An Efficient Finger-knuckle-print based Recognition System Fusing SIFT and SURF Matching Scores

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Biometrics Based Authentication Systems

- They are required badly as places like airports, ATMs others.
- Modes
  - Verification
  - Identification
- Several Traits
  - Face
  - Fingerprint
  - Iris
  - Palmprint
  - Ear
  - Knuckleprint (recently introduced)

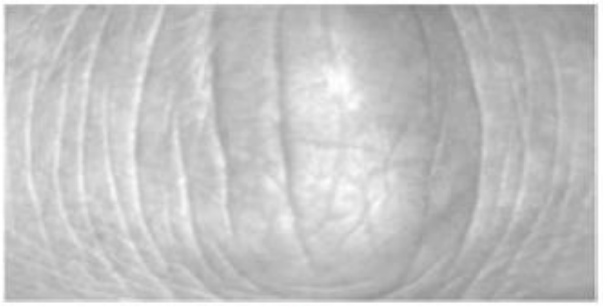
Several challenges

- Face (Occlusion, Expression, Illumination, Pose, Ageing)
- Iris (Difficult and expensive to acquire, Occlusions)
- Fingerprints (Dirty fingers, Fail to acquire)
- Knuckleprints

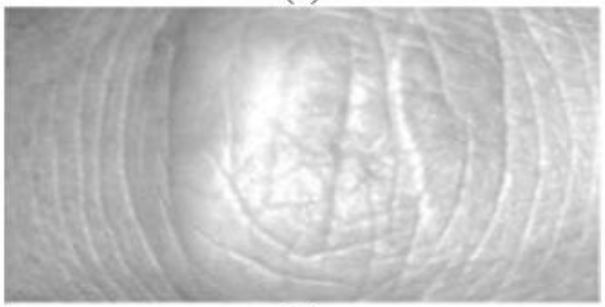
Knuckleprint Database

- PolyU Hong Kong FKP database is the largest publically available database.
- It consist of
  - 165 Subjects
  - 4 fingers per subject (165x4=660 distinct subjects)
  - 12 images per finger (660x12=7920 images) taken in different sessions.

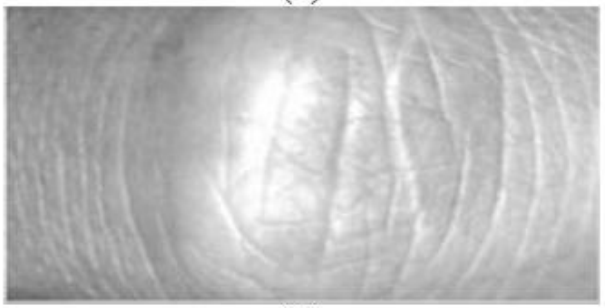
(a)



(b)



(c)



