

Processing of Palm Print and Blood Vessel Images for Multimodal Biometrics

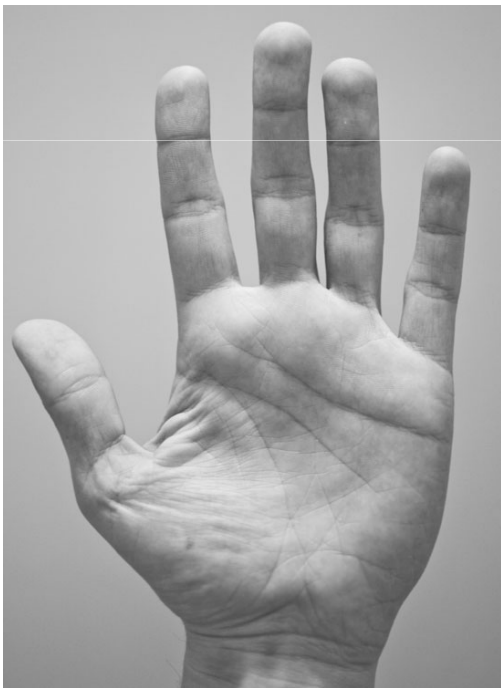
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Biometric and ID Management Workshop BioID 2011
March 8-10, Brandenburg, Germany



Motivation

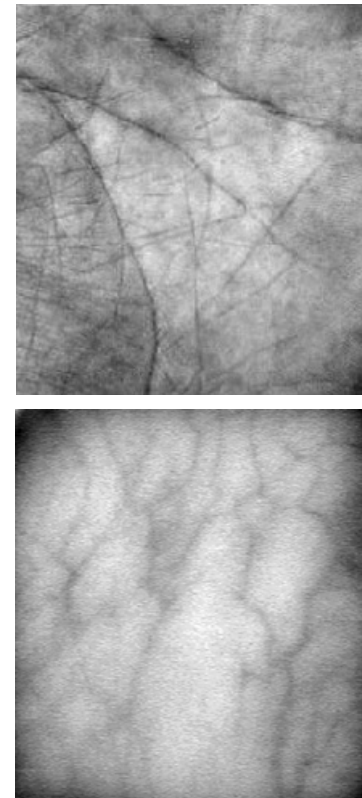
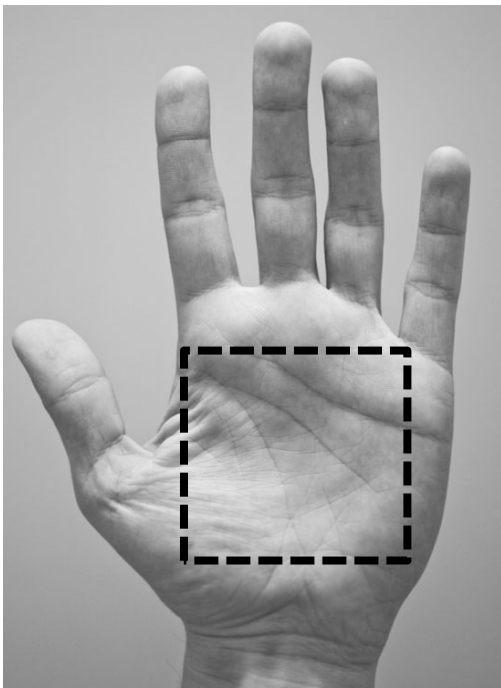
Multimodal Biometrics



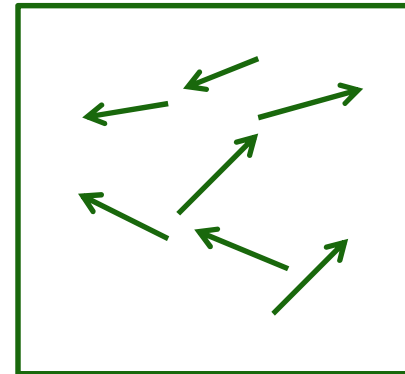
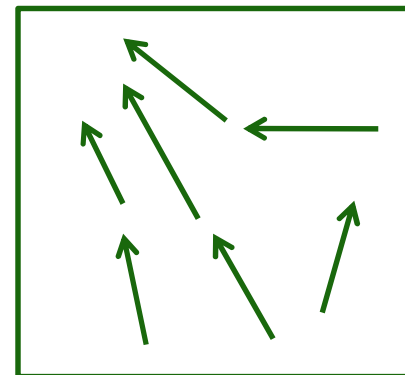
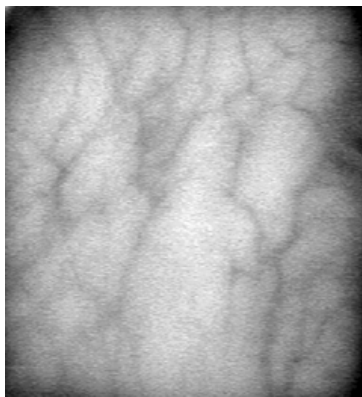
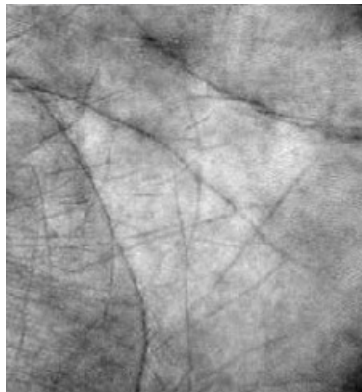
- Provides:
 - Easy enrolment
 - Unique parameters
 - Hard to falsify



