PROPOSAL OF EXAGGERATION METHOD BASED ON SHAPE AND POSITIONAL RELATIONS OF AUTOMOTIVE PARTS

Hiroshi Fujimoto Takuma Funahashi Takayuki Fujiwara Hiroyasu Koshimizu
Chukyo University
101, Tokodachi, Kaizu-cho, Toyota, 470-0393, JAPAN
fujimoto@koshi-lab.sist.chuyko-u.ac.jp

Abstract

Automotive frontal view often looks very similar to the human face. It is feasible that the automotive frontal mask affects both the total concept automotive and the impression of the automotive. Then authors proposed a Automotive Frontal Mask Caricature System coche-PICASSO. In this paper authors proposed a new technique for improving the quality of coche-PICASSO by means of several kinds of analytic curves so that (1) facial parts could be smoothly connected and (2) the deformation methods both in positional relation among facial parts and in shape of the respective parts could be separately controlled. In addition, based on the proposed methods, a set of experiments of coche-PICASSO and of subjective evaluations were conducted and the basic properties of the proposed methods were clarified.

1 Introduction

Automotive frontal views often look very similar to the human face. This fact means the design of automotive frontal view is important to represent the product concept and the total impression of it. In addition in these studies these impressions on a front mask of the automotive are evaluated so that "an expression" and "an age impression" could be used for the impression evaluation of the person. As a result, the fact that front mask of the automotive had close relation to the face of the person was examined [1-3]

Similarly, authors defined automotive frontal views as automotive face. Then authors developed the automotive frontal mask caricature system “coche-PICASSO” based on facial caricature system PICASSO [4].

This system is not only to catch the design of the automotive, but also to express an expression and the age impression more visually effective. However, when authors exaggerate a facial feature as it is, the line segments of the face are likely to be bent and jumped out, and therefore automotive facial parts are separated or over-lapped. Figure 1 shows of the front mask of previous method the automotive which collapsed of the form. In this paper, authors aimed for the improvement of these problems and suggested new exaggeration technique for the automotive face caricaturing system coche-PICASSO. Moreover authors evaluated an impression for the auto-motive face caricaturing which authors investigated the effectiveness of this system.

2 coche-PICASSO

2.1 Definition of automotive frontal mask caricature

Our system expresses the automotive face that is com-posed of typical face parts without wrinkles.
In the case of coche-PICASSO system, the number of parts is decreased from 37 of original PICASSO system to 21. Figure 2 shows the correspondence of automotive parts. coche-PICASSO divides automotive frontal face with 21 parts. Then this system expresses 201 feature points in 2 dimensions. Authors show a two-dimensional coordinate to Eq. (1).

$$F = \{(x_i, y_i) \mid i = 1,2,\cdots,201\} \quad (1)$$

(F : A coordinate of the feature points)

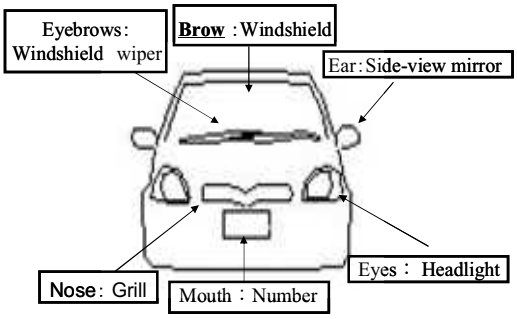

Figure 2. Correlation of facial parts and automotive parts

2.2 Caricature generation method

Authors are developing a facial caricaturing system PICASSO [4] which extracts some facial characteristics of the facial image and deforms these characteristics to generate a caricature. As for the basic principle of PICASSO, the facial caricature *Q* is generated by comparing the input face *P* with the mean face *S*, which is defined by averaging input faces. Authors call this idea the "Mean face assumption" for facial caricaturing. The individuality features can be expressed by the vector (*P* - *S*), and the deformation parameter *b*. The general idea of PICASSO is shown in Eq. (2). These data are composed of the total of

