Scattering Wavelet Transform Based Palm Print Biometric Recognition

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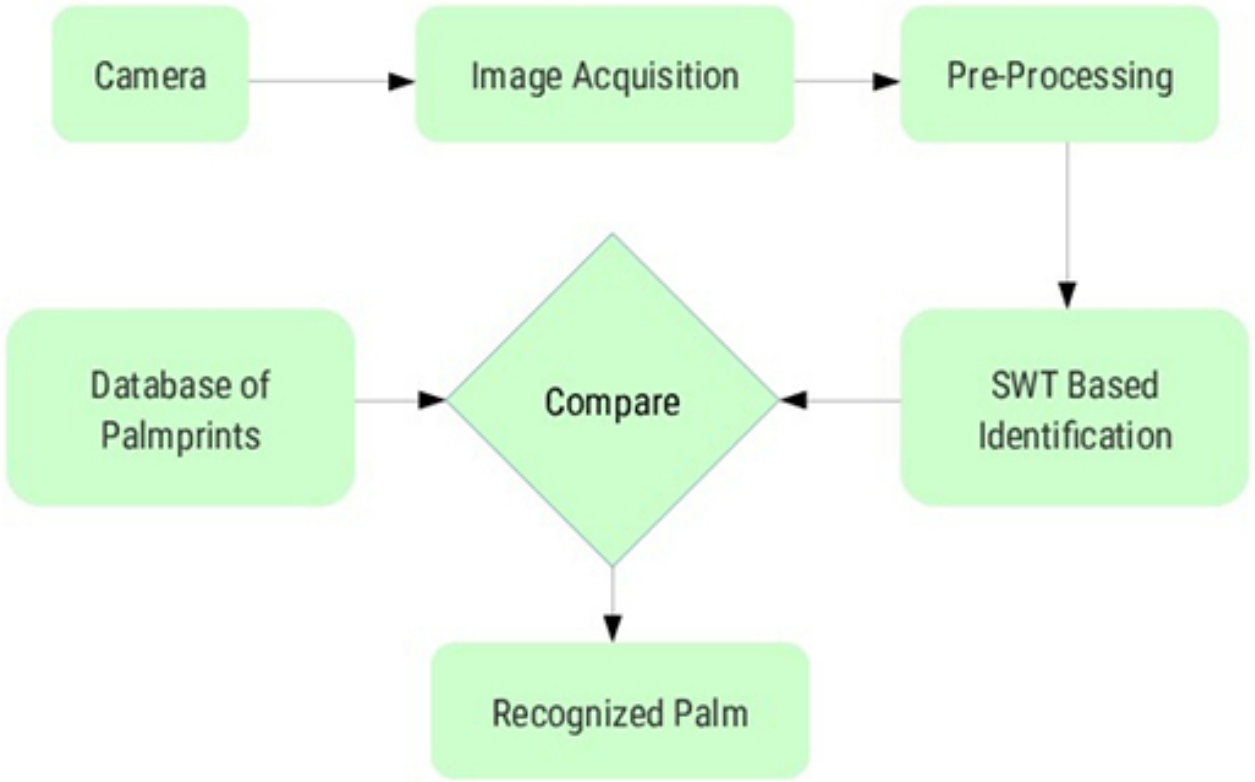
Palm Print Biometric Recognition System



Phase Congruency

$$PC(x) = \frac{E(x)}{\sum_n A_n}$$

Monogenic Signal

$$f_M(x_1, x_2) = \begin{bmatrix} f(x_1, x_2) \\ f_{R_1}(x_1, x_2) = R_1(x_1, x_2) * f(x_1, x_2) \\ f_{R_2}(x_1, x_2) = R_2(x_1, x_2) * f(x_1, x_2)) \end{bmatrix}$$

Local Monogenic Phase and Orientation

$$\phi(x_1, x_2) = \tan^{-1}\left(\frac{\sqrt{f_{R_1}(x_1, x_2)^2 + f_{R_2}(x_1, x_2)^2}}{f(x_1, x_2)}\right)$$

$$\theta(x_1, x_2) = \tan^{-1}\left(\frac{f_{R_2}(x_1, x_2)}{f_{R_1}(x_1, x_2)}\right)$$

Amplitude of Fourier Components

$$A_n(x_1, x_2, s) = \frac{}{\sqrt{f(x_1, x_2, s)^2 + f_{R_1}(x_1, x_2, s)^2 + f_{R_2}(x_1, x_2, s)^2}}$$

