

3D Face Synthesis Based on the Information of Words Expressing Facial Features

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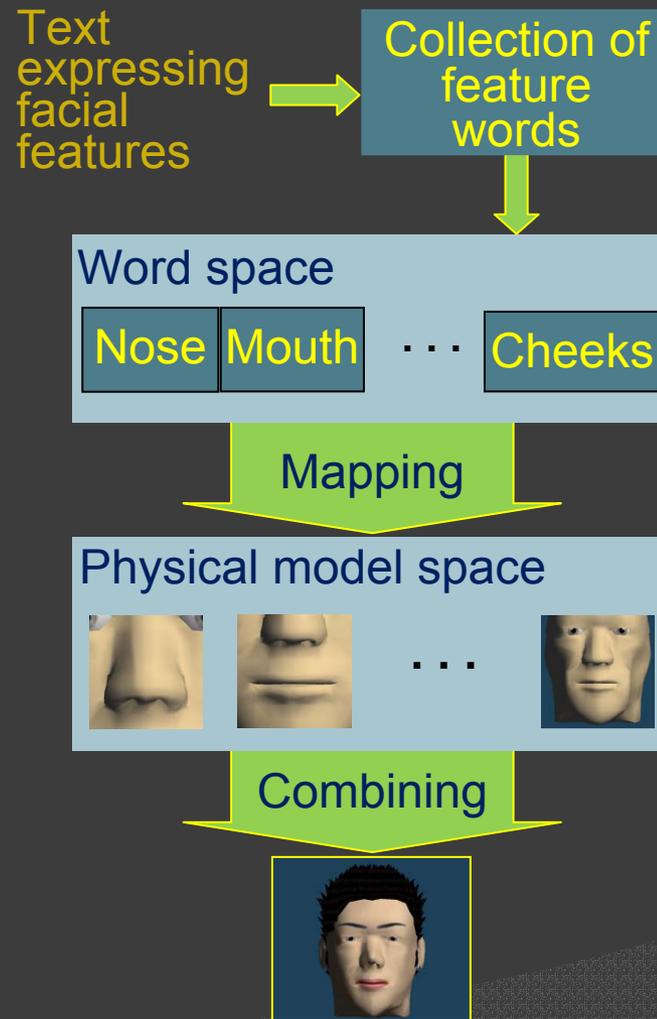
Background

- ① Feelings and sensitivity are indispensable elements in establishing a human-centered system
- ② Information expressed by the human face plays a pivotal role in human communication
- ③ Various kinds of research have recently been conducted that deal with various types of sensitivity information about face
- ④ We focused on the synthesis of individual faces based on verbal expressions with a high degree of freedom

Goal

- ◎ In the past studies on the synthesis of a face based on word information, the words are very restrictive
 - words expressing physical quantities, such as the height of nose or the size of eye
 - others expressing their degree, such as slight, a little, and very
- ◎ Our research attempts to synthesize a face based on abstract, sentimental and metaphoric expressions and descriptions
 - gimlet eye, piggy nose, and haggard face

Outline of the facial synthesis system



Facial elements and Feature words



Facial element	The number of words	Examples of feature words
mouth	27	big mouth, thin mouth
nose	52	long nose, plump nose, snub nose
eyes	23	eyes slanting upward, puffy eyes
eye-brows	26	thin eye-brows, thick eye-brows
cheeks	16	plump cheeks, haggard cheeks
jaw	25	sharp jaw, protruding jaw
profile	23	egg-shaped face, firm face

