Palmprint Image Processing With Non-Halo Complex Matched Filters For Forensic Data Analysis

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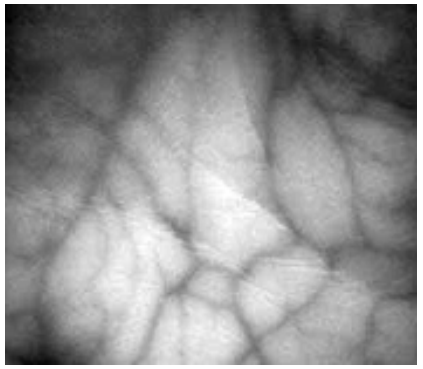
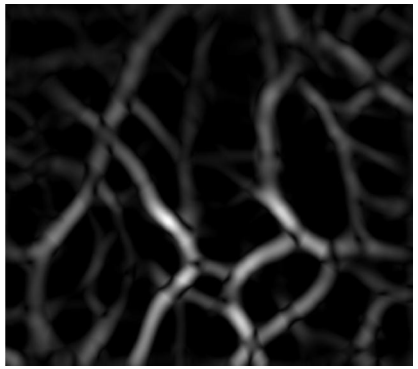
Previous work

- Line-like object extraction (NH-CMF)
- Real-time image processing (30 fps)
- Possibility to implement in embedded systems (FPGA)

Multimodal Palm Biometrics





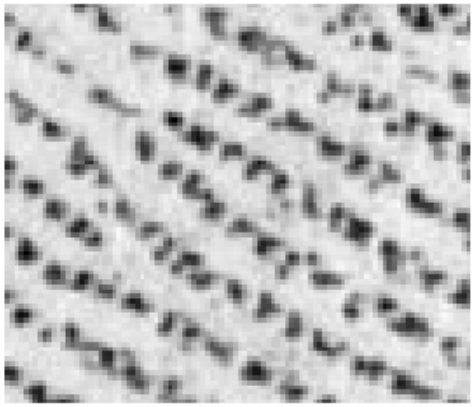
Motivation

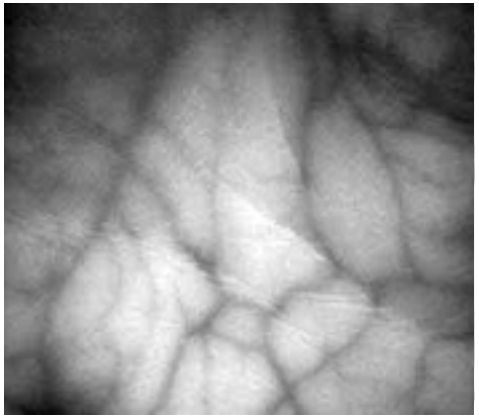
- Line-like object extraction (NH-CMF)
- Real-time image processing (30 fps)
- Possibility to implement in embedded systems (FPGA)

Multimodal Palm Biometrics

Forensic Data Analysis

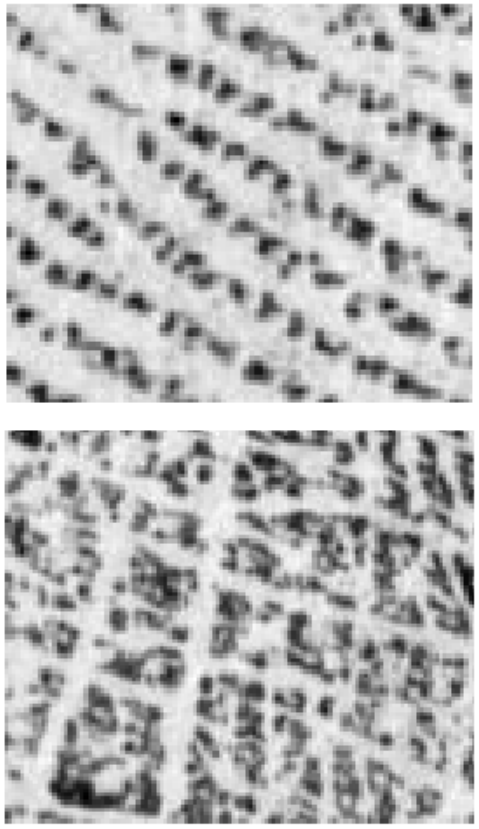
Analysis of latent palmprints





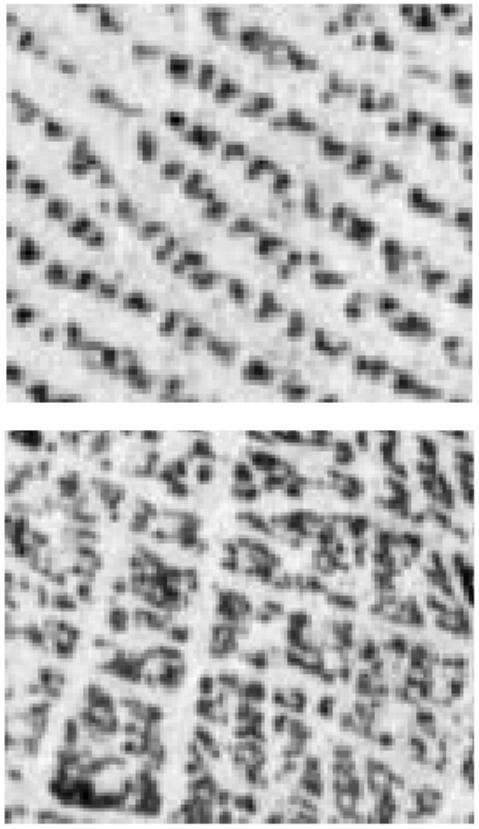
- **Palmprint images also as palm vein images contain line-like objects of known intensity (dark)**

