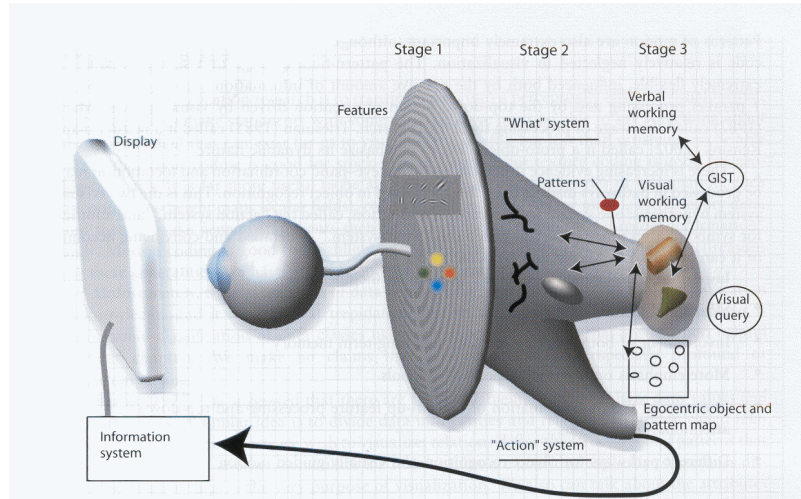
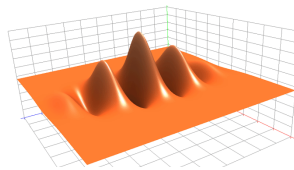


Sistema Visual

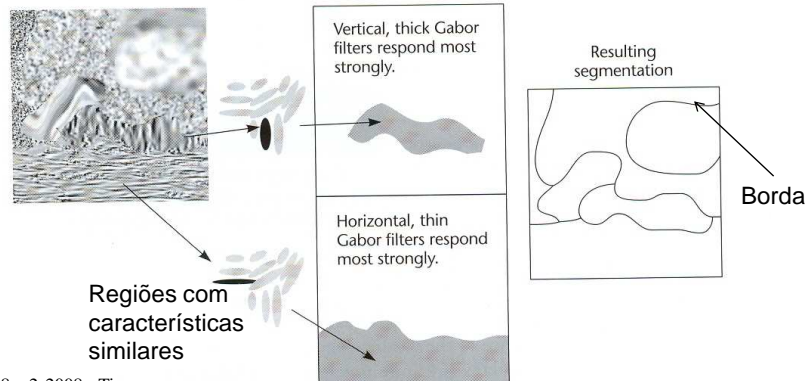


Sinais visuais são agregados em padrões, propiciando a percepção de formas, texturas e/ou movimentos

Filtro de Gabor



Um modelo para o campo receptivo do córtex visual



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Agrupamento Perceptivo

Leis de Gestalt

Proximidade



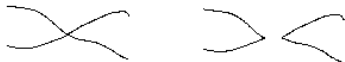
Similaridade



Fechamento



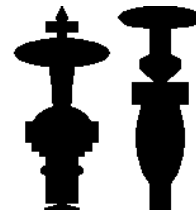
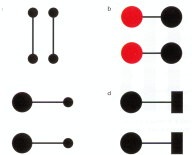
Continuidade



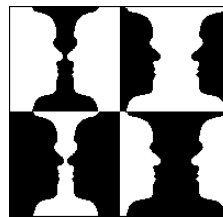
Região comum



Conectividade

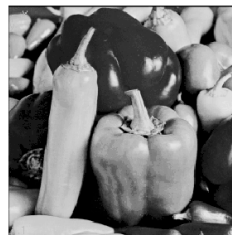


Simetria



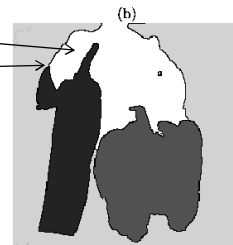
Tamanho relativo

Segmentação



(a)

