**CLASS : T.E. E&TE** **SUBJECT: DIP**

**EXPT. NO. : 7** **DATE:**

**TITLE: PERFORM EDGE DETECTION USING VARIOUS MASKS**

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|---|---|
| **CO 1:** | Apply the fundamentals of digital image processing to perform various image enhancement and image segmentation operations on gray scale image. |

**AIM:**

1. Study of Image segmentation techniques
2. Implement edge detection using Gradient Operators
   a. Robert's operator
   b. Prewitt operator
   c. Sobel operator

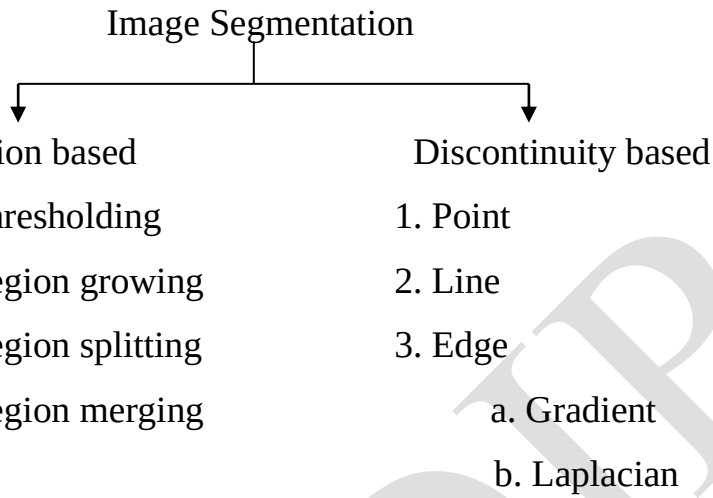
**SOFTWARE REQUIREMENT:** Google Colaboratory /Jupyter Notebook.

**THEORY:**

**7.1 Image Segmentation**

The first step in image analysis is to segment the image.

Segmentation is the process to subdivide the image into its constituent parts or objects. The level to which subdivision is carried depends on the problem being solved.




Segmentation algorithms for monochrome images are generally based on one of the two basic properties of grey level values:

1. Discontinuity :

   In this category the approach is to partition the image based on abrupt changes in grey level.

2. Similarity :

   In this category the approaches are based in thresholding, region growing, region splitting and merging.

### 7.2 Edge Detection :

Edge detection is by far the most common approach for detecting meaningful discontinuities in gray level. The reason is that isolated points and the thin lines are not frequent occurrences in most practical applications. An edge is the boundary between two regions with relative distinct gray level properties. Note from the profile that an edge (transition from dark to light) is modeled as a smooth, rather than as an

abrupt, change of gray level. This model reflects the fact that edges in digital images are generally slightly blurred as a result of sampling.

### 7.3 Gradient Operator:

The gradient of an image f (x,y) at the location (x,y) is defined as

$$\nabla \mathbf{f} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}.$$

Gradient vector always points in the direction of maximum rate of change of f at co-ordinates (x,y). Magnitude of the vector is the main quantity in edge detection and given by,

$$\nabla f = \text{mag}(\nabla \mathbf{f}) = \left[G_x^2 + G_y^2\right]^{1/2}.$$

**Different Gradient Operators:**

Use of different gradient operators for the following 3x3 grey level image is discussed below.

| | | |
|---|---|---|
| Z1 | Z2 | Z3 |
| Z4 | Z5 | Z6 |
| Z8 | Z8 | Z9 |

3x3 Grey Level Image

## 1. Roberts Operator:

One of the simplest way to implement first order partial derivative is to use Roberts cross-gradient operator.

The mask for Roberts operator are given by,

| | |
|---|---|
| -1 | 0 |
| 0 | -1 |

| | |
|---|---|
| 0 | -1 |
| 1 | 0 |

The two cross differences for x and y gradient components are given by equation,

$$Gx = Z9 - Z5 \text{ and } Gy = Z6 - Z8.$$

Then we can implement first order derivative ▼f at point Z5.

Mask of size 2x2 is awkward to implement because they don't have clear center. So generally 3x3 masks are used.

## 2. Prewitt Operator :

In this formulation, the difference between first and third row of 3x3 image approximates the derivative in x direction and difference between first and third column of 3x3 image approximates the derivative in y direction.

The mask for Prewitt operator are shown below,

| | | |
|---|---|---|
| -1 | -1 | -1 |
| 0 | 0 | 0 |
| 1 | 1 | 1 |

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -1 | 0 | 1 |
| -1 | 0 | 1 |

Thus 1st order derivative at point Z5 with Prewitt operator is

Gx = (Z8+Z8+Z9)-(Z1+Z2+Z3)

Gy = (Z3+Z6+Z9)-(Z1+Z4+Z8).

Prewitt is mostly used for computing digital gradient and is simple to implement than sobel mask.

### 3. Sobel Operator :

Sobel operator has advantage of providing both of differencing and smoothing effect. Since derivative enhanced noise, the smoothing effect is the most attractive feature of this operator.

Mask of Sobel Operator are,

| | | |
|---|---|---|
| -1 | -2 | -1 |
| 0 | 0 | 0 |
| 1 | 2 | 1 |

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -2 | 0 | 2 |
| -1 | 0 | 1 |

The 1st order derivative at point Z5 using Sobel operator is given by,

Gx = (Z8+2Z8+Z9)-(Z1+2Z2+Z3)

Gy = (Z3+2Z6+Z9)-(Z1+2Z4+Z8).

## 7.4 Algorithms for Edge Detection:

## 7.5 Conclusion:

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## 7.6 References:

i. Gonzalez R, Woods R, "Digital image processing", Pearson Prentice Hall, 2008.

ii. Gonzalez R, Woods R, Steven E, "Digital Image Processing Using MATLAB®", McGraw Hill Education, 2010.

iii. Jayaraman S, Esakkirajan S and Veerakumar T, "Digital Image Processing" Tata McGraw Hill, 2010

iv. Joshi, Madhuri A. "Digital Image Processing: an algorithm approach", PHI Learning Pvt. Ltd., 2006.

v. Pictures taken from:
http://www.imageprocessingplace.com/root_files_V3/image_databases.html



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**(Course Teacher)**