Analysis of latent palmprints



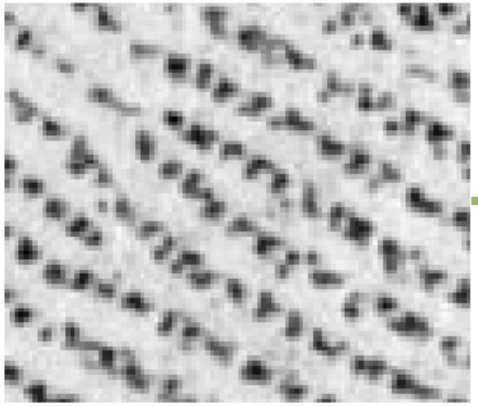
- Palmprint images also as palm vein images contain line-like objects of known intensity (dark)
- **Images are usually distorted and only partially acquired**

Analysis of latent palmprints

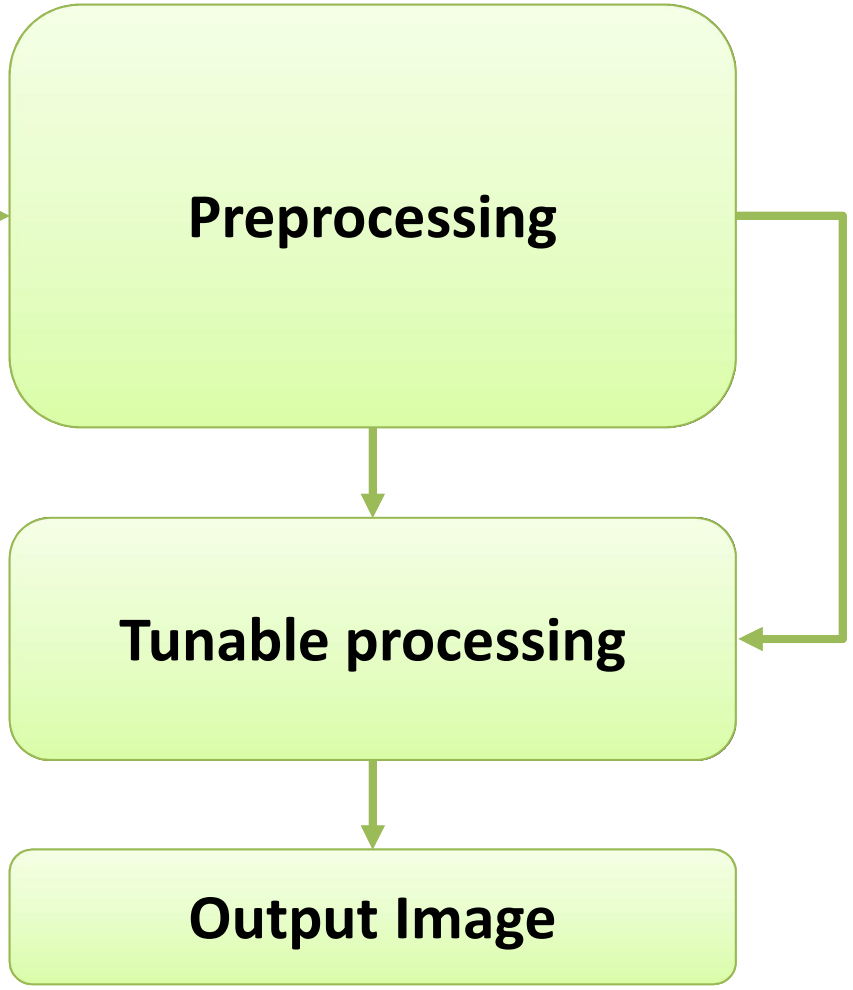


- Palmprint images also as palm vein images contain line-like objects of known intensity (dark)
- Images are usually distorted and only partially acquired
- **Ridges in some local areas are semi-parallel**
  - **Statistical methods can be used for analysis (MWAH)**