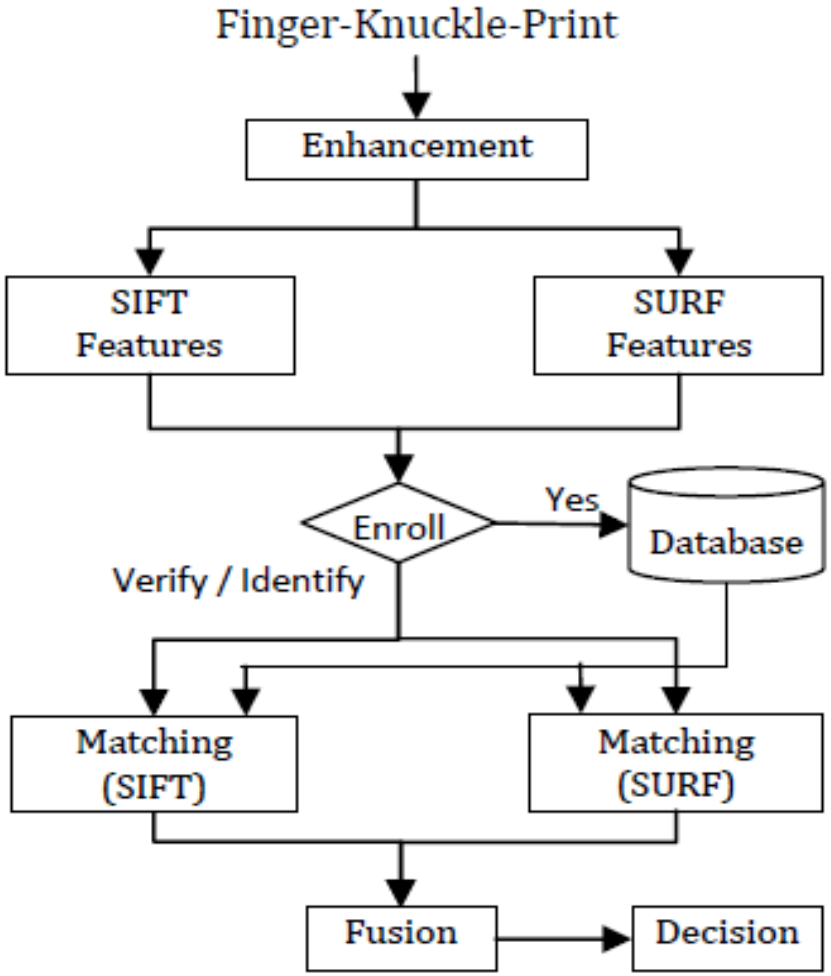
(d)

Sample ROI images

Previous Work

- Used Global as well as Local feature.
- Also Combined and fused both of them.
- PCA, ICA and LDA used but they didn't perform well also computationally very expensive.
- Global feature BLPOC (Band Limited Phase only Correlation) performed well when fused with local features such as Compcode.
- Finally Compcode is improved to ImCompcode and Magcode to achieve better accuracy.

Block Diagram of Proposed Recognition System

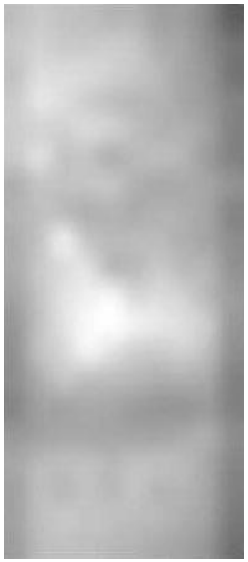


Various Steps involved in Proposed System

- Enhancement
- Feature Extraction
  - SIFT
  - SURF
- Matching
- Fusion

FKP ENHANCEMENT

Finger-knuckle-print



Estimated coarse reflection

Uniform brightness knuckleprint image

Enhanced Knuckle-print image

SIFT FEATURE EXTRACTION

- STEPS

1. Scale-space extrema detection
2. Key-point localization
3. Orientation assignment
4. Key-point descriptor
   - Feature vector of 64 values

FEATURE EXTRACTION (contd.)

- SURF

1. Key-point detector
2. Key-point descriptor
   - Feature vector of 64 values

EXTRACTED SIFT and SURF Points

(a) (b)

