Local Binary Pattern-based Fingerprint Matching

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Biometric identification

- Recognizing humans based on their body characteristics became more and more popular in emerging technology applications.
- The most common biometric identifiction methods: fingerprint recognition, facial recognition, iris recognition, and voice recognition
- Fingerprint recognition is the most widely deployed biometric identification:
  - persistence (fingerprints do not change with time)
  - individuality (the fingerprint is unique to an individual)

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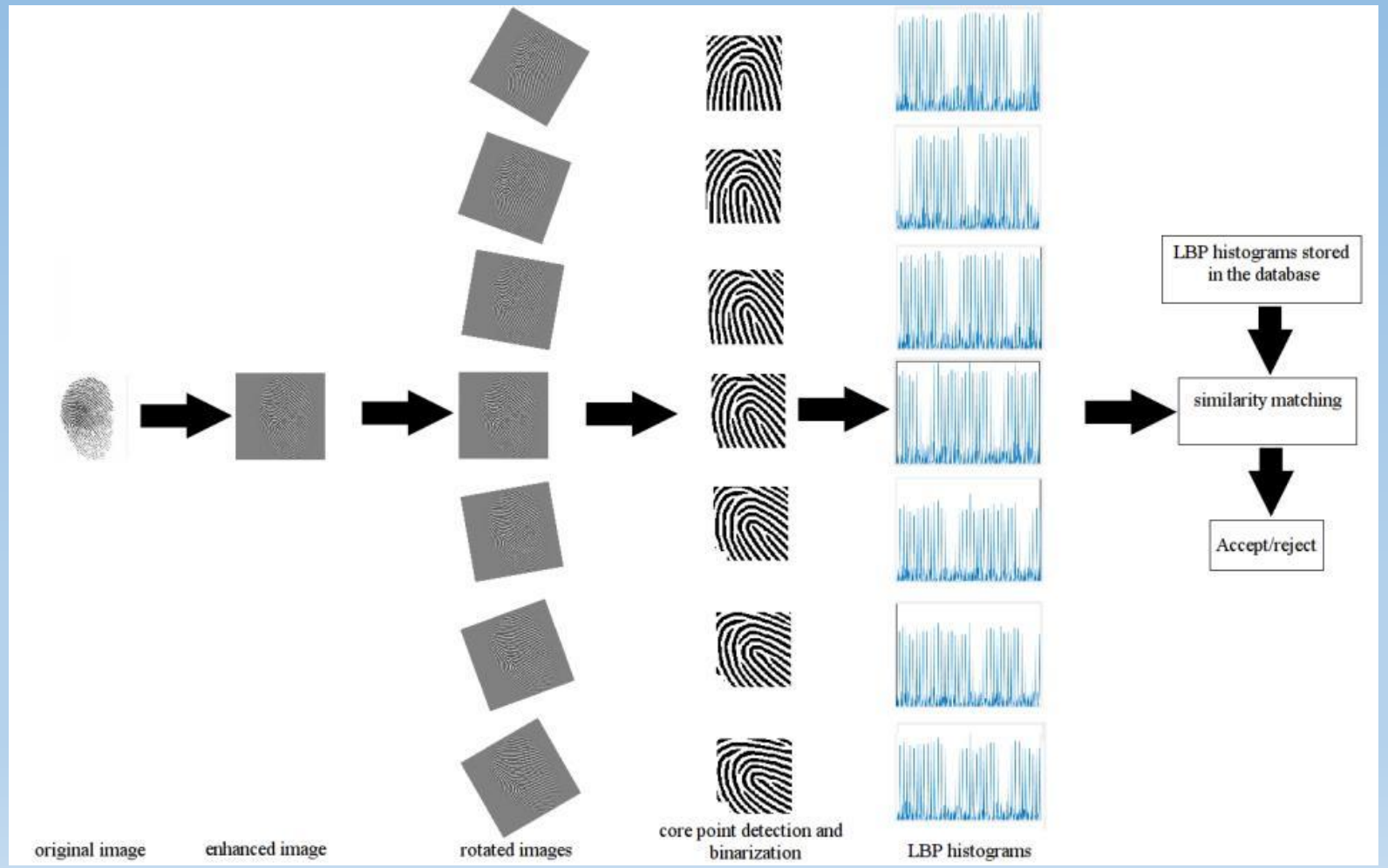
Categorization of the fingerprint matching approaches

- Minutiae-based approaches
- Correlation-based approaches
- Image-based approaches