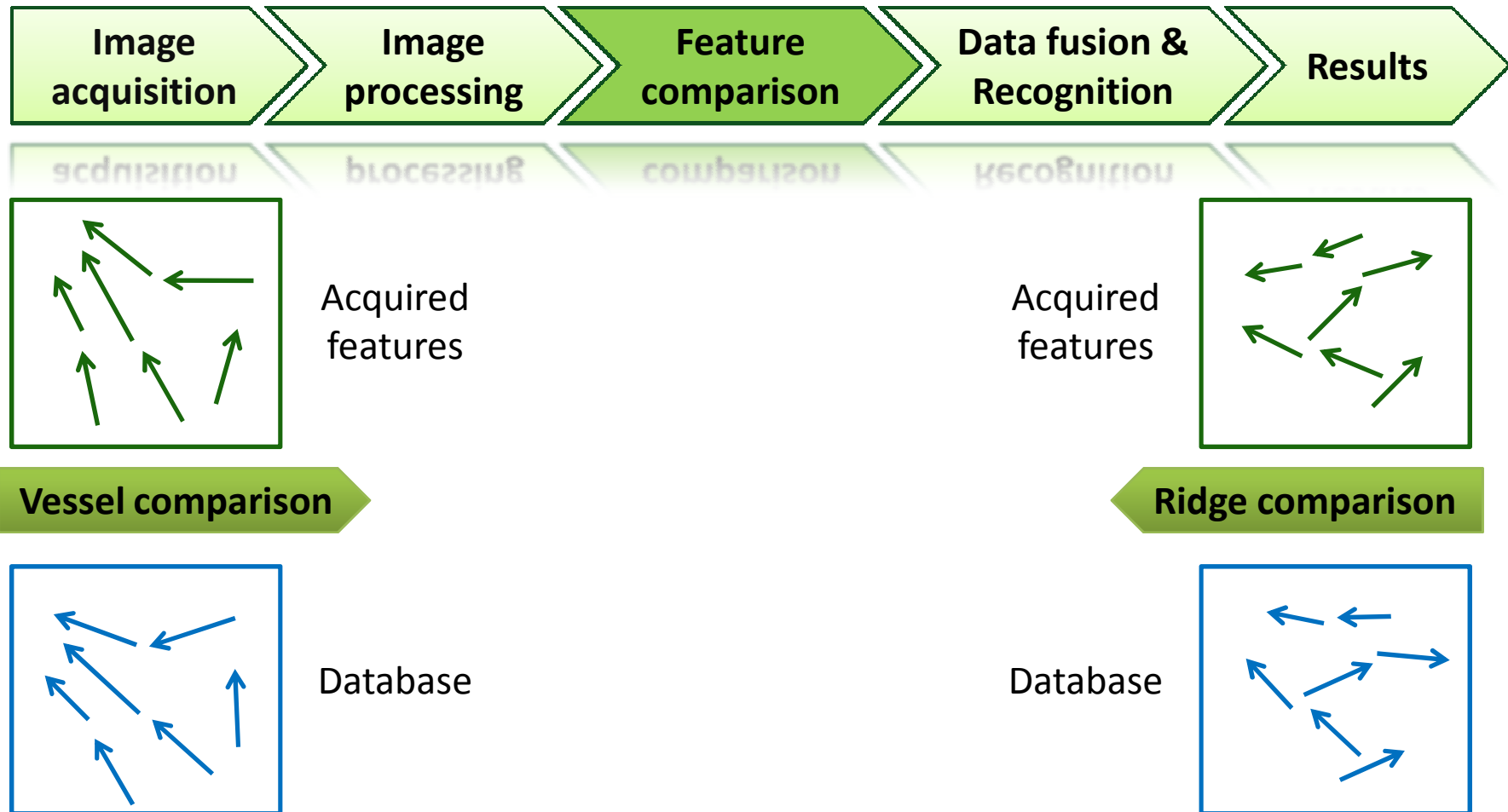
Outline



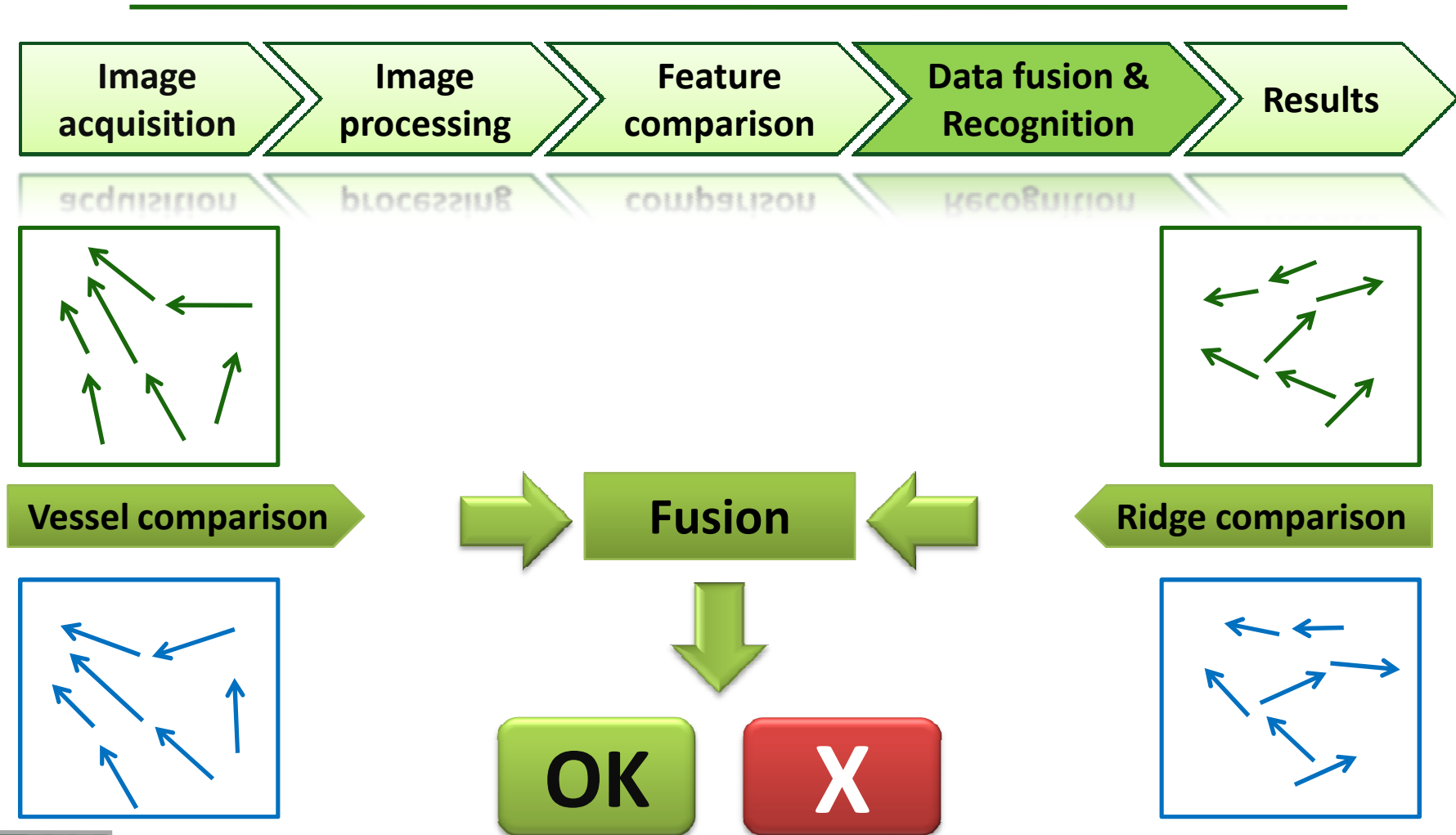
Outline



Outline



Outline



Outline

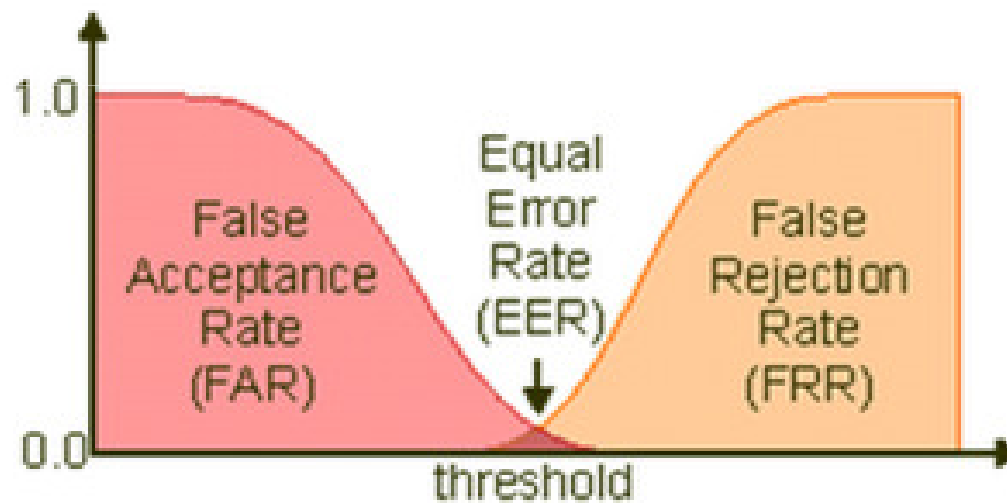
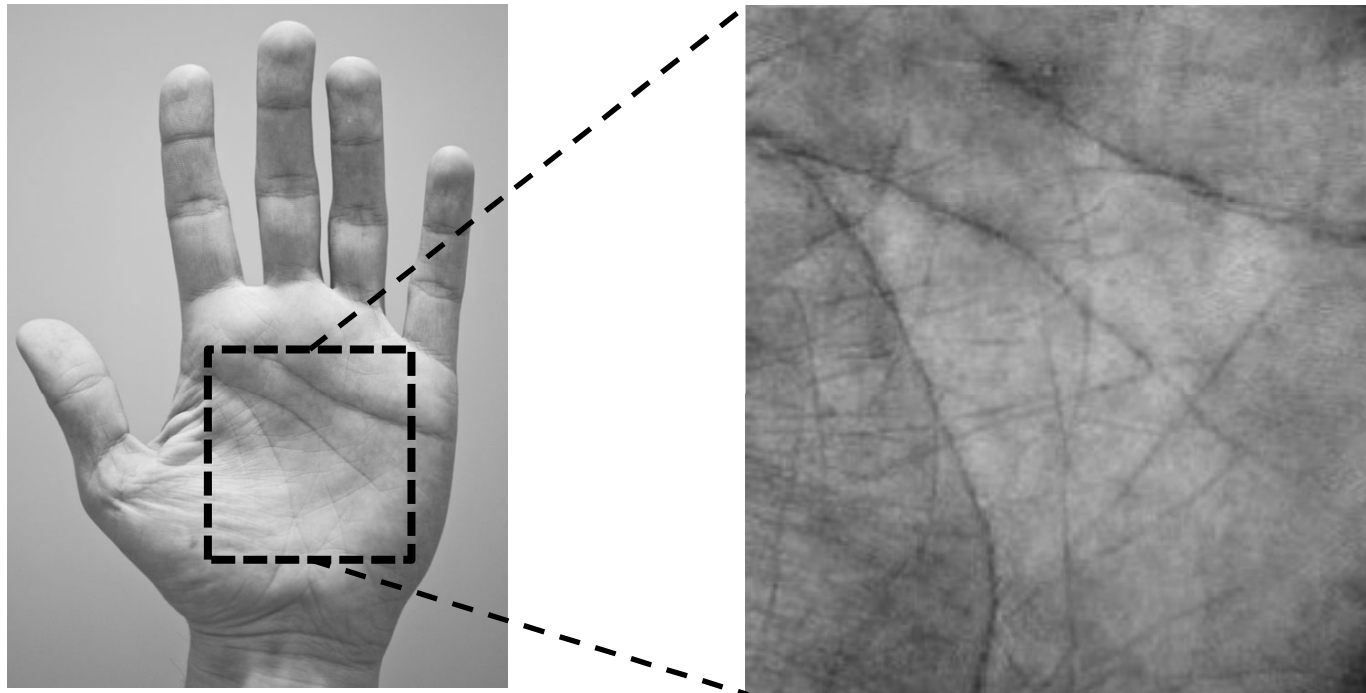


Image Acquisition (I)

