Rotation Invariant Finger Vein Recognition

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Abstract

Finger vein recognition deals with the identification of subjects based on its venous pattern within the fingers. The majority of the scanner devices capture a single finger from the palmar side using light transmission. Some of them are equipped with a contact surface or other structures to support in finger placement. However, these means are not able to prevent all possible types of finger misplacements, in particular longitudinal finger rotation can not be averted. It has been shown that this type of deformation causes severe problems to finger vein recognition systems. This paper proposes two new methods in which finger vein images from different perspectives are captured during enrolment and, but only one during authentication. In the first method, the authentication image is compared to all enrolment images, whereas in the second method they are linked together to form a perspective cumulative finger vein template. As the enrolled finger vein images depict the vein structure of a larger range of the finger, the longitudinal positioning of the finger during the acquisition for the biometric recognition is less critical. The experimental results confirm the applicability especially of the first approach.

Longitudinal Finger Rotation

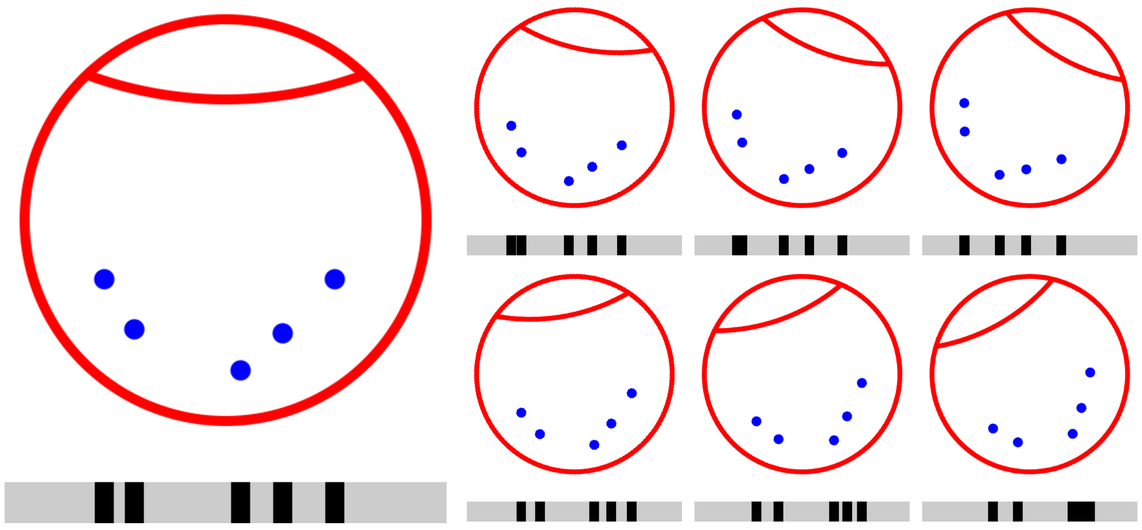

Figure 1: Longitudinal finger rotation principle: a schematic finger cross section showing five veins (blue dots) rotated from -30° (left) to +30° (right) in 10° steps. The projection (bottom row) of the vein pattern is different depending on the rotation angle according to a non-linear transformation.

Performance Validation

PLUSVein-FR-ED

- equally distributed rotation angles
- rotational distance of samples between 0° and 89°

PLUSVein-FR-ND

- normally distributed rotation angles
- $\mu = 0.03, \sigma = 11.12$
- rotational distance of samples between 0° and 55°