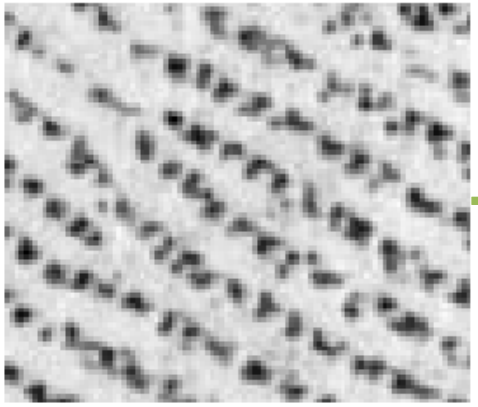
Proposed method



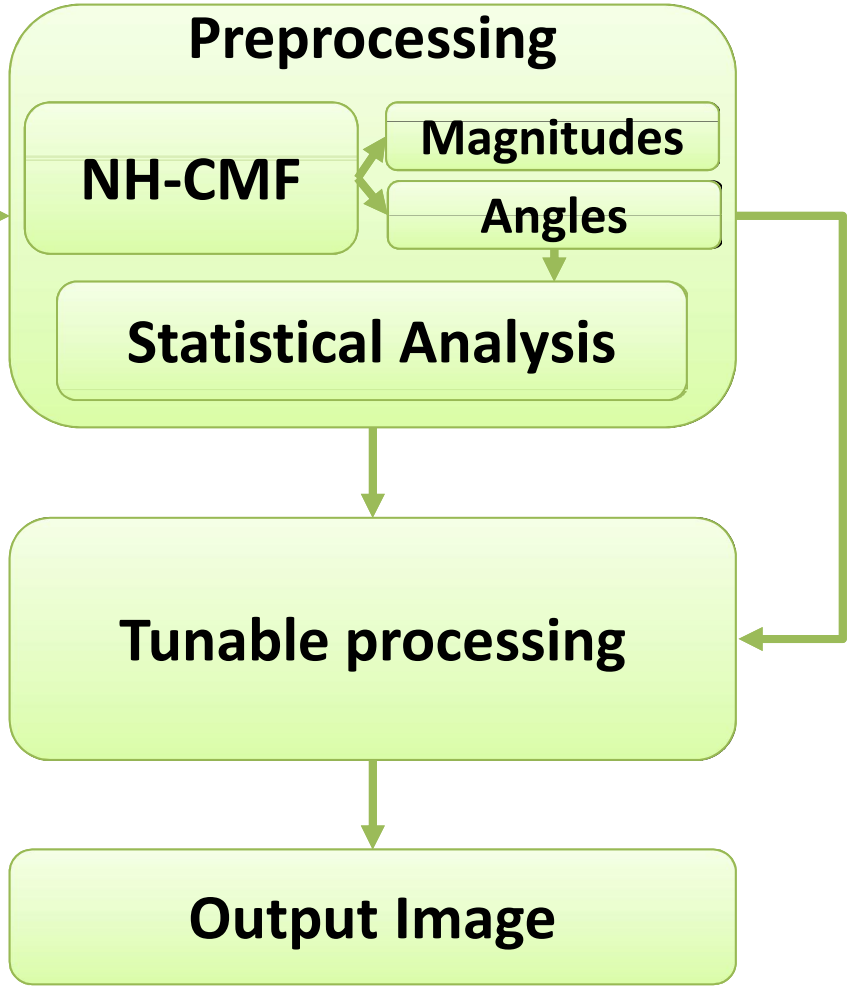
Input image



Proposed method

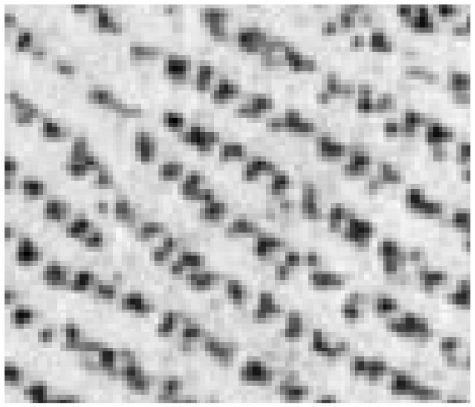


Input image



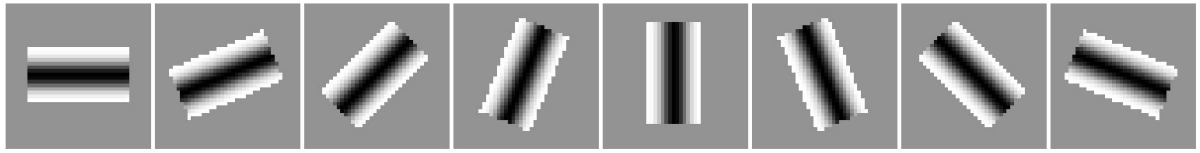
NH-CMF

- **N**on **H**alo – **C**omplex **M**atched **F**iltering
  1. Filter image with matched filter masks



Input image

$f(x, y)$



Rotated Matched filter kernels

$M(x, y; \varphi_n)$

$$s_n(x_0, y_0; \varphi_n) = \sum_D \sum f(x, y) \cdot M(x - x_0, y - y_0; \varphi_n)$$

NH-CMF

- **N**on **H**alo – **C**omplex **M**atched **F**iltering
  1. Filter image with matched filter masks
  2. Eliminate negative values from further processing

$$c_n(x, y; \varphi_n) = \frac{s_n(x_0, y_0; \varphi_n) + |s_n(x_0, y_0; \varphi_n)|}{2}$$

