Geometric Features for Face Recognition

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A study of geometric approach to face recognition problem is presented. The Euclidian distance was used as a similarity measure in the feature space. The recognition rate equals 90% on the database of 50 images.

INTRODUCTION

There is a lot of approaches to face recognition problem. We have analysed most of them in the survey [1]. The oldest one is based on the face feature points, which are also called the anthropometric points. There are some merits and demerits of this approach. It is need about 40 anthropometric points to describe a face quite robustly. These points are known and used by criminalists widely. The problem is to find the optimal geometric feature set for a face description. It means the images of similar people or images of one person must be closer to each other in the feature space than to images of other persons. The difficulties are in great quantities of geometric feature variations. For example, there are 780 of all possible segments what may be drawn between 40 points. Beside that, geometric features may be presented by perimeters and areas of some figures formed by the points and so on. It makes choosing difficult. The aim of our study is to obtain several steady features sets, to compare them and to find the best one. This paper presents the first steps of our study.

We can present faces as patterns in the feature space. That is why the simplest measure in the recognition process may be the Euclidian distance between the points. To check effeciency of this idea we have provided several experiments. We used the ORL face database. The image name – SI_J means the J-th image of I-th person.

Table 1. Points and Distances used

N	Distance	N	Distance
1	((ER2,ER1)+(EL1,EL2))/2	16	((ER2,ER1)+(EL1,EL2))/2
2	((ER4,ER6)+(EL4,EL6))/2	17	((LL2,FL11)+(LR2,FR1))/2
3	(EL5,ER5)	18	((ER2,NR1)+(EL2,NL1))/2
4	(NL2,NR2)	19	(BL3,BR3)
5	(LL2,LR2)	20	((ER1,BR1)+(EL1,BL1))/2
6	(FL1,FR1)	21	((EL2,BL3)+(ER2,BR3))/2
7	(LL1,FL1)	22	((ER2,ER1)+(EL1,EL2))/2
8	(LR1,FR1)	23	((ER6,BR4)+(EL6,BL4))/2
9	(LL1,LR1)	24	((BR5,BR4)+(BL5,BL4))/2
10	(LM.LU)	25	((BL5,BL1)+(BR5,BR1))/2
11	(LM,LD)	26	((BL5,BL1)+(BR5,BR3))/2
12	(LD,TL)	27	(EL2,NN)
13	(NN,LU)	28	(ER2,NN)
14	(NL1,NR1)	29	((ER2,LR1)+(EL2,LL1))/2
15	((EL5,NL2)+(ER5,NR2))/2	30	((EL1,EL5)+(ER1,ER5))/2

EXPERIMENT 1

First we tested images of 5 people which were organized as 5 clusters. Every cluster included 5 photos of one person. Total number of images was 25. In the experiment the goal was "to find 5 nearest images". Carrying out the experiment, we measured 45 distances between 35 anthropometric points (Fig. 1) for every image. The distances were transformed into 30 features, Table 1. After that, the features were normalized by dividing on the distance between centers of the left and right irises. Describing the faces as points in 30-d feature space, we calculated the distances from every image to every other one and found 5 nearest images. The results are presented in Table 2.

Table 2. Results of experiment 1

Tested Image	Nearest to the tested image				
	1	2	3	4	5
S5_6	S5_9	S5_2	S5_8	S9_4	S9_8
S5_10	S7_5	S7_4	S7_1	S6_5	S6_4
S5_9	S5_6	S5_8	S5_2	S10_5	S9_4
S5_2	S5_6	S5_9	S5_10	S7_5	S9_8
S5_8	S5_9	S5_6	S5_2	S10_5	S10_6
S6_5	S6_4	S6_7	S6_6	S10_10	S10_8
S6_3	S6_6	S6_5	S6_4	S6_7	S10_10
S6_4	S6_5	S6_6	S6_7	S9_8	S9_9
S6_6	S6_7	S6_3	S6_5	S6_4	S10_10
S6_7	S6_5	S6_6	S6_4	S6_3	S10_10
S7_5	S7_1	S7_4	S5_10	S7_8	S7_7
S7_7	S7_8	S7_1	S7_5	S7_4	S5_10
S7_8	S7_7	S7_1	S7_5	S7_4	S5_10
S7_1	S7_5	S7_8	S5_10	S7_4	S7_7
S7_4	S7_5	S5_10	S7_1	S7_8	S7_7
S9_9	S9_8	S9_4	S9_6	S9_1	S10_5
S9_8	S9_9	S9_4	S9_6	S9_1	S6_4
S9_6	S9_9	S9_4	S9_1	S9_8	S10_1
S9_1	S9_4	S9_6	S10_8	S9_9	S10_5
S9_4	S9_1	S9_9	S9_6	S9_8	S10_8
S10_5	S10_6	S10_8	S9_4	S9_1	S9_9
S10_10	S6_5	S6_6	S6_4	S6_7	S6_3
S10_6	S10_5	S10_8	S9_1	S9_4	S9_6
S10_8	S9_1	S10_5	S10_1	S10_6	S9_4
S10_1	S10_8	S9_4	S9_6	S9_1	S10_5

There are two images S5_10 and S10_10 for which 5 nearest to them are not images of the same person. (see Table 2.). There is just one case (S10_8) when the nearest face is belonged to other person. The recognition accuracy was 23/25 =92%. By the word, the people whose images were used in first part of experiments were not similar to each other.

