Extracting Contour Shape of Passenger Car Form in Front View Based on Form Similarity Judgement by Young Chinese Consumers

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Abstract. It explores how a reduced contour shape is extracted to reveal the underlying vital parts of passenger car form in front view based on young Chinese consumers' form similarity judgement. Young Chinese consumers as subjects are invited to estimate the similarity of 130 form samples of triple-compartment passenger car form in front view from main brands in Chinese auto market, and 76 form samples are selected as representative ones by cluster analysis. By defining 20 character lines of form in front view and segmenting points on each character line, coordinate value data on all points are recorded and slope values of all 76 segments are calculated. Furthermore, factor analysis is completed and 15 common factors is extracted. The result shows that (1) the passenger car form in front view can be extracted and presented as a reduced but recognizable contour shape with about forty-one percent loss of information on the form in front view; and (2) the contour shape is mainly consisted of character lines defining such basic design parts as side windows, side doors, the upper boundary and the transitional edges of engine hood, the upper and the lower boundaries across Y0 section of grille, almost entire contour of fog light, most of the upper contour of headlight, and the entire contour of intake and almost entire skirt line of front bumper.

Keywords: Passenger car form in front view · Reduced contour shape · Consumer research

1 Introduction

Many researchers have studied and analyzed passenger car form's styling and design and related consumer perception, showing that passenger car form in front view has a stronger influence on the aesthetic perception of passenger car than form in side view as well as form in rear view [1]. The typical and iconic features of passenger car form in front view is an important recognition and guidance for consumers to establish visual information channels between working memory and long-term memory [2]. The form of passenger car in front view is a shaping direction that consumers pay more attention to [3].

In ergonomics field, it is found that different types of visual appearance of passenger car form in front view will bring different emotional experiences to consumers [4]. There has a mapping relationship in customers' potential cognition between lexical semantics of passenger car form in front view and its styling elements [5], and the

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organizational relationship between the various partial elements has an important impact on the consumer's evaluation on the 'overall aesthetics' of passenger car form in front view [6]. In the cognition of automobile brands, there are several methods that can help satisfy consumers' perceptions and emotional appeals to the brand: by means of machine vision to establish the image training library for passenger car form in front view [7], encoding the styling elements of passenger car form in front view by the theory of Cognitive Psychology [8], and developing sustainable styling language which can be used as shape grammars in articulating brand identity [9]. In terms of consumers' perception of the passenger car form in front view, Liu [10] studied the cognitive characteristics of young consumers' judgement on similarity as well as the differentials presented in consumers' perceptional space when they are exposed to different passenger car forms in front view.

These studies show that the visual appearance of passenger car form in front view has an important impact on consumers' understanding of forms and brands and helps generate differentiated cognition. In view of the facts that passenger car form in front view is composed of complicated line-surface structure and that, in passenger car market background, the Chinese consumer group tends to be younger and is paying more and more attention to the styling and brand characteristics [11], analyzing and extracting the vital parts of the passenger car form in front view as a reduced but recognizable contour shape is conducted in this study based on young Chinese consumers' judgement on similarities between passenger car forms in front view. It will not only help designers to precisely target the young consumer group so as to understand their styling cognitions and consumption choices, but enable designers to carry out innovative design based on specific brand and visual identity targeted at young consumers.

2 Methods

2.1 Cluster Analysis and Sample Screening

Experimental Preparation. In the early stage of the experiment, pictures of 130 triple-compartment passenger car forms in front view with engine exhaust capacity of 1.5 L to 2.4 L in current Chinese mainland market are collected from the Internet and selected as stimuli, involving in the following 31 brands: Beijing Benz, Beijing-Hyundai, BYD, Dongfeng, Dongfeng-Honda, Dongfeng-Peugeot, Dongfeng-Renault, Dongfeng-Yueda-Kia, Dongfeng-Nissan, Dongfeng-Citroen, Qoros, GAC, GAC-Honda, GAC-Toyota, BMW-Brilliance, Chery, SAIC MG, SAIC Volkswagen, SAIC Roewe, SAIC-GM Buick, SAIC-GM Chevrolet, SAIC-GM-Wuling, FAW, FAW Audi, FAW-VW, FAW-Toyota, FAW-Mazda, Changan, Changan Ford,Changan-Mazda and Great Wall.