NH-CMF

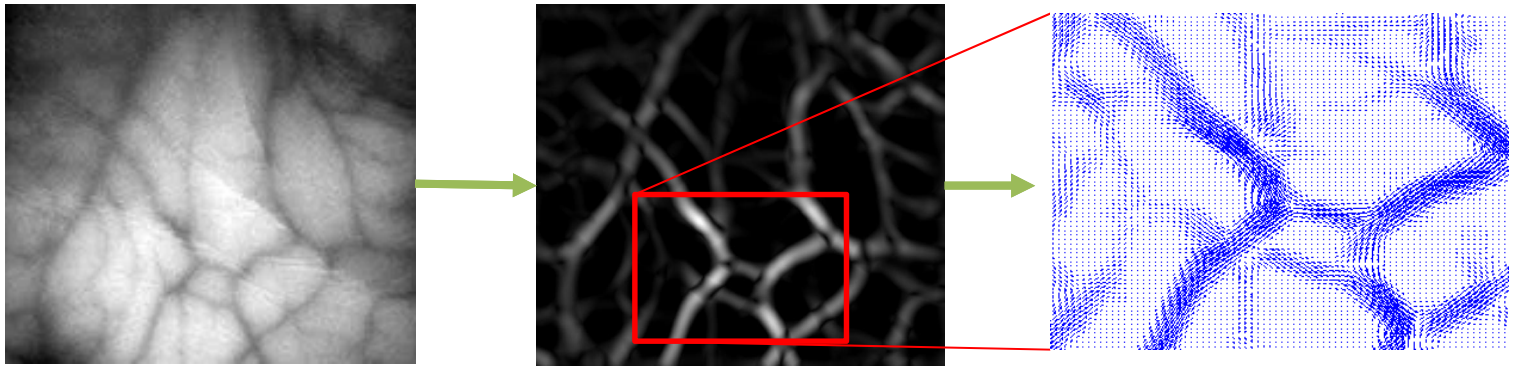
- **N**on **H**alo – **C**omplex **M**atched **F**iltering
  1. Filter image with matched filter masks
  2. Eliminate negative values from further processing
  3. Double the angle (to amplify signal and supress the noise) and sum

$$\vec{c}(x,y) = \sum_n c_n(x,y;\varphi_n) \cdot e^{j2\varphi_n}$$

NH-CMF

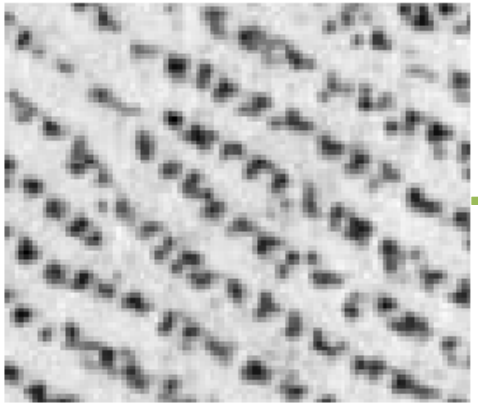
- **N**on **H**alo – **C**omplex **M**atched **F**iltering
  1. Filter image with matched filter masks
  2. Eliminate negative values from further processing
  3. Double the angle (to amplify signal and supress the noise) and sum
  4. Reduce the angle and obtain the result