Local Energy of Image for N scales

$$E(x_1, x_2) = \sqrt{[f_{sum}(x_1, x_2)]^2 + [f_{R1\,sum}(x_1, x_2)]^2 + [f_{R2\,sum}(x_1, x_2)]^2}$$

where,

$$f_{sum}(x_1, x_2) = \sum_{s=1}^{N} f(x_1, x_2, s)$$

$$f_{R1\,sum}(x_1, x_2) = \sum_{s=1}^{N} f_{R_1}(x_1, x_2, s)$$

$$f_{R2\,sum}(x_1, x_2) = \sum_{s=1}^{N} f_{R_2}(x_1, x_2, s)$$

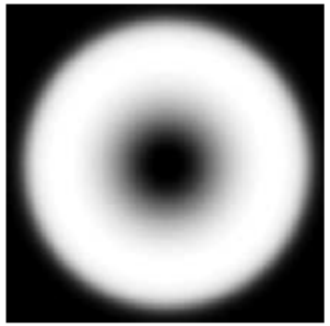
Phase Congruency at (x_1,x_2)

$$PC(x_1, x_2) = \frac{E(x_1, x_2)}{\sum_{s=1}^{N} A_n(x_1, x_2, s)}$$

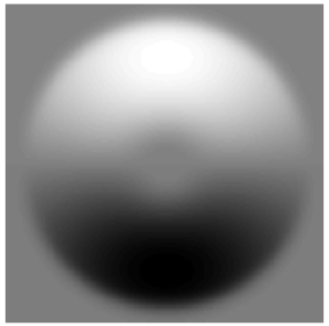
2-D Log-Gabor Isotropic Wavelet

$$G(u_1, u_2) = \exp \frac{-\left(log\left(\frac{\sqrt{(u_1)^2 + (u_2)^2}}{\omega_0}\right)\right)^2}{2\left(log\left(\frac{\zeta}{\omega}\right)\right)^2}$$

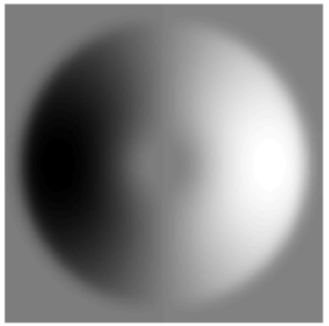
Radial Response Profile



(a)



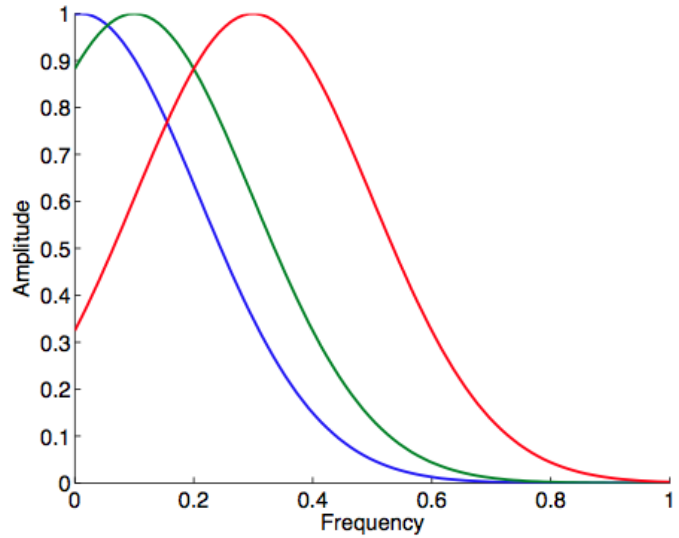
(b)



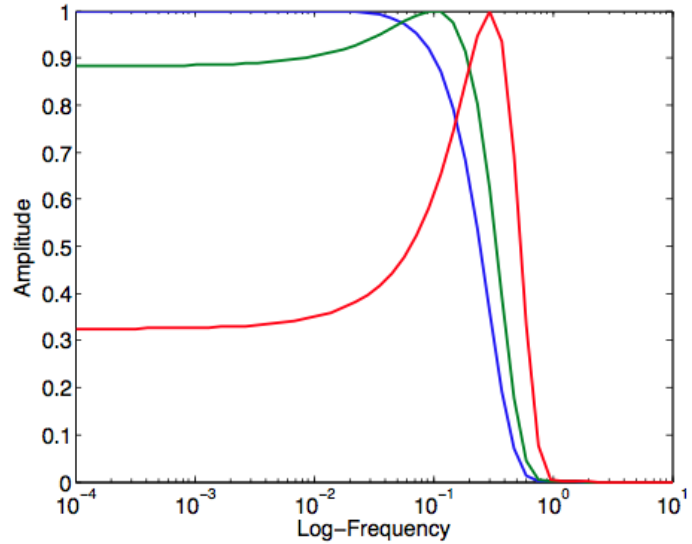
(c)

