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3—18 Facial Caricaturing System Controlled by the KANSEI of Gallery Through the Feedback from Eye-Camera

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Abstract

Facial caricaturing process should be investigated and modeled from multiple viewpoints of three relations among the model, the caricaturist and the gallery. Furthermore, some kinds of interactive mechanism should be installed in order especially to implement the relation between the facial caricature generation system PICASSO[1] and gallery.

In this paper, we propose a dynamic caricaturing system by using KANSEI visual information acquired from the Eye-camera mounted on the head of gallery. This system analyzes the eye-mark patterns from the Eye-camera and extracts the measures for the fixation and saccade of this gallery. Therefore, this system could make the caricature more suitable for the gallery by utilizing his own KANSEI visual information.

1 Introduction

Face is the most effective visual media for supporting human interface and communication [2]. Nevertheless, no one knows exactly what the KANSEI information is. Facial caricaturing is to draw the face just in the same way as drawer's visual KANSEI feels. Therefore, in computer facial caricaturing system, the pattern features of the face must be sufficiently recognized in such a way that the individuality features are involved in them. From the viewpoint of computer vision, it is important to brush up the technique of drawing, and it is more important to clarify how the human vision extracts the feature points of the face and recognizes them in advance. In the conventional systems or researches concerning facial deformation for facial feature extraction [3,4], caricaturing has been discussed in the viewpoint of the relation only between the model and the caricaturist, and the flow of information also has been treated as one-way from caricaturist to the gallery. As the caricature varies according to who draws the caricature, the evaluation varies according to who observes it. From these analytical considerations, facial caricaturing should be discussed from the multiple viewpoints of these three relations among the model, the caricaturist and the gallery as shown in Fig.1. Furthermore, some kinds of interactive mechanism should be required between the caricaturist and the gallery.

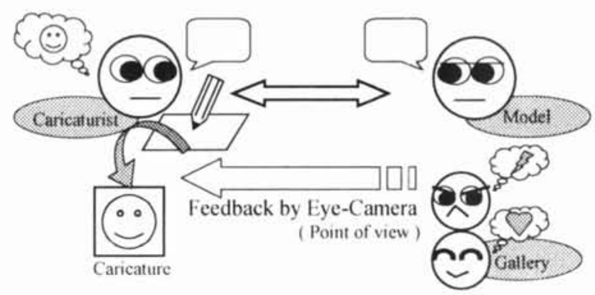

Fig.1 The relations among model, caricaturist and gallery.

In this paper, we propose an interactive and dynamic caricaturing system by using KANSEI visual information acquired from the eye-camera mounted on the head of the gallery. In our system, the utilization of in-betweening method realizes the generation mechanism from the caricaturist to the gallery, and on the contrary, the utilization of eye-camera vision realizes the feedback mechanism from the gallery to the caricaturist. This is an original and unique point of our system PICASSO. The eye-camera is mounted on the head of the gallery, and visual characteristics of the gallery are directly reflected onto the works of facial caricature. After observing the image of the model and analyzing the gaze distribution, the characteristic and impressive facial parts are more strongly deformed than other non-impressive facial parts, and finally the caricature which is suited especially for this gallery is generated.

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2 PICASSO System

2.1 Principle of PICASSO System

The face is defined by 331 feature points (x_i, y_i) : $i = 1,2,\cdots,331$ in Fig.2, and the feature points are divided into 37 facial parts in PICASSO System. The line drawing of the face is composed by connecting these feature points.

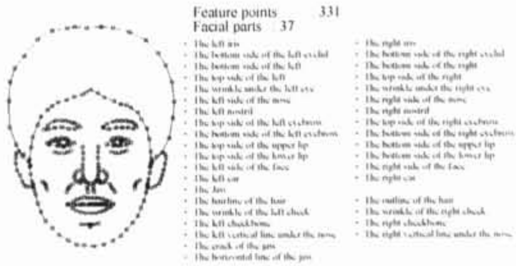


Fig.2 "face" in PICASSO System.

Facial caricature Q in PICASSO system is generated from the input face P by comparing the mean face S by

$$Q = P + b \cdot (P - S), \qquad (1)$$

where b is exaggeration weight. The term $(P - S)$ can be identified conceptually as the individuality feature of the face P (Fig.3).

$$S_{(x_i, y_i)} = \sum_j \frac{P^j_{(x_i, y_i)}}{M} \qquad i = 1,2,\cdots,331, \quad j = 1,2,\cdots,M \qquad (2)$$

This fact is called the "mean face assumption" in PICASSO for the individuality feature extraction.

As given also in Fig.3, PICASSO can deform the input face P by using eq.(1) and provide Q as a caricature of it.

P : Input face S : Mean face Q : facial caricature

Fig.3 Principle of PICASSO for caricaturing.