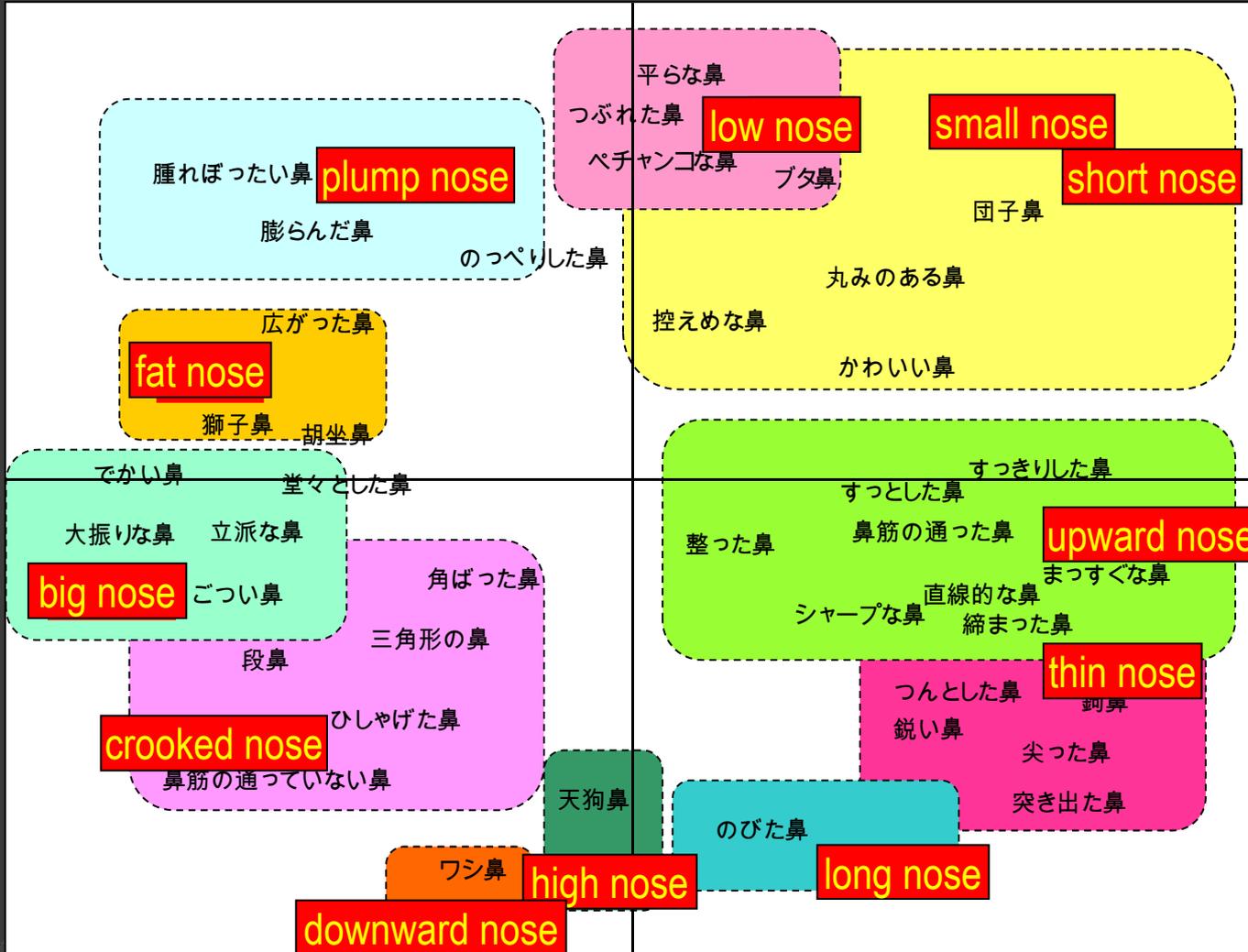
Word space

- ① A similarity matrix among the feature words is obtained based on the similarity of the shape recalled by the words
- ② A spatial layout of the feature words is obtained by inputting the similarity matrix into Multi-Dimensional Scaling method (MDS)
- ③ This spatial layout of the feature words is the word space
- ④ The word space is made for each facial element

Characteristics of word space

- ◎ The origin is neutral
- ◎ The farther away a feature word is from the origin, the greater the characteristic of the feature word
- ◎ Similar words are arranged close together
- ◎ Dissimilar words are arranged further away from each other
- ◎ Every word space of the feature words has six dimensions