(a) SIFT key-points detected (b) SURF key-points detected

MATCHING

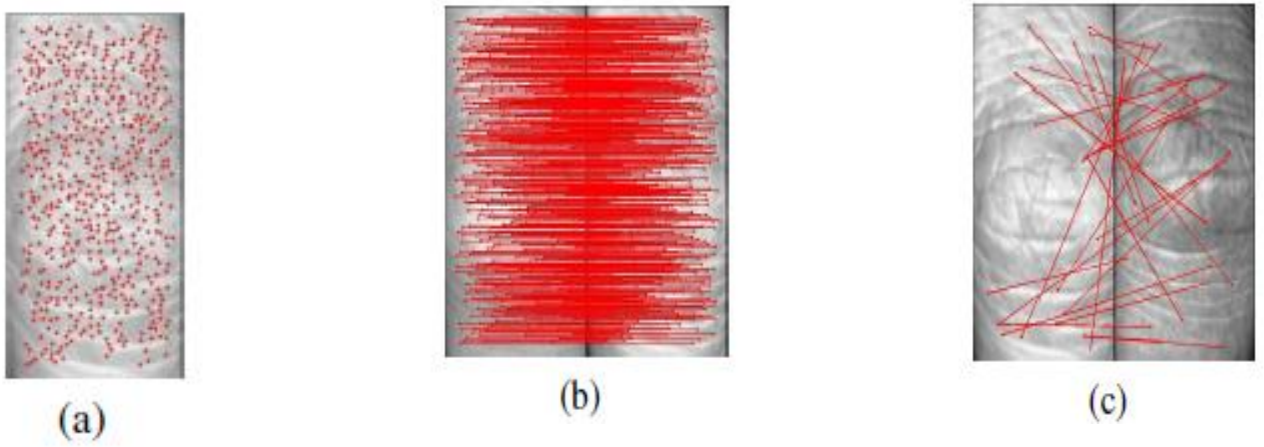
- Nearest – neighbour-ratio method is used for both SIFT and SURF key-points
- Here $||q_i - e_j||$ and $||q_i - e_k||$ are euclidean distance between qi and its first neighbour (i.e e_j) and second one (i.e e_k)

$$Q = \{q_1, q_2, q_3, \cdots q_m\}$$

$$E = \{e_1, e_2, e_3, \cdots e_n\}$$

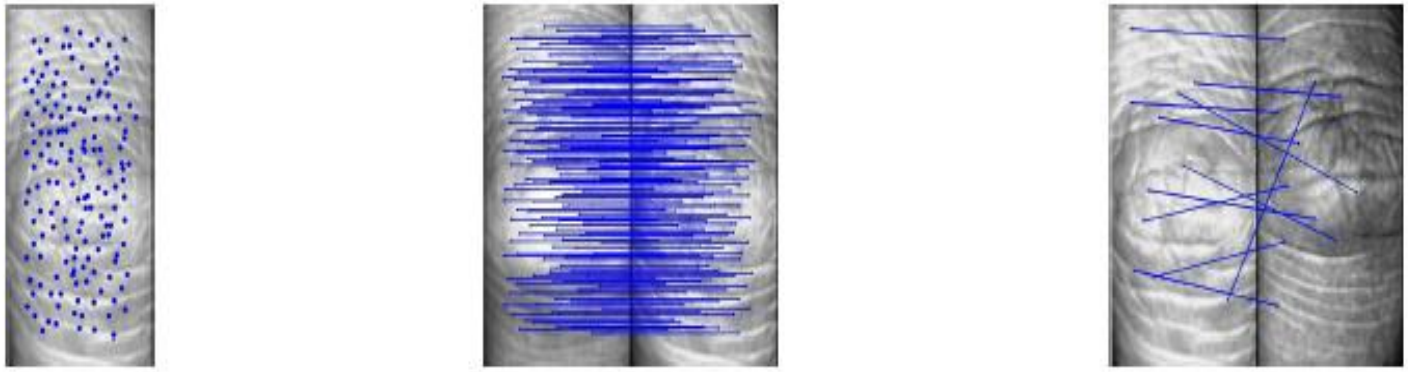
$$q_i = \begin{cases} \text{Matched with } e_j & \text{if } \frac{\|q_i - e_j\|}{\|q_i - e_k\|} < T \\ \text{Unmatched} & \text{Otherwise} \end{cases}$$

MATCHING (contd.)



(a) SIFT key-points detected (b) Genuine matching of SIFT key-points (c) Imposter matching of SIFT key-points

MATCHING (contd.)