$$\vec{v}(x,y) = |\vec{c}(x,y)| \cdot e^{j0.5 \cdot Arg(\vec{c}(x,y))}$$

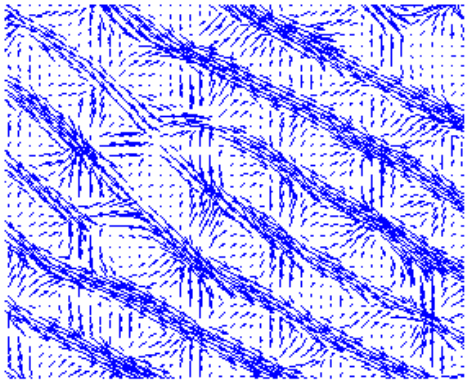


Input image **Filtered image** **Obtained vectors**

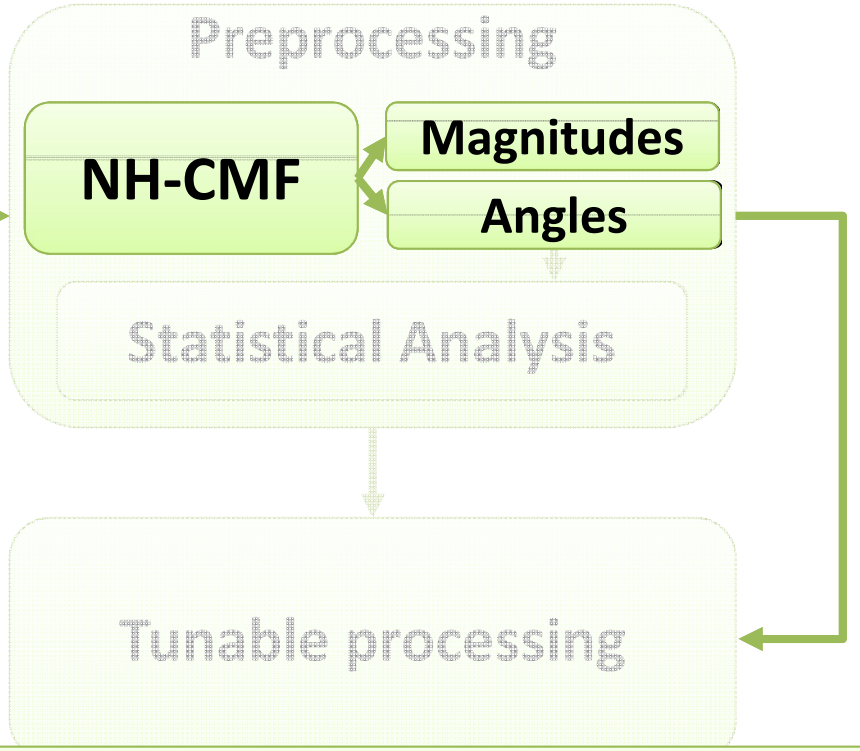
NH-CMF Result



Input image

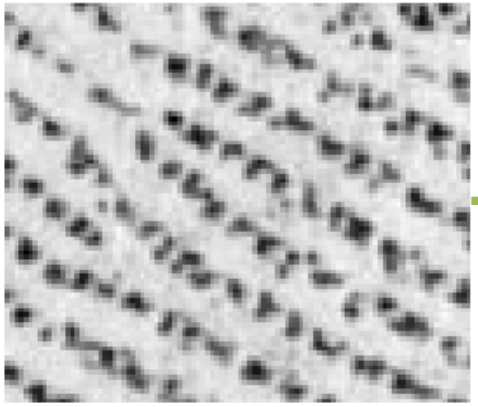


NH-CMF result

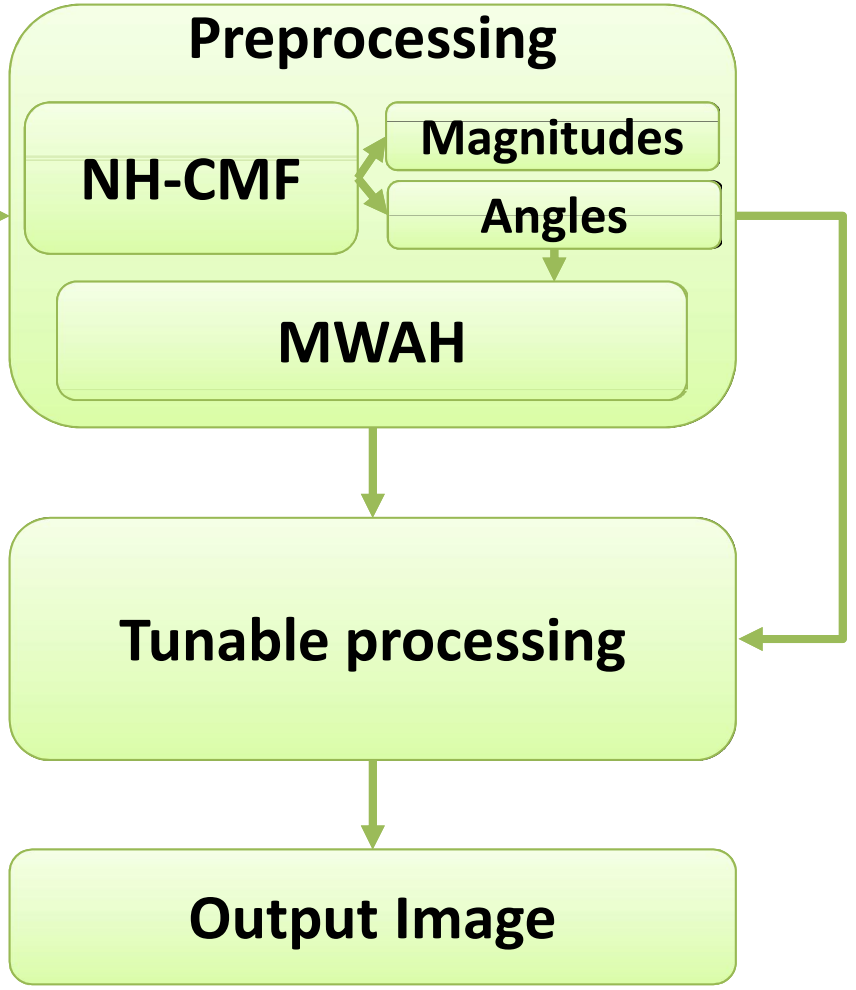


- Additional info about NH-CMF can be found in: M.Pudzs, M.Greitans, R.Fuksis. "*Complex 2D Matched Filtering Without Halo Artifacts*", IWSSIP 2011, Bosnia and Herzegovina, June 16-18, 2011, pp. 109-112