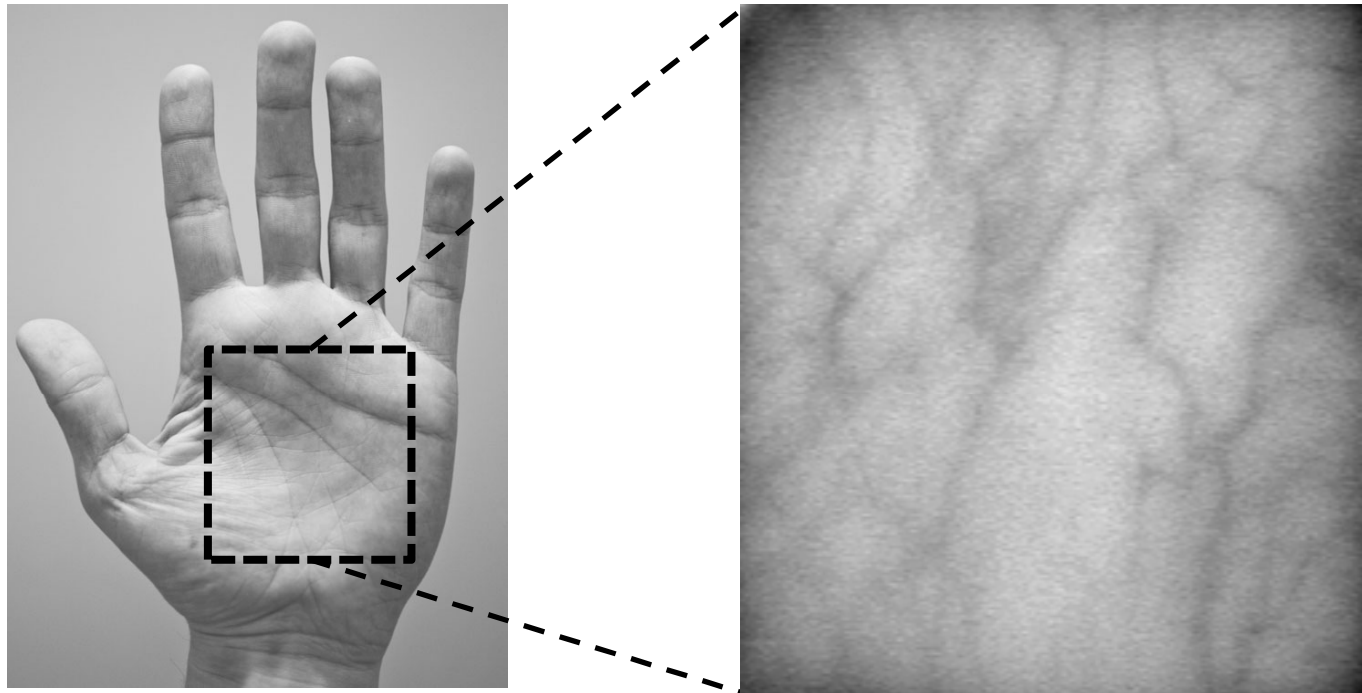


White LEDs

In visible light spectrum using white LEDs



Image Acquisition (II)

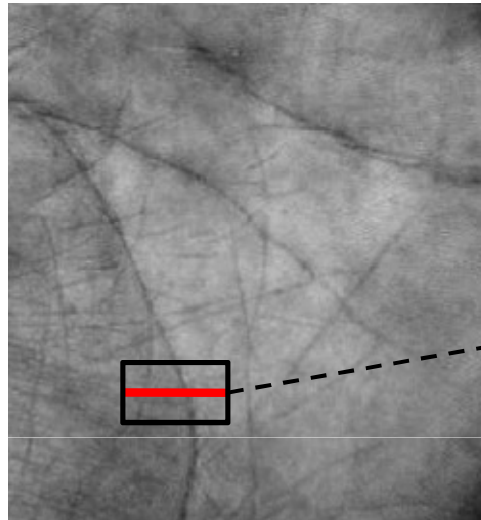


IR LEDs

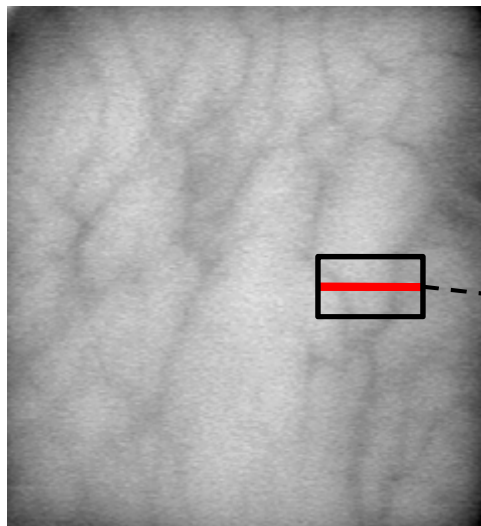
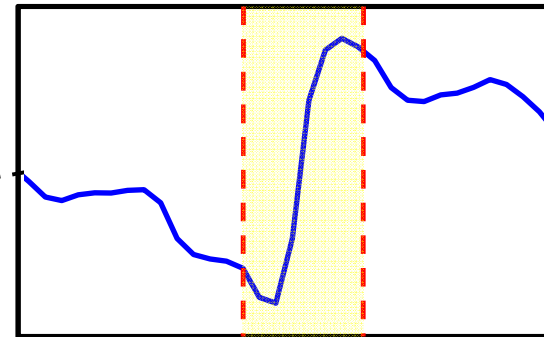
In infrared light spectrum using IR LEDs



Image processing (I)



Cross section of the ridge



Cross section of the vessels

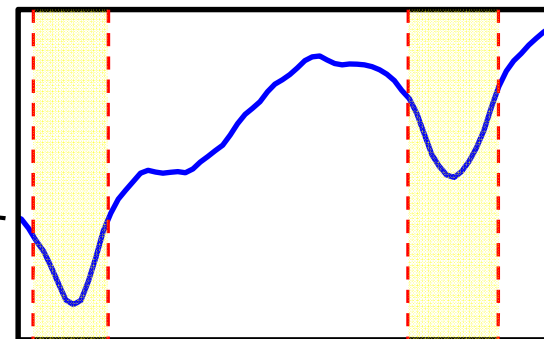


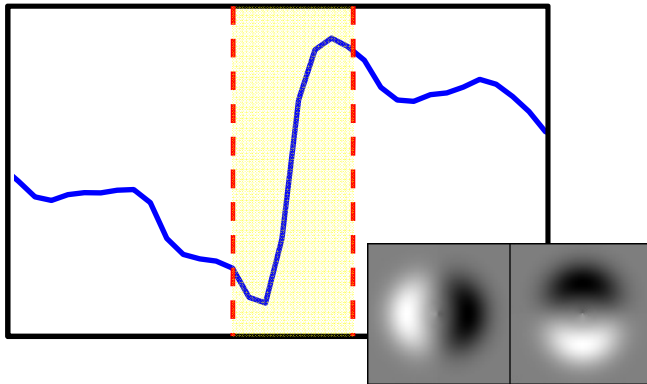
Image processing (II)

Complex 2D Matched Filtering:

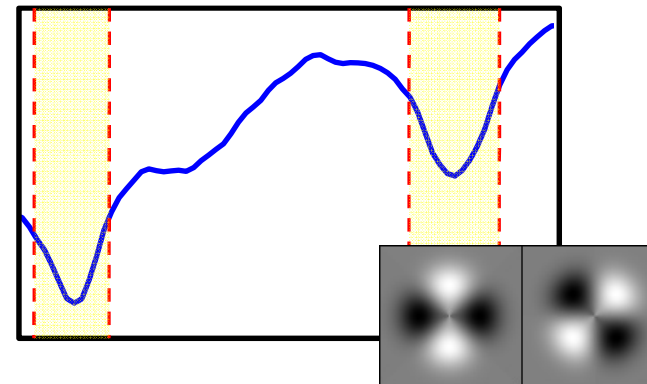
- Based on the matched filtering
- Improved processing speed (angle invariant)
- Obtains vectors and their angular orientation in the image

$$CMF(x, y) = \sum_l e^{jK\varphi_l} \cdot G(x, y, \varphi_l)$$

Cross section of the ridge



Cross section of the vessels

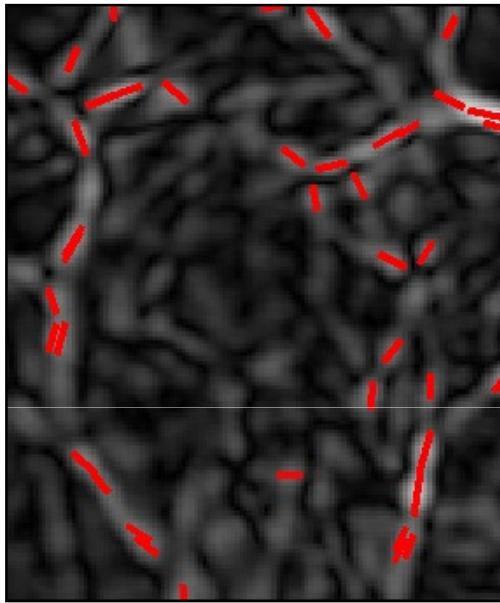


For further information:

M.Greitans, M.Pudzis, R.Fuksis. „Object Analysis in Images Using Complex 2d Matched Filters”, Proceedings of the IEEE Region 8 Conference EUROCON 2009. Saint-Petersburg, Russia, May, 2009., pp. 1392-1397.



Image processing (III)



Filtering result

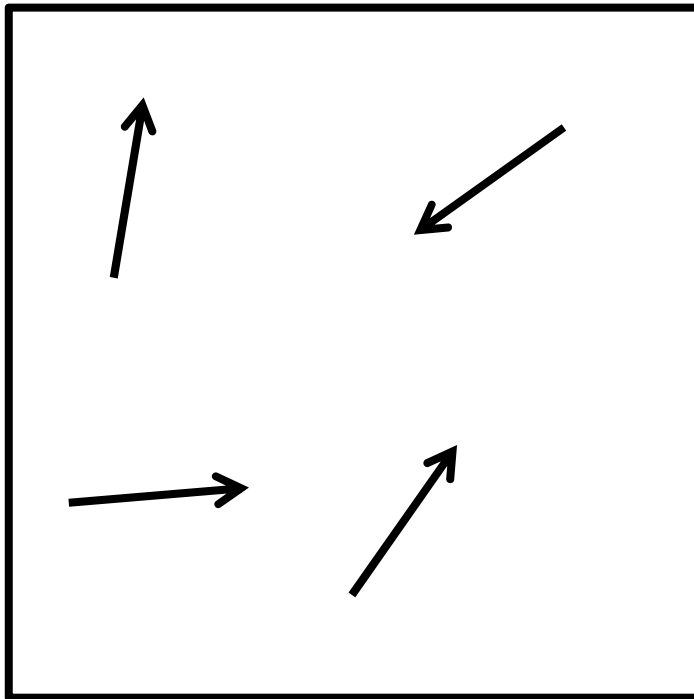


Vector set

Most significant vectors are extracted to describe the object.
The result is a data set of 64 vectors (256 bytes)

