

Biometrics: Fingerprint recognition

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1 Introduction

I chose fingerprint $id = 3$; $num = 7$; (I'm 11th in the list, but database has just 10 fingerprints series).

2 Preprocessing

2.1 Fingerprint processing without segmentation

Usually people can process fingerprints without preprocessing, but recognition with computer methods use methods based on computing orientation and frequency.

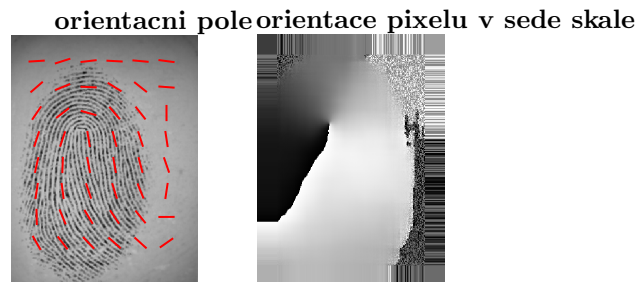


Figure 1: Example of computing orientation field without segmentation

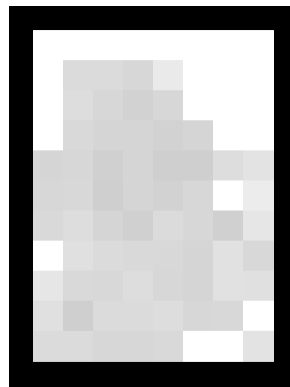


Figure 2: Computing a frequency of non-segmented fingerprint image.

2.2 Fingerprint segmentation from background

For segmentation fingerprint from background I chose method based on image pixel intensity variance thresholding. I compute variance of blocks $blockSize \times blockSize$ and threshold it. By default I use $blockSize=16$ and $threshold = 0.001$. Also I implemented method that removes misclassified foreground blocks (by default $minBlockSize = blockSize * 5$).

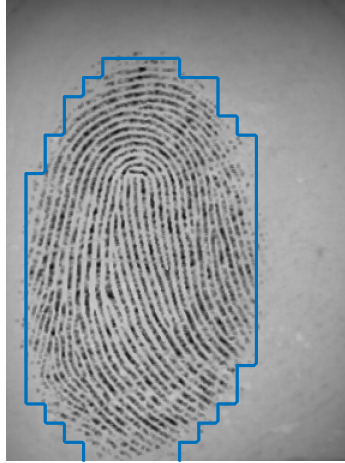


Figure 3: Fingerprint segmentation from background.

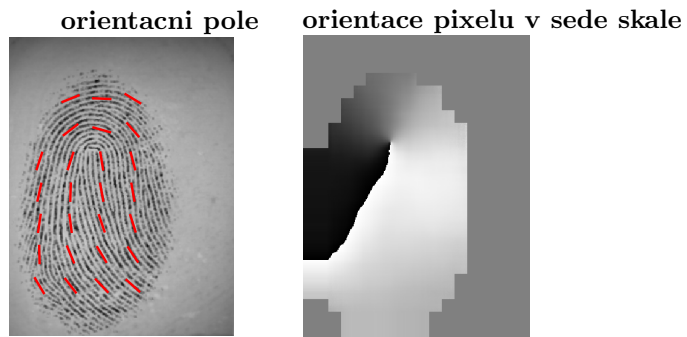


Figure 4: Visualization of orientation field

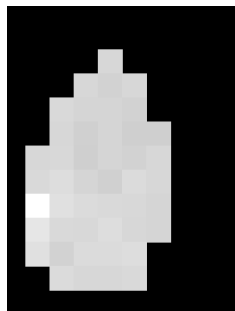


Figure 5: Visualization of frequency

enhance using Gabor filters ~~ilustra~~ otisku pred cistenim

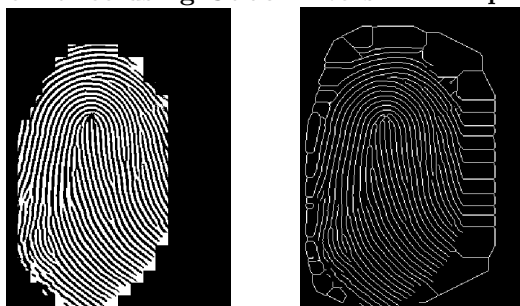


Figure 6: Enhancement using Gabor filters

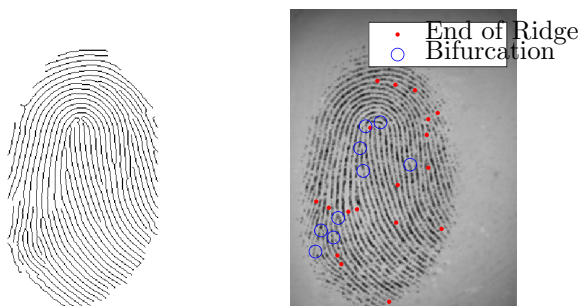


Figure 7: Highlighting minutiae.

2.3 Different types of fingerprint scanners

There are some types of scanners: **Optical scanners**, **Capacitive or CMOS scanners**, **Ultrasonic fingerprint scanners**, **Thermal scanners**.

There are examples of preprocessed images of my fingerprint using different scanners:



Figure 8: Examples of preprocessed fingerprints from different scanners

As you can see at Figure 8 majority of minutiae are highlighted right, but for better performances it's good to use different segmentation methods (or different parameters *threshold* and *blockSize*) for different scanners.

3 Fingerprint Matching

3.1 Example Matching (same person, same scanner)

Zadejte dva markanty v pravém obraze.