In order to avoid the distraction of car body color, material, internal structure and environment on subjects' judgement in the coming experiment, all pictures of 130 samples are preprocessed: car bodies in the pictures are reorientated to a unified angle of view and size and are put in white background; the influencing elements such as

brand logo, vehicle license plate and sticker are removed; the messy light and shadow are also adjusted; all pictures are transformed to grayscale images. The pictures of all samples are randomly numbered in the order of V1 to V130, respectively.

Similarity Judgement Experiment. 10 professionals in car styling and design are invited to divide passenger car form in front view into basic design elements by their professional knowledge and experience. The passenger car form in front view is initially divided into six parts, namely overall contour of passenger car form in front view, engine hood, headlights, grille, front bumper and front fog lights. 30 young consumers aged 18 to 28 are invited as subjects to estimate on the similarity between passenger car forms in front view by a grouping task tool where samples in pictures are divided into two groups in each turn until all 130 samples fall into eight groups. After the similarity judgement experiment is completed, 30 valid data are obtained and they are processed to export an averaged similarity matrix data. Next, the averaged matrix data is analyzed by hierarchical cluster analysis. By observing the resulted dendrogram, it is reasonable to divide all 130 samples into six cluster groups according to the relevant principle [12].

Then K-means cluster analysis is performed with K value set to 6, and distance of each sample in every cluster group is calculated to the center of cluster group where it belongs to. In each cluster group, the closer a sample is to the group center, the more it can represent the form characteristics of its cluster group, and it is then selected as representative sample. In this way, a total of 76 samples are selected from 130 passenger car forms in front view approximately at a screening rate of 60%.

2.2 Character Line Definition

The styling characteristics have a great impact on consumers' perception of the overall appearance of a passenger car [13]. People can often deepen their cognition and memory of things through the prominent features of complex things. In this way, features help people to build awareness and differentiation of a complete form of things. Moreover, it can be seen in car styling and design practice from sketching to 3D modeling, that lines are the first and the most important expression carrier to convey styling language [14].

Because passenger car form in front view has the characteristics of symmetry from the left to the right, the pictures of the selected 76 samples are divided along the center line so as to define character lines and to perform data acquisition only on half of passenger car form in front view. As mentioned above, passenger car form in front view can be divided into six basic design elements: the overall contour of passenger car form in front view, the engine hood, the headlights, the grille, the front bumper and the front fog lights. Therefore, when defining character lines, it should be considered that all character lines need to be combined together to express both the overall shape in front view and the relationship between the parts while being able to describe shape features of each part. At the same time, the versatility of the configuration of character lines is considered, ensuring all 76 forms can be outlined in front view by the configuration of character lines in brief and to the point way. Based on considerations mentioned above, a total of 20 character lines are defined and labeled (as shown in Fig. 1 and listed in Table 1).

