# Fingerprint Matching Techniques

- Minutiae-based
  - Uses location, orientation, and minutia type
  - Point pattern matching problem
  - Hard decision is made on the correspondence
- Correlation-based
  - Spatial correlation of template and query
  - Sensitive to rigid and non-linear transformation
  - Computationally expensive
- Ridge Feature-based
  - Orientation and frequency of ridges, ridge shape, texture information, etc. are used
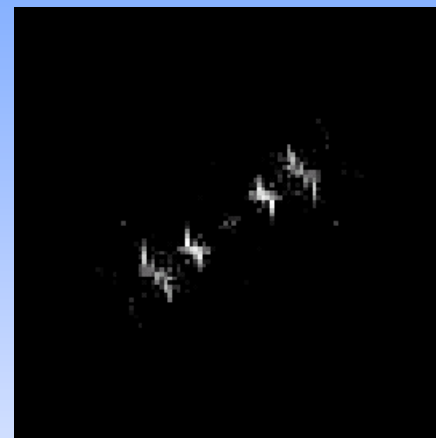 - Suffers from low discriminative ability

Texture-based Fingerprint Representation
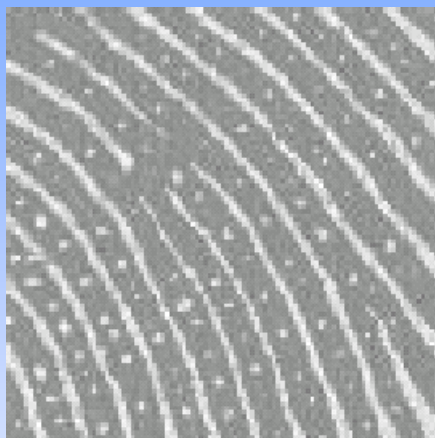
(a) Ridges in local region
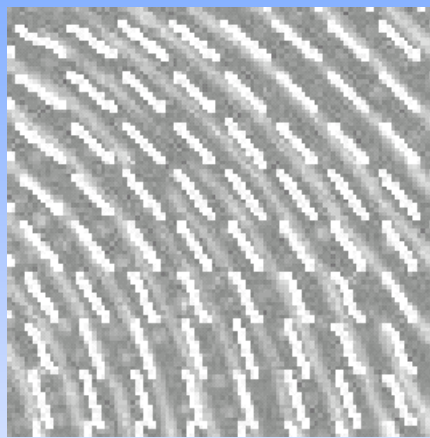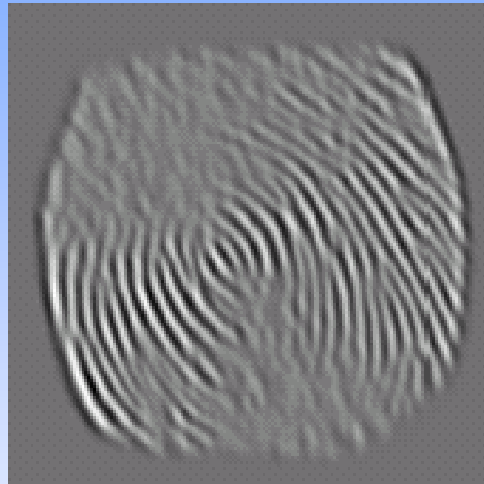
(b) Ridge directions in (a)

(c) Fourier spectrum of (a)

The ridge pattern in a fingerprint may be viewed as an oriented texture pattern having a fixed dominant spatial frequency and orientation in a local neighborhood. The frequency is due to the inter-ridge spacing present in the fingerprint and the orientation is due to the ridge flow pattern
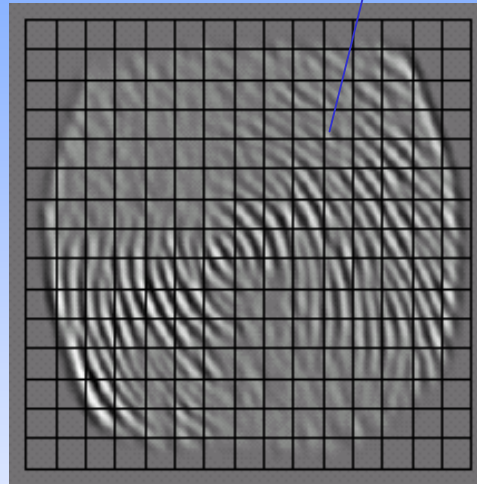
Filtered Images

