3
Accessory	8

Image size is 280*280 px

3. PROPOSED AUTOMATIC CHARACTER CREATION SYSTEM

Figure6 shows the flow of the proposed automatic character creation system.

3.1. *Kansei* words input

A user selects some of the *Kansei* words suitable to the image of a character the user wants to create from Figure 4.

3.2. Selection of parts

Next, the proposed system selects parts to create a character. The selection is carried out stochastically based on the attached 9-dimensional *Kansei* words for each part.

3.3. Composition of mascot characters

The proposed system composes 8 mascot characters by selecting parts stochastically at each generation.

3.4. Selection of mascot characters for display

The proposed system selects 4 characters based on the scores using the extracted 30 rules. Characters applied more rules having higher C.I. values are selected with a high probability.

3.5. Evaluation of mascot characters by a user

The user evaluates the displayed characters by 4 levels: 1. Excellent; 2. High; 3. Medium; 4. Low. Figure 7 shows an example of the interface window.

3.6. Interactive Genetic Algorithm

Interactive Genetic Algorithm (Hagiwara, 1994) is employed in the proposed system. Selection is based on roulette method and uniform crossover is used.

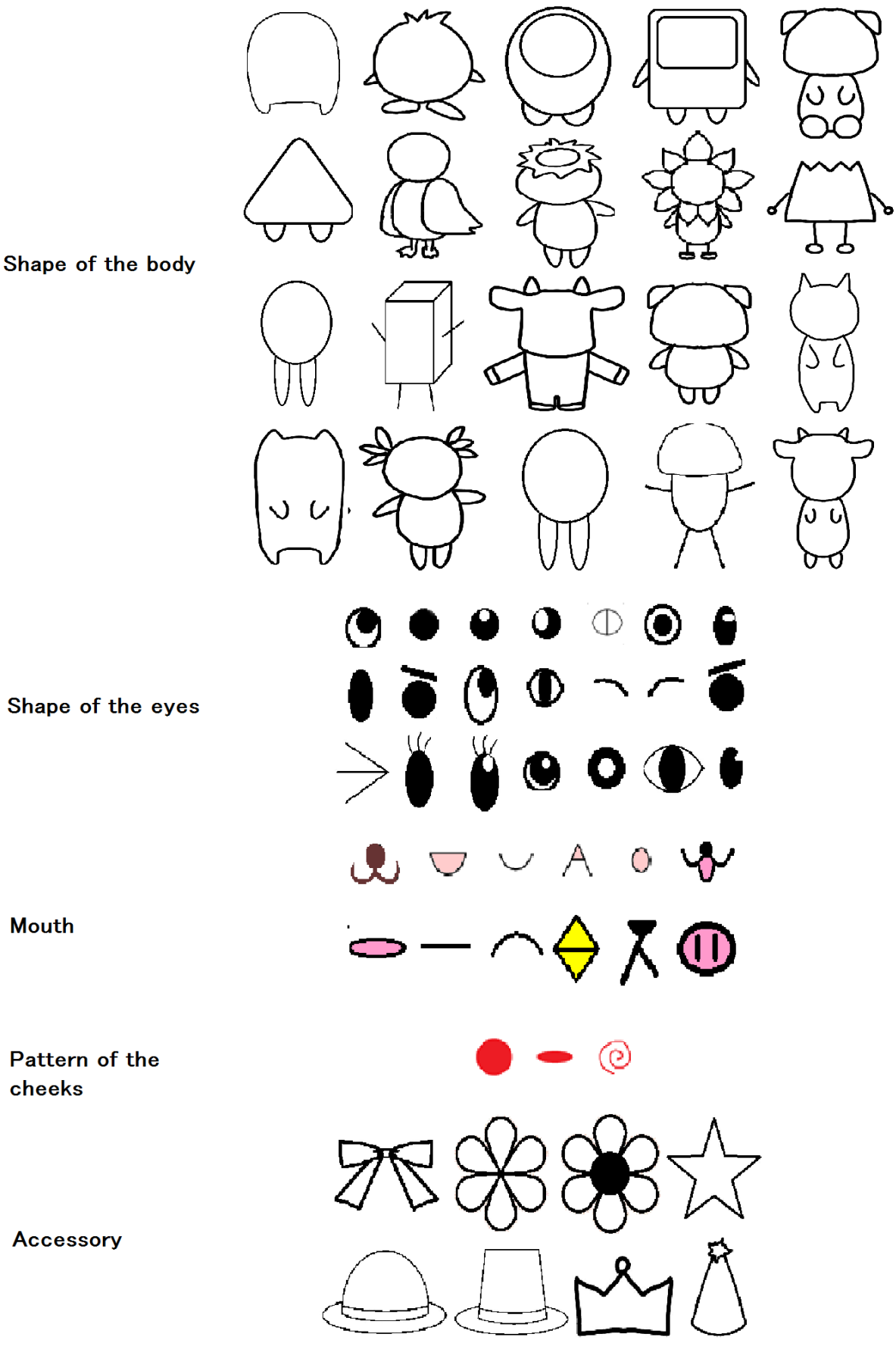


Figure 5: Examples of elements to construct a character.