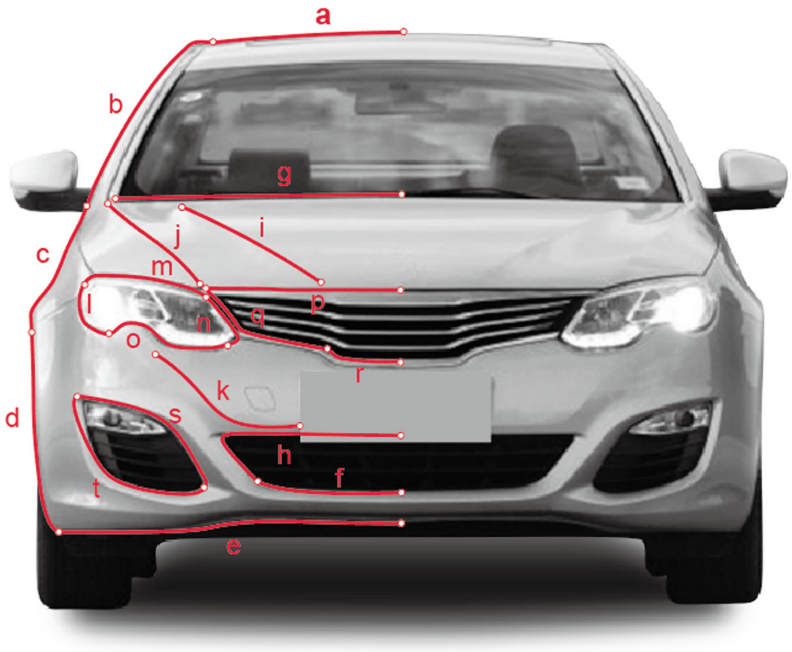

Fig. 1. Character line definition on a half of passenger car form in front view.

In order to facilitate the quantitative description of passenger car form in front view, the appropriate number of edit points are defined for every character line with consideration of appropriate spacing according to the different characteristics of the partial shape so that a character line can fit and represent the corresponding contour and partial shape. To put it in another way, the least number of edit points and the segments connected by the two adjacent edit points are used to describe each character line.

Table 1. Character line definition.

Parts character lines	
The contour in front view:	
The roof contour	a
The side window contour	b
The body shoulder contour	c
The side body contour	d
Bottom of the front bumper	e
The engine hood	g; i; j
The headlight	l; m; n; o
The grille	p; q; r
The front bumper	f; h; k
The front fog light	s; t

Finally, 20 character lines are defined to describe and to fit different contours and shapes in six parts. For example, in view of that, for headlight, the difference in the shape among samples is obvious and great, the character lines describing the shape of the headlights are divided into more segments. Finally, 76 segments are defined to form a configuration of 20 character lines and are named after the labelling letter of the corresponding character line together with its staring and ending points' serial numbers. For example, as shown in Fig. 2, the segment 'a12' is one of segments of 'character line a' with starting and ending points with serial number '1' and '2', respectively.