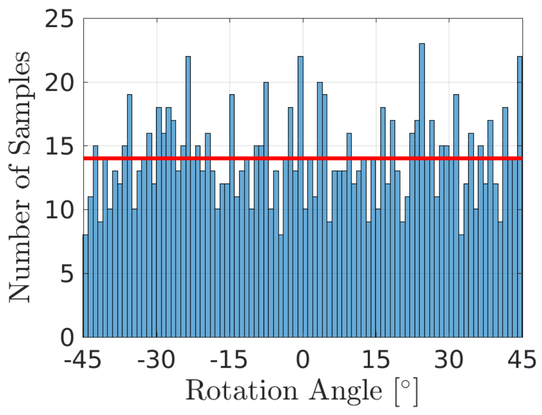

Figure 2: Distribution of rotation angles of PLUSVein-FR-ED

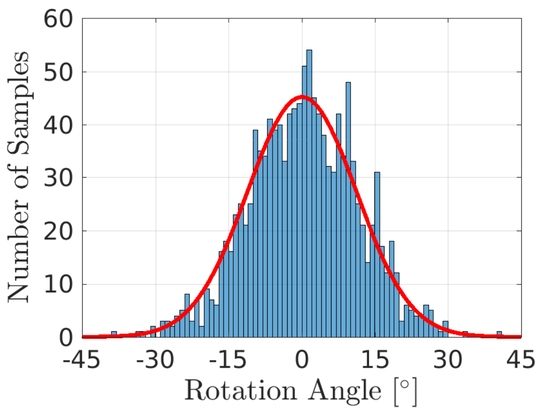

Figure 3: Distribution of rotation angles of PLUSVein-FR-ND.

Method	PLUSVein-FR-ED		PLUSVein-FR-ND	
	EER	RPI	EER	RPI
No Correction	21.63	-	3.39	-
CPN	15.34	41.0	1.52	122.3
EPN	15.87	36.3	1.72	96.4
Fixed Angle ($\varphi = 20°$)	5.24	312.5	**0.66**	412.4
Known Angle	5.44	297.6	1.13	200.4
MPE 2 Cameras	1.66	1202.8	0.80	324.0
MPE 3 Cameras	1.13	1807.1	**0.53**	534.1
MPE 4 Cameras	0.60	3513.8	0.67	407.3
MPE 7 Cameras	**0.33**	6379.3	**0.34**	909.9
PCT 15°	3.00	620.3	**2.20**	53.7
PCT 30°	3.53	512.2	**2.72**	24.7
PCT 45°	3.91	452.9	**2.80**	21.0

Figure 4: Performance results for PLUSVein-FR-ED and PLUSVein-FR-ND

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Contribution

Proposal of 2 rotation invariant finger vein recognition methods

- Multi-perspective enrolment (MPE)
- Perspective cumulative finger vein templates (PCT)

Introduction of 2 publicly available finger vein data sets

- PLUSVein-FR-ED (equally distributed rotation angles)
- PLUSVein-FR-ND (normally distributed rotation angles)

Results are available for download at:
http://wavelab.at/sources/Prommegger19d

Multi-Perspective Enrolment

Idea

- Enrol subject using multiple perspectives
- Verification: single perspective vs all enrolled perspectives
- Max score level fusion for final result
- Invariant to rotation as enrolment covers complete (rotational) range of interest

Assumptions

- Circular finger form
- Enrolment perspectives are linearly spaced over the acquisition range

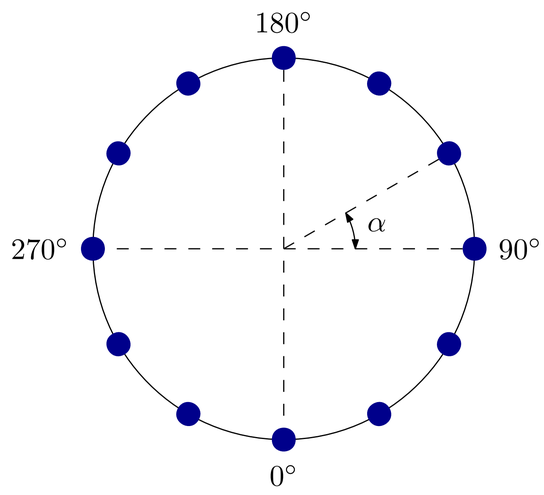

Figure 5: Camera positioning for MPE for a rotational distance of $\alpha = 30°$ between the enrolment perspectives.

