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

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- 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 → Preprocessing → Tunable processing → Output Image
Proposed method

Input image

Preprocessing

NH-CMF

Magnitudes

Angles

Statistical Analysis

Tunable processing

Output Image
Non Halo – Complex Matched Filtering

1. Filter image with matched filter masks

Input image

\[ f(x, y) \]

\[ s_n(x_0, y_0; \varphi_n) = \sum_{D} \sum_{D} f(x, y) \cdot M(x - x_0, y - y_0; \varphi_n) \]
NH-CMF

- **Non Halo – Complex Matched Filtering**
  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

- **Non Halo – Complex Matched Filtering**
  1. Filter image with matched filter masks
  2. Eliminate negative values from further processing
  3. Double the angle (to amplify signal and suppress the noise) and sum

\[
\tilde{c}(x, y) = \sum_n c_n(x, y; \varphi_n) \cdot e^{j2\varphi_n}
\]
NH-CMF

- **Non Halo – Complex Matched Filtering**
  1. Filter image with matched filter masks
  2. Eliminate negative values from further processing
  3. Double the angle (to amplify signal and suppress the noise) and sum
  4. Reduce the angle and obtain the result

\[ \tilde{v}(x, y) = |\tilde{c}(x, y)| \cdot e^{j0.5 \cdot Arg(\tilde{c}(x,y))} \]

![Input image](image1)

![Filtered image](image2)

![Obtained vectors](image3)
NH-CMF Result

Preprocessing

NH-CMF

Magnitudes

Angles

Statistical Analysis

Tunable processing

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

Preprocessing

NH-CMF

Magnitudes

Angles

MWAH

Tunable processing

Output Image
Proposed method

**MWAH**
- **Magnitude** Weighted **Angle** Histogram
- Sums up the magnitudes at similar angles
- Intensity of the extracted feature defines the angle significance
MWAH

Input image

Input image

MWAH for the selected region

accumulated magnitudes |$|l_k|$|

angle $k$ [degrees]

MWAH for the selected region

accumulated magnitudes |$|l_k|$|

angle $k$ [degrees]
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

\[ r(\varphi - \varphi'(x, y)) = \frac{r_{\text{max}} - 1}{r_{\text{max}}} \cdot \frac{\cos \left(2(\varphi - \varphi'(x, y))\right) + 1}{2} + \frac{1}{r_{\text{max}}} \]
Proposed method

Input image

Preprocessing

NH-CMF

Magnitudes

Angles

MWAH

Penalty function

Output 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 suppress the noise) and sum
4. Reduce the angle and obtain the result
5. Calculation of 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 suppress the noise) and sum
10. Reduce the angle and obtain the result

NH-CMF
MWAH

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 partially 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?

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