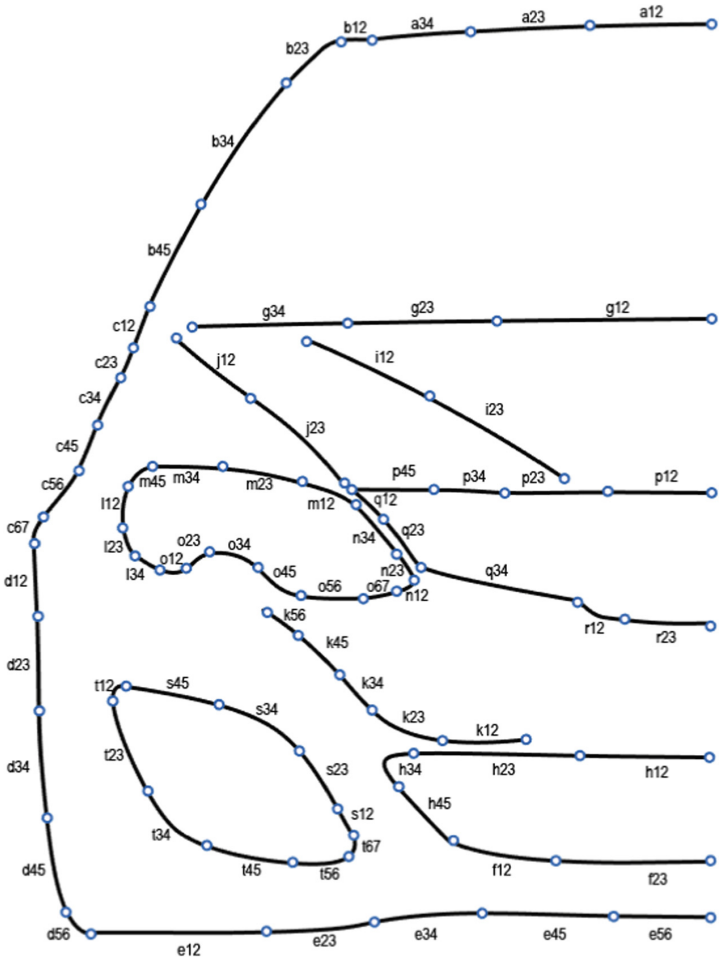

Fig. 2. 76 segments on 20 character lines.

2.3 Edit Points' Coordinate Value Extraction

The slope of each segment on a character line defines its own direction and has influence on the local flow of that character line. To calculate the slope of a segment, the coordinate values of its starting point and ending point need to be acquired as follows.

First of all, the preprocessed picture of a sample is imported into the top viewport of the CAD software, aligned with it height at a fixed value, and moved to coincide the intersecting point of left and right symmetry line and horizontal line across the bottom of the tires with the origin of coordinate system. Nextly, all character lines are figured out according to the defined configuration of character lines and the corresponding segments, and then adjusted, if necessary, by moving edit points to fit the contour and partial shapes in passenger car form of that sample. Since there are 96 edit points used to define all 76 segments for a sample, 96 pairs of coordinate values of edit points on character lines for that sample are acquired and recorded. In this way, all coordinate values of edit points in all form samples are acquired and recorded respectively.

2.4 Slope Calculation

An edit point's coordinate value data is composed of a pair of x-coordinate and y-coordinate values. The slope of a segment can be calculated from the coordinate value data of its starting point and ending point, more specifically, the ratio of the difference between its ending and starting points' y-coordinate values divided by that between its ending and starting points' x-coordinate values. In this way, 76 segments' slope values of character lines for all samples are calculated and recorded respectively.

2.5 Factor Analysis and Result

In this phase, factor analysis is employed to analyze the data on slope values for all samples. When conducting factor analysis, the principal components method is used, and the extraction is based on setting the eigenvalue and varimax rotation method is selected for extracting common factors. Three trials of setting the eigenvalue to 'greater than 1', 'greater than 2', and 'greater than 3' are carried out, respectively. When the eigenvalue is set to 'greater than 1', the total variance explained is 82.848%, while the total variance explained is 30.062% if the eigenvalue is set to 'greater than 3'. Both trials are not ideal as the contour shape extracted is not concise enough by the former trial and by the latter trial, the contour shape extracted has too much loss to be recognized.

After three attempts, it is found that when the eigenvalue is set to 'greater than 2', the contour shape is reduced but recognizable with the total variance explained of 58.816% and 15 common factors are determined and extracted by 51 segments, which have absolute value of loading greater than 0.5 on one common factor but relatively small value on the other common factors. They are retained for outlining the contour shape with about 41% of character lines erased. The partial rotated component matrix is shown in Table 2 and the retained 51 segments are listed in Table 3.

Table 2. Result of factor analysis.