- An input fingerprint image is filtered using 8 Gabor filters all having the same frequency but different orientations (0°, 22.5^o, 45°, 67.5^o, 90°, 112.5^o, 135°, 157.5^o)
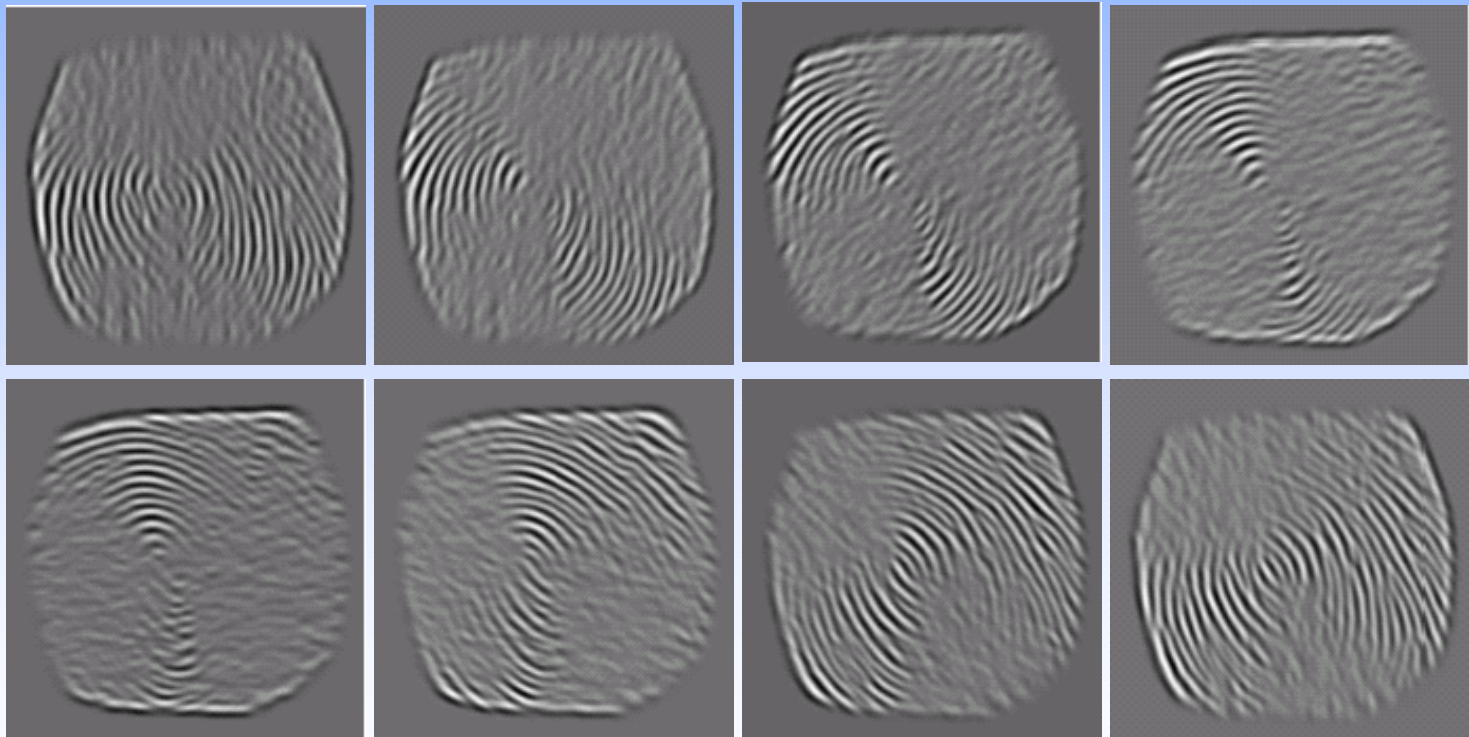
Texture-based Representation

Compute variance of
each cell
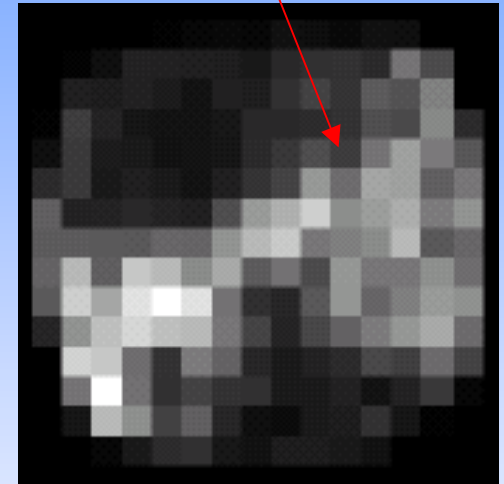
(a) Filtered image   (b) Square tessellation   (c) Feature values