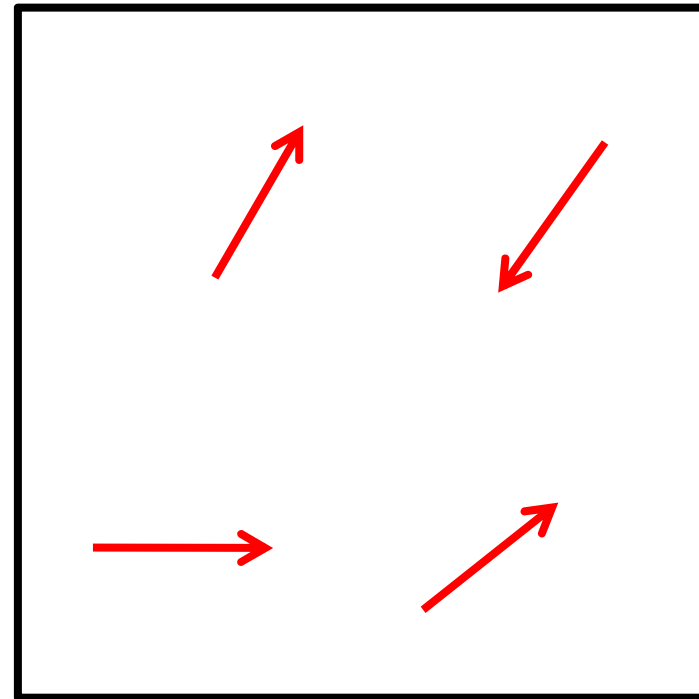


Feature comparison (I)



Vector set A

Vector set from the database

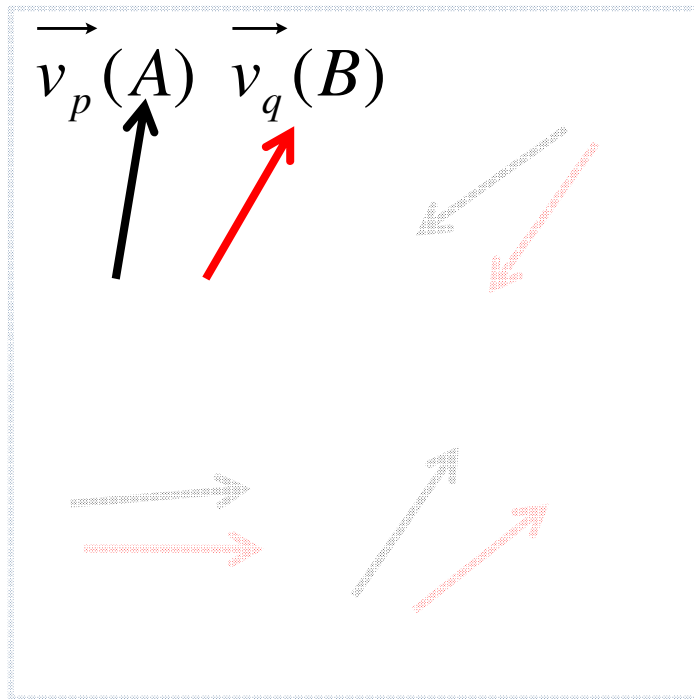


Vector set B

Acquired vector set

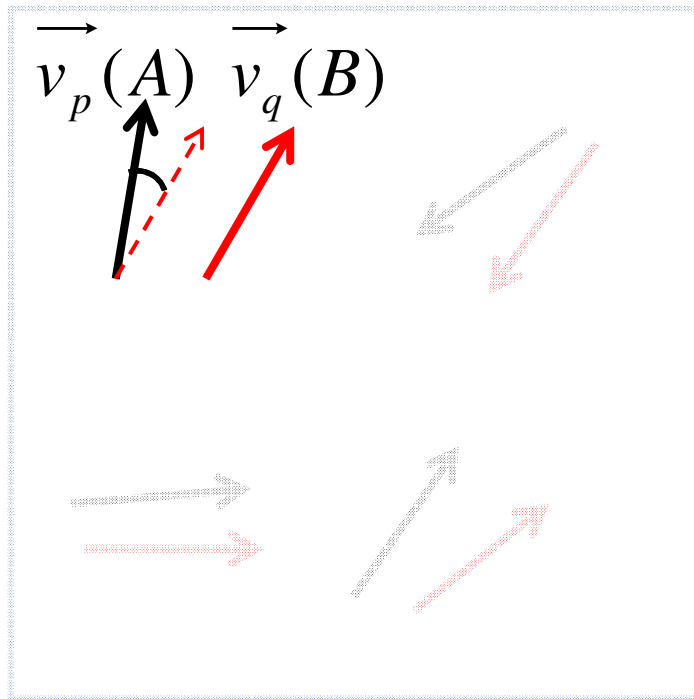


Feature comparison (II)



Magnitudes: $|\vec{v}_p(A)| \cdot |\vec{v}_q(B)|$

Feature comparison (II)

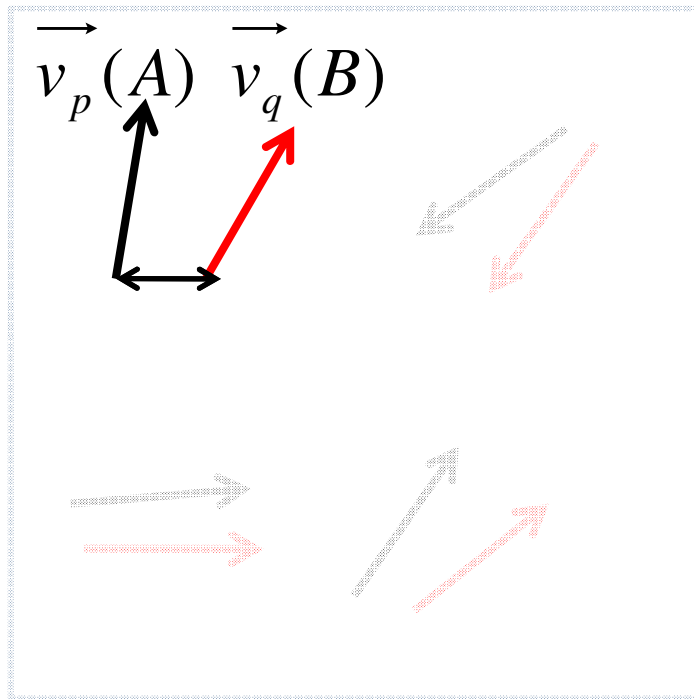


Magnitudes: $|\vec{v}_p(A)| \cdot |\vec{v}_q(B)|$

Angles: $|\cos \angle(\vec{v}_p(A); \vec{v}_q(B))|$



Feature comparison (II)



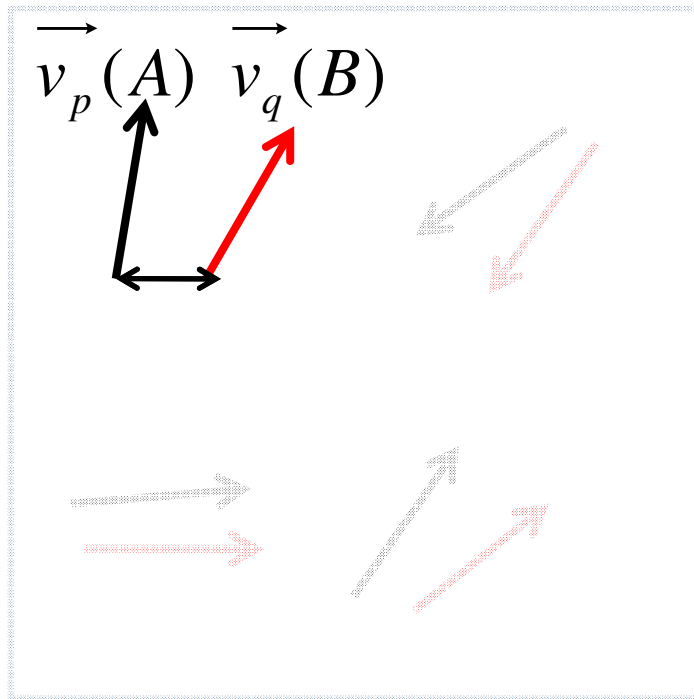
Magnitudes: $|\vec{v}_p(A)| \cdot |\vec{v}_q(B)|$

Angles: $|\cos \angle(\vec{v}_p(A); \vec{v}_q(B))|$

Distance: $\exp\left(-\frac{d_{\parallel}^2}{\sigma_{\parallel}^2}\right) \cdot \exp\left(-\frac{d_{\perp}^2}{\sigma_{\perp}^2}\right)$



Feature comparison (II)



Magnitudes: $|\vec{v}_p(A)| \cdot |\vec{v}_q(B)|$

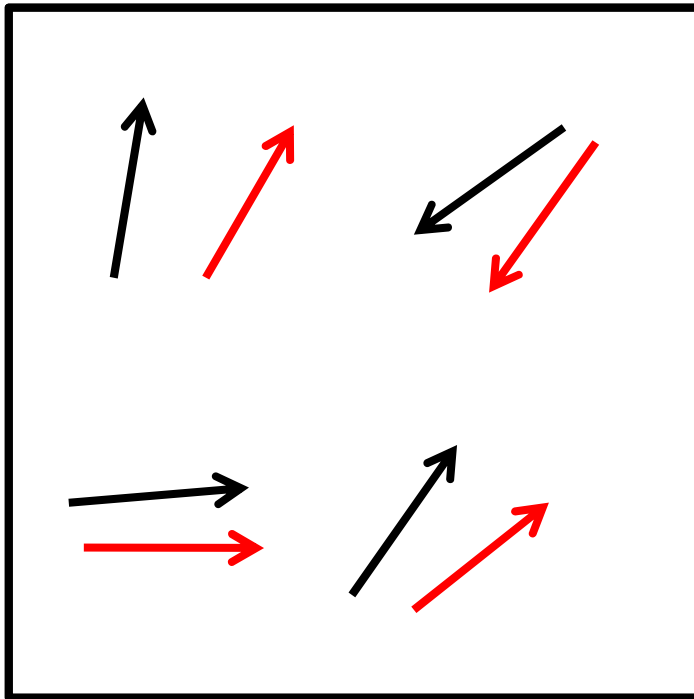
Angles: $|\cos \angle(\vec{v}_p(A); \vec{v}_q(B))|$

