Rotation and Scaling Invariant Texture Classification Based on Gabor Wavelets

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Keywords:

Abstract

2 Gabor Feature Extraction

1 Introduction

$$\psi_{\omega\,\theta}(x\ y) = \frac{}{\pi\sigma} e^{-\left(\frac{(x\quad\theta + y\quad\theta)\ +(-x\quad\theta + y\quad\theta)}{\sigma}\right)} \cdot \left[e^{i(\omega x\quad\theta + \omega y\quad\theta)} - e^{-\frac{\omega\ \sigma}{}} \right] \quad \textbf{1}$$

$x\ y$ ω θ σ x y σ_x σ_y σ σ

$$\sigma = \kappa / \omega \quad \textbf{2}$$

$\kappa = \sqrt{\quad}\left(\left(\ ^{\phi} +\ \right) / \left(\ ^{\phi} -\ \right)\right)$ ϕ

$f\,x\,y$ $f\,x\ y$ $\psi_{\omega\,\theta}(x\ y)$

$$Y_{\omega\,\theta}(x\ y) = f(x\ y) * \psi_{\omega\,\theta}(x\ y) \quad \textbf{3}$$

$$\mathbf{Y}_{\omega\theta} = [Y_{\omega\theta}(\ )\ Y_{\omega\theta}(\ ) \cdots Y_{\omega\theta}(\ N_H -)\ Y_{\omega\theta}(\ ) \cdots Y_{\omega\theta}(N_W -\ N_H -)]^T$$

N_W N_H T

$\mathbf{Y}_{\omega\theta}$

ω θ

$$\mathbf{Y} = [\mathbf{Y}^T_{\omega\ \theta}\ \mathbf{Y}^T_{\omega\ \theta} \cdots \mathbf{Y}^T_{\omega_m\ \theta_n}]^T$$

m n

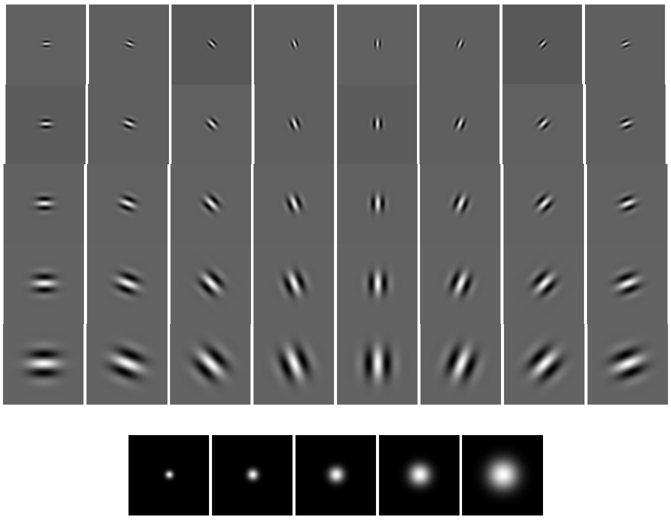

Fig. 1:

$\pi/$ $\sqrt{\ }\pi/$ $\pi/$ $\sqrt{\ }\pi/$ $\pi/$

$\pi/$ $\pi/$

3 Rotation and Scaling Invariant Feature Representation and Texture Classification

$\mathbf{Y}_{\omega\theta}$ $\mu_{\omega\theta}$

$\sigma_{\omega\theta}$

$$\mu_{\omega\theta} = \frac{\sum_y \sum_x Y_{\omega\theta}(x\ y)}{N_W \cdot N_H}$$

$$\sigma_{\omega\theta} = \sqrt{\frac{\sum_y \sum_x (Y_{\omega\theta}(x\ y) - \mu_{\omega\theta})}{N_W \cdot N_H}}$$

$$P = [\mu_{\omega\ \theta}\ \sigma_{\omega\ \theta}\ \mu_{\omega\ \theta}\ \sigma_{\omega\ \theta} \cdots \mu_{\omega_m\ \theta_n}\ \sigma_{\omega_m\ \theta_n}]^T$$

P

P

P

$\mu_{\omega\theta}$

P

θ_i

$$P = [\mu_{\omega\ \theta_i}\ \sigma_{\omega\ \theta_i}\ \mu_{\omega\ \theta_i}\ \sigma_{\omega\ \theta_i} \cdots \mu_{\omega_m\ \theta_i}\ \sigma_{\omega_m\ \theta_i}\ \mu_{\omega\ \theta_{i+}}\ \sigma_{\omega\ \theta_{i+}} \cdots \mu_{\omega_m\ \theta_{i-}}\ \sigma_{\omega_m\ \theta_{i-}}]^T$$

$\mu_{\omega\theta}$

$\mu_{\omega\theta}$

ω θ

ω_i

P_{ω_i} $P_{\omega_i} = [\mu_{\omega_i\ \theta}\ \sigma_{\omega_i\ \theta}\ \mu_{\omega_i\ \theta}\ \sigma_{\omega_i\ \theta} \cdots \mu_{\omega_i\ \theta_n}\ \sigma_{\omega_i\ \theta_n}]^T$

P_{ω_i} $\mu_{\omega_i\ \theta_j}$

θ_j

ω_i $\mu_{\omega_i\ \theta_j}$

P_{ω_i}

P'_{ω_i}

$P'_{\omega_i} = [\mu_{\omega_i\ \theta_j}\ \sigma_{\omega_i\ \theta_j}\ \mu_{\omega_i\ \theta_{j+}}\ \sigma_{\omega_i\ \theta_{j+}} \cdots \mu_{\omega_i\ \theta_{j-}}\ \sigma_{\omega_i\ \theta_{j-}}]^T$ P'_{ω_i}

$$P = \left[P_{\omega}'^{\,T} \;\; P_{\omega}'^{\,T} \;\; \cdots \;\; P_{\omega_m}'^{\,T} \right]^T$$

P_{ω_i}'

μ

σ

$$P = \left[\mu \;\; \sigma \;\; P_{\omega}'^{\,T} \;\; P_{\omega}'^{\,T} \;\; \cdots \;\; P_{\omega_m}'^{\,T} \right]^T$$

P

$$D = \sum_{i} D_i + D$$

$$\left(\; () \qquad () \; \right) \qquad () \qquad ()$$

Recognition Rate (%)	Set I	Set II	Set III
Gabor Wavelets			
GW+ Circular Shift [11]			
GW+ Adaptive Circular Orientation Normalization			
Intensity Values			
GW+ Adaptive Circular Orientation Normalization + Intensity Values	95.7		
GW+ Intensity Values+Elastic Inter-Frequency Searching		89.6	
GW+ Adaptive Circular Orientation Normalization+Elastic Inter-Frequency Searching + Intensity Values			80.1

Table 1:

	Radon transform [7]	Lgo-polar wavelet energy signature [12]	Standard wavelet packet energy signature [13]	Our method
Recognition Rate (%)				99.2

Table 2:

5 Conclusion

References

CVGIP Image Understanding **57**

Pattern Recognition **29**

Pattern Recognition **35**

Pattern Recognition Letters **24**

Pattern Recognition Letters **24**

IEEE Trans. Neural Networks **14**

Pattern Recognition Letters **27**

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IEEE Trans. Pattern Anal. Machine Intell. **25**

IEEE Trans. Pattern Anal. Machine Intell. **15**