Rotated component matrix[a]															
	Component														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a23	−0.15	0.01	0.15	0.06	−0.18	−0.02	−0.23	−0.21	0.33	−0.01	**0.57**	0.04	0.23	−0.08	−0.08
b12	−0.03	−0.10	**0.60**	0.00	0.23	−0.08	0.17	−0.09	−0.12	0.02	−0.04	0.04	0.30	−0.05	−0.01
b23	0.12	0.06	**0.78**	0.15	0.13	0.07	-0.02	−0.07	−0.05	0.06	−0.01	−0.11	0.06	0.20	0.07
b34	0.07	0.18	**0.80**	0.10	−0.13	0.04	−0.03	−0.08	−0.04	0.04	−0.03	0.01	−0.04	0.17	0.02
b45	0.13	0.05	**0.68**	−0.01	−0.24	0.08	−0.08	−0.10	−0.02	0.02	0.06	−0.09	−0.17	0.02	−0.03
c12	0.11	0.11	0.08	−0.09	0.01	0.09	−0.30	−0.05	0.07	−0.04	0.19	0.03	0.20	**0.55**	−0.02
c23	0.18	−0.08	0.06	0.06	−0.22	−0.01	−0.05	0.16	−0.14	−0.12	0.02	0.16	0.03	**0.63**	0.00
c56	0.04	−0.02	0.08	0.03	0.02	−0.04	−0.12	0.04	0.13	0.03	**−0.66**	0.03	0.14	−0.01	0.03
c67	−0.05	0.00	0.07	**0.66**	0.11	−0.02	0.04	0.01	−0.06	0.00	0.01	0.01	0.01	−0.12	−0.03
d12	−0.02	0.02	−0.12	−0.19	−0.14	−0.04	−0.05	−0.04	−0.01	**0.71**	−0.05	0.04	0.00	0.11	−0.03
d23	−0.01	0.01	−0.07	−0.01	0.01	0.03	**0.72**	−0.06	−0.02	−0.04	−0.06	0.04	0.01	−0.09	−0.19
d56	0.09	0.02	−0.13	0.10	0.01	0.18	0.14	−0.08	0.00	**−0.67**	−0.06	−0.09	−0.01	0.18	0.18
e12	0.33	−0.15	−0.07	−0.06	−0.02	0.63	−0.02	−0.08	0.10	0.11	0.08	0.01	0.01	0.14	−0.17
e45	0.18	−0.01	−0.01	0.05	0.14	0.11	0.09	−0.07	−0.09	0.19	0.26	**0.69**	−0.30	0.12	−0.07
e56	0.08	0.09	−0.12	0.11	0.00	0.11	0.15	0.03	0.03	0.10	0.14	**0.62**	0.10	0.08	−0.09
f12	0.05	−0.03	0.02	0.22	0.11	0.02	0.08	0.18	0.06	0.27	0.13	0.14	0.07	0.18	**−0.70**
f23	−0.09	−0.02	0.00	0.17	0.10	0.07	−0.32	0.02	−0.01	0.12	0.11	0.00	0.05	0.06	**−0.77**
g12	0.00	−0.03	−0.20	**−0.72**	−0.04	0.05	0.04	-0.02	0.01	0.15	−0.04	−0.03	0.10	0.10	0.17
g23	−0.01	0.12	−0.04	**−0.56**	0.25	0.12	−0.12	−0.21	0.00	0.14	−0.03	0.10	0.05	−0.08	0.16
h12	−0.02	0.00	0.02	−0.02	0.06	−0.02	**0.71**	0.01	−0.05	0.02	0.58	0.08	0.02	0.05	0.17
h23	0.09	0.10	−0.01	−0.06	0.11	0.03	0.17	0.13	−0.04	−0.02	**0.74**	0.02	−0.04	0.02	−0.05
h34	−0.03	−0.01	0.19	0.20	0.10	0.01	0.08	0.18	−0.04	**0.53**	0.00	0.07	−0.18	0.07	−0.02
h45	0.26	**−0.50**	−0.11	0.03	−0.03	−0.01	0.02	0.09	−0.09	−0.08	−0.02	0.05	0.05	−0.35	−0.02
i12	**0.89**	−0.03	0.08	0.04	−0.01	0.10	−0.06	0.02	0.05	0.04	0.01	0.03	0.12	−0.06	0.12
j12	**0.86**	−0.02	0.03	0.12	−0.03	0.16	−0.07	−0.04	0.06	0.07	−0.01	-0.07	0.12	0.00	0.13
