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ANALYZING THE IMAGE OF THE FACE

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Abstract: *The face recognition technology has emerged as an attractive solution to address many contemporary needs for identification and verification of identity claims. It brings together the promise of other biometric systems, which attempt to tie identity to individually distinctive features of the body, and the more familiar functionality of visual surveillance systems. Face recognition systems are based on the anthropological minutiae on the face. One of the easiest methods used during the 1960s is the graphical method based on the descriptive geometry principles made by the Soviets. This paper deals with the differences between faces in normalized images with straight faces and no swings. This research will be further utilized in novelty approach to face recognition system software.*
Key words: *face recognition, pattern recognition, resemblance calculation, distances between anthropological minutiae*

1. INTRODUCTION

Identification of the person by their externals is a necessary tool in the criminalistics and in other security applications important not only for the investigation tasks and to search for the persons, but also for the direct identification. The biometric systems use following science. Anthropology deals with the description and the human body characteristics evaluation. The anthropological methods can be divided into two groups: the anthropometrical and the somatoscopical. The anthropometry evaluates the characteristics by the objective tools, and is expressed by lenght measures, circumferences, arches, axes, weight, etc. The somatoscopy studies the evolution, size or absence of certain characteristic by the observation. These two approaches are complementary, or one may predominate where necessary (Rak et al., 2008). The description of the person is mainly limited to the somatoscopy, while the identification system by A. Bertillon was based mostly on the anthropometry.

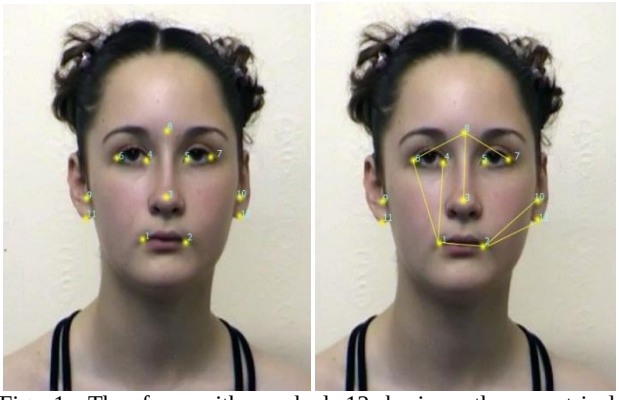

Fig. 1. The face with marked 12 basic anthropometrical minutiae (left), some of the minutiae connected together by the abscisae (right)

As the identification is, in our case, done by the software, utilization of the somatoscopy as the only one tool may be misleading and sometimes insufficient. Therefore, this paper deals with the anthropometry as we wanted to statistically evaluate differences in single images of faces, and use this knowledge as a background for the further research in statistical evaluation of emotions, and in measurements of distances in rotated faces and aging faces. Together, the better view on the needs while creating the sofware should be obtained and employed.

2. METHODS

2.1 Software employed

More thoroughly research was done by the help of the programme Adobe Photoshop CS 5 ver. 10.0 (64 bit version), where the images from the University of Stirling (UK) could be easily measured manually because of the easy manipulation with them. The manual measurement was chosen to avoid errors made by the software.

2.2 Images

The images' proportions are 720 × 576 pixels (≈ 25.4 cm × 20.32 cm). All of the faces were photographed from the same distance, and all faces have straight expressions. The distances were measured in pixels. The survey was done for eleven faces, on which 17 anthropometrical minutiae were selected (see Fig. 2), and for which the distances of each abscissae were measured. It should be noted that the point 13 is the centre of the abscissae 1-2. The eyebrow and pupils was not under consideration, because some individuals do not have them visible, or the boundaries are not sharp enough.