Distance: $\exp\left(-\frac{d_{\parallel}^2}{\sigma_{\parallel}^2}\right) \cdot \exp\left(-\frac{d_{\perp}^2}{\sigma_{\perp}^2}\right)$

Similarity of particular pair of vectors: $S_{p,q}$



Feature comparison (II)



Similarity of two vector sets:

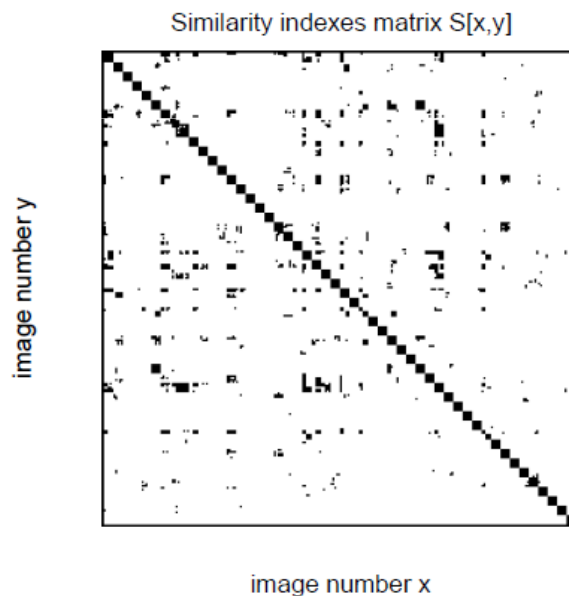
$$s(A, B) = \sum_p \sum_q s_{p,q}$$

**Similarity index is normalized
so that $S(A,B)$ is in the $[0;1]$**

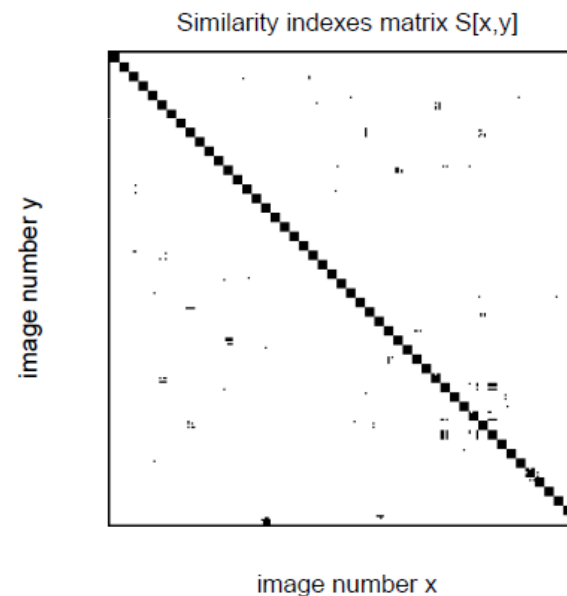


Database evaluation (I)

- Two databases; 500 images from 50 persons
- 5 images in IR and 5 in visible light spectrum



Palm prints EER = 2.82%



Palm vessels EER = 0.32%

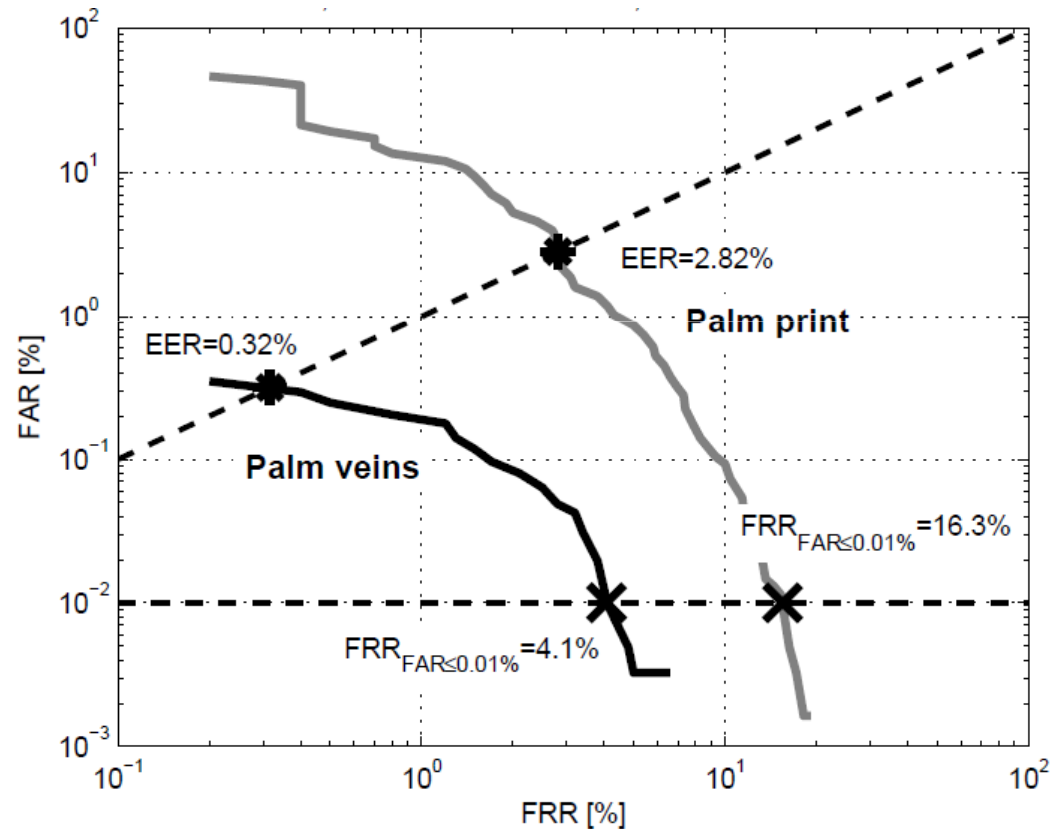


Database evaluation (II)

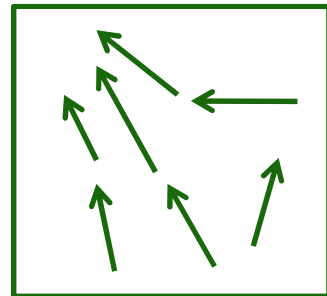
We evaluate two parameters to estimate the system's overall performance:

EER and FRR at $\text{FAR} \leq 0.01\%$

Because minimal FAR is more important in practical systems than FRR.



Fusion (I)



