# EEL6935 Biometric Identification HW 2

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## Minutiae Matching

Procedure for finding out the minutiae matching points.

1. The probe and gallery is loaded and then the $\theta$ values which go more than 360° are corrected by taking the mod of the input theta. If the theta is greater than 360 it will be reduced back into 0 to 360 range.
2. Assume the probe set is Mi and gallery set is Mj
3. Now for each minutiae point in Mj we calculate the $\Delta x$, $\Delta y$ ,$\theta$, $s$ values and store it in the matrix D if it satisfies the directional distance and spatial distance property. This is done for every minutiae points in Mi and Mj.
4. This $\Delta$ values are found out using the Hough Transform.
5. We quantize the D matrix by comparing every value with every other value in the matrix for a bin size of 10 and 15 units for angle and distance respectively. This is the accumulator which votes for the bins.
6. We find the peaks in the accumulator and use those peaks to get the final $\Delta x$ ,$\Delta y$, $\theta$ values.
7. No for this set of del values we remap the Mj and find the number of matches and match score.
8. For each mapping the max matching score is calculated and the sum of the number of matches for that configuration is the Number of matches
9. From the number of matches we can find out the matching score by using the formula

$$number\ of\ matches/(number\ of\ points\ in\ Mi + number\ of\ points\ in\ Mj)$$

During testing different spatial and directional threshold were changed and the spatial threshold and directional was finalized to be 15 and 15 units. If these distances were very large we get a large undue amount of matches which is similar to large False Match case in verification systems, and if the distances were very small we get less or no matches which which is similar to False Non Match case. The threshold values for the different sets tested have been reported in table 2. The Del values and the matching scores that they produced is available in Table 1. The two finger prints that match are the ones that have the highest number of matches and the highest matching score. This method gives a perfect one pair match for every test case provided.

| File 1 | File 2 | $\Delta x$ | $\Delta y$ | $\theta$ | # Matches | Score |
|---|---|---|---|---|---|---|
| 0101 | 0102 | 68.8589 | -108.4601 | 35.9 | 9 | 0.0070 |
| 0101 | 0202 | 106.0680 | -114.5292 | 32.63 | 5 | 0.0050 |
| 0101 | 0302 | 182.9977 | -69.9347 | 30 | 6 | 0.0052 |
| 0101 | 0402 | 213.3418 | -191.5310 | 33.5 | 1 | 0.0012 |
| 0101 | 0502 | 140.8316 | -179.8301 | 36.25 | 3 | 0.0034 |
| 0201 | 0102 | 85.7513 | 340.0332 | 281 | 7 | 0.0083 |
| 0201 | 0202 | 64.2118 | 298.5714 | 284.5714 | 12 | 0.0166 |
| 0201 | 0302 | 84.8764 | 215.4391 | 287.5714 | 8 | 0.0086 |
| 0201 | 0402 | -3.7111 | 272.7749 | 273.50 | 10 | 0.0164 |
| 0201 | 0502 | 75.5942 | 343.7701 | 269.71 | 9 | 0.0141 |
| 0301 | 0102 | 155.7678 | -190.60 | 42 | 5 | 0.0038 |
| 0301 | 0202 | 172.1031 | -178.0864 | 39.9231 | 6 | 0.0053 |
| 0301 | 0302 | 239.7676 | -122.9192 | 42 | 14 | 0.0097 |
| 0301 | 0402 | 333.5116 | -247.9885 | 49.85 | 3 | 0.0032 |
| 0301 | 0502 | 212.2160 | -236.2912 | 43 | 2 | 0.0020 |
| 0401 | 0102 | 525.5841 | 228.1760 | 189 | 1 | 0.0010 |
| 0401 | 0202 | 533.8293 | 153.9002 | 172.2857 | 1 | 0.0012 |
| 0401 | 0302 | 448.5595 | 157.1573 | 172.5 | 2 | 0.0018 |
| 0401 | 0402 | 349.1814 | 409.0728 | 212 | 2 | 0.0028 |
| 0401 | 0502 | 375.7185 | 417.9444 | 224 | 2 | 0.0027 |
| 0501 | 0102 | 630.5841 | 179.1760 | 189 | 1 | 0.0012 |
| 0501 | 0202 | 577.3827 | 229.5597 | 199.0909 | 1 | 0.0014 |
| 0501 | 0302 | 494.2185 | 201.0939 | 202.0909 | 1 | 0.0022 |
| 0501 | 0402 | 437.1814 | 360.0728 | 212 | 2 | 0.0034 |
| 0501 | 0502 | 463.7185 | 368.944 | 224 | 3 | 0.0048 |

Table 1: Del values and their match scores

| Set No | $\theta_0$ | $r_0$ |
|---|---|---|
| Set 1 | 15 | 15 |
| Set 2 | 40 | 45 |
| Set 3 | 40 | 45 |
| Set 4 | 20 | 25 |
| Set 5 | 20 | 25 |

Table 2: Threshold Values