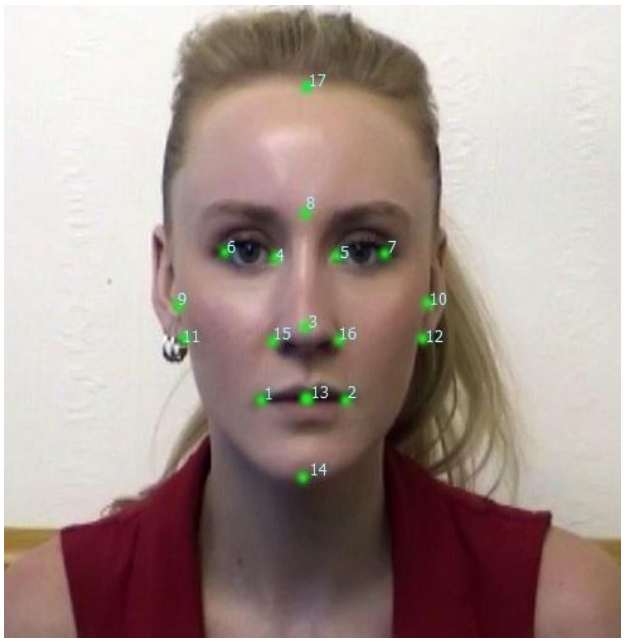

Fig. 2. Chosen 17 anthropometrical minutiae

Face No.	Distances between antrophological minutiae [pixels]																							
	6-4	5-7	6-8	4-8	5-8	7-8	8-3	15-3	16-3	3-13	3-14	6-3	4-3	5-3	7-3	9-11	10-12	9-3	11-3	10-3	12-3	1-2	6-1	7-2
1	38.12	38.33	69.78	45.65	46.87	71.10	86.00	27.20	31.30	53.04	111.00	85.91	56.80	51.89	84.39	42.11	39.12	134.01	126.25	100.57	94.53	68.01	113.76	111.83
2	42.11	37.12	79.16	48.01	48.41	73.43	87.02	26.40	31.38	57.00	116.00	87.66	54.20	56.60	84.02	27.00	26.00	115.02	120.07	107.00	110.35	61.07	113.22	118.30
3	42.01	39.20	72.01	40.36	41.11	72.42	76.24	24.29	23.20	50.09	120.04	83.73	55.00	53.23	80.92	27.29	26.20	90.35	93.98	103.17	102.96	62.51	105.47	103.45
4	51.01	47.68	83.24	46.65	48.26	82.29	90.20	33.96	28.16	47.27	132.06	93.65	54.71	52.92	85.91	27.46	24.33	107.67	112.36	104.04	104.14	111.11	92.05	95.63
5	40.45	39.05	68.96	38.42	35.36	69.89	63.07	27.31	27.29	60.01	117.04	78.55	46.87	48.26	78.55	28.28	-	106.47	109.44	-	103.46	74.01	105.77	106.90
6	41.01	32.39	65.80	35.38	36.88	66.10	70.03	29.41	30.68	58.08	73.03	77.10	49.93	51.00	76.69	25.18	29.02	103.12	111.40	98.25	101.98	73.03	106.48	107.71
7	38.01	39.46	82.38	51.48	50.61	78.26	100.24	24.74	24.80	46.10	109.17	91.61	64.14	59.62	86.89	23.90	28.28	106.08	107.08	99.14	98.73	78.77	107.21	104.14
8	41.05	41.11	72.01	43.83	41.05	69.77	52.01	25.96	23.35	54.01	114.02	83.60	56.82	54.63	81.47	30.41	28.70	100.04	100.57	96.13	101.84	72.01	105.51	108.67
9	44.18	39.12	69.46	38.01	41.04	72.09	51.01	27.70	29.02	48.26	120.07	83.74	53.71	58.60	87.21	37.34	30.80	103.75	98.06	105.17	101.41	78.41	109.14	103.59
10	45.01	39.01	85.88	52.63	53.26	83.35	89.09	33.11	28.12	67.03	134.00	92.44	57.01	56.94	83.23	27.2	27.20	113.00	114.98	101.04	102.36	76.00	122.09	118.09
11	37.12	41.05	70.58	32.60	40.61	73.82	79.06	26.25	24.70	57.08	116.35	82.22	55.46	55.07	80.16	27.29	17.00	98.05	105.30	95.60	103.79	69.01	111.61	106.63

Face No.	Distances between antrophological minutiae [pixels]																							
	13-14	2-12	1-11	6-9	7-10	4-5	4-1	5-2	2-10	1-9	3-1	3-2	15-16	6-10	7-9	9-10	11-12	1-14	2-14	15-1	16-2	17-8	17-3	17-14	17-13
1	58.01	79.20	86.82	49.40	42.19	46.00	105.30	104.17	105.26	112.29	65.30	64.66	49.01	160.65	174.26	202.00	197.01	65.76	68.60	43.57	41.59	94.00	183.00	295.00	236.02
2	56.01	85.91	88.26	68.41	67.48	58.01	108.12	108.02	98.23	99.30	66.89	66.21	53.08	186.40	188.60	220.00	221.02	67.23	60.42	44.72	46.04	101.18	189.02	303.01	246.02
3	55.04	75.24	62.63	53.85	59.41	56.22	97.13	94.53	88.87	78.60	62.17	57.14	46.04	175.52	165.75	194.44	186.76	56.60	62.65	51.16	49.48	90.14	164.44	268.37	215.46
4	86.00	48.85	54.74	63.95	62.80	48.01	96.30	92.31	66.71	63.51	74.52	68.51	62.20	191.13	187.97	214.53	205.70	104.29	107.54	44.78	47.20	84.05	172.29	306.24	221.38
5	56.04	67.42	69.64	64.82	-	53.04	97.74	99.32	-	86.21	72.67	69.35	52.00	-	177.88	-	200.00	67.42	66.29	47.30	48.66	90.05	156.03	273.00	216.01
6	74.03	71.69	77.25	64.03	55.87	52.04	104.39	102.59	89.11	88.41	69.84	68.51	56.00	169.32	170.45	202.36	207.29	79.26	81.86	48.66	49.65	110.37	179.28	309.27	235.31
7	62.01	65.30	76.69	62.97	58.14	55.15	104.31	97.49	82.76	86.21	64.54	58.00	48.09	177.89	179.08	207.54	202.36	74.40	77.82	44.27	40.31	89.09	189.32	299.43	235.61
8	56.00	62.97	59.81	62.68	66.65	48.04	99.85	102.96	78.24	79.51	65.00	64.64	50.00	170.14	170.46	195.01	188.00	70.72	66.73	46.32	46.10	90.14	175.10	285.06	228.11
9	72.01	62.77	67.60	51.62	64.66	48.00	105.22	101.27	84.81	96.43	66.03	63.03	55.013	176.38	169.10	207.41	194.00	79.61	81.84	55.11	49.24	97.00	180.01	299.03	229.02
10	67.01	74.63	82.49	58.41	55.80	62.07	115.043	113.07	97.59	104.69	78.089	74.24	56.01	186.27	188.94	214.00	213.01	76.66	76.06	54.74	52.17	97.05	189.00	322.00	255.00
11	57.31	63.79	69.69	67.42	77.25	51.35	109.66	103.12	68.88	80.81	67.80	63.63	48.04	175.26	172.26	193.37	192.31	64.41	69.04	48.70	47.52	82.49	163.31	275.66	218.52