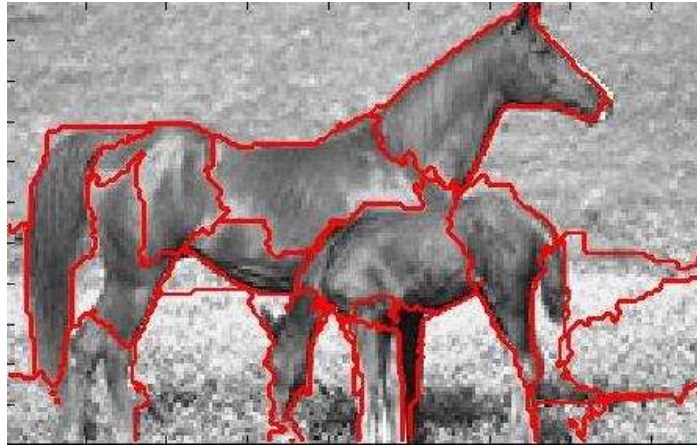
Particionamento de uma imagem digital em **regiões com características similares** e as **bordas** são identificadas como diferenças entre elas.



(b)

(d)

Segmentação



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Segmentação



(a) Color Labels (ACA)



(b) Texture Classes



(c) Crude Segmentation



(d) Final Segmentation

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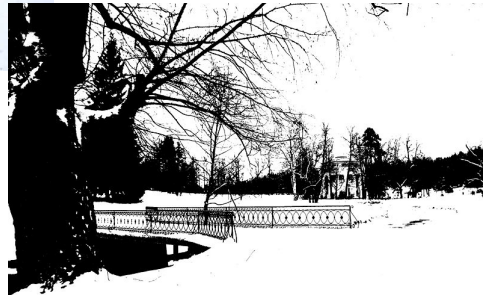
Limiarização

$f(x,y)$



Geração de imagens binárias

$g(x,y)$



$$g(x,y) = \begin{cases} 1, & \text{se } f(x,y) > Th \\ 0, & \text{se } f(x,y) \leq Th \end{cases}$$

$$Th = Th[x,y,p(x,y),f(x,y)]$$

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Intensidade e Iluminação

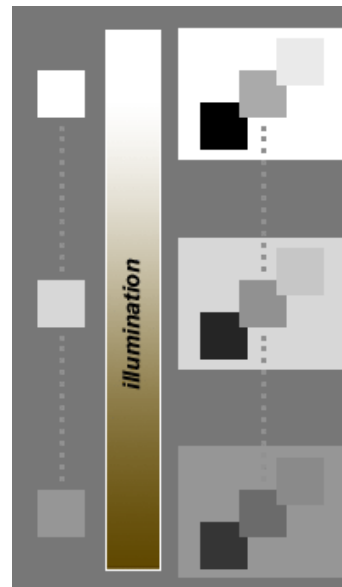
$$I(x,y) = r(x,y) L(x,y)$$

↓ ↓ ↓
Intensidade reflectância Luminância

Constância na percepção dos níveis de cinza

X

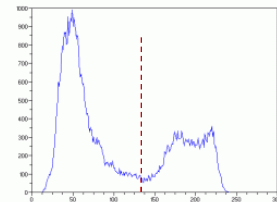
Grande variação em histogramas



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Escolha de Limiares

- **Limiar Global:** escolha baseada em intensidades ($Th = Th[f(x,y)]$).
- **Limiar Local:** além das intensidades, alguma propriedade local é utilizada ($Th = Th[p(x,y), f(x,y)]$).
- **Limiar Dinâmico;** inclui ainda a posição do *pixel* ($Th = Th[x,y,p(x,y), f(x,y)]$).



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Limiarização ótima Imagem Bimodal

$$ATh^2 + BTh + C = 0$$

$$A = \sigma_1^2 - \sigma_2^2$$

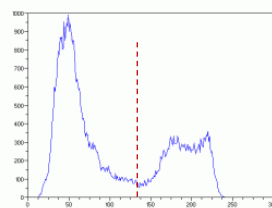
$$B = 2(\mu_1 \sigma_2^2 - \mu_2 \sigma_1^2)$$

$$C = \sigma_1^2 \mu_2^2 - \sigma_2^2 \mu_1^2 + 2\sigma_1^2 \sigma_2^2 \ln\left(\frac{\sigma_2 P_1}{\sigma_1 P_2}\right)$$