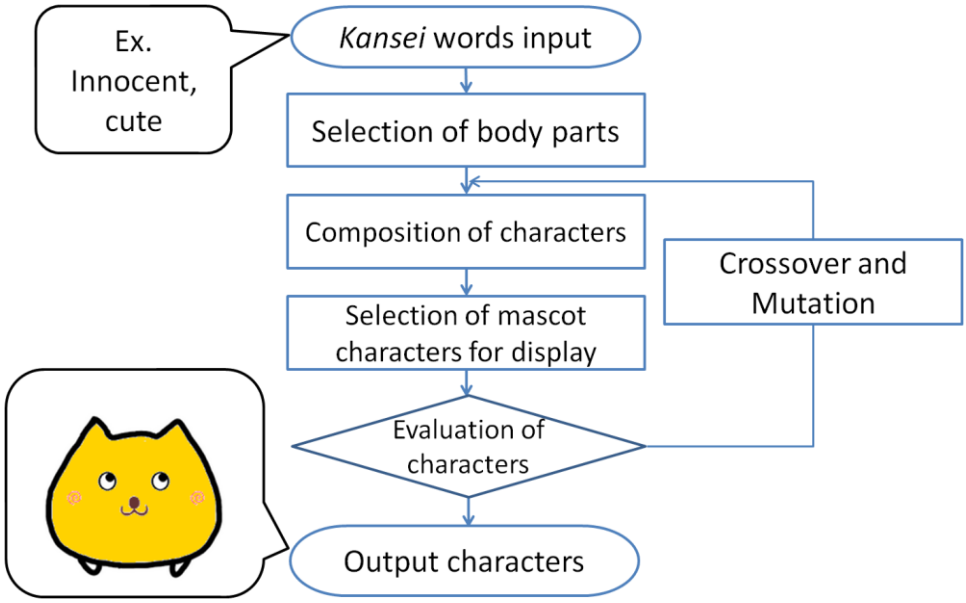


Figure 6: Flow of the proposed automatic character creation system.