Word space of nose



Physical model space

- ① Concrete shapes of the facial elements are determined by wire frame model on 3-dimensional computer graphics
- ① A set of xyz coordinates of all the apexes in the wire frame model becomes the parameters of the physical model space
- ① The number of parameters is different from each facial element
- ① The physical model space is made for each facial element

Mapping function

- A feature word \mathbf{W}_i of a facial element is described as follows;

$$\mathbf{W}_i = (w_1, w_2, \dots, w_6) \quad (1)$$

$i = 1, \dots$, the number of feature words

- A physical model \mathbf{M}_i of the same facial element is described as follows;

$$\mathbf{M}_i = (\mathbf{P}_{i1}, \mathbf{P}_{i2}, \dots, \mathbf{P}_{in}) \quad (2)$$

$$\mathbf{P}_{ij} = (x_{ij}, y_{ij}, z_{ij}), j = 1, 2, \dots, n \quad (3)$$

- The mapping function is described as follows;

$$\mathbf{M}_i = \mathbf{f}(\mathbf{W}_i) \quad (4)$$

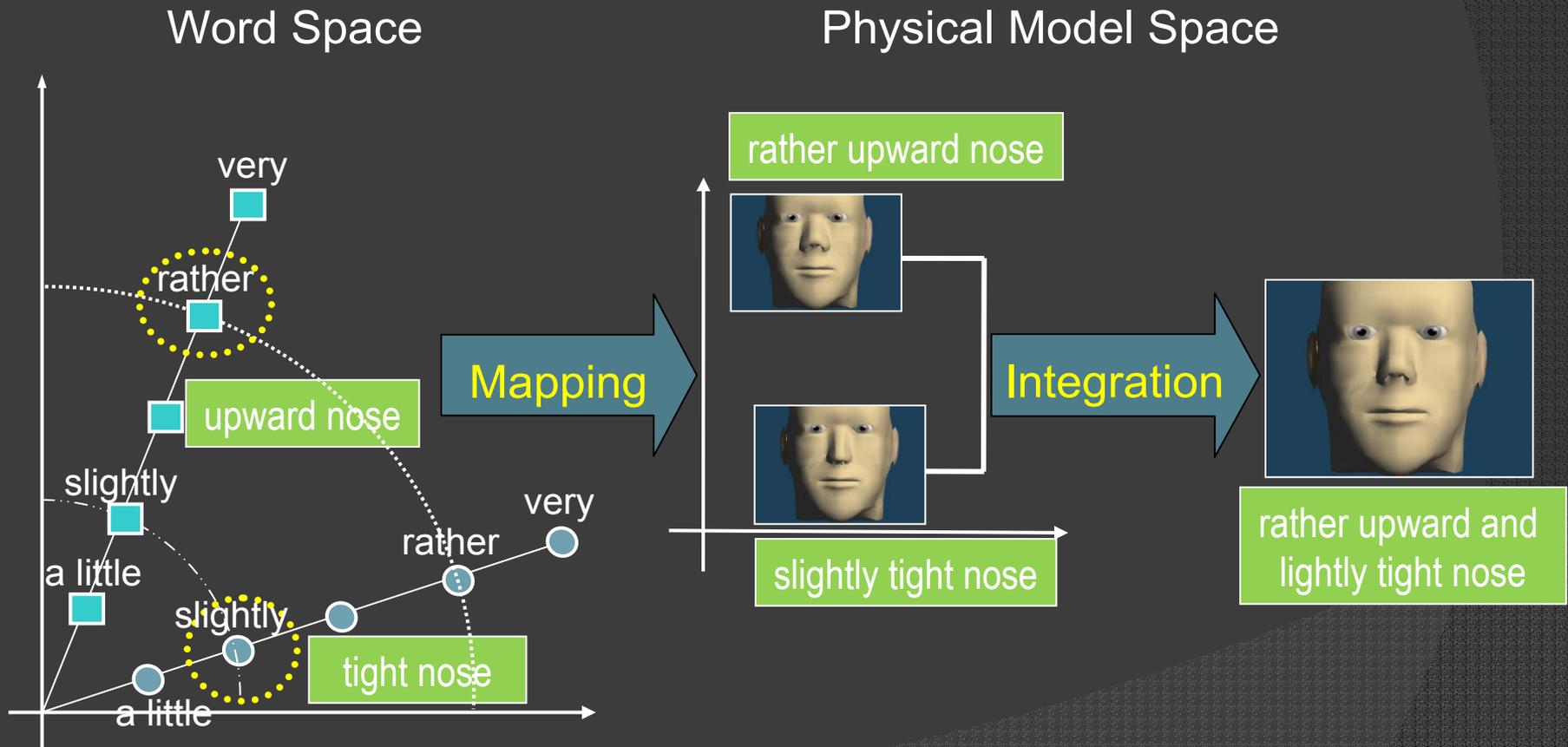
$$\mathbf{P}_{ij} = \mathbf{f}_j(\mathbf{W}_i) \quad (5)$$