The block diagram of our fingerprint recognition system



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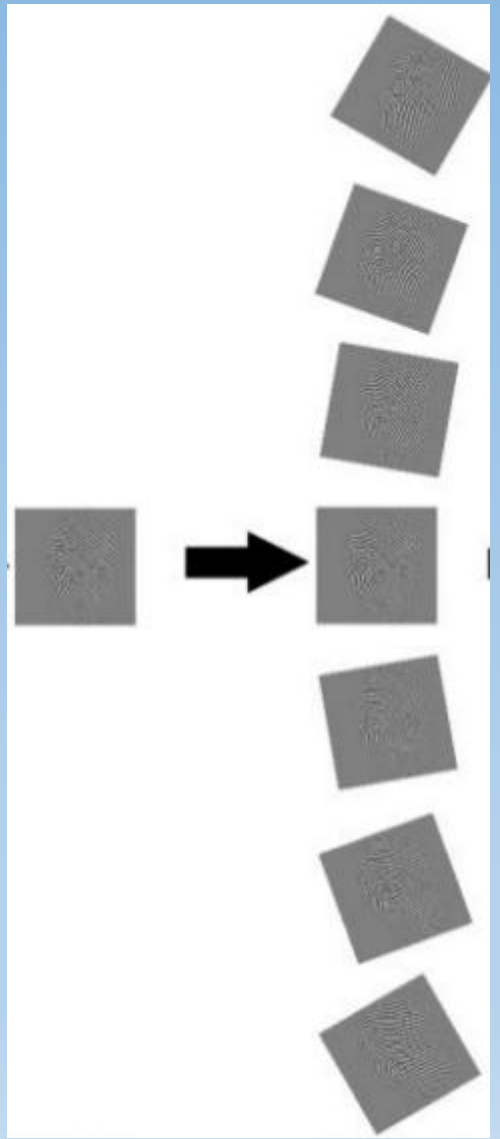
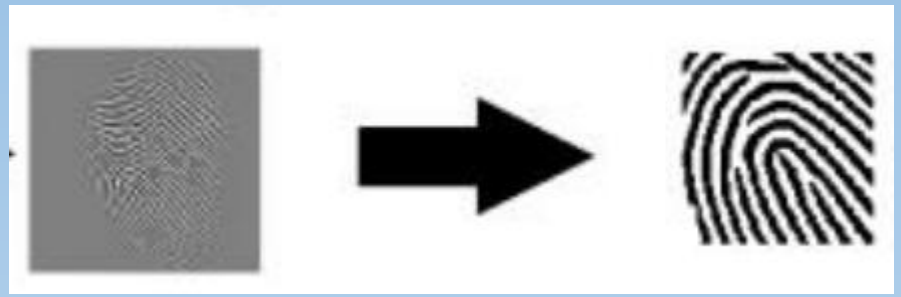
Rotation

- the enhanced fingerprint images were rotated with -30, -20, -10, 10, 20 and 30 degrees because
- in the FVC2002 dataset the relative rotation of the fingerprint pairs does not exceed 35 degrees.



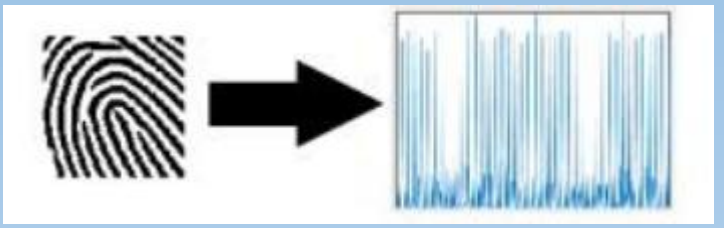
Core point detection and binarization

- The core point refers to the center area of a fingerprint.
- The core point detection was performed on every fingerprint image (enhanced version of the original and rotated ones), and the 100x100 square regions were selected around the core point for the further processes.
- The 100x100 images were converted to binary images.