P_1, P_2 Probabilidades das 2 regiões unimodais

μ_1, μ_2 Valores médios das 2 regiões

σ_1, σ_2 Desvio padrão em torno da média das 2 regiões

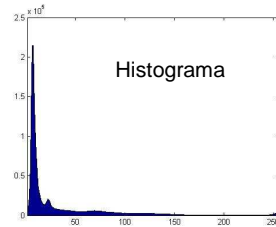


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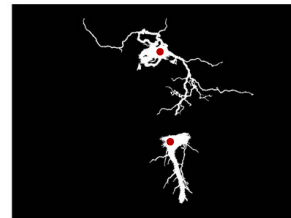
Segmentação orientada a regiões

Fatores:

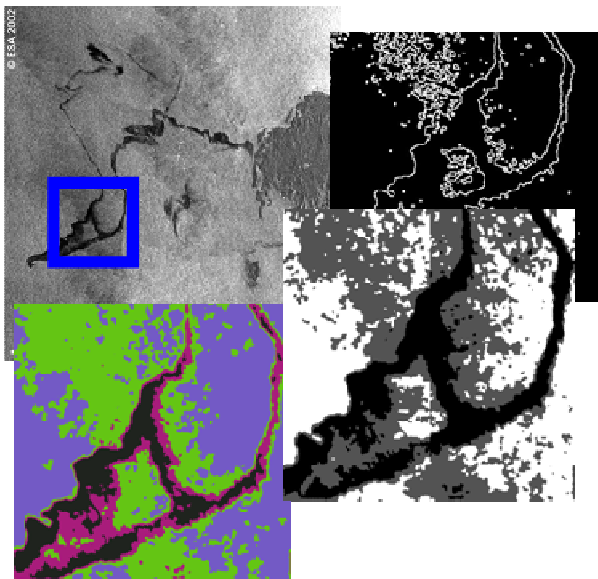
- Sementes
- Tipo de conectividade
- Critério de similaridade



• semente

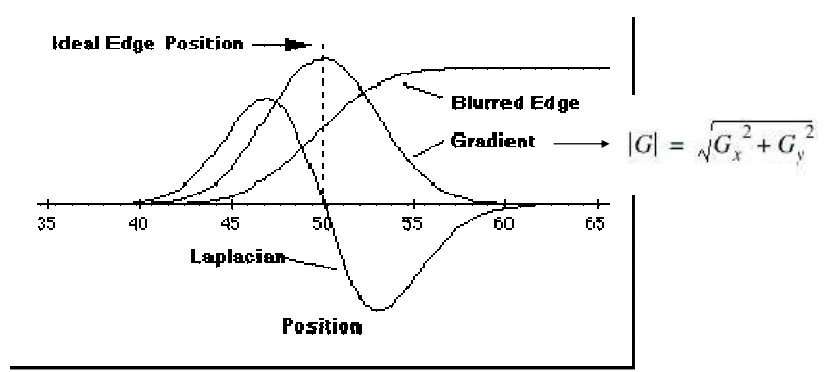


Segmentação orientada a borda



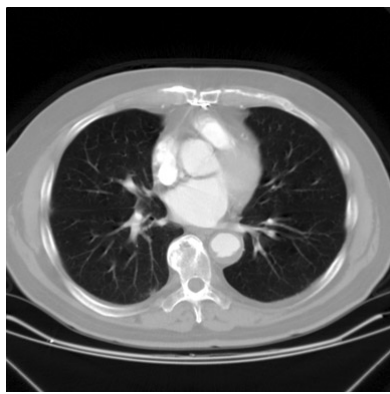
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Operador de Gradiente



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Operador de Roberts



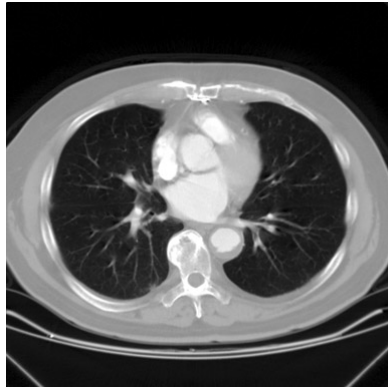
$$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \quad \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$



