Multi-Perspective Finger-Vein Recognition

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Abstract

Most finger-vein recognition systems use palmar finger images. There is some work on the dorsal view, but the remaining views have not been sufficiently investigated yet. All major public available finger-vein databases contain only images from the palmar view and only one smaller database has images from the dorsal view. We aim to fill this gap and evaluate the performance using other perspectives than dorsal and palmar. Therefore, we established a new finger-vein data set that consists of videos showing the vein structure all around the finger. We carried out several experiments utilizing common finger-vein recognition algorithms to quantify the recognition performance of each single projection. We further analyzed if a fusion of different views can improve the recognition performance of the system.

Multi-Perspective Finger-Vein Scanner

Operating principle

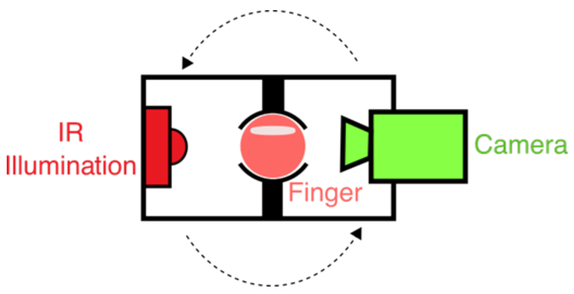


Figure 1: Operating principle of finger-vein scanner

- Finger in axis of rotation
- Illumination module and camera placed on opposite sides of finger
- Camera and illumination module rotate around finger
- Acquisition during rotation (video sequence)

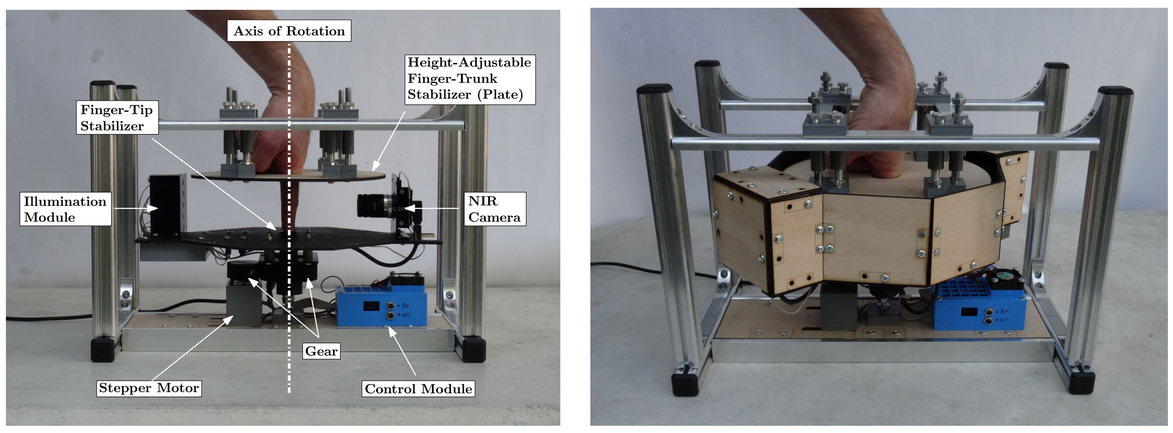


Figure 2: Left: unwrapped custom build multi-perspective finger-vein canner, right: scanner during data acquisition

Multi-Perspective Finger-Vein Data Set

- New finger-vein data set providing images all around the finger (360°-view)
- Acquired using our custom build sensor

Figure 3: Example images of the data set acquired from 0° to 300° in 60° steps

Statistical Data

- 63 subjects (27 female, 36 men)
- 11 nations[a], but mainly white Europeans (73%)
- Age: 18 to 79 years
- 252 unique fingers (63 different subjects, 4 fingers per subject)
- 5 samples per finger
- 1.260 images per view
- Step-size: 1°
- 361 different views (0° + 360°)
- 454.860 images in total.

[a] Austria, Brazil, China, Ethiopia, Germany, Hungary, Iran, Italy, Russia, Slovenia, USA

Recognition Tool-Chain

Preprocessing:

- ROI extraction (finger outline edge detection based)
- CLAHE, High Frequency Emphasis Filtering (HFE), Circular Gabor Filtering (CGF)

Feature Extraction:

- Vein-pattern based: Maximum Curvature (MC), Principal Curvature (PC), Gabor Filter (GF)
- Key-point based: SIFT based (SIFT)

Comparison and Evaluation:

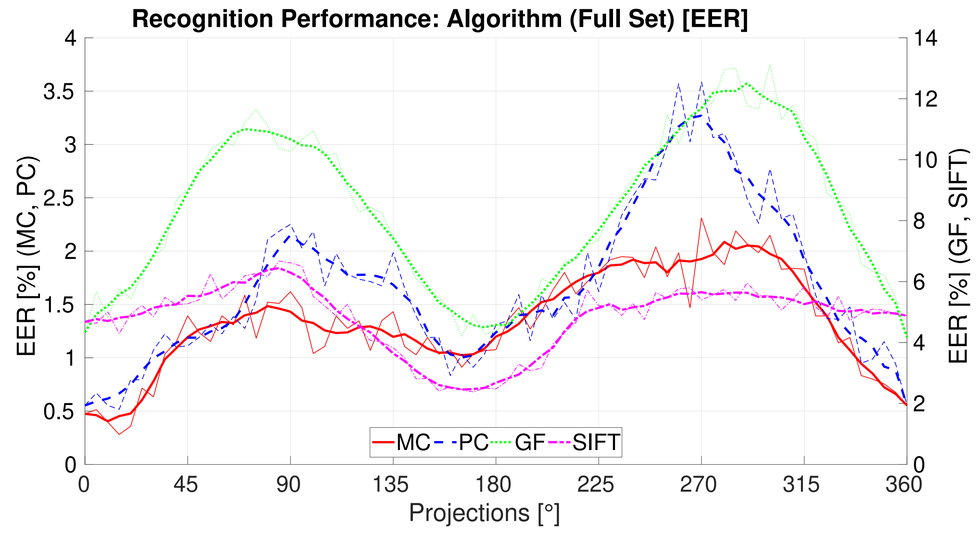
- Miura's proposed comparison scheme for MC, PC and GF
- EER/FMR1000 and ZeroFMR, FVC2004 protocol