k23	0.01	**−0.87**	−0.05	0.10	0.07	0.08	0.05	−0.05	−0.05	0.05	0.00	-0.07	0.08	0.09	−0.08
k34	0.01	**0.90**	−0.01	0.01	−0.01	0.08	0.01	−0.03	0.05	0.05	0.05	0.01	0.08	−0.01	−0.06
k45	−0.01	0.03	0.05	0.01	0.03	−0.07	**0.80**	0.01	0.03	−0.01	0.22	0.12	0.08	0.06	0.22
k56	−0.08	0.00	0.25	−0.01	**0.64**	−0.12	0.47	0.12	0.10	0.03	0.14	0.14	−0.02	0.05	0.12
l34	−0.02	0.05	0.12	−0.07	−0.03	**0.81**	0.01	−0.04	0.02	−0.22	−0.02	0.02	−0.02	−0.08	0.04
m12	0.25	0.03	−0.08	0.06	−0.08	−0.01	0.16	−0.07	**−0.53**	0.08	0.38	−0.13	−0.05	−0.22	−0.25
m23	0.26	0.01	−0.11	−0.01	0.08	−0.03	−0.01	−0.01	−0.23	0.02	0.10	0.01	−0.07	**−0.57**	0.11
m45	−0.07	0.01	0.15	0.01	0.02	0.00	−0.04	**−0.75**	0.08	0.13	0.03	−0.05	0.12	−0.18	0.19
n23	−0.08	0.07	0.15	−0.09	−0.02	**0.80**	0.02	0.14	0.02	−0.07	−0.03	−0.01	−0.10	−0.05	−0.04
o23	−0.03	0.03	−0.09	−0.02	**0.84**	−0.02	−0.05	0.00	−0.01	0.03	−0.01	−0.04	−0.01	−0.03	−0.01
o34	0.01	−0.05	0.04	0.03	**−0.86**	0.05	0.06	−0.02	−0.03	−0.01	−0.03	−0.01	0.05	0.05	0.05
o67	0.04	0.12	−0.05	−0.14	0.00	0.04	0.04	−0.03	**0.81**	0.05	0.00	0.01	−0.08	−0.02	0.01
p12	0.05	0.00	−0.01	0.08	0.02	0.08	0.02	0.07	0.00	0.09	0.16	**−0.82**	0.06	−0.04	0.05
p34	0.04	−0.02	0.09	0.02	0.05	−0.37	−0.01	−0.07	**−0.65**	0.01	−0.04	0.03	0.13	−0.06	0.05
q12	0.00	0.07	−0.03	0.06	**−0.53**	−0.22	−0.06	−0.11	0.19	0.23	0.19	0.16	−0.09	0.03	0.25
q23	0.11	0.13	−0.06	0.12	0.07	−0.18	−0.14	**0.69**	0.21	0.05	0.09	0.11	−0.06	−0.02	0.23
r12	−0.02	−0.24	0.04	**−0.76**	0.13	−0.04	0.17	0.09	0.09	0.06	0.11	−0.17	0.15	−0.01	0.00
r23	0.04	**−0.80**	0.03	−0.39	0.04	0.03	0.09	0.03	0.02	0.05	0.05	−0.24	0.06	0.06	0.01
s23	**0.82**	0.05	0.17	−0.01	0.00	−0.04	0.06	0.04	0.04	0.04	−0.01	−0.02	0.02	0.04	−0.08
s34	0.14	**0.68**	0.10	0.00	0.15	0.00	0.14	0.01	−0.02	0.13	0.21	−0.10	0.29	0.05	−0.06
s45	0.00	0.28	0.09	−0.02	0.06	0.03	0.04	−0.06	−0.05	0.06	0.12	−0.17	**0.53**	−0.06	0.10
t12	0.10	−0.04	0.02	−0.06	0.00	0.01	−0.03	0.04	**0.70**	−0.02	0.03	0.06	0.08	−0.03	0.07
t23	0.02	0.10	0.13	0.09	−0.03	−0.16	0.00	**−0.57**	0.02	−0.10	0.08	0.13	0.06	−0.08	0.08
t34	**−0.61**	−0.02	0.09	0.11	0.04	0.07	−0.01	−0.42	0.04	0.11	0.01	−0.08	−0.02	0.18	0.21
t45	−0.10	−0.03	0.07	0.20	0.11	0.09	0.04	0.07	−0.03	0.17	0.10	−0.02	**−0.65**	−0.07	0.08
t56	0.15	−0.02	0.02	−0.05	0.02	−0.01	0.06	−0.06	−0.11	0.00	−0.07	0.10	**0.71**	0.15	−0.07