<http://www.inf.ufsc.br/~patrec/imagens.html>

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Operador de Prewitt



$$\begin{pmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} \quad \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix}$$



<http://www.inf.ufsc.br/~patrec/imagens.html>

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Operador de Sobel



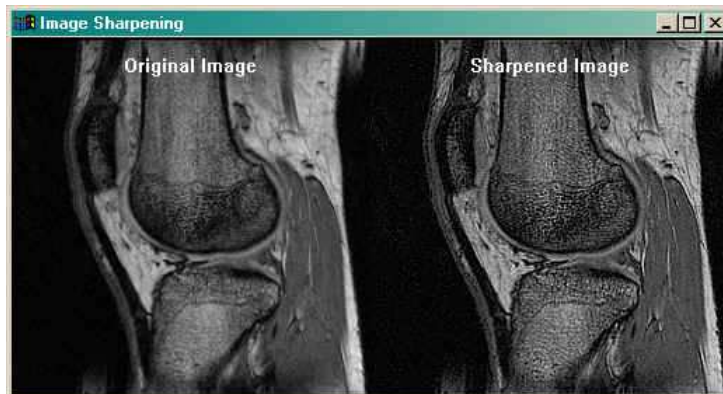
$$\begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \quad \begin{pmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{pmatrix}$$

G_y G_x



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Operador Laplaciano



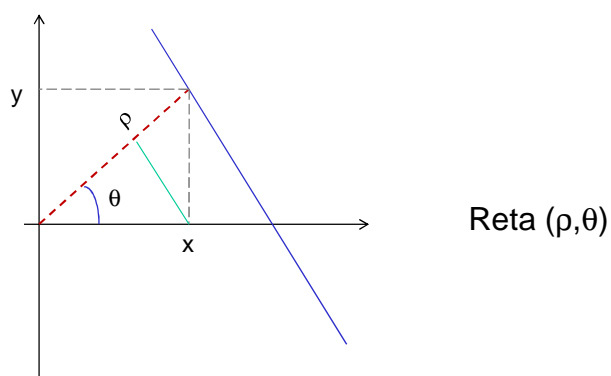
$$\frac{1}{4} \begin{pmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

$$\frac{1}{9} \begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

Imagem Original + Filtrada com
laplaciano

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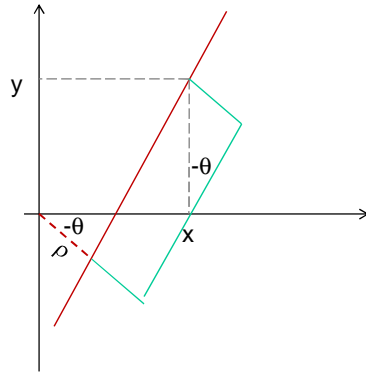
Ligação de Bordas Transformada de Hough



$$\rho = x \cos \theta + y \sin \theta$$

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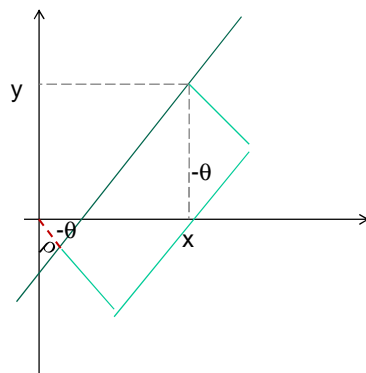
Ligação de Bordas Transformada de Hough



$$\rho = x \cos \theta + y \sin \theta$$

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Ligação de Bordas Transformada de Hough

