EIE4512 - Digital Image Processing

Week 6 Tutorial

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Content

1. Sobel Edge Detector
2. Laplacian of a Gaussian(LoG) Detector
3. Canny Edge Detector
4. Hough transform algorithm

1. Sobel Edge Detector

Better approximations of the derivatives exist

- The *Sobel* operators below are very commonly used

$$\frac{1}{8}\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad s_x$$

$$\frac{1}{8}\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \qquad s_y$$

- The standard defn. of the Sobel operator omits the 1/8 term
  - doesn't make a difference for edge detection
  - the 1/8 term **is** needed to get the right gradient value, however

2. Laplacian of a Gaussian(LoG) Detector

Consider the Gaussian function

$$h(r) = -e^{-\frac{r^2}{2\sigma^2}}$$

where $r^2 = x^2 + y^2$ and σ is the standard deviation. This is a smoothing function which, if convolved with an image, will blur it. The degree of blurring is determined by the value of σ. The Laplacian of this function (the second derivative with respect to r) is

$$\nabla^2 h(r) = -\left[\frac{r^2 - \sigma^2}{\sigma^4}\right] e^{-\frac{r^2}{2\sigma^2}}$$

3. Canny Edge Detector

Summarizing, the Canny edge detection algorithm consists of the following basic steps:

1. Smooth the input image with a Gaussian filter.
2. Compute the gradient magnitude and angle images.
3. Apply nonmaxima suppression to the gradient magnitude image.
4. Use double thresholding and connectivity analysis to detect and link edges.

4. Hough transform algorithm

Typically use a different parameterization

$$d = xcos\theta + ysin\theta$$

- d is the perpendicular distance from the line to the origin
- θ is the angle this perpendicular makes with the x axis
- Why?

Basic Hough transform algorithm

1. Initialize H[d, θ]=0
2. for each edge point I[x,y] in the image

   for θ = 0 to 180

   $$d = xcos\theta + ysin\theta$$

   H[d, θ] += 1
3. Find the value(s) of (d, θ) where H[d, θ] is maximum
4. The detected line in the image is given by $d = xcos\theta + ysin\theta$

What's the running time (measured in # votes)?