Creating LBP feature vectors

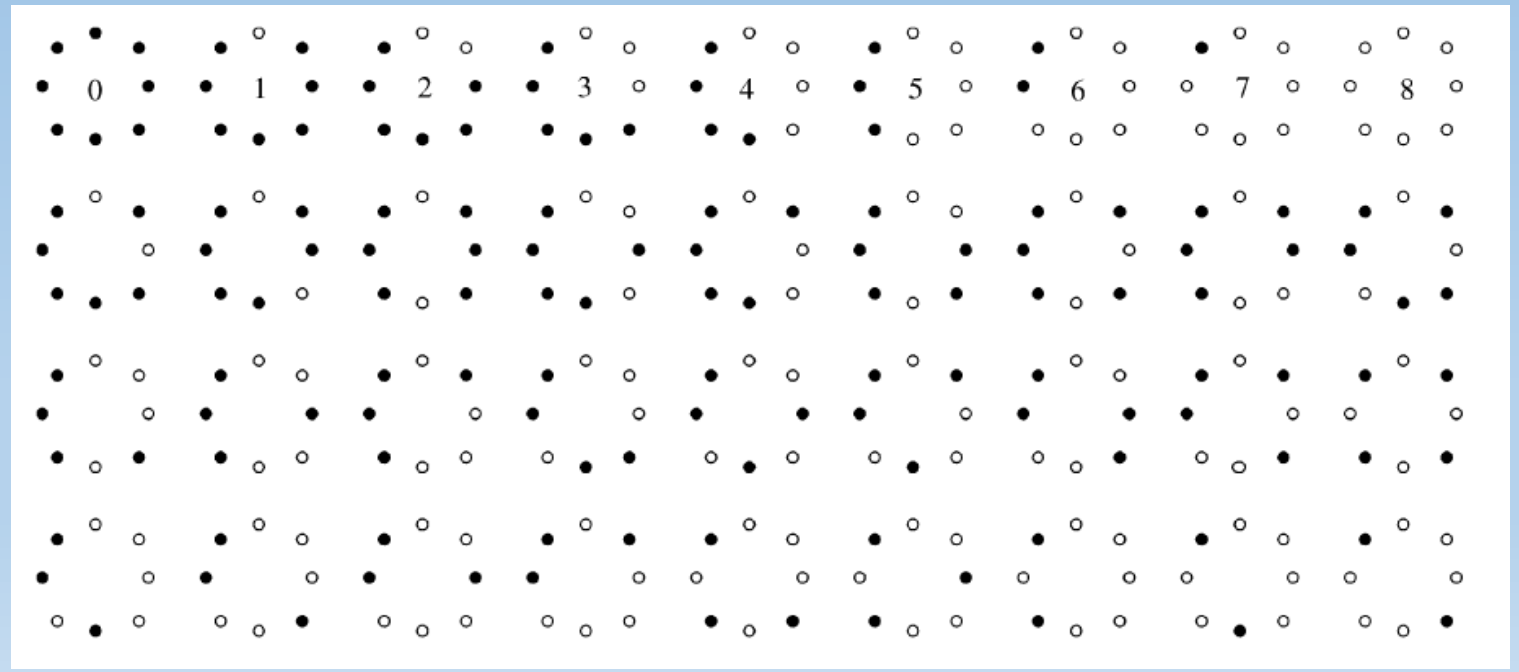
- Local Binary Pattern (LBP) is a simple, very efficient texture operator based on the neighborhood for the pixels of the image.
- The advantages of LBP are its ease implementation, invariance to monotonic illumination changes, and low computational complexity.
- In our approach a rotation invariant uniform Local Binary Pattern operator was used which was presented by Ojala *et. al.*
- LBP features vectors were calculated for the non-overlapping sub-windows of the images, and then these feature vectors were concatenated.



Rotation invariant uniform Local Binary Pattern operator

$$LBP^{riu2}_{P,R} = \begin{cases} \sum_{p=0}^{P-1} s(g_p - g_c) & \text{if } U(LBP_{P,R}) \leq 2 \\ P+1 & \text{otherwise,} \end{cases}$$

$LBP^{riu2}_{8,R}$



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Matching

- For similarity matching the Euclidean distances of the normalized LBP feature vectors were calculated.
- The similarity score of two fingerprints is the minimum Euclidean distance between the LBP histograms of the binary images.
- If the distance is below the threshold then the result is a match.