Ridge Feature Map

- The filtered images are examined using a square tessellation and the variance of pixel intensities in every cell is used as a feature value
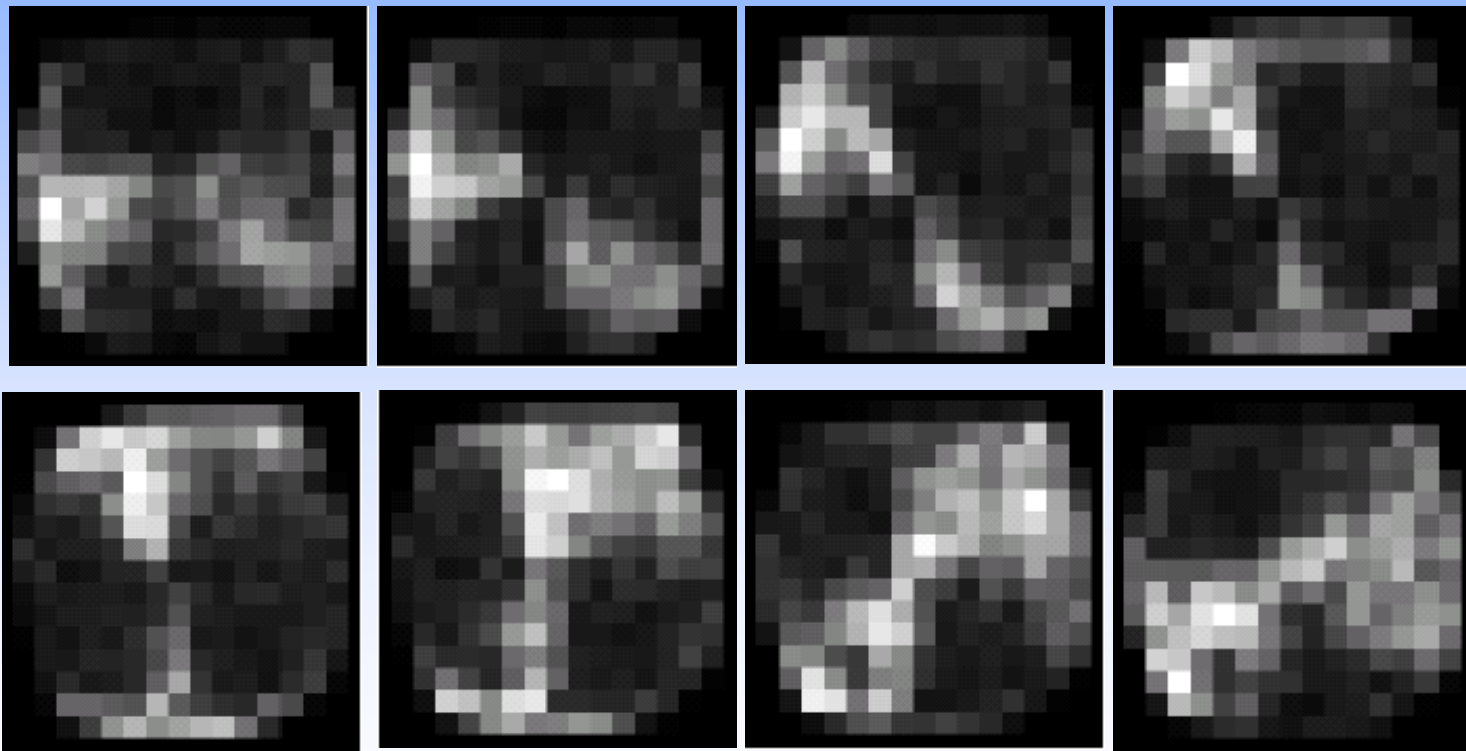
The ridge feature map is a fixed-length feature vector

Ross et al, "A Hybrid Fingerprint Matcher", Pattern Recognition, Vol. 36, July 2003

Performance of Hybrid Matcher (Minutiae & Texture)