(a) (b) (c)

(a) SURF key-points detected (b) Genuine matching of SURF key-points (c) Imposter matching of SURF key-points

FUSION (Weighted Sum Rule)

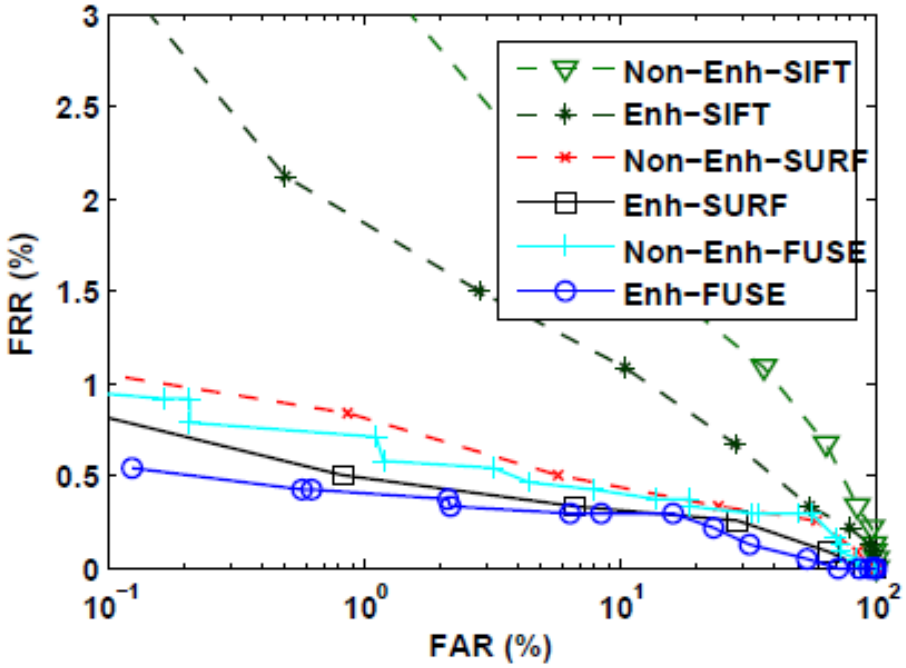
$$S = W_T * M_T + W_S * M_S$$

$$W_T + W_S = 1$$

$$W_T = C_T/(C_T + C_S)$$

$$W_S = C_S/(C_T + C_S)$$

EXPERIMENTAL RESULT

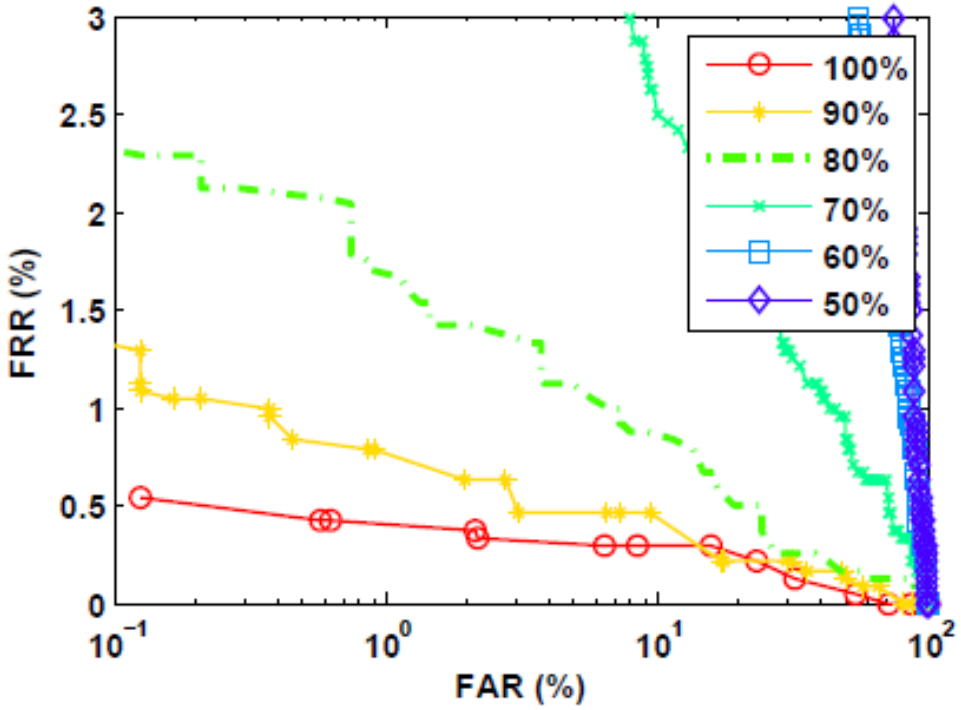


ROC curves of the proposed system

PERFORMANCE

Systems	$CRR\,(\%)$	$EER\,(\%)$
CompCode	-	1.658
BLPOC	-	1.676
ImCompCode&MagCode	-	1.475
MonogenicCode	-	1.720
OE-SIFT	-	0.850
LGIC	-	0.402
Proposed Non-Enh-SIFT	98.667	2.691
Proposed Enh-SIFT	99.125	1.900
