Canny edge detector

1. Smooth image with a Gaussian filter
2. Approximate gradient magnitude and angle (use Sobel, Prewitt . . .)

$$M[x,y] \approx \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}$$

$$\alpha[x,y] \approx \tan^{-1}\left(\frac{\partial f}{\partial y} \Big/ \frac{\partial f}{\partial x}\right)$$

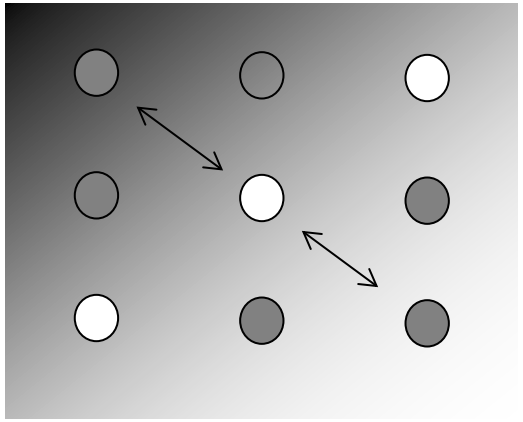
3. Apply nonmaxima suppression to gradient magnitude
4. Double thresholding to detect strong and weak edge pixels
5. Reject weak edge pixels not connected with strong edge pixels

[Canny, IEEE Trans. PAMI, 1986]

Canny nonmaxima suppression

- Quantize edge normal to one of four directions: horizontal, -45º, vertical, +45º
- If $M[x,y]$ is smaller than either of its neighbors in edge normal direction

  ➔ suppress; else keep.



[Canny, IEEE Trans. PAMI, 1986]

Canny thresholding and suppression of weak edges

- Double-thresholding of gradient magnitude

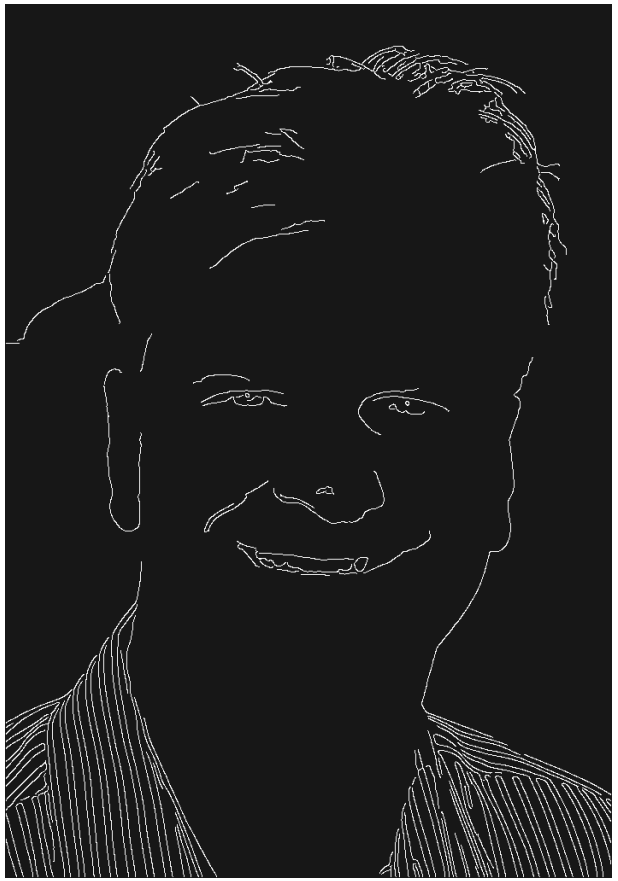
$$\text{Strong edge:} \quad M\left[x,y\right] \geq \theta_{high}$$

$$\text{Weak edge:} \quad \theta_{high} > M\left[x,y\right] \geq \theta_{low}$$

- Typical setting: $\theta_{high} / \theta_{low} = 2...3$
- Region labeling of edge pixels
- Reject regions without strong edge pixels

[Canny, IEEE Trans. PAMI, 1986]

Canny edge detector



$\sigma = \sqrt{2}$

$\sigma = 2\sqrt{2}$

$\sigma = 4\sqrt{2}$