Noakhali Science and Technology University

Department of Information and Communication Engineering

# DIGITAL IMAGE PROCESSING

# LAB MANUAL 7

Edge Detection

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## Lab Objectives:

The objective of this lab is to understand & implement:

1. To learn about different edge detection operators

## Morphological Processing:

Edge detection includes a variety of mathematical methods that aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. Edge detection is performed using various masks/operators. An edge detection mask is usually a n × n matrix which is used as a sliding window on an image and the dot product of the maks and image window is placed on the edge-derived image's corresponding window's center pixel. In Table 6.1, we have shown a 3 × 3 image pixel window. Different edge detection operators can be applied here.

| | | |
|---|---|---|
| $z_1$ | $z_2$ | $z_3$ |
| $z_4$ | $z_5$ | $z_6$ |
| $z_7$ | $z_8$ | $z_9$ |

## Algorithm:

1. Construct an empty image with same dimensions as input image
2. Choose an edge detection mask and use it as sliding window over the image
3. With each input image pixel as center, calculate the dot product of the mask and the corresponding image window
4. Place the result in the corresponding image pixel (center) of the empty image
5. At the end, return the new image

## Robert's Mask:

Equation: $\nabla f \approx |z5 - z9| + |z6 - z8|$

Masks along x-axis, y-axis and the sum of masks are:

$$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} and \begin{bmatrix} 1 & - \\ -1 & -1 \end{bmatrix} respectively$$

## Prewitt Operator:

Equation: $\nabla f \approx |z1 - z7 + z2 - z8 + z3 - z9| + |z3 - z1 + z6 - z4 + z9 - z7|$

Masks along vertical axis and horizontal axis are:

$$\begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

## Sobel Operator:

Equation: $\nabla f \approx |z1 - z7 + 2z2 - 2z8 + z3 - z9| + |z3 - z1 + 2z6 - 2z4 + z9 - z7|$

Masks along vertical axis and horizontal axis are:

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

## Laplacian Operator:

Equation: $\nabla f \approx |z9 - z5| + |z8 - z6|$

$\nabla^2 f = [f(x + 1,y) + f(x - 1,y) + f(x,y + 1) + f(x,y - 1)] - 4f(x,y)$

$$g(x,y) = \begin{cases} f(x,y) - \nabla 2f(x,y) \text{ If the center coefficient of the Laplacian Mask is negative} \\ f(x,y) - \nabla 2f(x,y) \text{ If the center coefficient of the Laplacian Mask is positive} \end{cases}$$

Laplacian Mask Operator:

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

## Practice Tasks:

### TASK 1

Use all the operator/masks to exercise for edge detection algorithm, display the entire output images with original image in same figure and write down your observations.