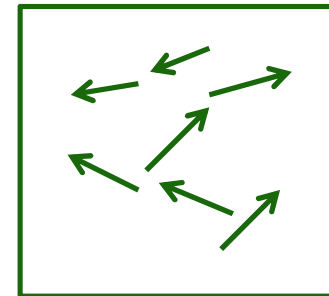
Acquired
features

Vessel comparison

S_1

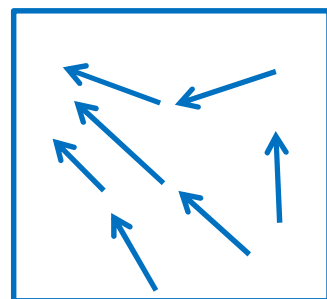
A pair of similarity indexes

S_2

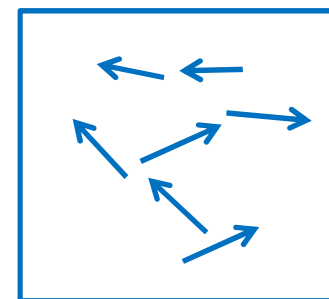


Acquired
features

Ridge comparison



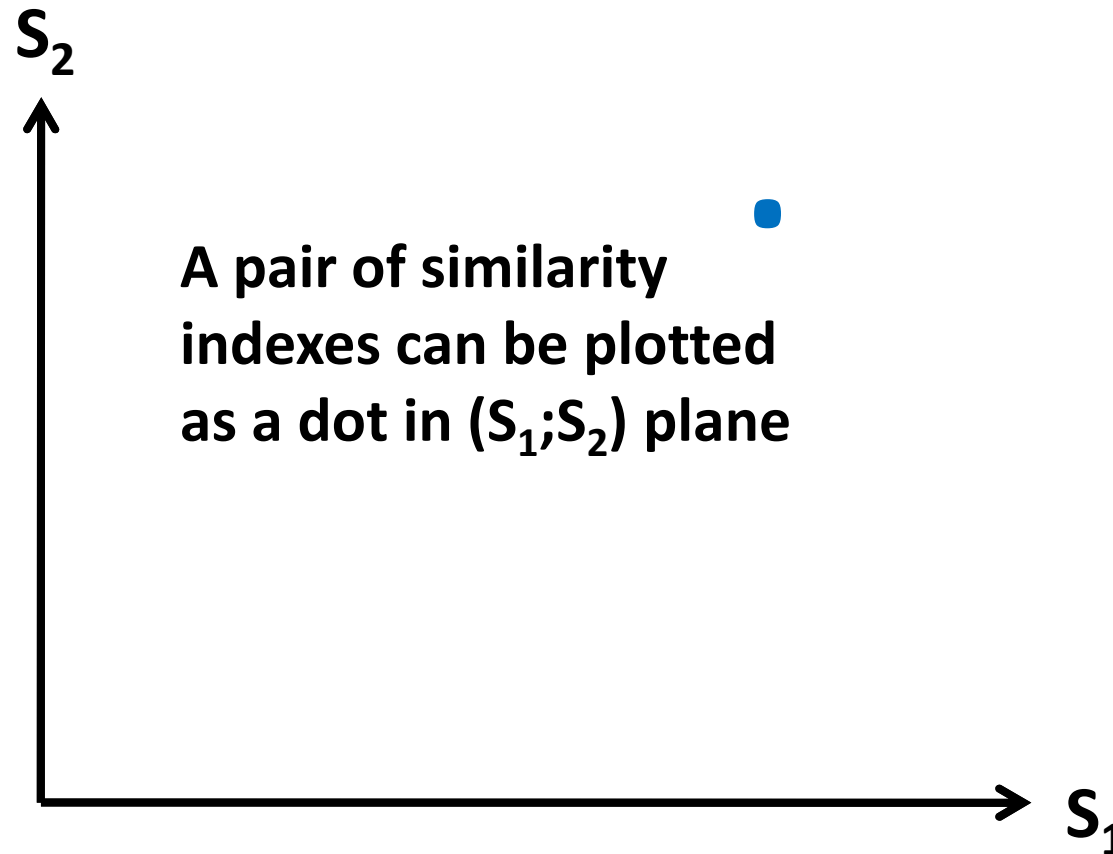
Database



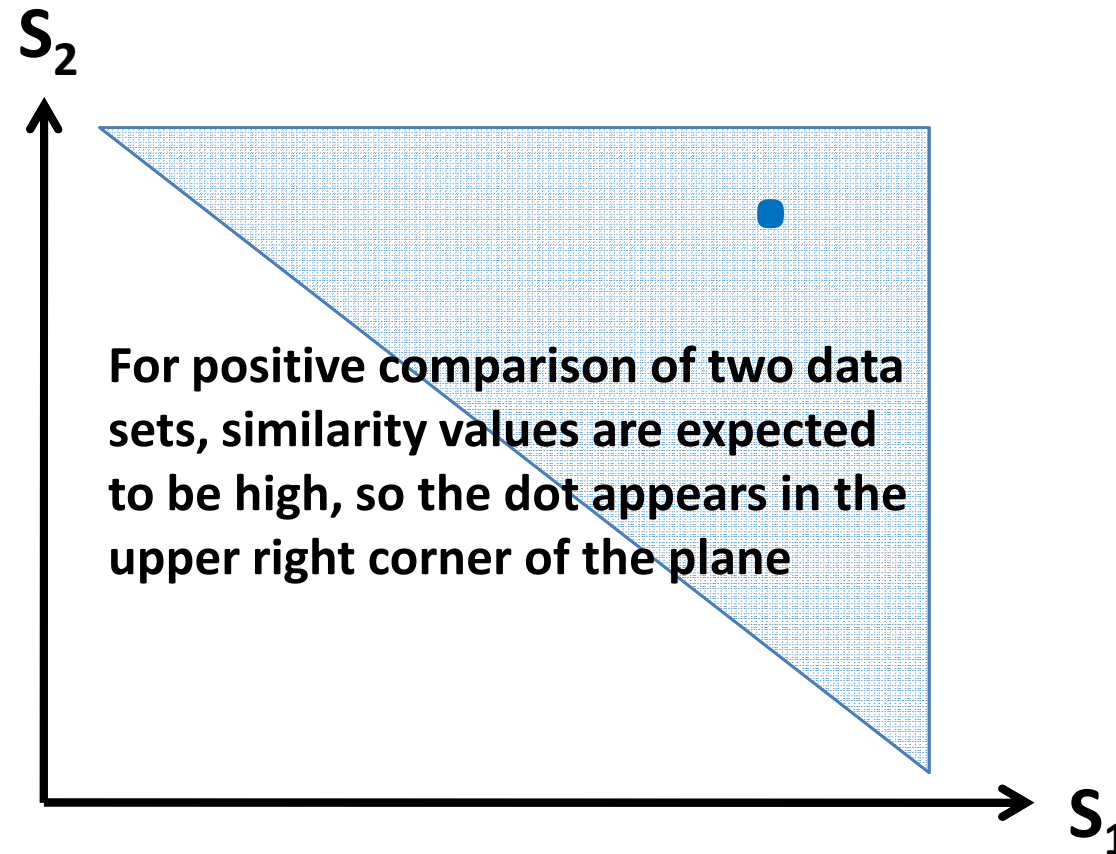
Database



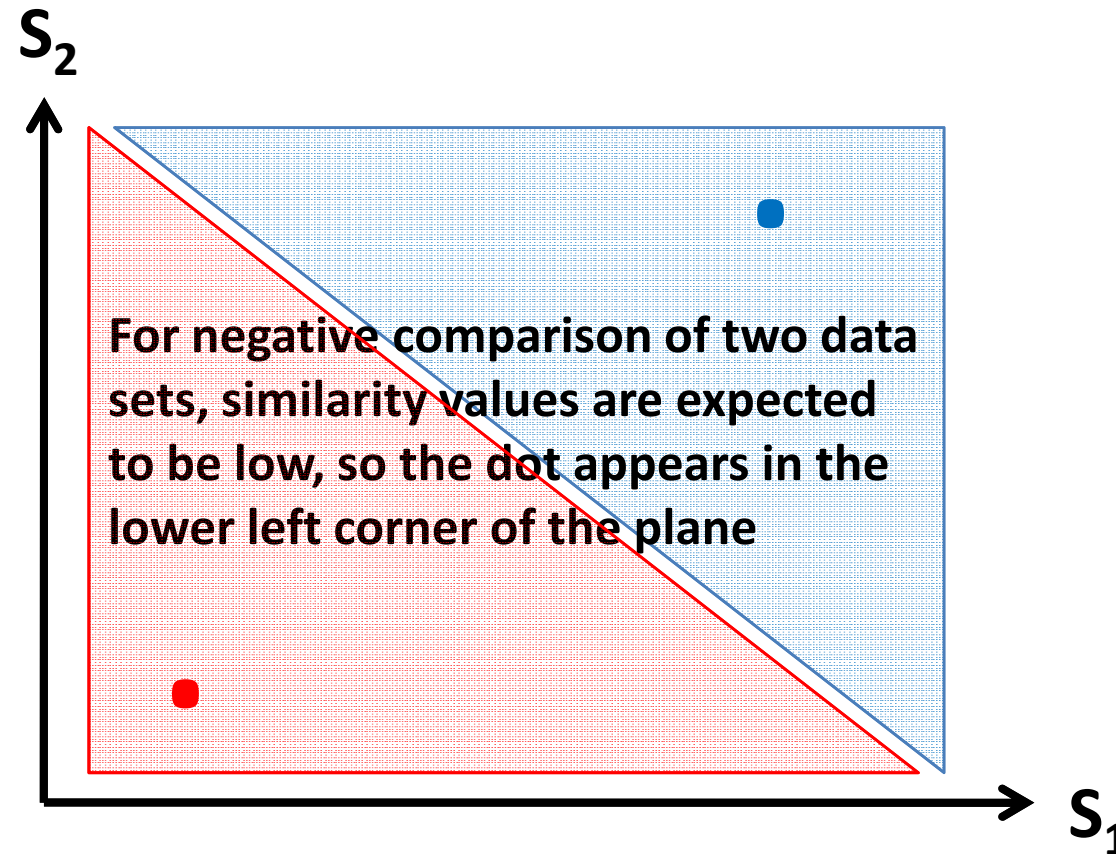
Fusion (I)



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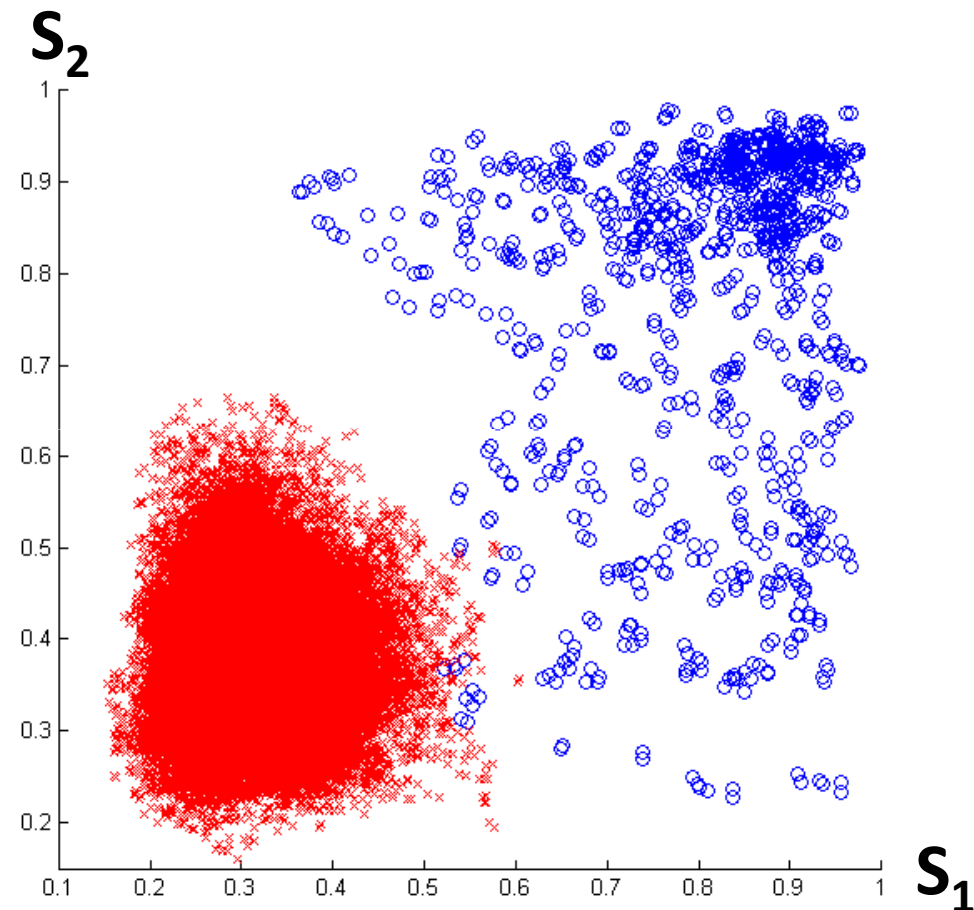