201 feature points. The mean face is de-fined by Eq. (3) which is generated from the coordinate values of many input faces.

$$Q = P + b \cdot (P - S) \tag{2}$$

$$F^{(S_{(x)})} = \sum_{j} \frac{F^{(P^{j}_{(x_i, y_i)})}}{M} \tag{3}$$
$$(i = 1,2,\cdot\ \cdot\ \cdot,201,\ j = 1,2,\cdot\ \cdot,M)$$

2.3 System flow

coche-PICASSO system has some automotive data and drawing modules as follows:

(a) Input automotive face parts P is generated from the automotive picture by using input module of coche-PICASSO
(b) Normalization module is became equal to distance between two head light by affine transform
(c) This system exaggerates it in extraction of the feature of the individual automotive
(d) This system displays the output of the caricaturing

A summary of this system is shown in Figure 3.

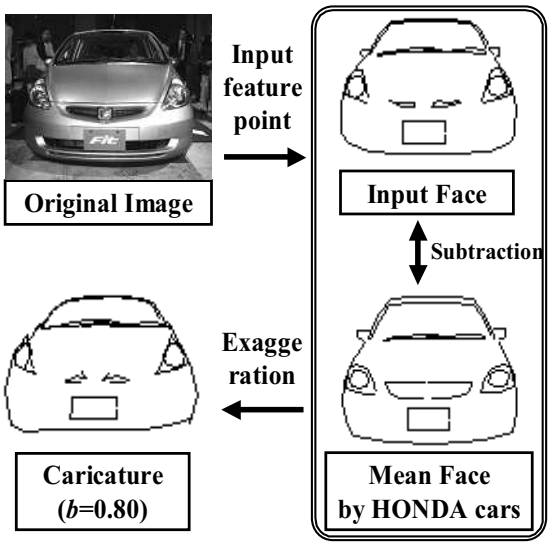

Figure 3. System flow

3 Proposed method

3.1 Control of feature points for exaggeration

In this method, our system fixed the edge of the feature point of the automotive parts. Our system assumes feature points according to the automotive parts *n*. Authors exaggerate *n-i* point from *i* point, controlled a feature point as shown figure 4.

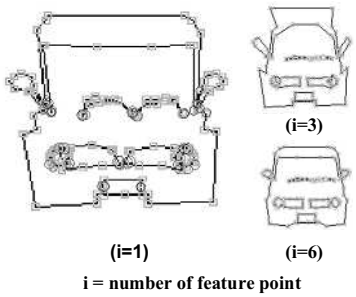

Figure 4. Example of caricatures changed number of feature points

3.2 Exaggeration rate by using elementary function

In the previous section, authors spoke technique to fix the endpoint of the parts about control of the exaggeration object points. Authors explain the technique of the calculation of the exaggeration rate corresponding to the feature points of the automotive. The calculation technique used a straight line, a second curve, 1-cos curve, exponential curve, a logarithm curve. Authors show a calculation result example of each exaggeration rate in table1 Table 1, and example of caricature genera-tion are shown in Figure 5.

Table1. Example of exaggeration rate by using elementary function

Point	1	2	3	4	5
Line	0	0.2	0.4	0.6	0.8
Quadratic Curve	0	0.05	0.2	0.49	0.8
1-Cos Curve	0	0.21	0.42	0.59	0.8
Exponential	0	0.04	0.11	0.32	0.8
Logarithm	0	0.37	0.60	0.75	0.8