(a) Isotropic log-Gabor wavelet response

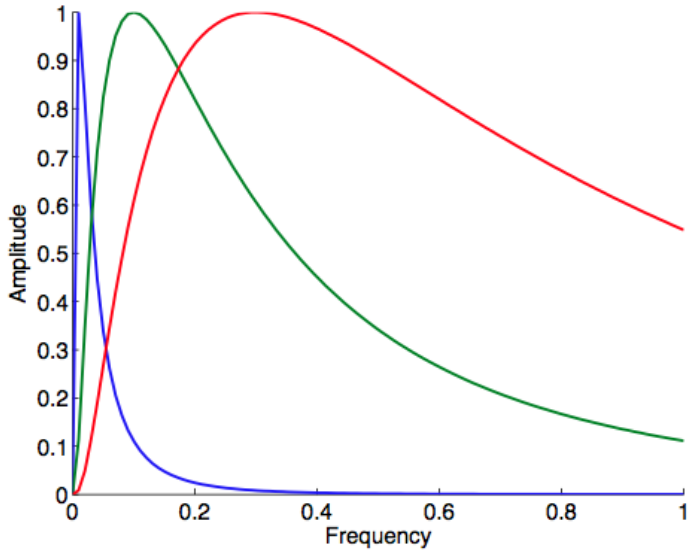
(b) and (c) corresponding Riesz wavelets filter responses