3 Interactive PICASSO using Eye-camera

3.1 System Configuration

In our system, the utilization of in-betweening method realizes the generation mechanism from the caricaturist to the gallery, and the utilization of the Eye-camera realizes the feedback mechanism from the gallery to the caricaturist. In our system, the basic mechanism is composed of three sub-processes;

Step-1:[presentation of original image]

An original gray image of the model is displayed on the screen at the fixed place (the angle and the distance between the image and the gallery are calibrated in advance; about 1[m]) (Fig.4).

Step-2:[analysis of view point information]

An instruction is given to the gallery to look at some characteristic point of the face where he feels impressive. Then, totally 3.2[sec]'s data are analyzed.

Step-3:[generation of caricature]

the distribution of view points data is analyzed, and the exaggeration weight of caricature generation is controlled by it.

Figure 5 shows a scene for extracting visual characteristic points by using the eye-camera mounted on the head. The direction of the eye can be calculated by using the difference of the reflection-rate of white part and colored-part (iris and pupil) shown in Fig.6. The gray image is also inputted through small CCD camera attached on the Eye-camera shown in Fig.7, and the system can calibrate where the gallery looks at in the gray image.

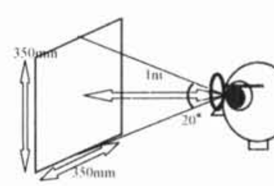


Fig.4 Presentation of original image.

Fig.5 Eye-camera mounted on the head.

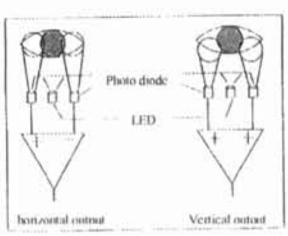


Fig.6 Configuration of Eye-camera.

Fig.7 An image from CCD camera attached on Eye-camera.

3.2 The Analysis of the Visual Characteristics

The distribution of view locus (eye-mark pattern) is analyzed by the following steps.

Step-1: the facial area is divided into 20×20 sub-areas,

Step-2: The sample is every 16 [msec]'s intervals,

Step-3: the locus is voted to the sub-areas.

Furthermore, the distribution is analyzed by the three methods shown below.

1. to extract the distribution of the total fixation time
2. to extract the distribution of the number of saccade to/from the sub-area
3. to extract the transition matrix of the saccade

3.3 How to Calculate an Exaggerated Weight

An exaggeration weight for the caricature is calculated by

$$b = \frac{n \times e\_\max}{N} , \tag{3}$$

where N is the total number of the feature point, n is the total of the number of sub-area's, and $e\_\max$ is the maximum limit of the weight for exaggeration (ex. $e\_\max=1.50$).

4 Experiment and Consideration

4.1 View Point Distribution

Figure 8 shows the result given by the analysis of the distribution of the total fixation time of the point of view in sub-area. The "L" shows the left eye's fixation, and the "R" shows right eye's fixation. Figure 9 is the result given by the analysis of the number of saccade to/from the sub-area. The "I" is arrival saccade, and the "O" is departure saccade. Table 1 shows the result given by the analysis of the transition matrix of the saccade. This shows the number of counts of the eye movements to the parts on the vertical line from the parts on the horizontal line. Figures 8, 9 and Table 1's (a), (b) and (c) show the results given by the different testees.

The KANSEI visual features of the testee A were

- The center of the face is being watched well.
- There are many eyes movements to the nose (the center of the face).

The KANSEI visual features of the testee B were

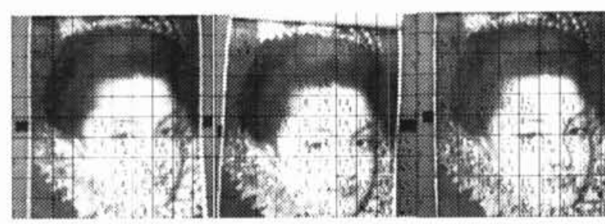
- Both eyes are being watched well.
- Fixations are distributed in the whole of the face.

The KANSEI visual features of the testee C were

- There are many eyes movements from the nose and mouth (the center of the face) to whole of the face..
- Fixations are distributed between the face parts to observe position..

(a) testee A (b) testee B (c) testee C

Fig.8 A analysis of the distribution of the total fixation time.



(a) testee A (b) testee B (c) testee C

Fig.9 Analysis of saccade to/from the sub-area.

Table1. Result of analysis by the transition matrix among the facial parts.

