Biometric Recognition

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Exercises

Problem 01. Translate an image by 45 columns to right and 16 rows up and also rotate by 30°. Determine the new coordinate for point (100,66).

Problem 02. Derive a Laplacian 3×3 kernal having non-zero weights to the diagonal elements.

Problem 03. Consider following matching score of 9 subjects in Table 1. Determine a suitable threshold for matching. What are FAR and FRR with respect to that threshold?

ID	1	2	3	4	5	6	7	8	9
1	38	35	34	28	39	29	32	30	42
2	43	44	43	39	41	43	42	37	41
3	40	39	31	29	40	37	33	32	38
4	35	41	40	41	41	39	39	43	34
5	40	38	42	37	38	40	42	40	43
6	42	43	39	31	35	28	33	33	45
7	35	39	36	37	38	37	35	38	36
8	42	32	32	29	39	32	33	30	39
9	42	43	38	36	38	38	35	31	39

Table 1: Matching Scores

Problem 05. A multimodel biometric system uses two traits i.e. face and fingerprint. Face returns a dissimilarity score lying between 0 and 1 while fingerprint gives a similarity score lying between 1 and 100. Suppose, for a given query score returned by face and fingerprint are 0.18 and 65 respectively. Find the combined (used) score for a multimodel system using weighted sum of scores technique. Assume that equal weights are given to both the traits.

Problem 06. Consider the Table. 2 which gives the genuine and the imposter score obtained from face recognition.

Genuine	Imposter
96	84
92	74
90	89
87	76
95	81
91	70
94	71
81	64
98	87
88	83

Table 2: Genuine and Imposter Scores

Using threshold 82, 85, 88, and 90 determine

1. Estimate equal error rate.

2. Accuracy

3. Estimated threshold for maximum accuracy

Problem 07. Drawbacks of various biometric traits are given in Table 3 while importance weightings for various applications is given in Table 4. Assume, High carries penalty of 10 while Medium ans Low carries penalty of 3 and 1 respectively. Determine the Trait to be used for above said application.

Biometric Drawbacks	Airport Access	Credit Card	Physical Access
Intrinsic Properties			
Cooperation Needed	High	Low	Low
Social Stigma	Med	Med	Med
Population Missing	Med	Med	Low
Imaging Properties			
Inconvenience	Med	Low	Med
Acquisition time	High	Med	High
Failure to Enroll	Med	High	Med
Failure to Image	High	High	Med
1:1 Matching Properties			
#FA per 10K	High	High	Med
#FR per 10K	High	Med	Med
Template Size	Med	High	Low
Technology Properties			
Installation Cost	Med	High	Med
Running cost	Med	High	Med
Cost per Match	Med	Med	Low

Table 3: Drawback of Biometric Traits

Biometric Drawbacks	Finger	Face	Iris
Intrinsic Properties			
Cooperation Needed	High	Low	Med
Social Stigma	High	Med	Med
Population Missing	Low	Low	Low
Imaging Properties			
Inconvenience	Low	Low	Med
Acquisition time	Low	Low	Med
Failure to Enroll	Med	Low	High
Failure to Image	Med	Med	Med
1:1 Matching Properties			
#FA per 10K	Low	Med	Low
#FR per 10K	Med	High	Low
Template Size	Med	High	High
Technology Properties			
Installation Cost	Low	Low	Med
Running cost	Low	Low	Med
Cost per Match	Med	Low	Low

Table 4: Importance Weightings

Problem 8. Suppose we have three biometric systems. Their respective FAR and FRR along with their respective cost for false accept (CFA) and that for false reject (CFR) are given in Table 5.

The organization has decided that it can implement a multimodel biometric system with at most 2 traits (using OR rule) provided it has the minimum cost. CFA and CFR for any two traits can be obtained by 75% of sum of CFAs and CFRs of the two traits respectively. Determine the system that will be implemented by the organization.

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Trait	FAR	FRR	CFA	CFR
Face	3.0%	2.5%	5	2
IRIS	0.5%	0.8%	3	8
EAR	1.0%	2.0%	4	6

Table 5: FAR, FRR, CFA and CFR of 3 Traits

Problem 9. Use Haar Wavelet transformation of second level to determine the matching score between the given two image segments given in Table 6.

12	4	23	12	22	18	12	16
23	15	14	14	20	1	23	4
19	5	24	15	21	2	11	3
17	21	24	18	23	19	9	22
14	23	19	9	3	10	15	23
21	16	21	4	4	11	16	1
23	13	17	7	15	13	12	18
3	11	16	13	14	17	13	15

3	8	23	14	19	11	8	4
6	4	1	24	18	9	12	15
16	24	3	14	1	15	23	5
10	34	7	18	5	23	19	21
15	15	12	19	16	3	4	23
13	13	23	20	12	4	15	16
16	12	5	21	24	23	5	13
6	1	6	22	13	14	14	11

Table 6: Two Images

Problem 10. Consider the three matrices A, B and C provided in table 7,8 and 9. The $(i,j)^{th}$ element of the matrix gives the matching score between i^{th} and j^{th} subjects on a biometric trait.

A	S_1	S_2	S_3	S_4	S_5	S_6	S_7
S_1	0.90	0.50	0.60	0.20	0.10	0.40	0.80
S_2	0.40	0.80	0.40	0.20	0.80	0.50	0.50
S_3	0.80	0.10	0.90	0.50	0.60	0.60	0.40
S_4	0.10	0.60	0.50	0.70	0.30	0.50	0.30
S_5	0.30	0.40	0.40	0.40	0.60	0.40	0.30
S_6	0.10	0.90	0.40	0.40	0.30	0.90	0.50
S_7	0.10	0.30	0.40	0.70	0.60	0.20	0.40

Table 7: Similarity Scores for Face [score range from 0 to 1]

1. For each trait determine

   (a) Appropriate operating threshold.

   (b) FAR, FRR, EER

   (c) Minimum Expected Error,

   (d) Maximum Accuracy that can be achieved and its FAR and FRR.

2. Use weighted sum rule to determine the fused matching score when it is found that the accuracy of Face, Ear and Iris are 95%, 97% and 99% respectively.

   (a) Determine an appropriate threshold to achieve maximum accuracy.

   (b) Determine Maximum accuracy, it corresponding FAR and FRR

   (c) Determine the optimum value of k so that the system provides 100% CRR for top k best matches in case of identification.

B	S_1	S_2	S_3	S_4	S_5	S_6	S_7
S_1	0.60	0.70	0.80	0.60	0.90	0.60	0.80
S_2	0.60	0.40	0.70	0.90	0.50	0.80	0.10
S_3	0.80	0.60	0.20	0.60	0.70	0.10	0.80
S_4	0.70	0.10	0.70	0.70	0.80	0.80	0.80
S_5	0.70	0.80	0.90	0.80	0.10	0.80	0.20
S_6	0.70	0.10	0.80	0.70	0.60	0.20	0.70
S_7	0.20	0.70	0.70	0.80	0.80	0.90	0.30

Table 8: Dissimilarity Scores for Ear [score range from 0 to 1]

C	S_1	S_2	S_3	S_4	S_5	S_6	S_7
S_1	90	50	50	20	10	10	30
S_2	10	80	20	30	80	40	40
S_3	30	10	50	40	40	40	80
S_4	10	30	30	80	20	30	70
S_5	80	20	10	20	40	10	20
S_6	30	90	20	10	20	90	30
S_7	80	40	20	40	20	40	90

Table 9: Similarity Scores for Iris [score range from 0 to 100]