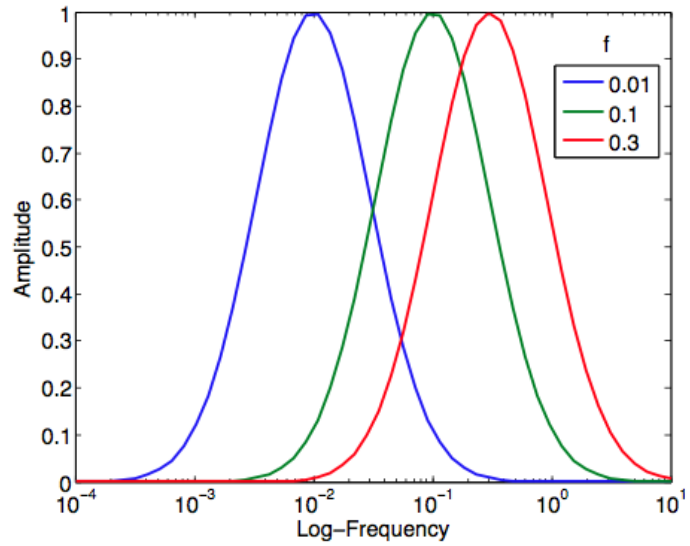
(a) Gabor - Linear Frequency



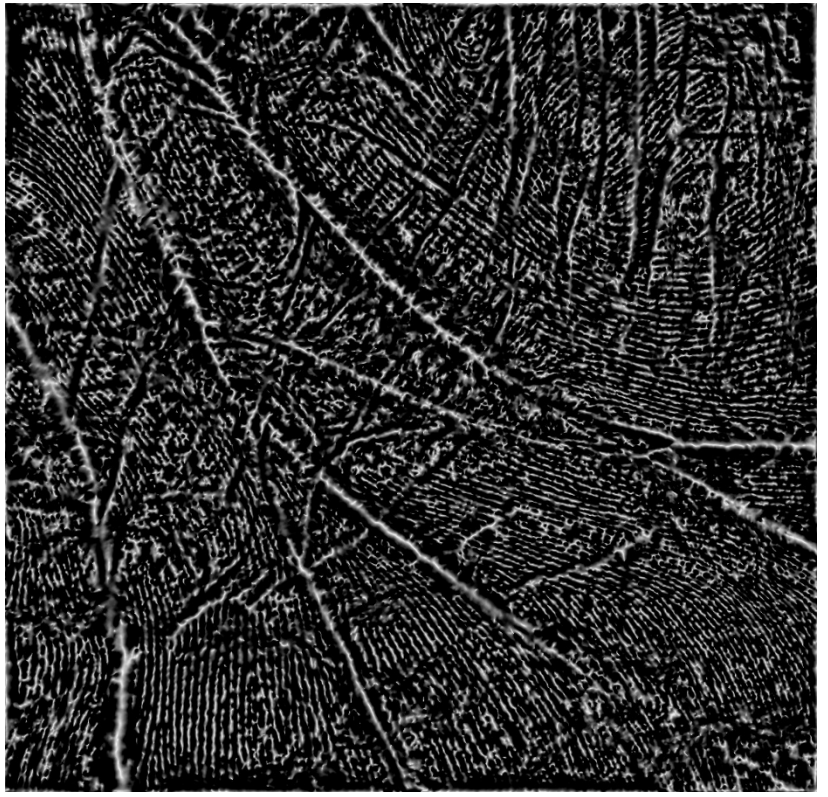
(b) Gabor - Log Frequency



(c) Log-Gabor - Linear Frequency



(d) Log-Gabor - Log Frequency



Why Scattering Wavelet Transform?

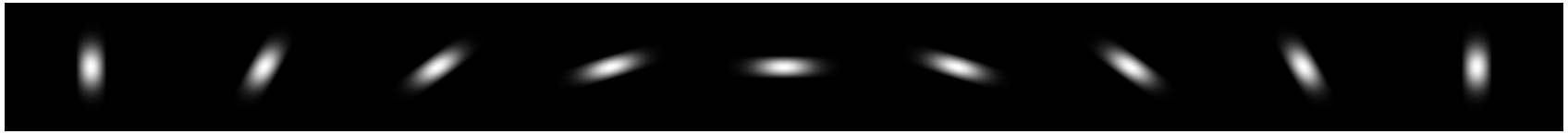
- Rotational Invariance
- Translational Invariance
- Deformation Invariance

Morlet Wavelet Equation

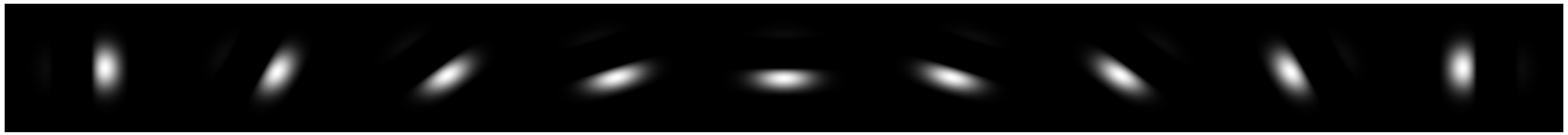
$$\psi(u) = \alpha \left(e^{iu.\xi} - \beta\right) e^{-|u|^2/(2\sigma^2)}$$