Rotation Method: Varimax with Kaiser Normalization.

[a] Rotation converged in 17 iterations.

Table 3. Common factors and the corresponding segments.

Common factors	Remained segments
Loading value > 0.5	
Common factor 1	i12, j12, s23, t34
Common factor 2	h45, k23, k34, r23, s34
Common factor 3	b12, b23, b34, b45
Common factor 4	c67, g12, g23, r12
Common factor 5	k56, o23, o34, q12
Common factor 6	e12, l34, n23
Common factor 7	d23, h12, k45
Common factor 8	m45, q23, t23
Common factor 9	m12, o67, p34, t12
Common factor 10	d12, d56, h34
Common factor 11	a23, c56, h23
Common factor 12	e45, e56, p12
Common factor 13	s45, t45, t56
Common factor 14	c12, c23, m23
Common factor 15	f12, f23

The retained 51 segments are then drawn to rebuild the reduced passenger car form in front view. The retained character lines are plotted as shown as the left figure in Fig. 3 and the extracted contour shape is shown as the right figure in Fig. 3. The contour shape reflects underlying vital parts in passenger car form in front view selected by consumer's perception of and judgement on similarity between passenger car forms.

The contour shape is mainly composed of 51 retained segments related to the shape of six parts of passenger car form in front view. By mirroring the contour shape, a complete contour shape is generated and shown in Fig. 4. As listed in Table 1, each part is outlined by at least one character line, but significant differences in contribution of six parts to the contour shape are observed in the contour shape. The more segments retained in the contour shape a character line has, the more important it is to the entire form. As for the whole contour of passenger car form in front view, side window contour and bottom of the front bumper are more vital than roof contour, body shoulder contour and side body contour while, as for the partial shapes, front fog lights and front bumper are more important to the styling and design and have carried more basic design elements of the passenger car form in front view.

Fig. 3. Underlying vital parts of passenger car form in front view expressed in retained character lines and extracted contour shape.

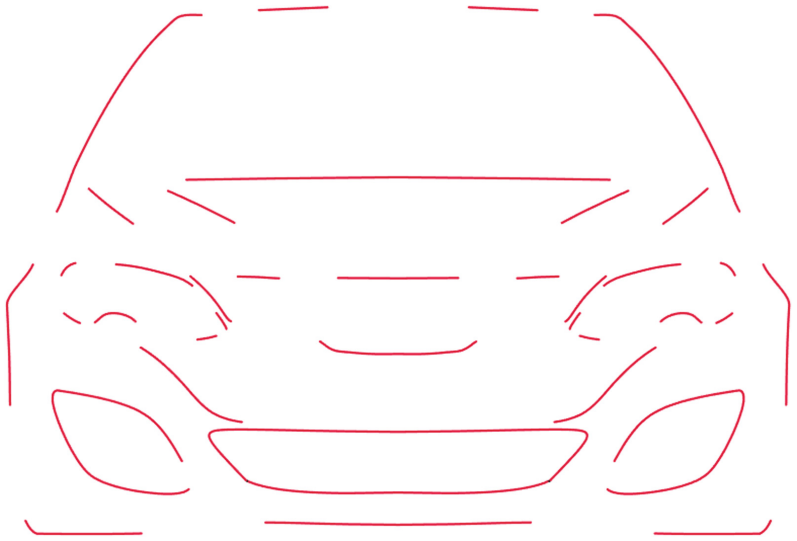

Fig. 4. A reduced but recognizable contour shape of passenger car form in front view.