EXPERIMENT 2

In the second test we took at 5 images of 10 people (totally 50 images). The goal was the same. Images of the first test were used in the experiment. 5 clusters of patterns included images of two people quite similar to the people from the first part of the test set. These pairs are S5-S40 and S7-S17 (Fig. 2). For every cluster of images (one person – one cluster) we calculated average of every feature. The point with average values will be the center of a cluster in the 30-d space. Then we got distances between every pattern of a cluster and its center. After that we chose farthest (F in Table 3) and nearest (N) images from the center of every cluster and also choose one of the rest images (usually with the average distance from the center of a cluster - M in Table 3). We calculated distances between each of the images and found 5 nearest ones (Fig. 3) for every of chosen portraits (totally for 30 images). The results are presented in Table 3.

There are 3 images (S5_10, S10_10 and S17_3 in Table 3) for which all 5 nearest to them images display the other persons. The recognition rate was 27/30=90%. Note, that all 3 unrecognized images are farthest from the center of their clusters. That means these images have quite strong difference with the rest patterns of the clusters. Looking from the point of similarity of two people pairs (S5-S40 and S7-S17 Fig. 2) there is just in one case when 5 nearest images included image of the similar person. We can say that the chosen features set is not sensitive to the people similarity from the human point of view.

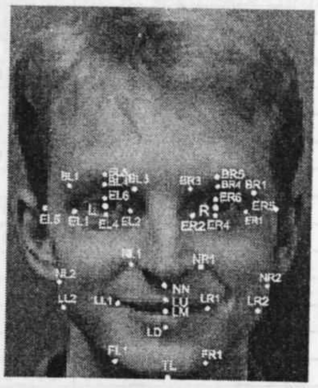


Fig. 1. Anthropometric points.

Table 3. The results of experiment 2

	Tested Image	Nearest to the tested image				
		1	2	3	4	5
N	S5_6	S5_9	S5_2	S17_3	S40_6	S27_3
F	S5_10	S7_5	S7_4	S7_1	S6_5	S8_8
M	S5_9	S17_3	S5_6	S5_8	S5_2	S10_5
N	S6_5	S6_4	S6_7	S40_10	S40_7	S8_8
F	S6_3	S6_6	S6_5	S6_4	S6_7	S10_10
M	S6_4	S6_5	S8_8	S40_10	S40_7	S40_2
N	S7_5	S7_1	S7_4	S5_10	S7_8	S17_4
F	S7_7	S7_8	S7_1	S7_5	S7_4	S5_10
M	S7_8	S7_7	S7_1	S7_5	S7_4	S5_10
N	S9_9	S9_8	S9_4	S9_6	S9_1	S10_5
F	S9_8	S9_9	S9_4	S9_6	S40_6	S9_1
M	S9_6	S9_9	S9_4	S9_1	S9_8	S10_1
N	S10_5	S10_6	S10_8	S9_4	S9_1	S9_9
F	S10_10	S6_5	S6_6	S6_4	S8_5	S8_6
M	S10_6	S10_5	S10_8	S9_1	S9_4	S9_6
N	S8_6	S8_5	S8_8	S8_2	S17_6	S8_1
F	S8_8	S6_4	S8_5	S17_4	S8_8	S40_2
M	S8_2	S8_1	S8_6	S40_6	S17_6	S17_7
N	S13_5	S13_8	S13_10	S6_7	S6_5	S17_7
F	S13_3	S13_5	S13_10	S13_8	S6_7	S17_6
M	S13_8	S13_5	S13_10	S10_10	S6_5	S6_6
N	S17_6	S17_7	S17_9	S8_6	S17_4	S40_7
F	S17_3	S5_9	S40_5	S5_6	S5_2	S40_2
M	S17_4	S40_2	S8_8	S17_6	S17_9	S8_6
N	S27_3	S27_2	S27_1	S27_10	S40_6	S9_4
F	S27_7	S40_6	S27_3	S27_2	S5_6	S17_3
M	S27_1	S27_3	S27_2	S27_7	S9_4	S10_1
N	S40_10	S40_7	S6_5	S6_4	S40_2	S40_5
F	S40_6	S40_2	S9_8	S8_2	S27_3	S8_1
M	S40_5	S40_10	S40_2	S6_4	S6_8	S8_8

CONCLUSION

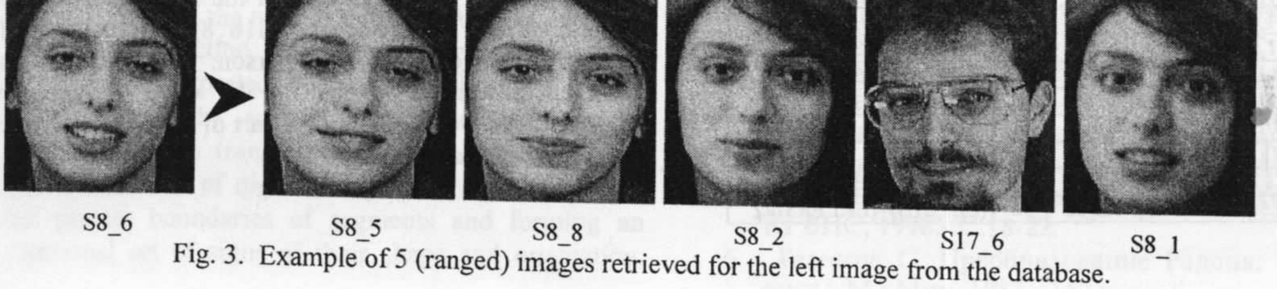
Our preliminary experiments have demonstrated that our approach is acceptable to people retrieving from the face-image databases. At present we make extended experiments.

REFERENCE

1. Samal D. Starovoitov V. "*Approaches and methods to people recognition used on photos* ", preprint #8, Inst. of Eng. Cybernetics, Minsk, 1998, 54 p, (in Russian).

S40_7 S5_5 S7_8 S17_3

Fig. 2. Pairs of similar people in our test database.



S8_6 S8_5 S8_8 S8_2 S17_6 S8_1

Fig. 3. Example of 5 (ranged) images retrieved for the left image from the database.