Tab. 1 & 2. Measured distances between chosen points (minutiae) - cells with "-" mean that one of the points was concealed

2.3 Resemblance calculation

The resemblance calculation m is a quantity, which evaluates the similarity of two vectors or continuous signals. In this case, the measured dimensions of the semantic features are the components of the vectors a and b.

$$m = 0.5 + 0.5 \times \frac{\sqrt{\vec{\Delta} \cdot \vec{\Delta}}}{3\times\sigma} = 0.25 \times \frac{\sqrt{(a_1-b_1)^2+\cdots+(a_n-b_n)^2}}{3\times\sigma} \qquad (1)$$

where the σ is the standard deviation or the typical dispersion of the diversity of two individuals .

3. RESULTS AND DISCUSSION

As can be seen in Table 1 & 2, the measured values are almost similar, differing only in units (by 5 on average), except some faces differing e.g. by 16 units (No. 4, vector 3-14). According to the same table, the most symmetric face is that under No. 5. Other faces are very natural, respectively imperfect in the sense of the symmetry. The resemblance was calculated for the following couples:

1 & 2 (58%), 2 & 3 (82%), 3 & 4 (100%), 4 & 5 (87%), 5 & 6 (63%), 6 & 7 (58%), 7 & 8 (58%), 8 & 9 (38%), 9 & 10 (72%), 10 & 11 (87%)

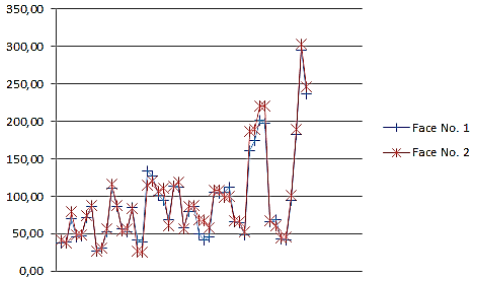

Fig. 3. Comparison of faces with the resemblance 58%

As the best results can be selected resemblance values 38% and 58%. The values 63% and 72% can be regarded as average. The most alarming results are those above 80% of resemblance (e.g. 100% resemblance between No. 3 & 4). These results propably occur due to the utilization of the equation (1), because the faces show variations at first sight as well as the obtained data.

4. CONCLUSION

The obtained data is very important for our further research, because some researches (Rak et al., 2008) show only the conformity coefficients, which do not serve us so much. Those data will be further processed and confronted with values of faces with emotions and rotations. The issues of the 100% resemblance will be further studied for better understanding of the arisen problem. This brings us better knowledge of the face deformation models.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Cipolla, R et al. (2010) *Computer Vision: Detection, recognition and reconstruction*. Berlin: Springer-Verlag, 2010, ISBN 978-3-642-12847-9

Jain, A et al. (2004) *An Introduction to Biometric Recognition.* IEEE Transactions on Circuits and Systems for Video Technology, 2004, vol. 14, no. 1

Mou, D. (2010) *Machine based intelligent face recognition.* Berlin: Springer-Verlag, 2010, ISBN 978-3-642-00750-7

Norman, T. (2007) *Integrated security systems design: Concepts, design, and implementation.* Oxford: Elsevier Inc., 2007, ISBN 978-0-7506-7909-1

Rak, R. et al. (2008). *Biometry and identity of the person in forensic and commercial application,* Prague, Grada Publishing, 2008, ISBN 978-80-247-2365-5

Wayman, J., et al. (2005) *Biometric Systems: Technology, design and performance evaluation*. London: Springer-Verlag, 2005, ISBN 1-85233-596-3