Morlet Wavelet Orientations

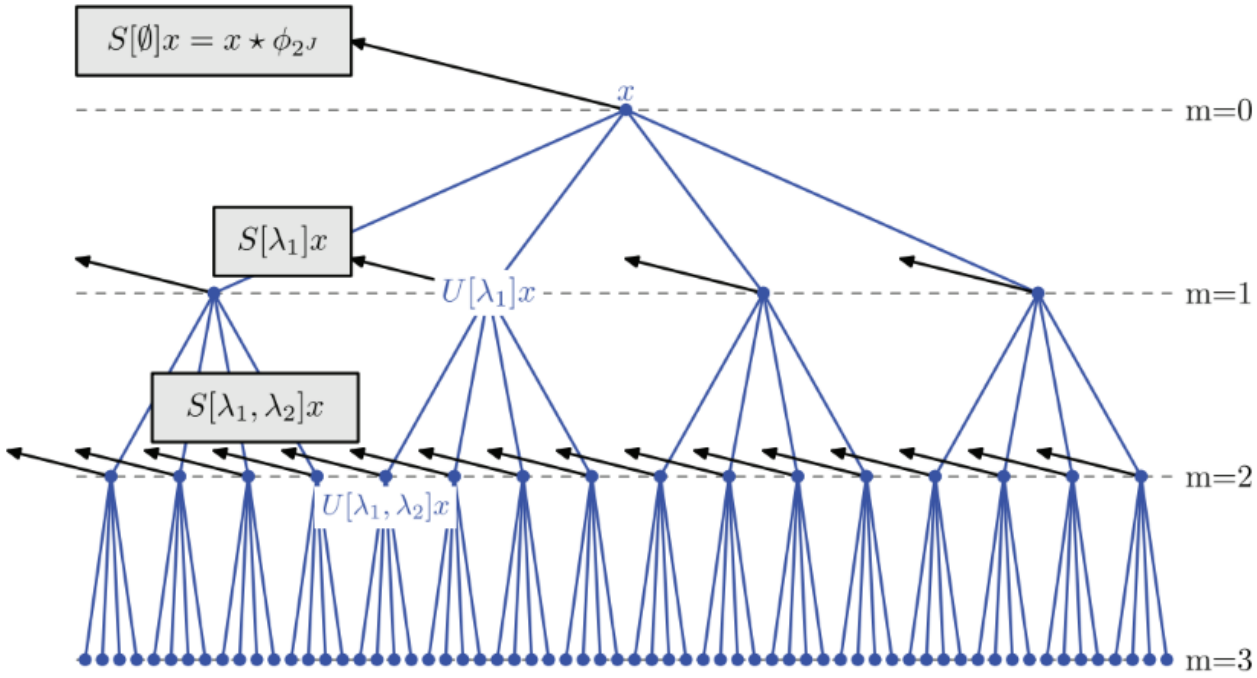
Real Part



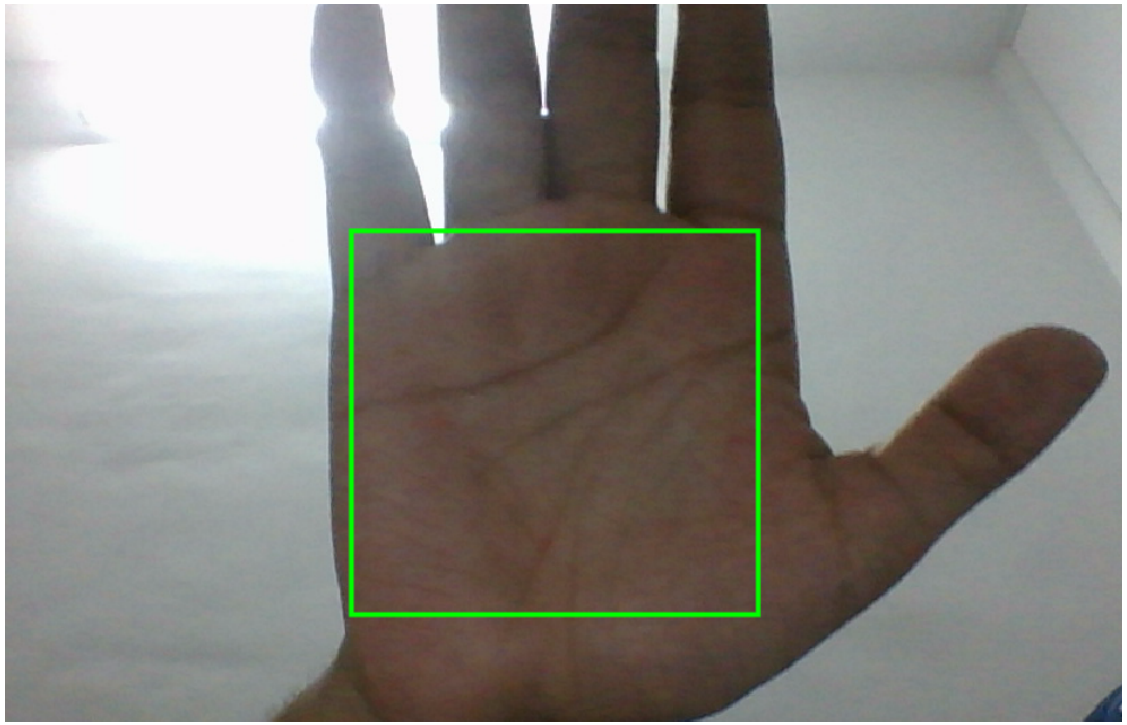
Imaginary Part



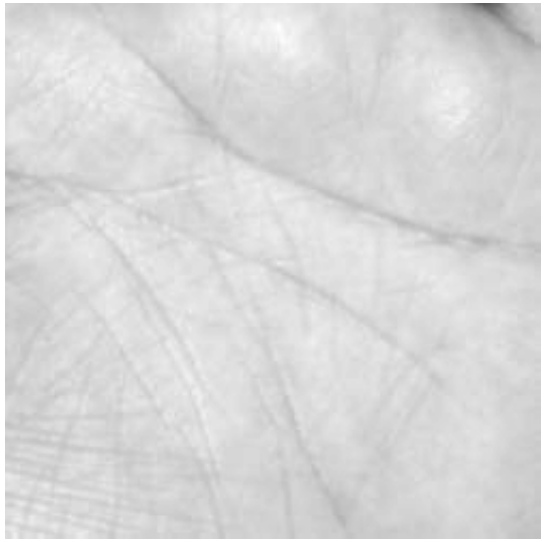
Convolution network architecture of the scattering wavelet decomposition