Performance on FVC2002 Database 3a

Legend:
- 2-D DP
- Ridge Feature Maps
- Hybrid
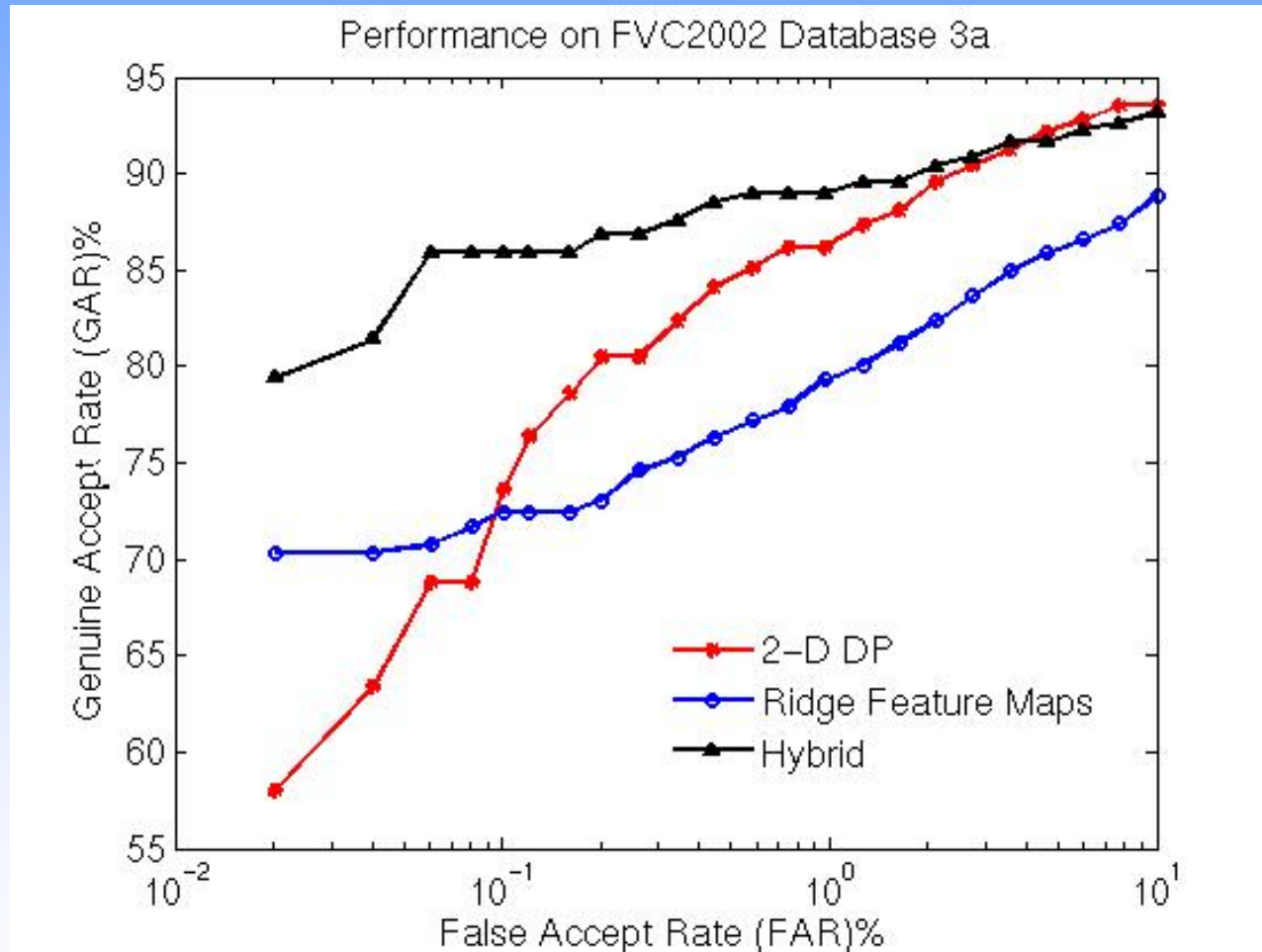
Correlation-based Matching Algorithm