Proposed method



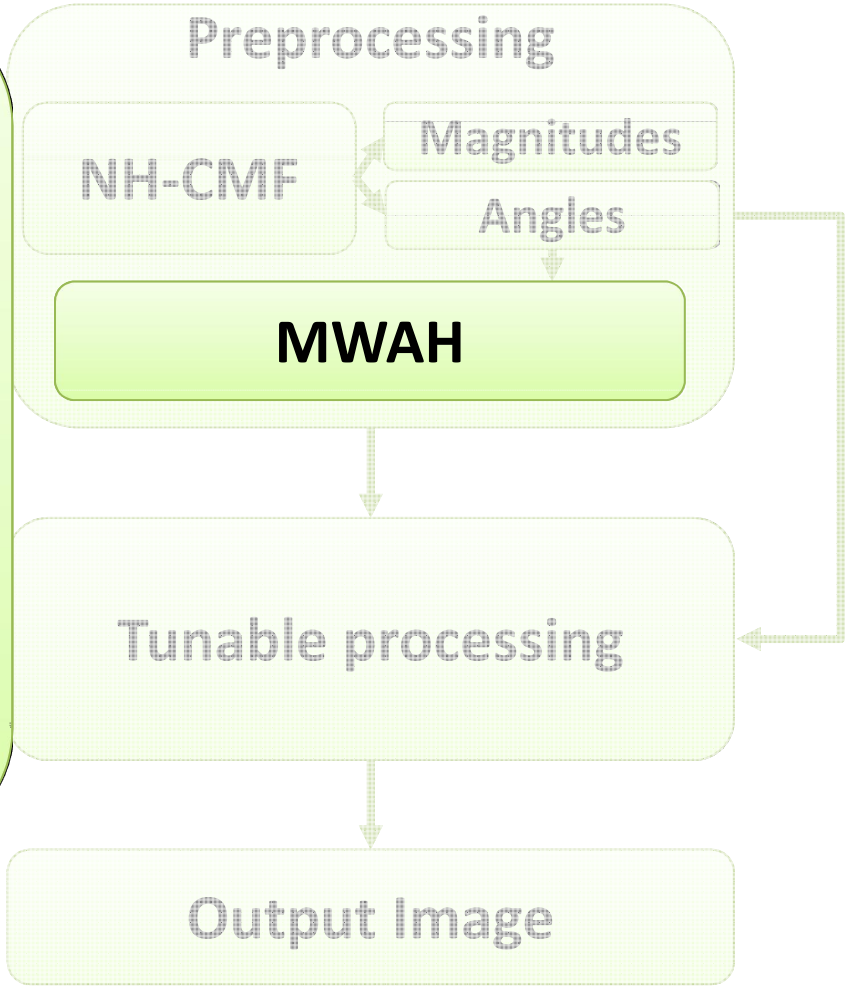
Input image



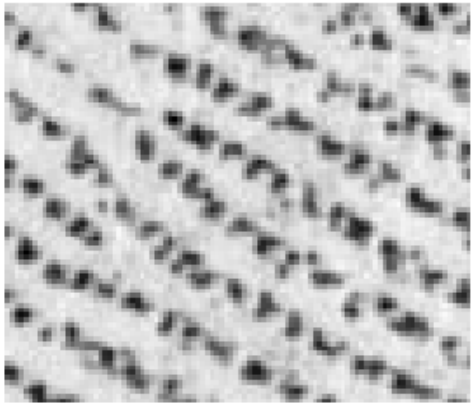
Proposed method

MWAH

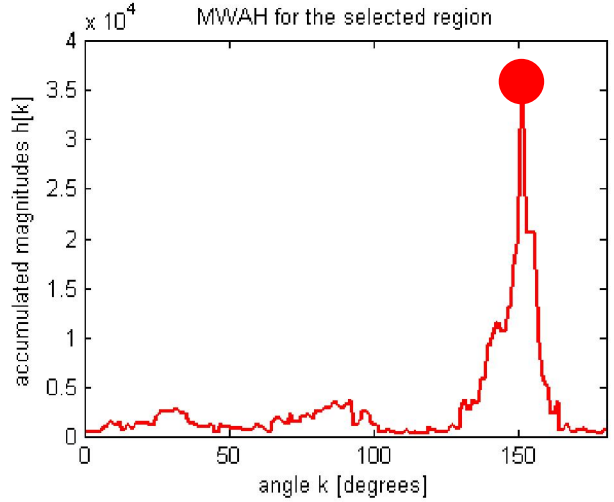
- **M**agnitude **W**eighted **A**ngle **H**istogram
- Sums up the magnitudes at similar angles
- Intensity of the extracted feature defines the angle significance