Main Results

- Established the first multi-perspective finger vein data set (360°-view)
- Analysis of perspectives all around the finger
  - Best performance at 0° (palmar) and 180° (dorsal) region
  - In between the performance is inferior
  - Opposite perspectives are independent from each other
- Preliminary fusion of selected perspectives
  - Fusion increases recognition performance

Experimental Results - Single Views

- Analysis of recognition performance of different projections
- No cross-projection comparison
- 73 perspectives in 5° steps



Recognition Performance

	Best Result		Worst Result	
	View	EER	View	EER
MC	15°	0.28	270°	2.31
PC	15°	0.52	270°	3.59
GF	360°	4.16	300°	13.12
SIFT	170°	2.38	85°	6.67

Table 1: Recognition performance (EER) for single views

Opposite Views

	EER for Perspective		
	0°	180°	0° vs 180°
MC	0.47	1.08	47.28
PC	0.55	1.31	49.41
GF	4.33	4.38	50.04
SIFT	4.68	2.48	46.74

Table 2: Recognition performance (EER) for palmar vs dorsal view

Experimental Results - Fusion

Two perspective fusion

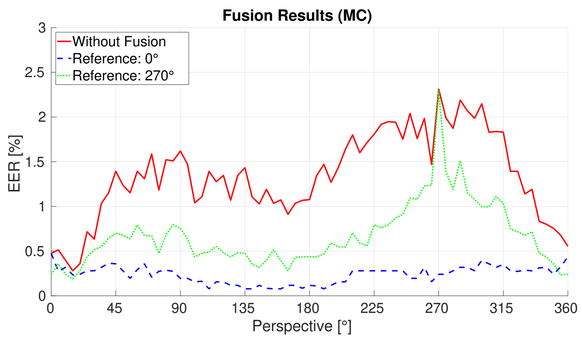


Figure 4: Recognition performance for fusion of two perspectives

	Reference		Best Result		Worst Result	
	View	EER	View	EER	View	EER
MC	0°	0.47	110°	0.08	5°	0.47
	270°	2.31	15°	0.19	275°	2.30
PC	0°	0.55	170°	0.15	305°	0.68
	270°	3.59	360°	0.59	275°	3.58
GF	0°	4.33	170°	1.63	5°	4.33
	270°	11.65	165°	3.25	275°	11.64
SIFT	0°	4.68	170°	1.27	5°	4.68
	270°	5.40	175°	1.59	275°	5.39

Table 3: Detailed performance results for reference view fusion

Multi-perspective fusion

- Increasing number of views
- Views evenly distributed over the circle (2 to 72)
- Different reference views

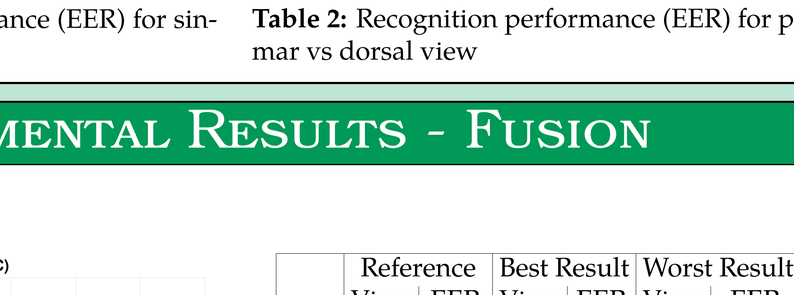


Figure 5: Selection of view angles for fusion with 2, 3 and 4 perspectives

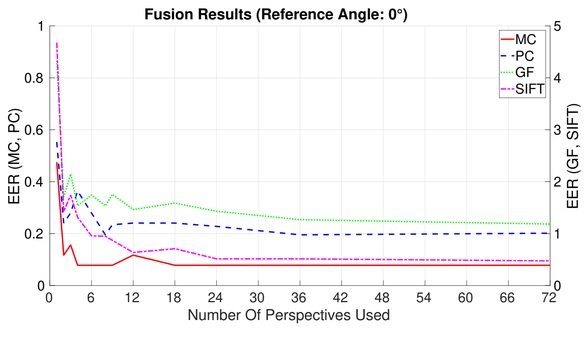


Figure 6: Recognition performance for fusion of different number of perspectives

	Reference		Worst Result		Best Result	
	View	EER	#	EER	#	EER
MC	0°	0.47	3	0.16	4	0.08
	270°	2.31	2	0.75	9	0.04
PC	0°	0.55	4	0.36	8	0.20
	270°	3.59	2	1.47	8	0.20
GF	0°	4.33	3	2.15	72	1.18
	270°	11.65	2	6.81	72	1.18
SIFT	0°	4.68	3	1.74	72	0.47
	270°	5.40	2	3.73	72	0.47

Table 4: Detailed performance results for multi-perspective fusion

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