Edge Detection

Edges are significant local changes of intensity in an image

Edge Descriptors

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- Edge direction:
  - Perpendicular to the direction of maximum intensity change (i.e., edge normal)

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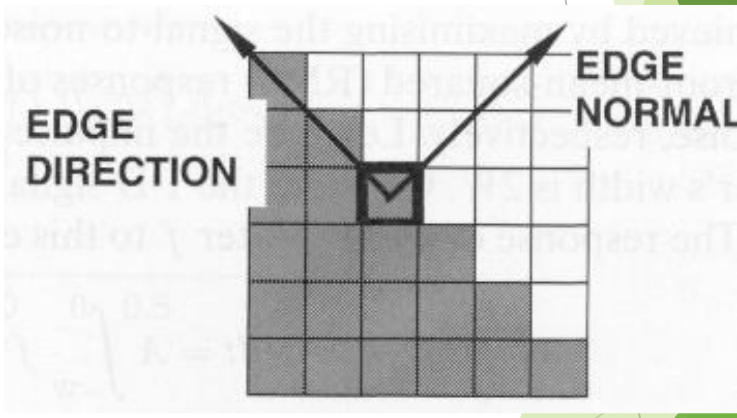
  - Perpendicular to the direction of maximum intensity change (i.e., edge normal)
- Edge strength:
  - Related to the local image contrast along the edge normal
- Edge position:
  - The image position at which an edge is located



Detecting the Edge

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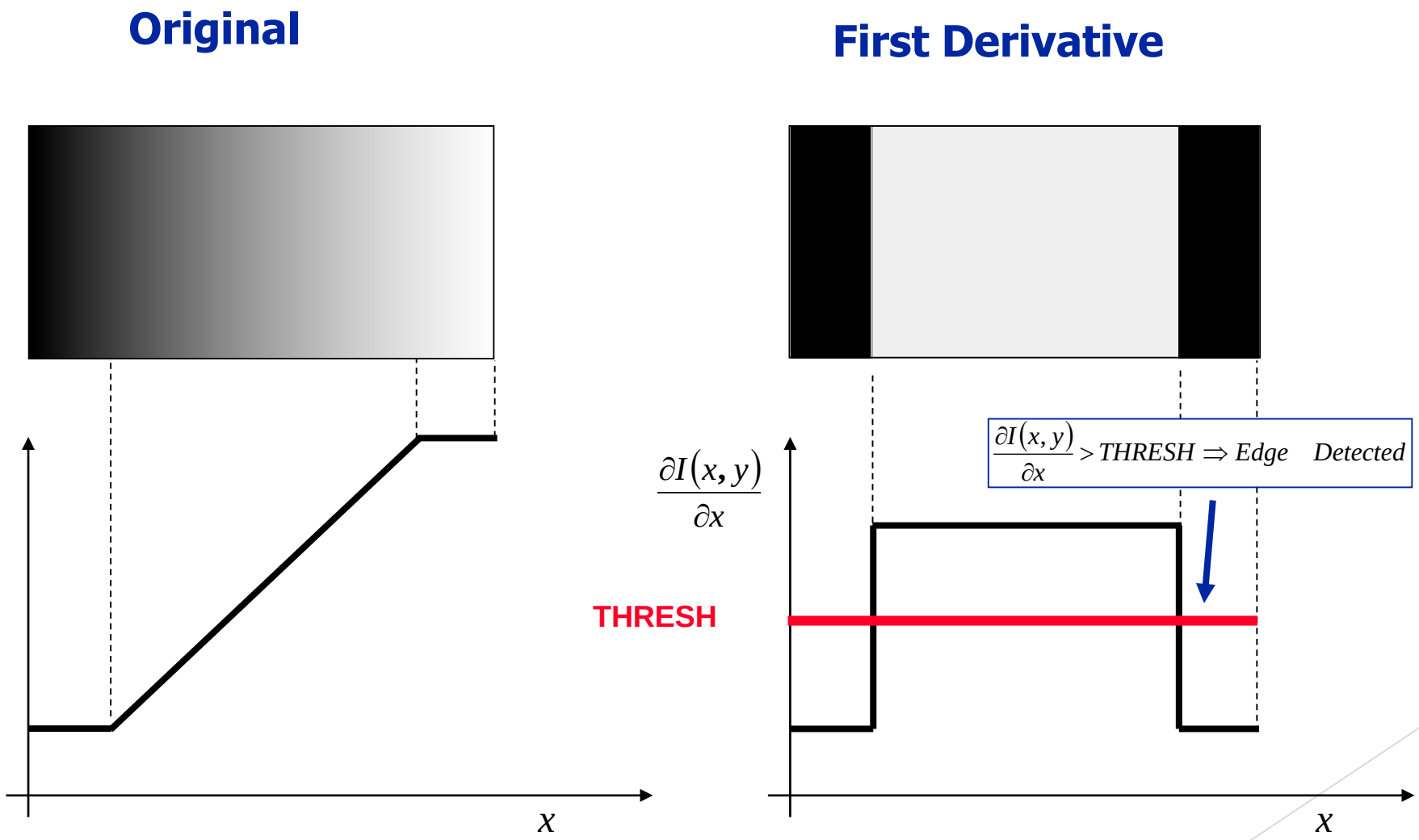