Fusion (I)



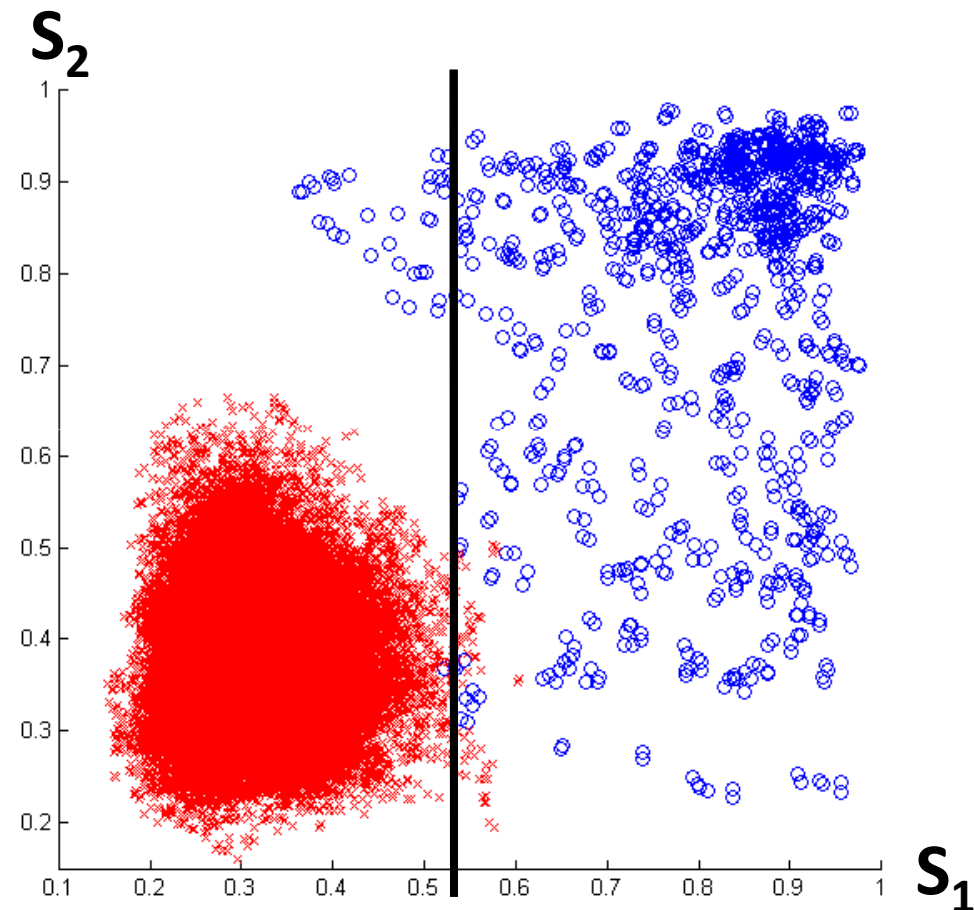
Fusion (I)

By analyzing both databases we can construct two sets that represent the positive and negative comparisons of evaluated database
The main task is to find an optimal separation threshold



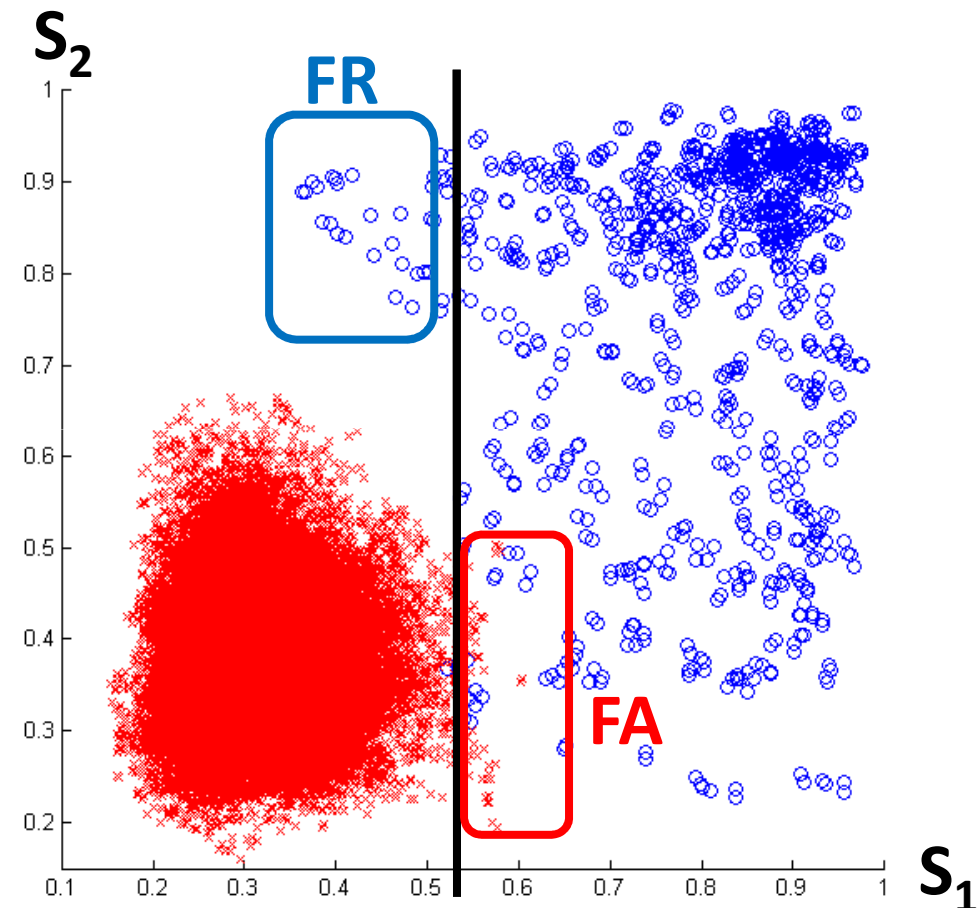
Fusion (I)

Using only one parameter (palm prints or palm blood vessels), separating line is either horizontal or vertical and the performance is poor