$$x_{ij} = f_{xj}(\mathbf{W}_i), y_{ij} = f_{yj}(\mathbf{W}_i), z_{ij} = f_{zj}(\mathbf{W}_i) \quad (6)$$

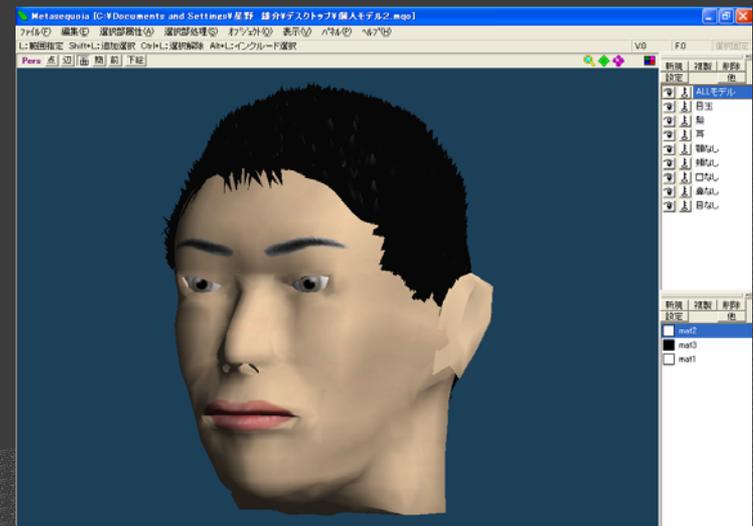
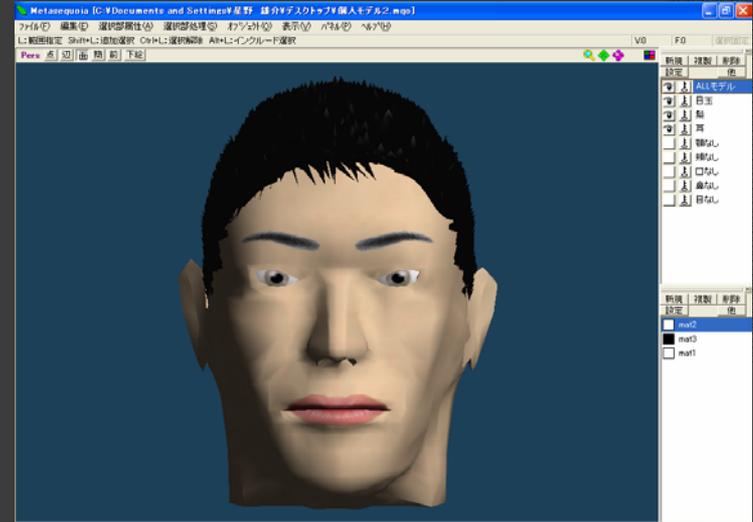
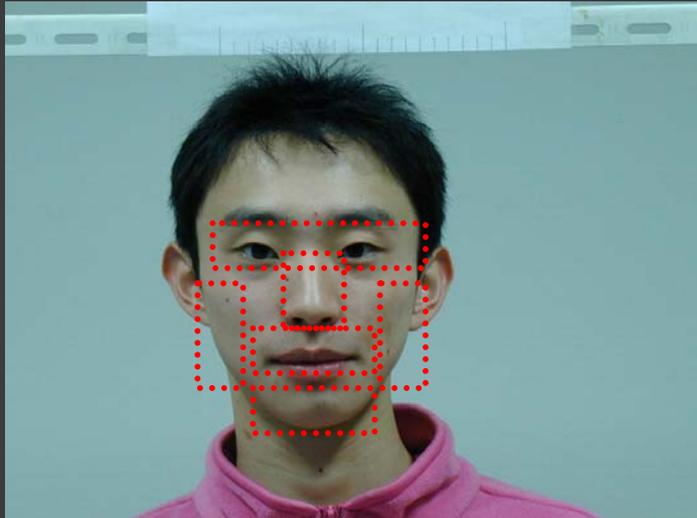
Training data of nose