Proposed Non-Enh-SURF	99.902	0.833
Proposed Enh-SURF	99.916	0.317
Proposed Non-Enh-FUSE	100.00	0.508
Proposed Enh-FUSE	**100.00**	**0.215**

PERFORMANCE AGAINST SCALE



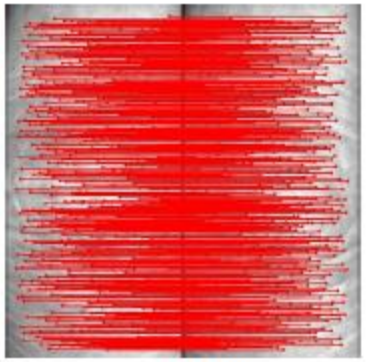
ROC curves of the proposed system for various scales of query image

PERFORMANCE AGAINST SCALE (contd.)

Scale (%)	CRR (%)	EER (%)
100	100.00	0.215
90	100.00	0.458
80	99.917	1.458
70	99.792	3.708
60	98.625	5.25
50	95.000	12.75

Performance of the proposed system for various scales of query image

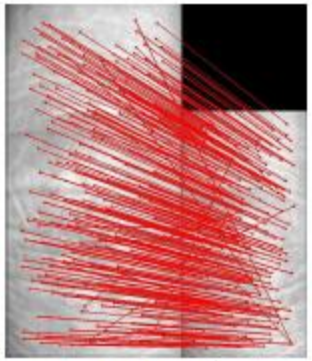
PERFORMANCE AGAINST SCALE (contd.)