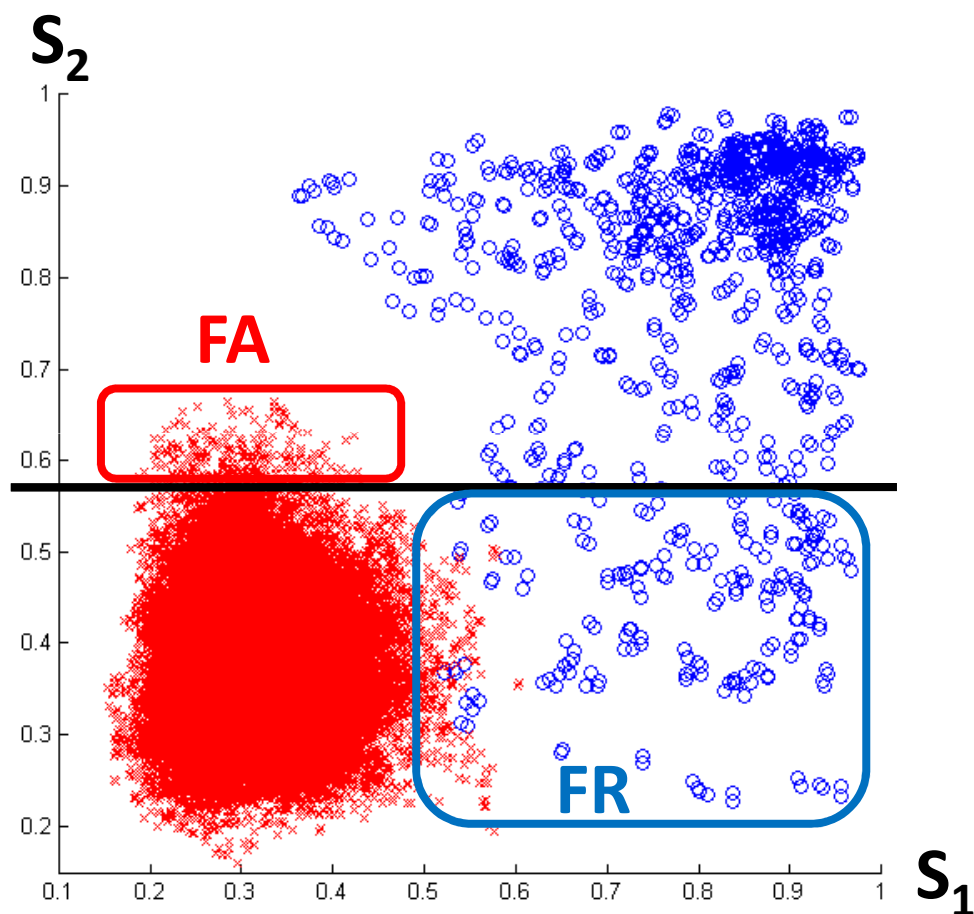
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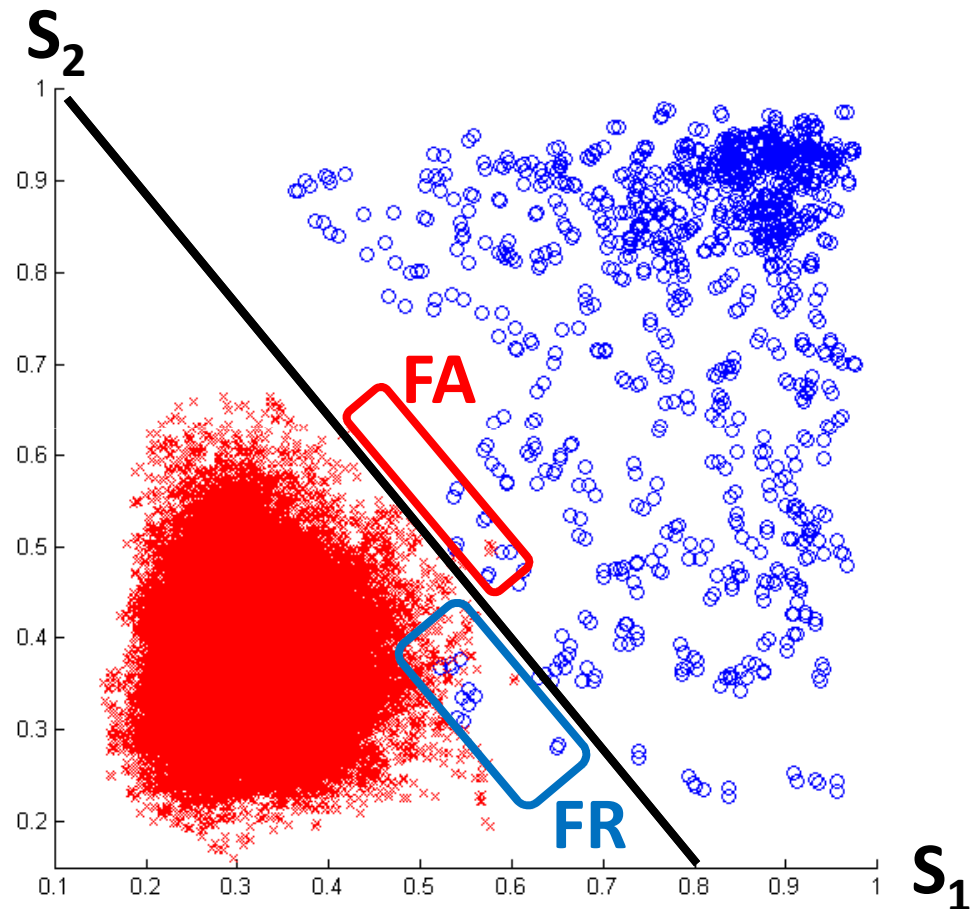
Fusion (I)

By using both parameters we can choose an arbitrary separating function which improves the performance of biometric system

$$T = f(S_1; S_2)$$

For simplicity we use a separating line

$$T = k \cdot S_1 + (1 - k) \cdot S_2$$



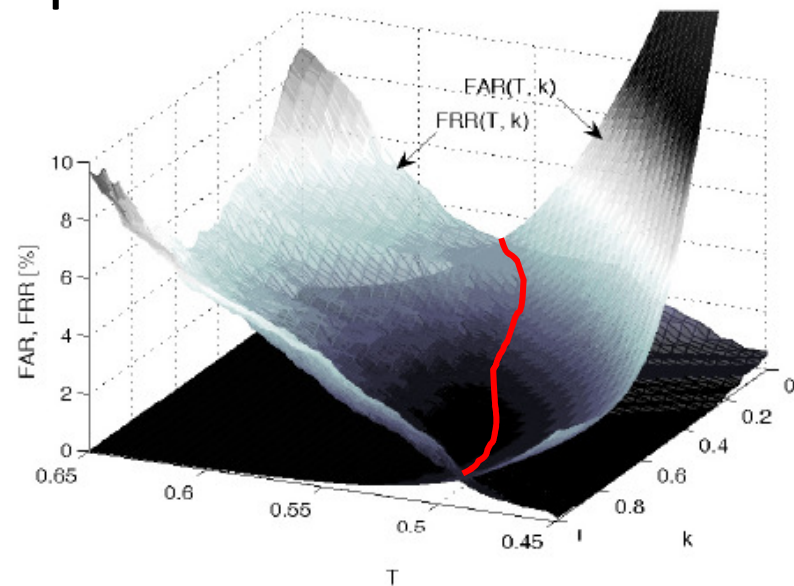
Fusion (II)

- Linear separation of two data sets

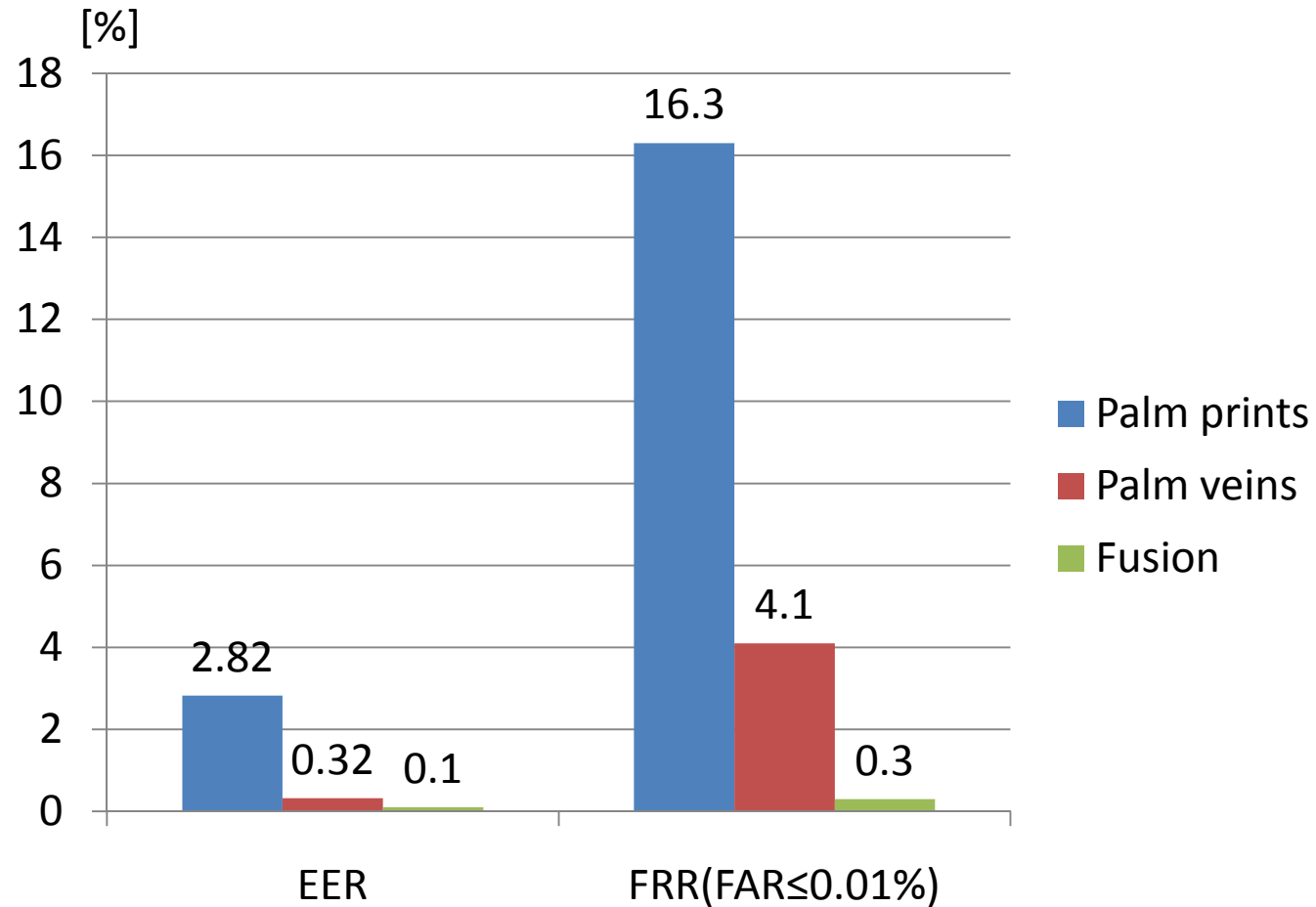
$$T = k \cdot S_1 + (1 - k) \cdot S_2$$

- Using this approach, FAR and FRR are functions of two parameters that can be plotted as surfaces:

We search for the optimal threshold and k value so that:
 $EER(k)$ is minimized and
 $FRR_{FAR \leq 0.01\%}(k)$ is minimized



Results



Conclusions

- Using the palm print and palm blood vessel images eases the enrolment procedure.
- Two parameters increase the overall system's precision.
- Complex 2D Matched Filtering approach speeds up the feature extraction procedure.
- Further research with larger database is needed.
- Future work: embedded system development



Thank you!

Questions?

This presentation was supported by ERAF funding under the agreement No.2010/0309/2DP/2.1.1.2.0/10/APIA/VIA/012

This research was supported by ESF funding under the agreement No. 2009/0219/1DP/1.1.1.2.0/09/APIA/VIAA/020



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