feature word	physical model	feature word	physical model
thick nose		thin nose	
big nose		upward nose	
crooked nose		short nose	
downward nose		small nose	
high nose		low nose	
long nose		plump nose	

Calculation to compound the feature words



Individual model 1



upward-slanting eyes

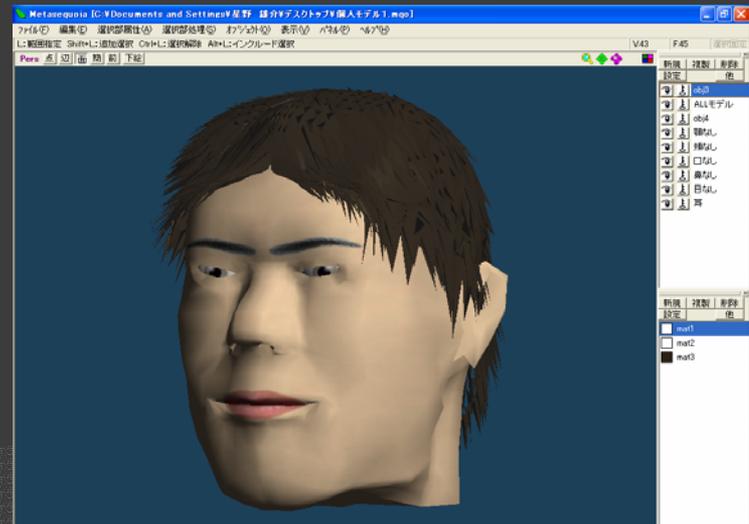
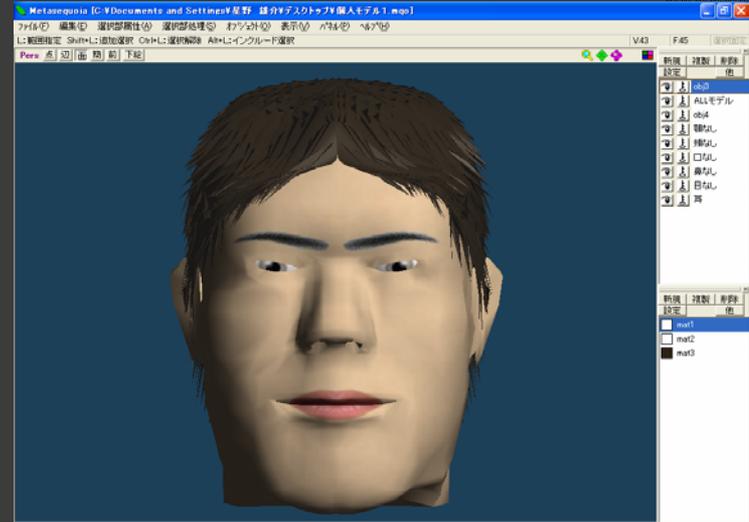
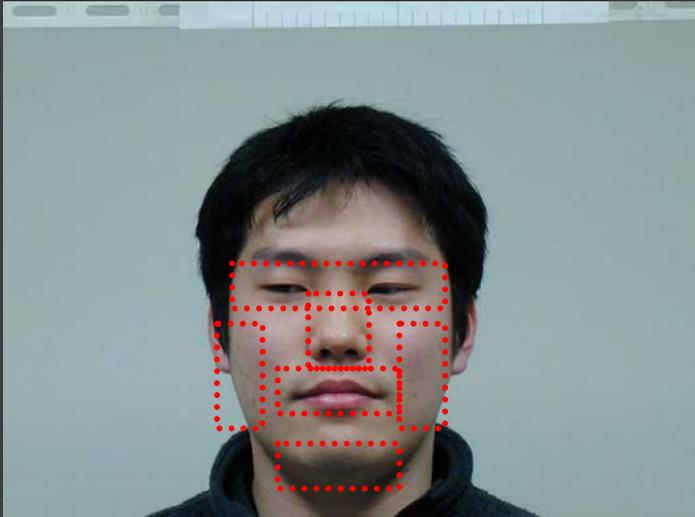
a thin nose