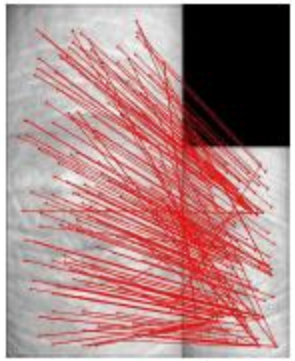
(a) 100%

(b) 90%

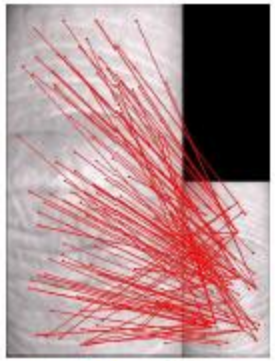
(c) 80%



(d) 70%



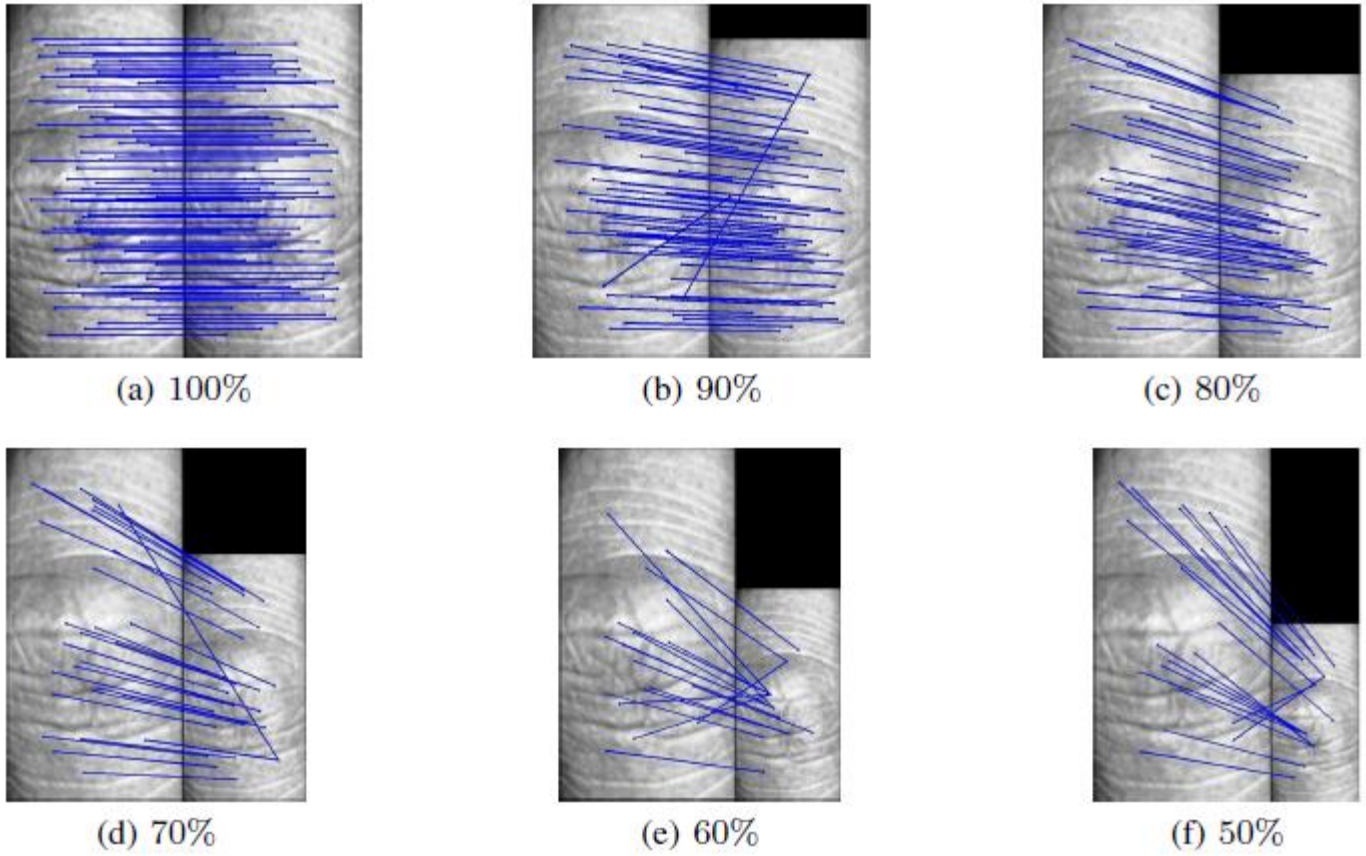
(e) 60%



(f) 50%

SIFT matching for various scales of query image

PERFORMANCE AGAINST SCALE (contd.)



(a) 100% (b) 90% (c) 80%

(d) 70% (e) 60% (f) 50%

SURF matching for various scales of query image

PERFORMANCE(SPEED)

	SIFT	SURF	Total
Feature Extraction (ms)	58.091	17.970	76.061
Matching (ms)	4.782	0.083	**4.865**
Total (ms)	62.873	18.053	**80.926**

Speed of the Proposed System

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Thank You