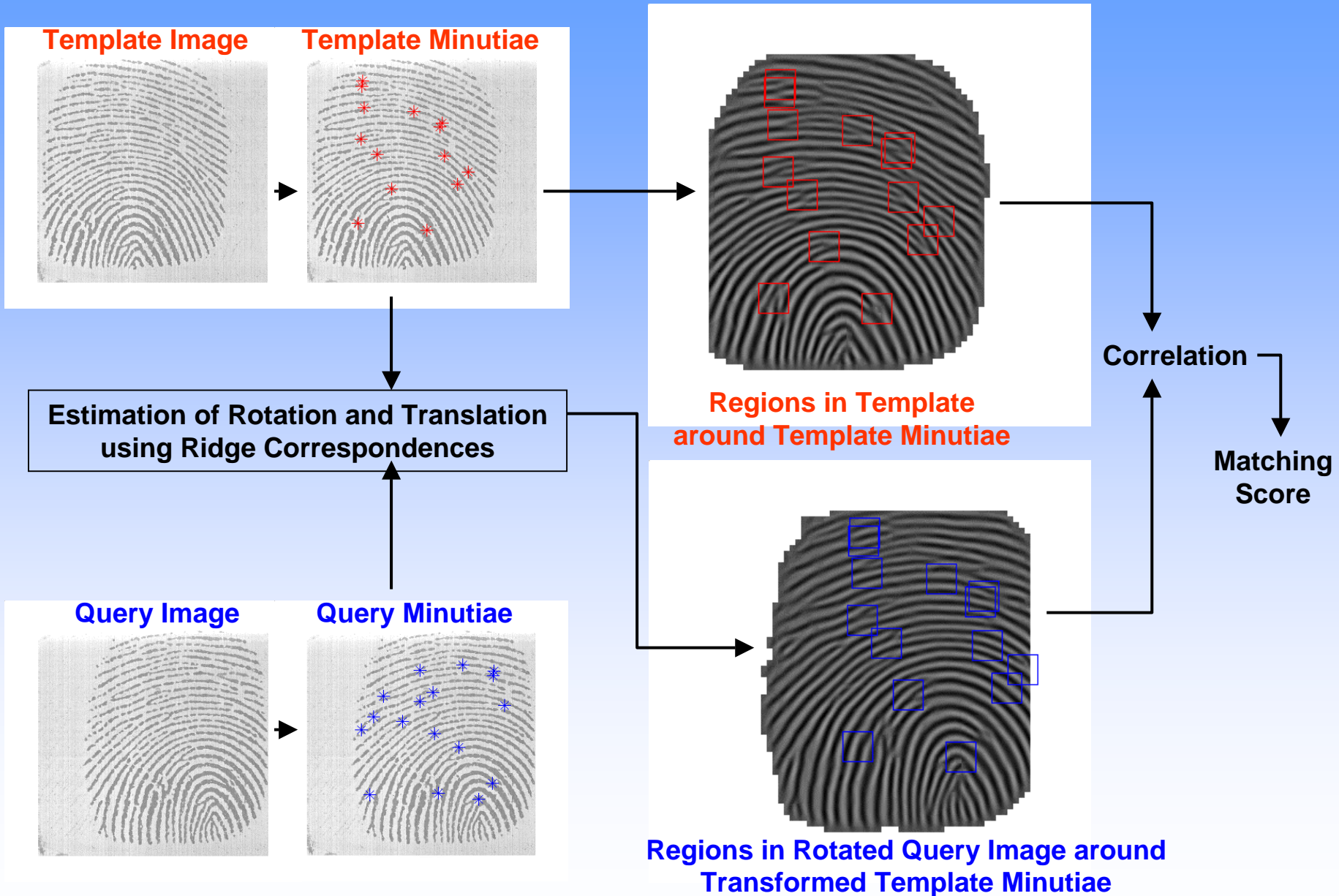
- Normalized cross-correlation of regions around corresponding minutia points is used to describe the quality of a minutia match