an oblong mouth

sink cheeks

a sharp jaw

Individual model 2



very thin eyes

a straight lined nose

a little edge upped mouth

a little chubby cheeks

a sturdy jaw

Experiment for evaluation (1)

(a)



He has very downward-slanting eyes and eyebrows, a little big nose, and chubby cheeks. His jaw is round.



(b)



He has very thin eyes, a straight lined nose, and a little edge upped mouth. His jaw is sturdy and cheeks a little chubby.



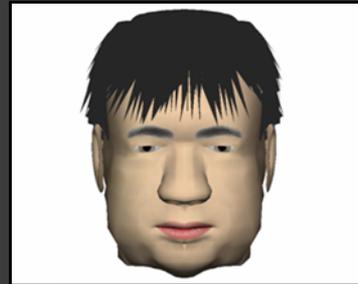
(c)



He has upward-slanting eyes, a thin nose, and an oblong mouth. His jaw is sharp and cheeks sink.



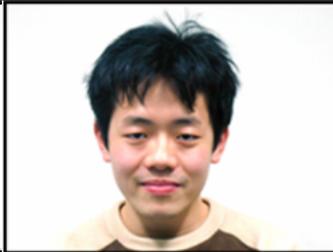
Experiment for evaluation (2)



(1)



(2)



(3)



(4)



(5)



(6)



(7)



(8)



(9)



(10)



Experimental results

Table 1

Synthesized face ID	Photograph ID										Rate of Correct Answer
	1	2	3	4	5	6	7	8	9	10	
(a)	0	4	0	0	0	<u>17</u>	0	1	0	0	0.773
(b)	0	0	0	0	0	0	0	0	1	<u>21</u>	0.955
(c)	4	0	<u>17</u>	0	0	0	0	1	0	0	0.773

Table 2

Synthesized face ID	Photograph ID										Rate of Correct Answer
	1	2	3	4	5	6	7	8	9	10	
(a)	0	0	0	0	0	<u>15</u>	0	3	0	4	0.682
(b)	2	0	1	0	0	0	0	1	1	<u>17</u>	0.773
(c)	1	2	<u>18</u>	1	0	0	0	0	0	0	0.818

Future works

- ① Collect feature words about hair style and texture of skin, and make their physical models
- ② Make more elaborate physical models using the face database of 300 people
- ③ Cope with differences in gender and age by changing the standard facial model