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Experiment – 03: To Perform Image Enhancement using Masking Process

Date: _________

1. **Aim :** To perform image enhancement using neighborhood processing technoques
   a. Low Pass Filter, b. High Pass Filter c. Un-sharp filter
   d. Sobel operator

2. **Requirements:** Python

3. **Pre-Experiment Exercise**
   3.1 Brief Theory

The filtering process simply consists of moving the filter mask from point to point in an image. At each point, the response of the filter at that point is calculated using a predefined relationship. For linear spatial filtering, the response is given by a sum of products of the filter coefficients and the corresponding image pixels in the area spanned by the filter mask. The expression to find the response *R*, of an *m* x *n* image at any point (x, y) is as shown below:

$$R = w_1 z_1 + w_2 z_2 + \dots + w_{mn} z_{mn}$$

$$= \sum_{i=1}^{mn} w_i z_i$$

where, the *w*'s are mask coefficients, the *z*'s are the values of the image gray levels corresponding to those coefficients, and *mn* is the total number of coefficients in the mask.

w_1	w_2	w_3
w_4	w_5	w_6
w_7	w_8	w_9

a. Low-Pass or Smoothing Spatial Filters

The output of a smoothing spatial low-pass filter is simply the average of the pixels contained in the neighborhood of the filter mask. These filters are sometimes are called *averaging filters*. The idea behind smoothing is to replace the value of every pixel in an image by the average of the gray levels in the neighborhood defined by the filter mask. This process results in an image with reduced "sharp" transitions in gray levels. Smoothing filters are used for blurring and for noise reduction. Two such 3x3 smoothing filter mask are given below:

1	1	1
1	1	1
1	1	1

Average filter mask

1	2	1
2	4	2
1	2	1

weighted average filter mask

Note that the constant multiplier in front of each mask is equal to the sum of the values of its coefficient, as it is required to compute an average.

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b. High-Pass or Sharpening Spatial Filters

The sharpening of an image can be accomplished by spatial differentiation. We use sharpening filters that are based on first- and second- order derivatives for image sharpening. Moreover, the filter employing the second derivative is preferred over the one employing the first derivative because of the ability of the former to enhance fine details. A Laplacian sharpening filter mask employed are shown below:

1	1	1
1	-8	1
1	1	1

c. **Un-sharp filter**

The unsharp filter is a simple sharpening operator which derives its name from the fact that it enhances edges (and other high frequency components in an image) via a procedure which subtracts an unsharp, or smoothed, version of an image from the original image. The unsharp filtering technique is commonly used in the photographic and printing industries for crispening edges.

d. **Sobel operator**

The most commonly used discontinuity based edge detection techniques are Sobel Edge Detection, Prewitt edge detection techniques. Such discontinuities are detected by using first and second derivatives. The first order derivative of choice in image processing is the gradient. The gradient of a 2-D function, f(x, y), is defined as the vector. The magnitude of this vector is approximately equal to

$$\nabla f = |Gx| + |Gy|$$

These approximations still behaves as derivatives; that is, they are zero in areas of constant intensity and their values are related to the degree of intensity change in areas of variable intensity. The Sobel technique performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges. In general it is used to find the estimated absolute gradient magnitude at each point in n input grayscale image. In conjecture at least the operator consists of a pair of 3x3 complication kernels as given away in under table. One kernel is simply the other rotated by 90°. This is very alike to the Roberts Cross operator. The operator consists of a pair of 3×3 convolution kernels as shown in below figure. One kernel is simply the other rotated by 90°.

-1	0	+1
-2	0	+2
-1	0	+1

Gy

-1	-2	-1
0	0	0
+1	+2	+1

Gx

It provides both a differentiating and a smoothing effect, which is particularly attractive as derivatives typically enhance noise.

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4. Laboratory Exercise

4.1 Algorithm:

1. Take a gray scale image as an input and define 3 X 3 mask filter.
2. Apply different types of filter masks as mentioned above on an input image with zero padding Enter the horizontal and vertical size of the mask.
3. Display all the output images using different mask.

5. Post-Expriment Exercice

5.1 Conclusion:

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5.2 Questions:

1. Write short note on: Spatial domain filtering.
2. Give the difference between first order derivative filter and second order derivative filter.
3. Apply Low and High Pass Spatial masks on the following image matrix.
   Assume virtual Rows and Columns.

f(x,y)	=	30	31	32
		33	120	30
		32	32	31

5. Prove that High Pass filter = Original image – Low pass filter.