- Gray level values around the minutiae retain most of the local information; hence, this method determines the degree of minutia match accurately

- Procrustes analysis of corresponding ridge curves is used to estimate rotations and displacements

- Gabor filter-bank based technique is used for fingerprint enhancement and segmentation

- Since correlation is done locally, the method is reasonably resistant to non-linear deformations

Fingerprint Matching using Local Correlation

Template Image

Template Minutiae

Estimation of Rotation and Translation using Ridge Correspondences

Query Image

Query Minutiae

Regions in Template around Template Minutiae

Regions in Rotated Query Image around Transformed Template Minutiae

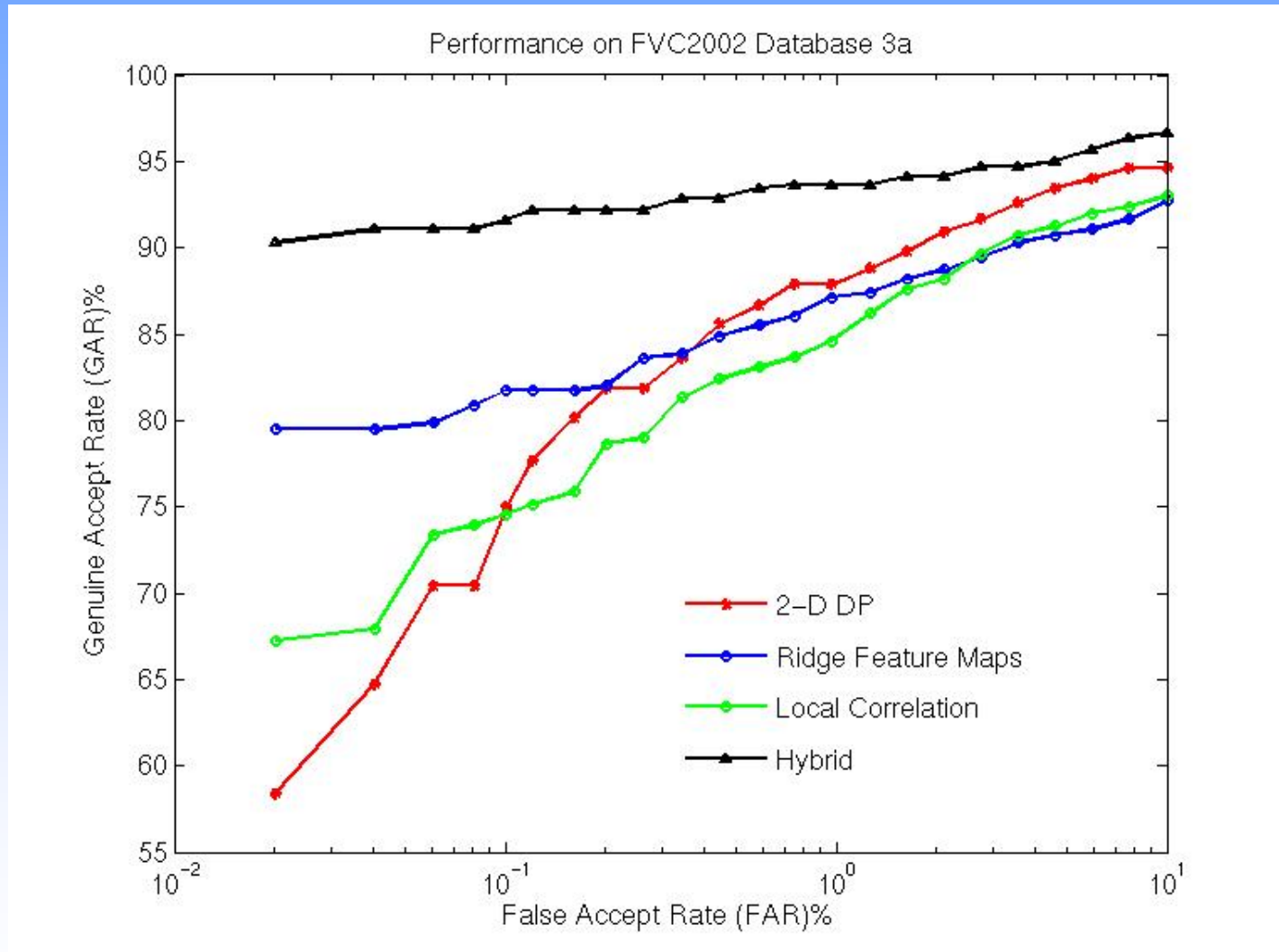**Correlation**

Matching Score