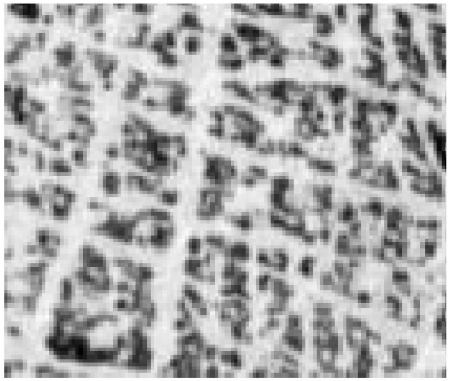


MWAH



Input image





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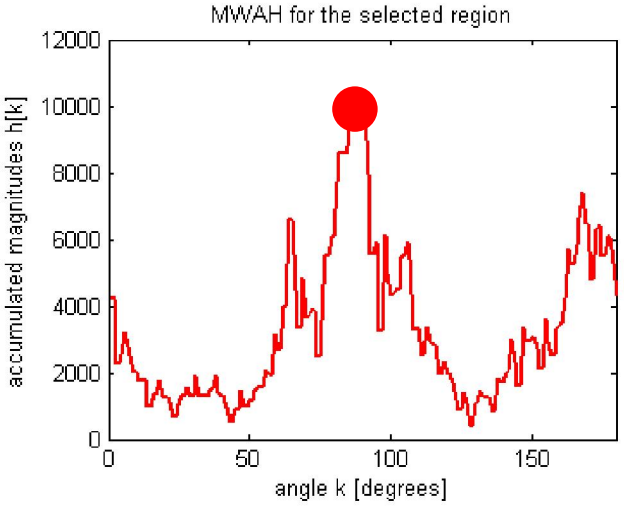
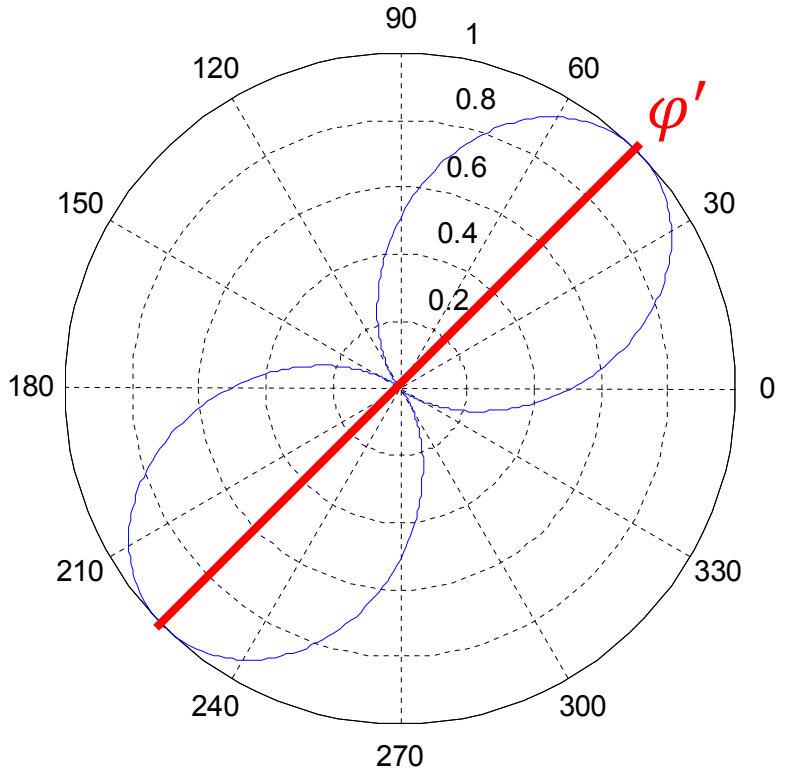


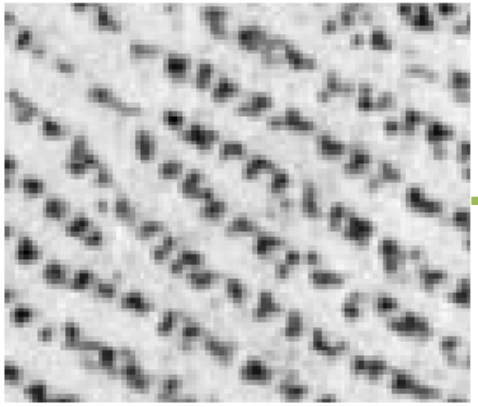
Using statistical data

- After finding the peak in MWAH the detail rejection function is formulated;
- This function acts like penalty function to reduce the unwanted angular appearances in the resulting image