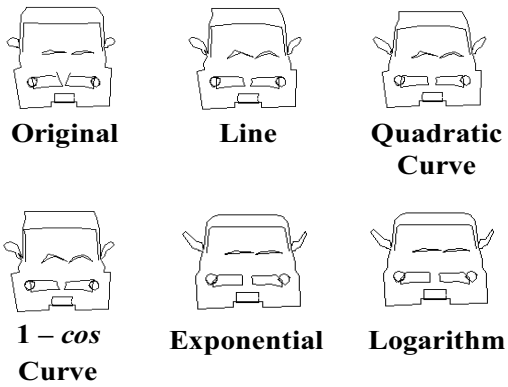

Figure 5. Example of caricatures by using calculated exaggeration rate

3.3 Exaggeration of positional relations

Authors suggest new technique to make the natural caricaturing which authors left an input lineament for. Authors left parts shape of the input face and changed a center of gravity every automotive parts into the position of the center of gravity of the caricaturing and exaggerated only a position.

Authors puts the shape vector of each parts before the exaggeration with $p(\rightarrow)$. Authors puts the shape vector of each parts after the exaggeration with $q(\rightarrow)$. Authors define each center of gravity as *pg*, *qg*. When authors moves $p(\rightarrow)$ so that pg accords in *qg*, authors have an exaggeration only for position relations. Authors show the automotive face caricaturing generation which authors used this technology for by expression Eq. (4). In addition, authors show the caricaturing generation example that exaggerated position relations in figure 6.

$$Q = P + (pg - qg) \tag{4}$$

(a) **Input Face** (b) **Original Exaggeration** (c) **Positional Exaggeration**

Figure 6. Example of exaggerated position

3.4 Exaggeration of shape

Authors suggest exaggeration technique authors let you exaggerate form with having left the position relations of the automotive face parts of the input face, and to make a caricaturing. Authors maintains the placement of the automotive face parts of the input face by introducing this technique and am aimed at reducing the unevenness of the caricaturing image.

Authors moves the center of gravity of the automotive face parts before an exaggeration from the exaggeration back. Authors puts the shape of the parts after the exaggeration with $q(\rightarrow)$. When center of gravity *qg* after the exaggeration moves it in center of gravity pg before the exaggeration, an exaggeration only for shape is provided. Authors show the automotive face caricaturing generation which authors used this technology for by expression Eq. (5). Besides, authors show the caricaturing generation example that exaggerated only shape in figure 7.

$$Q = P + b \cdot (P - S) - (pg - qg) \tag{5}$$

(a) **Input Face** (b) **Original Exaggeration** (c) **Shape Exaggeration**

Figure 7. Example of exaggerated shape

4 Proposed method

4.1 Experiment and result

Authors carried out a questionnaire by the automotive face caricaturing for 23 experiment participants to con-firm the quality of the caricaturing which authors generated by the technique that authors suggested. Authors used the front Original Image of 23 cars by this evaluation experiment from each maker. Authors classified this caricaturing generation technique in three kinds.

(a) A conventional exaggeration image

(b) Fix only an endpoint of the feature point, and the caricaturing which exaggerated

(c) Other exaggeration technique

It is the caricaturing which it made by an exaggeration to change an exaggeration rate in other exaggeration technique every feature point, an exaggeration only for positions, and an exaggeration only for shape. The subject compared automotive front of Original Image with these three kinds of the car caricaturing. Authors evaluated shape as the automotive face an order charge account. Authors show a psychology experiment result of the suggestion technique in figure 8.