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Performance of Hybrid Matcher (Minutiae and Local Correlation)
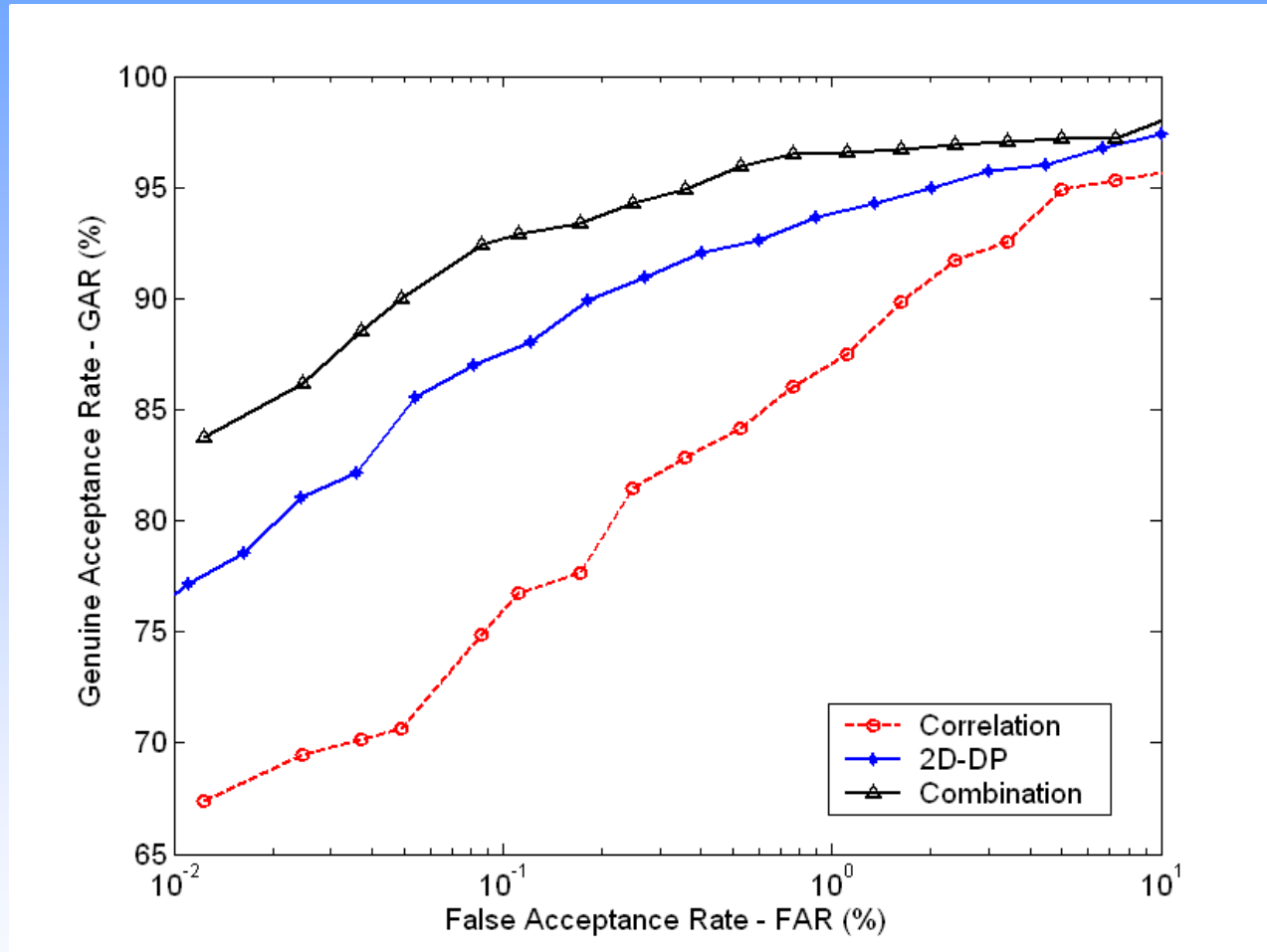
MSU-VERIDICOM fingerprint database; 160 users and 4 impressions/user

Performance of Hybrid Matcher (Minutiae, Texture & Local Correlation)

Performance on FVC2002 Database 3a

FVC 2004 Results

Algorithm	EER(%)	Avg Enroll Time (sec)	Avg Match Time (sec)	Avg Model Size (KB)
Bioscrypt Inc.	2.07	0.08	1.48	24
Sonda Ltd	2.10	2.07	2.07	1.3
Chinese Academy of Sciences	2.30	0.35	0.67	16.4
Gevarius	2.45	0.69	0.71	2.0
Jan Lunter	2.90	1.01	1.19	3.1

- Database:
  - DB1: optical sensor "V300" by CrossMatch
  - DB2: optical sensor "U.are.U 4000" by Digital Persona
  - DB3: thermal sweeping sensor "FingerChip FCD4B14CB" by Atmel
  - DB4: synthetic fingerprints