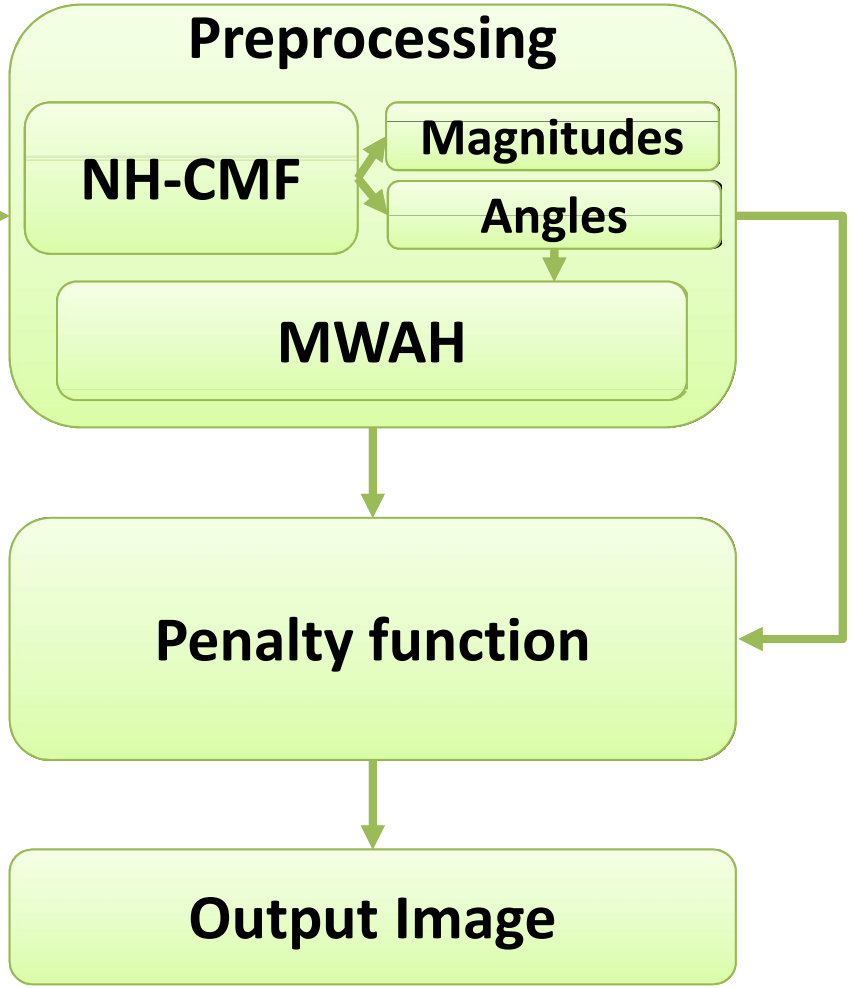


$$r\left(\varphi - \varphi'(x,y)\right) = \frac{r_{max} - 1}{r_{max}} \cdot \frac{\cos\left(2\left(\varphi - \varphi'(x,y)\right)\right) + 1}{2} + \frac{1}{r_{max}}$$

Proposed method



Input image



NH-CMF with angular preference

1. Filter image with matched filter masks
2. Eliminate negative values from further processing
3. Double the angle (to amplify signal and supress the noise) and sum
4. Reduce the angle and obtain the result

NH-CMF

5. Calculation of MWAH

MWAH

6. Filter image with matched filter masks
7. Apply penalty function for unwanted angle suppression
8. Eliminate negative values from further processing
9. Double the angle (to amplify signal and supress the noise) and sum
10. Reduce the angle and obtain the result

NH-CMF with AP

Results

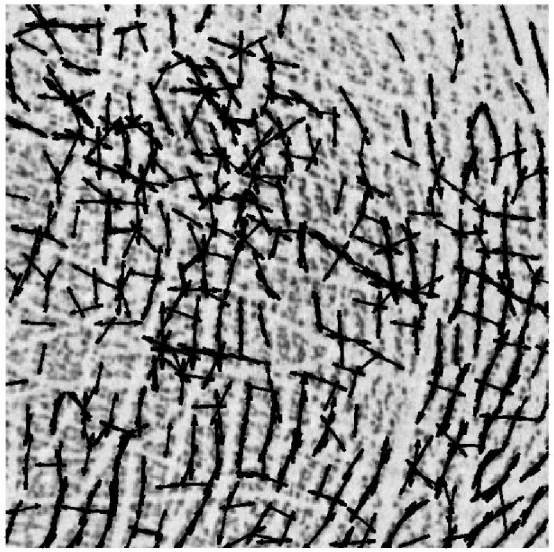


Image filtered with NH-CMF

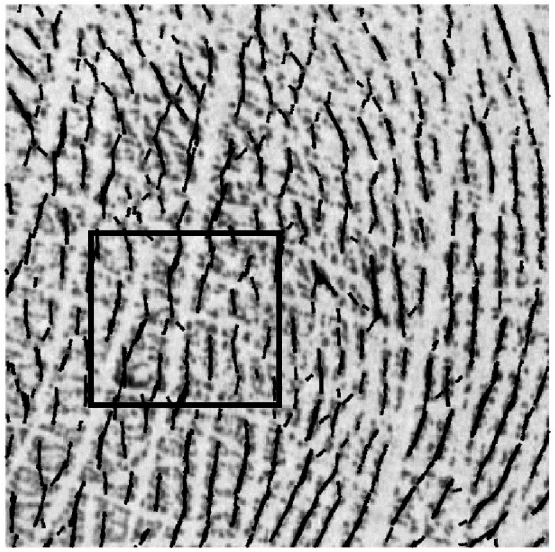
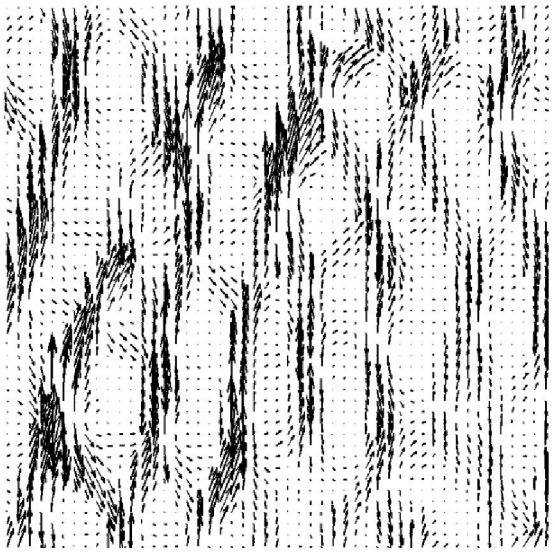


Image filtered with NH-CMF + MWAH



Resulting vectors

Conclusions

- NH-CMF with MWAH can be used to extract objects from noisy and only partialy acquired palmprint images;
- By using the NH-CMF with angular preference at local regions of the latent palmprint it is able to fine-tune the filter to detect only the desired details.

Future work:

Need to add a matcher and run the algorithm on latent palmprint database for precision evaluation.

Thank you!

Questions?

This research is partially supported by ERSF project No.2010/0285/2DP/2.1.1.1.0/10/APIA/VIAA/098

IEGULDĪJUMS TAVĀ NĀKOTNĒ