Gradient Approximation

- Consider the arrangement of pixels about the pixel (i, j):

3 x 3 neighborhood:

$$\begin{matrix} a_0 & a_1 & a_2 \\ a_7 & [i,j] & a_3 \\ a_6 & a_5 & a_4 \end{matrix}$$

- The partial derivatives $\frac{\partial f}{\partial x}$ $\frac{\partial f}{\partial y}$ can be computed by:

$$M_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6)$$
$$M_y = (a_6 + ca_5 + a_4) - (a_0 + ca_1 + a_2)$$

- The constant c implies the emphasis given to pixels closer to the center of the mask

Prewitt Operator

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- Setting $c = 1$, we get the Prewitt operator:

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$$M_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad M_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

M_x and M_y are approximations at (i, j)

Sobel Operator

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- Setting $c = 2$, we get the Sobel operator:

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$$M_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad M_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

M_x and M_y are approximations at (i, j)

Canny Edge Detector - example

original image

vertical edges

horizontal edges

norm of the gradient

after thresholding

after thinning

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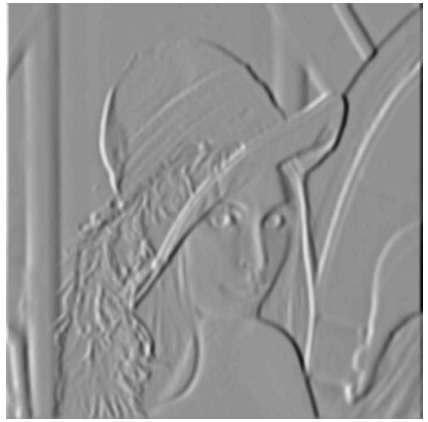

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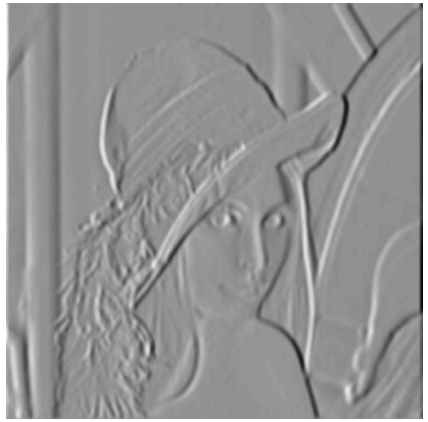

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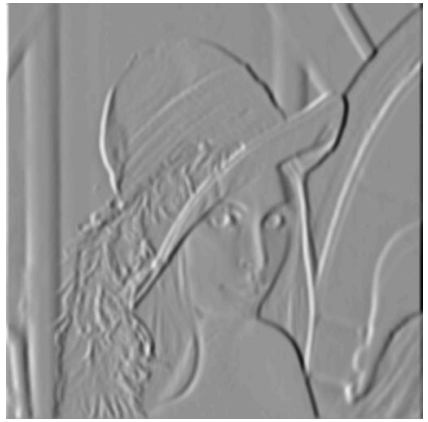

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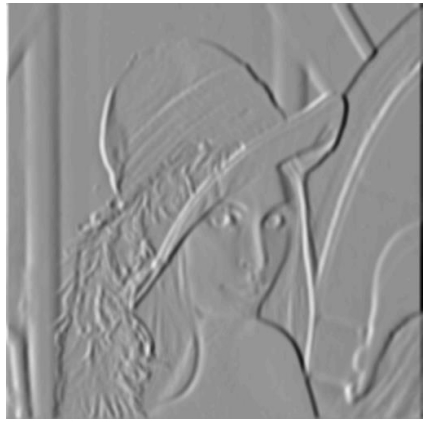

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