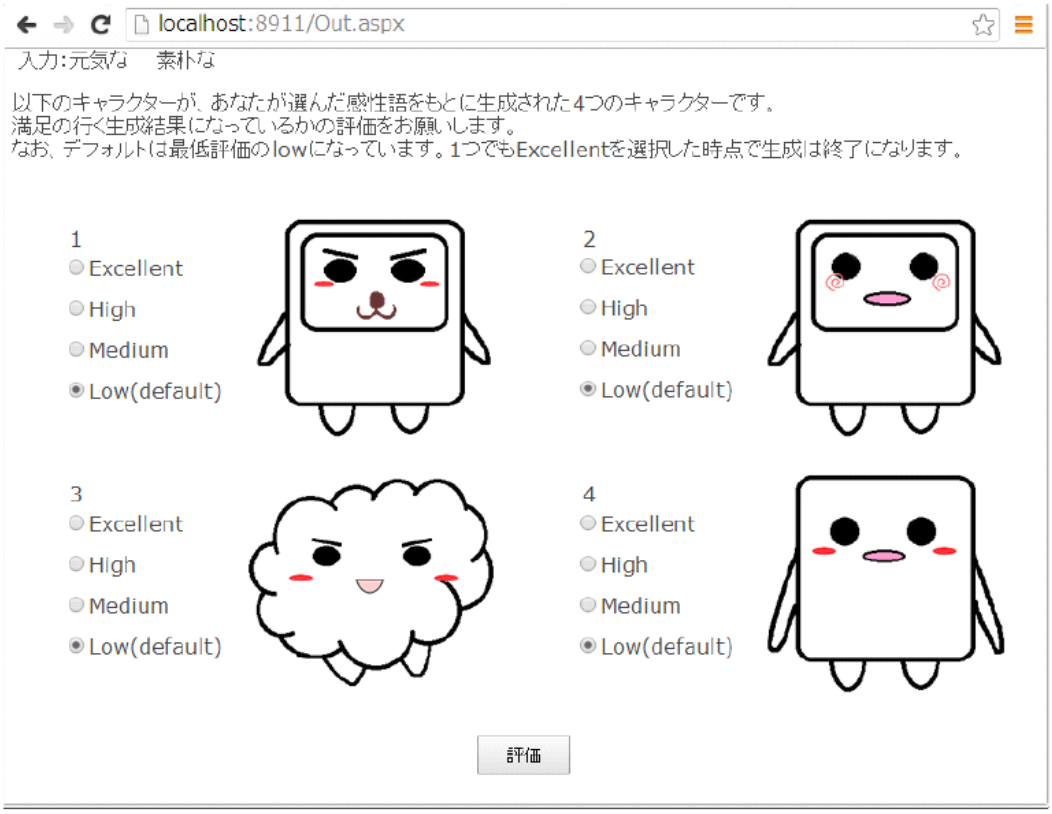


Figure 7: An example of the interface window.

4. EVALUATION EXPERIMENTS

We carried out three kinds of experiments. The first one is a subjective evaluation of the output of the proposed system and the second one is an objective evaluation of that, and the last one is an experiment about the *Kansei* image of the color.

4.1. Experiment 1 (Subjective evaluation of the output of the proposed system)

We asked 15 subjects, university students in their 20s(M:12, F:3), to create 32 characters in the following three ways and evaluate them. The first way is the usage of the proposed system, the second one is that without using the extracted rules, and the third one is the baseline system in which parts are selected randomly. Then comparison experiments are carried out. Figure 8 shows some examples of the created mascot characters by using the first way (proposed system).

Table 4 summarizes the results of the reflection degree of created characters to the input *kansei* words. It can be observed that the proposed system shows the highest evaluation values for all of the *kansei* words. In addition, significant differences ($p < 0.05$, difference of t-test) are detected between the proposed system and the others for all of the *kansei* words. One of the reasons might be usage of the rules extracted from analyses. The averaged reflection degree to input words of the proposed system was 4.4.

Table 5 shows the results concerning the favorability of the created characters. The values of *gorgeous* and *carefree* are not high. The reason concerning *gorgeous* can be considered as follows. *Gorgeous* is inherently difficult to express because the this kind of characters are not gorgeous. Another reason might be lack of gorgeous accessories such as hair jewelries, fur coat, and so on. As for *carefree,* the low value may be caused by their eyes. Almost all of the shape of the eyes we prepare are bright and circular forms which might not give the impression of *carefree*. If there are more various kinds of shape of the eyes, the value would be improved.

4.2. Experiment 2 (Objective evaluation of the output of the proposed system)

We carried out an objective evaluation experiment for the characters created by the proposed system. In this experiment, 10 subjects, university students in their 20s(M:9, F:1), evaluated the characters created by the other subjects.

Table 6 shows the results. The values are lower than the subjective experiment shown in Tables 4 and 5. The reason can be considered as follows. *Kansei* and the preference differ person by person. Therefore, even if someone likes a character very much, the character is not necessarily liked by the other people.

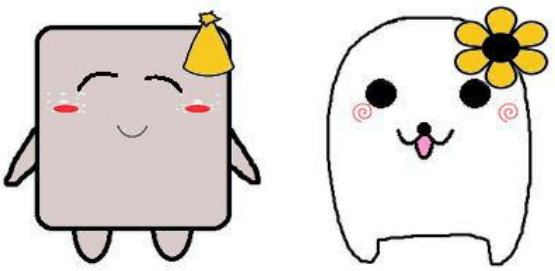
As for *cute*, it can be observed that the variance of the reflection degree to input the word and the favorability are both relatively small. It means that people tend to have more common images about *cute*.

4.3. Experiment 3 (Evaluation of the painted characters and unpainted ones)

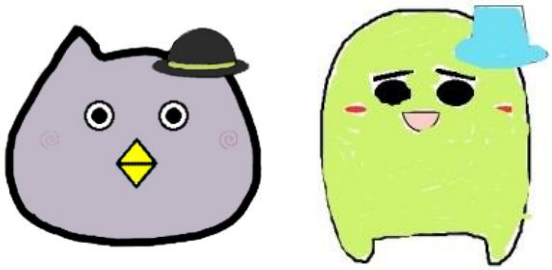
We compared the painted characters with those of the unpainted characters. The evaluators were 15 subjects, the same people as the subjects of the 1st experiment.