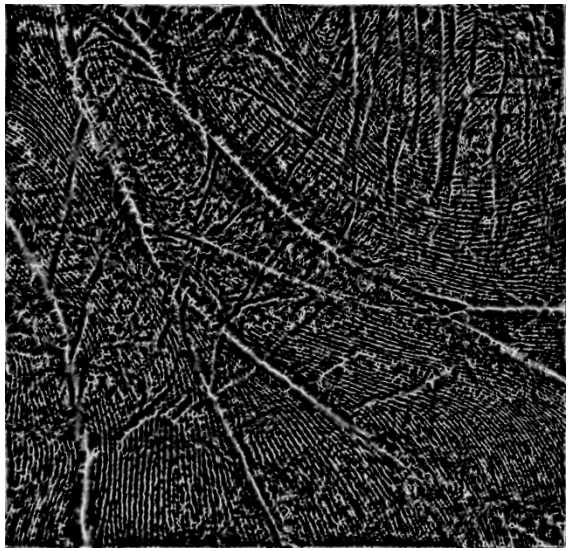
ROI Extraction



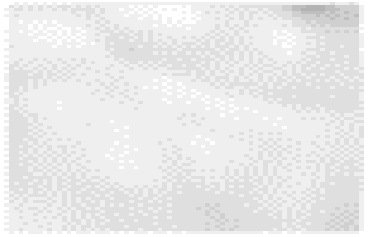
Extracted Palm Print



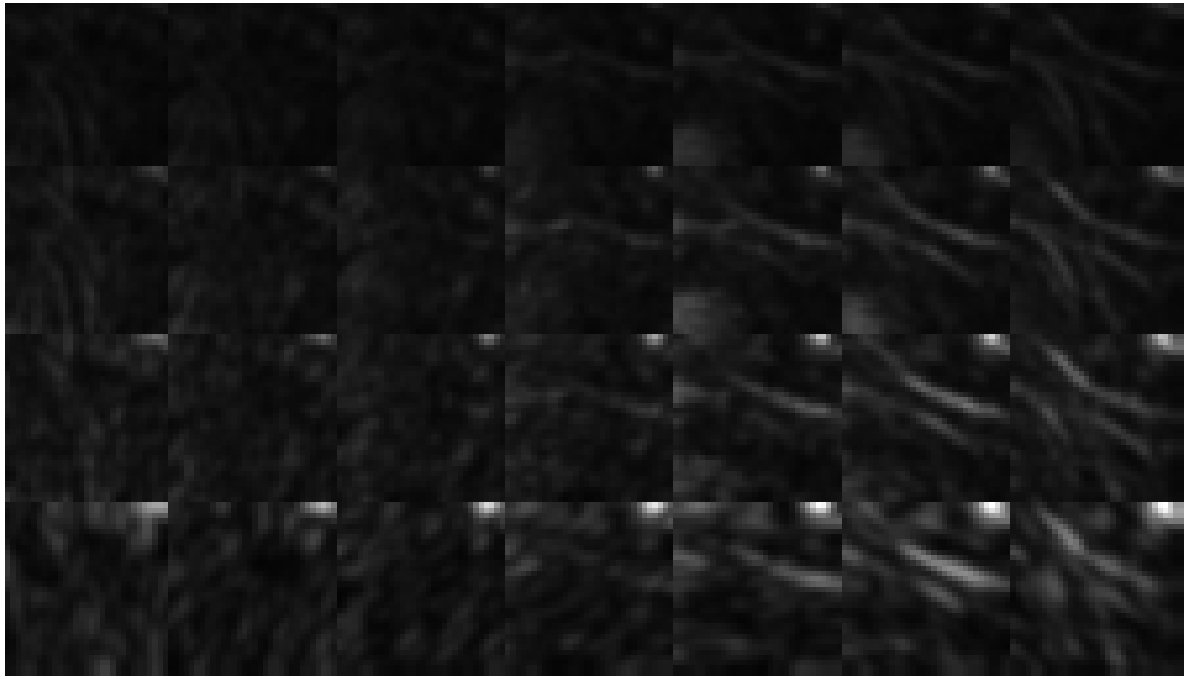
Pre-processed Palm Print Image



Averaged Output



First Layer SWT Coefficients



Second Layer SWT Coefficients