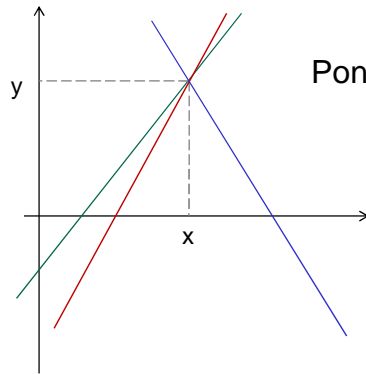


$$\rho = x \cos \theta + y \sin \theta$$

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Ligação de Bordas

Transformada de Hough



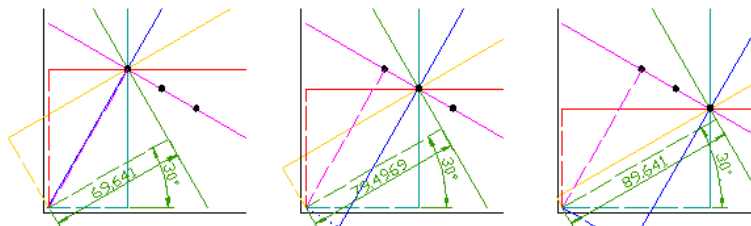
Ponto = Intersecção de retas

$$\rho = x \cos \theta + y \sin \theta$$

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Colinearidade no Espaço de Hough

Pontos Colineares = mesmo par (ρ, θ)



Angle	Dist.
0	40
30	69,6
60	81,2
90	70
120	40,6
150	0,4

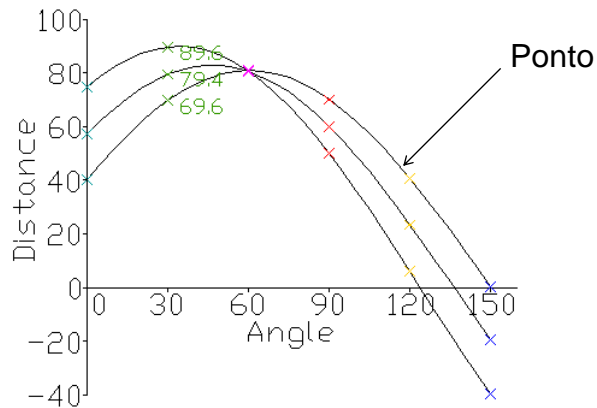
Angle	Dist.
0	57,1
30	79,5
60	80,5
90	60
120	23,4
150	-19,5

Angle	Dist.
0	74,6
30	89,6
60	80,6
90	50
120	6,0
150	-39,6

$$\text{Dist} = x \cos (\text{Angle}) + y \sin (\text{Angle})$$

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Colinearidade Interpretação Gráfica



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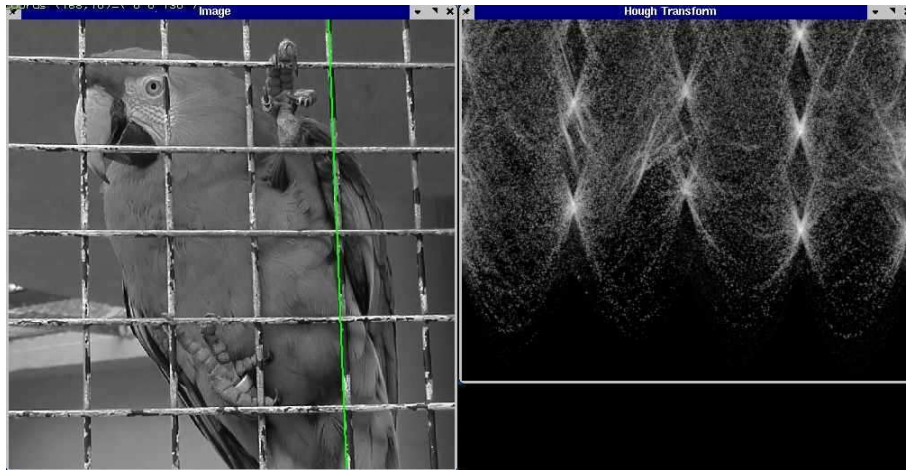
Determinar pontos colineares Algoritmo

1. Discretizar ρ em m valores e θ em n valores.
2. Inicializar $m \times n$ células acumuladoras com zero
3. Para cada ponto
Para cada θ_i
 1. Determinar ρ_j
 2. Incrementar de 1 a célula $[i,j]$
4. Enquanto existe ponto não agrupado
 1. Escolher a célula com maior valor, p.ex, $[i,j]$
 2. Agrupar todos os pontos (x,y) que satisfaçam $\rho_j = x \cos \theta_i + y \sin \theta_i$
 3. Zerar a célula acumuladora

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Ligação de Bordas

Exemplo



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