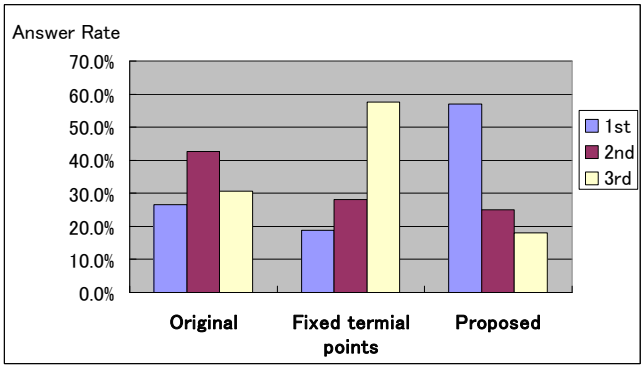

Figure 8. Examination of caricatures quality

4.2 Considerations

Authors were able to get the evaluation that was higher than conventional exaggeration technique from the evaluation experiment result of the automotive face caricaturing by seven techniques among eight suggestion exaggeration technique. The subject chose the following caricaturing among this result as a natural caricaturing. The subject judged a automotive face caricaturing with a caricaturing feature of following six items to be a natural caricaturing. Authors show the example of a natural caricaturing in figure 14 from figure 9. An automotive face caricaturing of the left in a figure is an expensive caricaturing of the evaluation. An automotive face caricaturing of the right side in a figure is a low caricaturing of the evaluation.

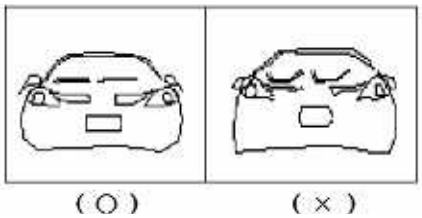

Figure 9.Symmetrical position of Light parts

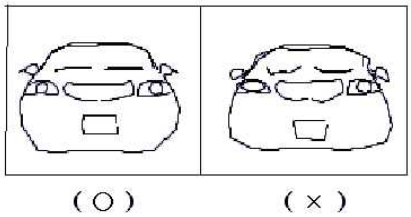

Figure 10. Symmetrical construction of Light parts

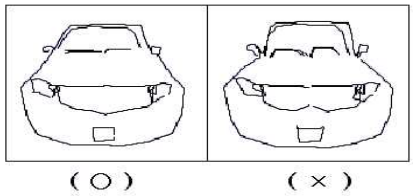

Figure 11. The form of the windshield wiper parts of automotive face

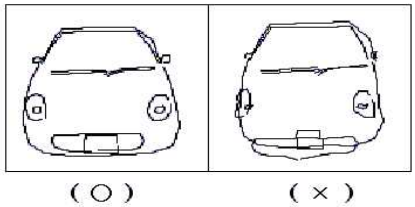

Figure 12. Similarity of shape between input face

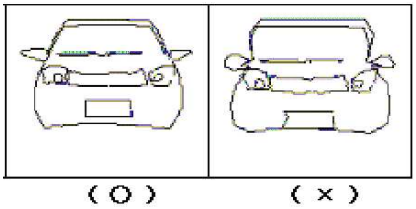

Figure 13. Fluent connectivity of roof and automotive face parts

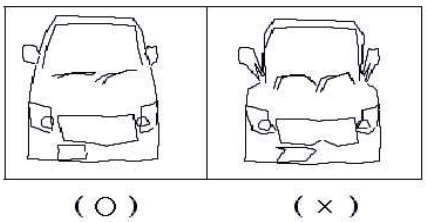

Figure 14. Fluent connectivity of roof and bumper

5 Conclusion

Authors suggested new exaggeration technique to improve the automotive face caricaturing which collapsed of the shape that was problems of automotive face caricaturing system coche-PICASSO in this study. And authors performed the automotive face caricaturing generation which authors used this suggestion technique for and evaluated the effectiveness experimentally and got a good result. As a result, authors used exponential curve and the approximation of the logarithm curve for the characteristic point of each the automotive face parts in this system. Authors were able to improve the sharpening of the parts by this exaggeration. As a result, a balanced caricaturing of the parts placement of the automotive face parts was provided. By the exaggeration only for positions, Authors were able to draw the automotive face caricaturing which reduced a break with shape. By the exaggeration only for shape, authors were able to reduce the interference of the automotive face parts. From the result of the evaluation experiment, the suggestion technique was able to get the natural caricaturing which captured the characteristic of the automotive model in comparison with the technique conventionally. And authors were able to produce good tools for me to produce automotive mean face and an automotive face caricaturing.

References

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