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Results

- **False Acceptance Rate (FAR):** the percentage of identification instances in which unauthorized persons are incorrectly accepted
- **False Rejection Rate (FRR):** the percentage of identification instances in which authorized persons are incorrectly rejected
- **Equal Error Rate (EER):** FAR=FRR

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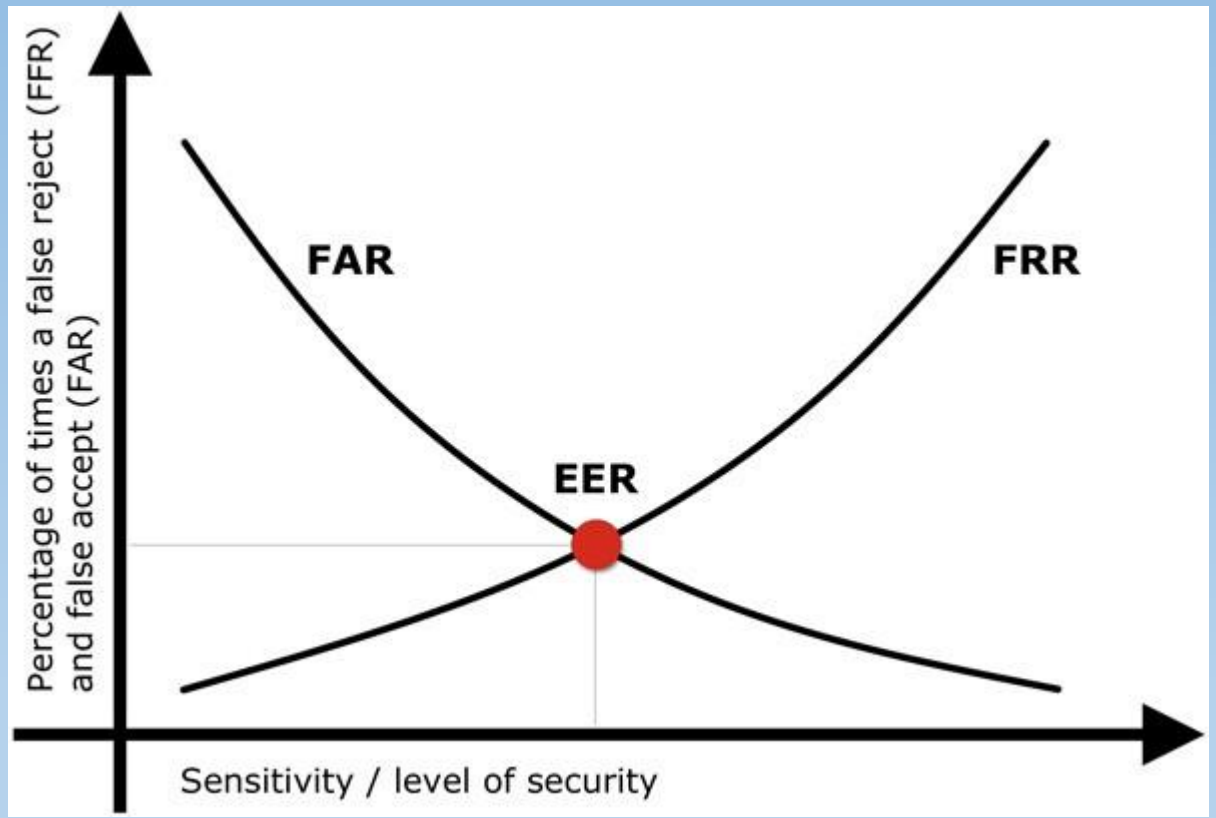
Equal Error Rate



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Results

- **FAR tests:** the first impression of each finger is matched against the first impression of all other fingers
- **FRR tests**: each impression of each finger is matched against all other impressions of the same finger

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Results

sub-windows size	LBP pattern	EER values	
		DB1B	DB2B
100x100	(8,1)	0.3	0.305
20x20	(8,1)	0.049	0.032
30x30	(8,1)	0.071	0.039
100x100	(16,2)	0.245	0.208
20x20	(16,2)	0.052	0.034
30x30	(16,2)	0.06	0.049
100x100	(24,3)	0.262	0.244
20x20	(24,3)	0.115	0.052
30x30	(24,3)	0.112	0.063
20x20	**(8,1)+(16,2)**	**0.044**	**0.031**

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Results

- k-NN classifier
- the configuration with the lowest EER value (20x20 sub-windows, (8,1)+(16,2) LBP patterns)
- Three images from each individual have been used as the training set, while the remaining images from each individual have been used for testing.

	DB1B	DB2B
k=1	0.95	0.966
k=3	0.95	0.95

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Conclusions

- The system was tested on two FVC2002 databases.
- The experiments showed the efficiency of our approach: the EER values are below 0.05, the matching accuracies are at least 95% with the k-NN classifier.
- In the future we would like to extend our approach with wavelet based image descriptors

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Thanks for your attention!