(a) testee A

	left eye braw	right eye braw	left eye	right eye	nose	mouth	other
left eye braw	0	0	0	0	0	0	1
right eye braw	0	0	0	0	0	0	0
left eye	0	0	0	0	6	0	10
right eye	0	0	2	0	5	0	1
nose	0	0	1	3	0	0	26
mouth	0	0	0	0	1	0	4
other	0	0	4	4	15	3	0

(b) testee B

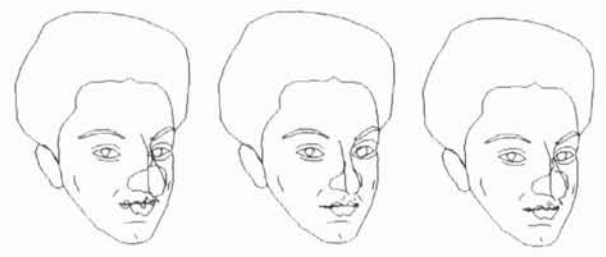
	left eye braw	right eye braw	left eye	right eye	nose	mouth	other
left eye braw	0	0	0	6	0	0	0
right eye braw	0	0	0	0	0	0	0
left eye	0	0	0	0	3	0	0
right eye	0	0	3	0	6	0	6
nose	6	0	0	7	0	0	0
mouth	0	0	3	0	0	0	2
other	6	0	6	4	3	0	0

(c) testee C

	left eye braw	right eye braw	left eye	right eye	nose	mouth	other
left eye braw	0	0	0	0	0	0	0
right eye braw	0	0	0	0	0	0	0
left eye	0	0	0	0	0	0	0
right eye	0	0	0	0	0	0	0
nose	0	0	0	0	0	24	48
mouth	0	0	0	0	30	0	60
other	0	0	0	0	30	66	0

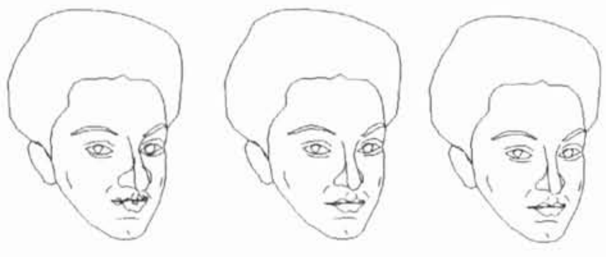
4.2 Caricature

Figure 10 shows the caricature generated based on the total fixation time in sub-area. Figure 11 shows the caricature generated based on the number of saccade to/from the sub-area. Figure 12 shows the caricature generated based on the transition matrix among facial parts. These figure's (a), (b) and (c) are caricatures by the different testee. Figure 10 -12's exaggeration weights are shown in Table 2.



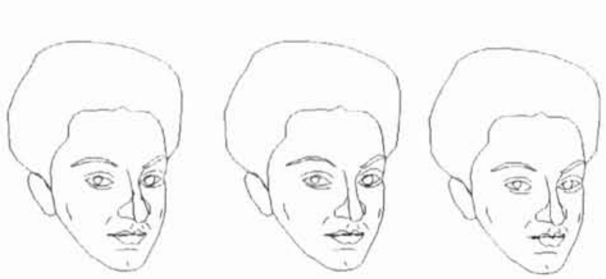
(a) testee A (b) testee B (c) testee C

Fig.10 Caricature based on the total fixation time.



(a) testee A (b) testee B (c) testee C

Fig.12 Caricature generated based on the number of saccade to/from the sub-area.



(a) testee A (b) testee B (c) testee C

Fig.12 Caricature generated based on the transition matrix among the facial parts.

Table2. Exaggeration Weight.

	left eye braw	right eye braw	left eye	right eye	nose	mouth	other
Fig.13-(a)	0	0	0	0	1.18	0.89	0
Fig.13-(b)	0	0	0	0.53	0.48	0.32	0
Fig.13-(c)	0	0	0	0	0.95	0.55	0
Fig.14-(a)	0	0	0	0.09	0.13	0.55	0
Fig.14-(b)	0.07	0.08	0.08	0.07	0.09	0.12	0
Fig.14-(c)	0.01	0.03	0.08	0.02	0.11	0.12	0
Fig.15-(a)	0	0	0.12	0.12	0.47	0.05	0
Fig.15-(b)	0.28	0	0.28	0.39	0.28	0	0
Fig.15-(c)	0	0	0	0	0.35	0.52	0

5 Conclusion

In this paper, (1) a mechanism to extract visual characteristics by using Eye-camera, and (2) an interactive caricature generation mechanism controlled by the gaze distribution were proposed. And the effectivities of these methods were experimentally demonstrated. It was experimentally known that the proposed method improves the result compared with the conventional method where coefficient b of all facial parts are constant. This result shows the possibility (a) to extract facial features by using an Eye-camera, (b) to represent the gallery's visual KANSEI characteristics onto facial caricaturing process.

In the experiment, although a static image is used for feature extraction, it is easily noticed and encouraging that it is better for the better facial feature extraction to utilize the continuous or motion images. To examine how to display these motion images to the gallery and how to analyze the gaze distribution are primal in our future works.

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