3 Conclusions and Discussion

Based on young Chinese consumers' perception of and similarity judgement on triple-compartment passenger car forms in front view in the mainstream brands in the Chinese market, an approach to extract the contour shape of passenger car form in front view is completed with quantitative analysis methods.

By cluster analysis method, 76 form samples of triple-compartment passenger car form in front view are selected as representative ones in a total of 130 form samples from 31 main brands in the Chinese passenger car market. With the acquired coordinate values of edit points segmenting 20 character lines, factor analysis is conducted, and the contour shape with about 41% loss of information on passenger car form in front view is extracted and illustrated.

The extracted contour shape is mainly related to and reflected by the following parts and their shapes: side windows, the upper side doors, the upper boundary and the transitional edges of engine hood, the upper and the lower boundaries across Y0 section and vertical boundary of grille, almost entire contour of fog light, most of the upper boundary of headlight, and the entire contour of intake, almost entire skirt line of the front bumper and the transitional edge of the upper area on front bumper. Among these parts, it is noticeable that frog lights and air intake seem to play more influential role in defining the contour shape than headlights and grille.

These findings imply the key areas for the front-view shape of the form in front view in the context of similarity judgement on passenger car form in front view by young consumers, suggesting to certain extent what basic design elements designer may focus on to highlight innovative car styling and design for the targeted consumer population.

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References

1. Ranscombe, C., Hicks, B., Mullineux, G., Singh, B.: Visually decomposing vehicle images: exploring the influence of different aesthetic features on consumer perception of brand. Des. Stud. **33**, 319–341 (2012)
2. Lu, Z., Zhang, Y., Cheng, B., Li, S., Fritz, F.: A study on the cognitive mechanism of car styling based on style feature. Automot. Eng. **38**(3), 280–287 (2016). (in Chinese)
3. Liu, G., Huang, D., Liu, C.: Preference of car form feature based on DEMATEL method. China Packag. Ind. (24), 34–36 (2014). (in Chinese)
4. Li, S., Zhang, H., Qin, Z.: Optimization design of the shape of automobile front face based on inference Kansei Engineering. Pack. Eng. **38**(18), 82–84 (2017). (in Chinese)
5. Li, B., Dong, Y., Zhao, D., Wang, B.: A computational method for car family analysis based on fine-grained classification. Chinese J. Automot. Eng. (4), 250–258 (2018). (in Chinese)
6. Xu, Z., Huang, M., Yuan, Q.: Research on family design theory of vehicle styling based on cognitive psychology. Automobile Appl. Technol. (7), 121–123 (2016). (in Chinese)
7. McCormack, J.P., Cagan, J.: Speaking the buick language: capturing, understanding, and exploring brand identity with shape grammars. Des. Stud. **25**, 1–29 (2004)

8. Guo, R., Yin, H., Peng, J.: Analysis of visual force in automobile front face modeling design. Pack. Eng. **38**(16), 152–157 (2017). (in Chinese)
9. Chen, L.: Research on front face modeling of cars based on gestalt theory. Master's thesis, Hunan University, Changsha (2007). (in Chinese)
10. Liu, C., Ding, X., Xie, Y., Jin, Y.: Young consumers' perception of the similarity between the passenger car forms in front view. Pack. Eng. **39**(24), 158–162 (2018). (in Chinese)
11. IRESEARCH: 2017 China automotive digital marketing case study report. http://report.iresearch.cn/report/201801/3120.shtml. Accessed 1 Nov 2018. (in Chinese)
12. Zhang, W.: Advanced Course of Statistical Analysis in SPSS, pp. 235–251. Higher Education Press, Beijing (2004). (in Chinese)
13. Jing, C.: The car design method based on evolutionary thinking. Doctoral dissertation, Hunan University, Changsha (2015). (in Chinese)
14. Zhao, D., Zhao, J.: Automobile form feature and feature line. Pack. Eng. **28**(3), 115–117 (2007). (in Chinese)