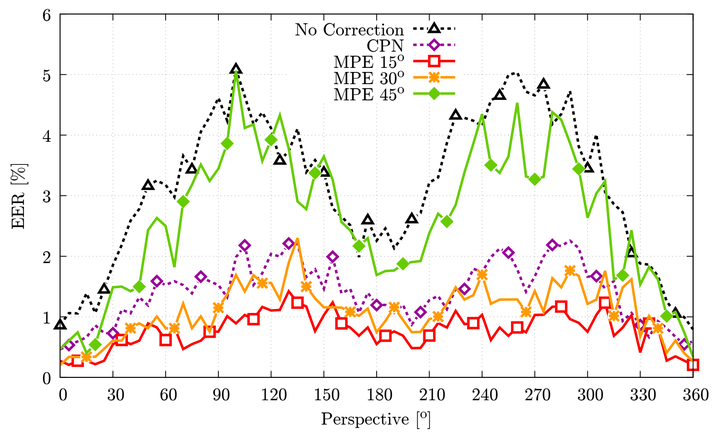

Figure 6: Recognition performance (EER): in-perspective vs MPE comparisons

Perspective Cumulative Finger Vein Templates

Idea

- Enrol subject using multiple perspectives
- Combine perspectives to a single PCT
- Verification: single perspective vs PCT
- Invariant to rotation as PCT covers complete (rotational) range of interest
- Applied in the feature space

Assumptions

- Circular finger form
- Enrolment perspectives are linearly spaced over the acquisition range

Issues

- "Noise" from knuckles, wrinkles, hair, ...
- Level of detail for PCT generation must be reduced

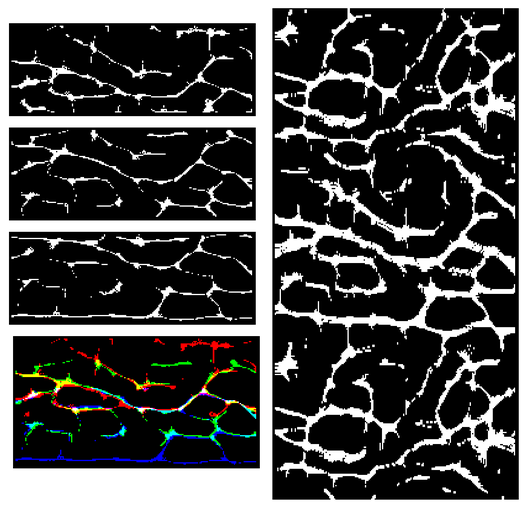

Figure 7: Example of an PCT. Left: single perspectives (rotation angle 30°) and the combined image of the three samples. Right: a PCT on the range of 360°.

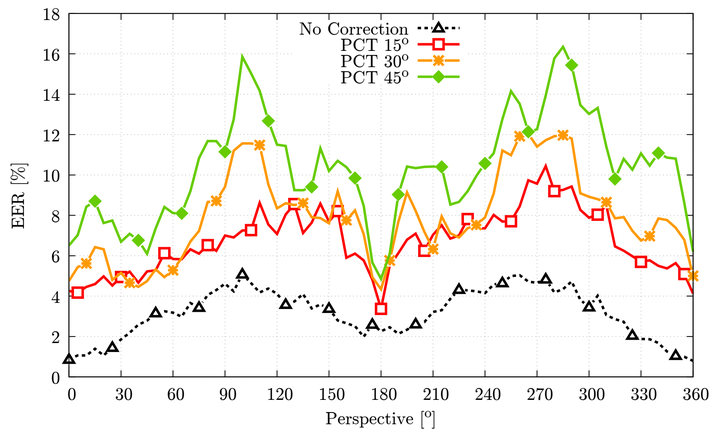

Figure 8: Recognition performance (EER): in-perspective vs PCT comparisons