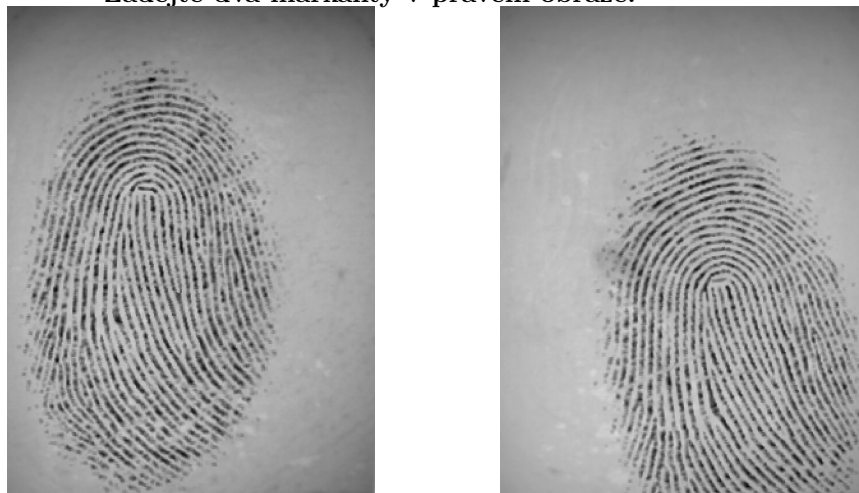


Figure 9: Two fingerprints from same person.



Figure 10: Aligning the fingerprint



Figure 11: Highlighted minutiae in two fingerprints.

number of matched minutiae : 13
 number of minutiae in input image : 22
 number of minutiae in database image : 23
 Score of the minutiae matching: 0.46984
 Score of the fingerprint matching: 0.00022896
 13/22 matched minutiae with just 0.42 minutiae score is a good result!

3.2 Attempt to find best matching

There are two fingerprints with best matching from *fv02_4*:

- id = 3, num = 7
- id = 1, num = 2

Zadejte dva markanty v pravém obraze.

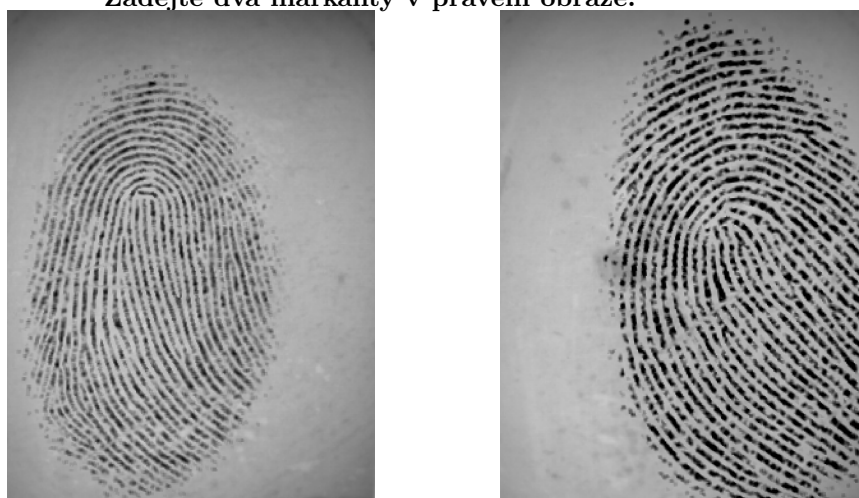


Figure 12: Two fingerprints from different persons.

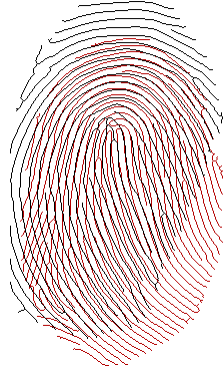


Figure 13: Aligning the fingerprint

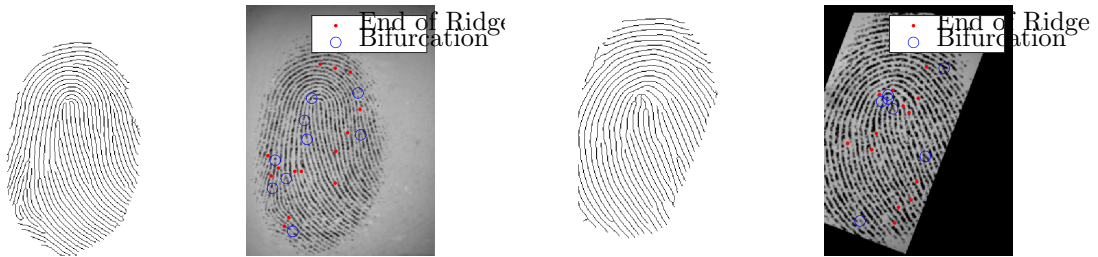


Figure 14: Highlighted minutiae in two fingerprints.

number of matched minutiae : 4
 number of minutiae in input image : 20
 number of minutiae in database image : 23
 Score of the minutiae matching: 0.5548
 Score of the fingercode matching: 0.004335

3.3 Matching results of same person, but with different scanners



Figure 15: Two fingerprints from same persons.



Figure 16: Highlighted minutiae in two fingerprints.

number of matched minutiae : 0
number of minutiae in input image : 9
number of minutiae in database image : 25
Score for minutiae : NaN
Score of the minutiae matching: NaN
Score of the fingercode matching: 0.0056104

Conclusion: We can't use different scanners to identify person. There is very big risk of identification error.