(a) cheerful

(b) simple

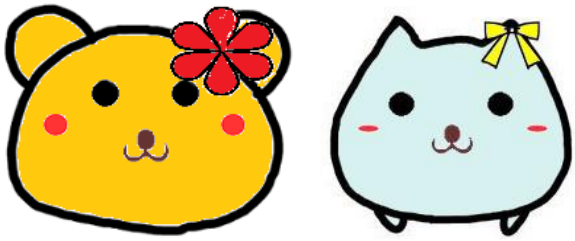


(c) amiable



(d) humorous

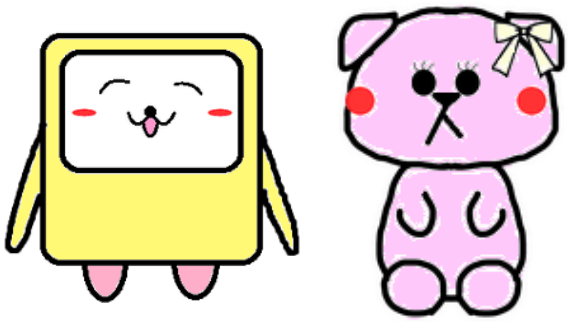
(e) gentle



(f) innocent

(g) cute

(h) gorgeous



(i) carefree

Figure 8: Some examples of the created mascot characters.

Table 4: Evaluation of the reflection degree of created characters to input the word.

	Reflection degree to input words		
	Proposed system	Without rules	Baseline
cheerful	**4.8**	3.9	3.3
simple	**4.5**	4.2	3.2
amiable	**4.3**	3.7	2.8
humorous	**4.7**	3.8	3.3
gentle	**4.2**	4.2	3.0
Innocent	**4.6**	4.1	3.1
cute	**4.8**	4.3	2.3
gorgeous	**4.0**	3.7	3.0
carefree	**3.8**	3.2	3.6

Table 5: Evaluation of the favorability of created characters.

	Favorability		
	Proposed system	Without rules	Baseline
cheerful	4.2	4.8	3.8
simple	4.5	3.9	3.5
amiable	4.3	3.7	3.0
humorous	4.7	4.3	4.0
gentle	4.2	4.2	3.3
Innocent	4.4	3.9	3.7
cute	4.0	4.0	3.3
gorgeous	3.8	3.8	3.3
carefree	3.6	3.4	2.8

Table 7 summarizes the result. Because of addition of colors, the reflection degree to input words was increased by 0.59 and the favorability was by 0.65. This shows that colors have large influence on people's impression and *kansei*.

Then we analyzed the influence of color: the relation between colors and the influence on *kansei* such as *cute* and *cheerful*.

We focused on the painted characters and investigated the tendency of the employed colors. As a result, it can be found that *amiable, cheerful, or gentle* characters tend to be painted in warm colors. Especially, *cheerful* characters tend to be painted in colors with high saturation, while *gentle* characters tend to be painted in colors with high luminosity. On the other hand, various kinds of colors are used to paint *humorous* characters. It can be considered that the colorfulness may be one of the essential features for *humorousness*.

Table 6: Objective evaluation experiment for the characters created by the proposed system.

	Reflection degree to input words		Favorability	
	Ave.	σ^2	Ave.	σ^2
cheerful	3.4	0.73	3.3	1.60
simple	3.7	0.81	3.5	0.81
amiable	3.4	0.52	3.2	1.00
humorous	3.4	0.81	3.0	1.10
gentle	3.7	0.80	3.5	0.89
Innocent	3.8	0.81	3.4	0.77
cute	3.6	0.64	3.3	0.69
gorgeous	3.1	0.89	3.0	0.58
carefree	3.5	0.75	3.2	0.81

Table 7: Evaluation of the painted characters and unpainted ones.

	Painted	Unpainted
Reflection degree to input words	4.34	4.21
Favorability	3.75	3.56

5. CONCLUSIONS

In this paper, first, we analyzed 200 local community mascot characters and obtained knowledge to be the popular ones. In the analyses, many interesting findings were obtained such that short limbs or dark-round eyes tend to contribute to be popular as a mascot character. Next a mascot characters automatic creation system has been proposed using these findings. The proposed system can reflect a user's image and favorability by usage of *Kansei* words for input and Interactive Genetic Algorithm.

We have performed three kinds of evaluation experiments. In the 1st experiment, many mascot characters satisfying user's image were created and remarkable results were obtained through subjective evaluations. For example, by using the extracted rules from the analyses and Interactive Genetic Algorithm, the proposed system can create favorable mascot characters. In the 2nd experiment, it can be observed that people tend to have more common images about *cute*. In the last experiment, we found some interesting tendencies concerning colors used in painted characters. One of them is that *cheerful* characters are often painted in warm colors with high saturation.

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