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Department of Electronics & Telecommunication Engineering

CLASS	**: T.E. E&TE**	**SUBJECT: DIP**
EXPT. NO.	**: 5**	**DATE:**

TITLE : **APPLY SMOOTHING SPATIAL FILTERS ON AN IMAGE**

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

AIM:

To implement :

1. Box Filter
2. Weighted Filter
3. Median Filter

SOFTWARES REQUIRED: Google Colaboratory / Jupyter Notebook

THEORY:

5.1 Basics of filtering operation

Filtering refers to accepting or rejecting certain frequency components. Filtering creates a new pixel with co-ordinates equal to the co-ordinates of the centre of the neighborhood and whose value is the result of the filtering operation. The processed (filtered) image is generated as the centre of the filter mask visits each pixel in the input image.

Image enhancement approaches fall into two broad categories: spatial domain methods and frequency domain methods. The term *spatial domain* refers to the image plane itself, and approaches in this category are based on direct manipulation of pixels in an image. *Frequency* *domain* processing techniques are based on modifying the Fourier transform of an image.The term *spatial domain* refers to the aggregate ofpixels composing an image. Spatial domain methods are procedures that operate directly on these pixels. Spatial domain processes will be denoted by the expression

$$g(x, y) = T[f(x, y)]$$

where f(x, y) is the input image, g(x, y) is the processed image, and *T* is an operator on *f*, defined over some neighborhood of (x, y). Some neighborhood operations work with the values of the image pixels in the neighborhood *and* the corresponding values of a sub-image that has the same dimensions as the neighborhood. The sub-image is called a *filter*, *mask*, *kernel*, *template*, or *window*.

The process of spatial filtering consists simply of moving the filter mask from point to point in an image. 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.

When interest lies on the response, *R*, of an m*n mask at any point (x, y), and not on the mechanics of implementing mask convolution, it is common practice to simplify the notation by using the following expression:

$$R = w1\ z1 + w2\ z2 + \ldots + w_{mn}z_{mn}$$

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

where the w's are mask coefficients, the z's are the values of the image gray levels corresponding to those coefficients, and m*n is the total number of coefficients in the mask. The filtering operation is based conditionally on the values of the pixels in the neighborhood under consideration, and they do not explicitly use coefficients in the sum-of-products.

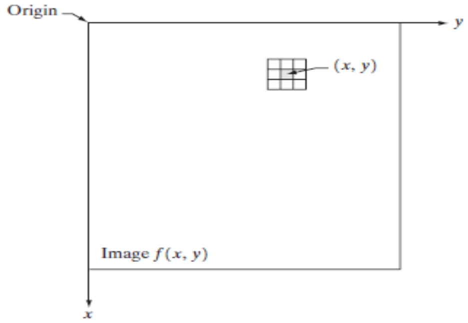

Fig: 5.1 (3*3 neighborhood about a point (x, y) in an image)

5.2 Smoothing filters

Smoothing filters are used for blurring and for noise reduction. Blurring is used in preprocessing steps, such as removal of small details from an image prior to (large) object extraction, and bridging of small gaps in lines or curves. Noise reduction can be accomplished by blurring with a linear filter and also by nonlinear filtering.

5.2.1 Smoothing Linear Filters

The output of a smoothing, linear spatial filter is the average of the pixels contained in the neighborhood of the filter mask. These filters sometimes are called *averaging filters*. It replaces 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. Averaging filters have the undesirable side effect that they blur edges. A spatial averaging filter in which all coefficients are equal is sometimes called a box filter. (As mentioned in Fig 5.3).

The second mask is weighted average mask, pixels are multiplied by different coefficients, thus giving more importance (weight) to some pixels at the expense of others. The basic strategy behind weighing the center point the highest and then reducing the value of the coefficients as a function of increasing distance from the origin is simply an attempt to reduce blurring in the smoothing process.

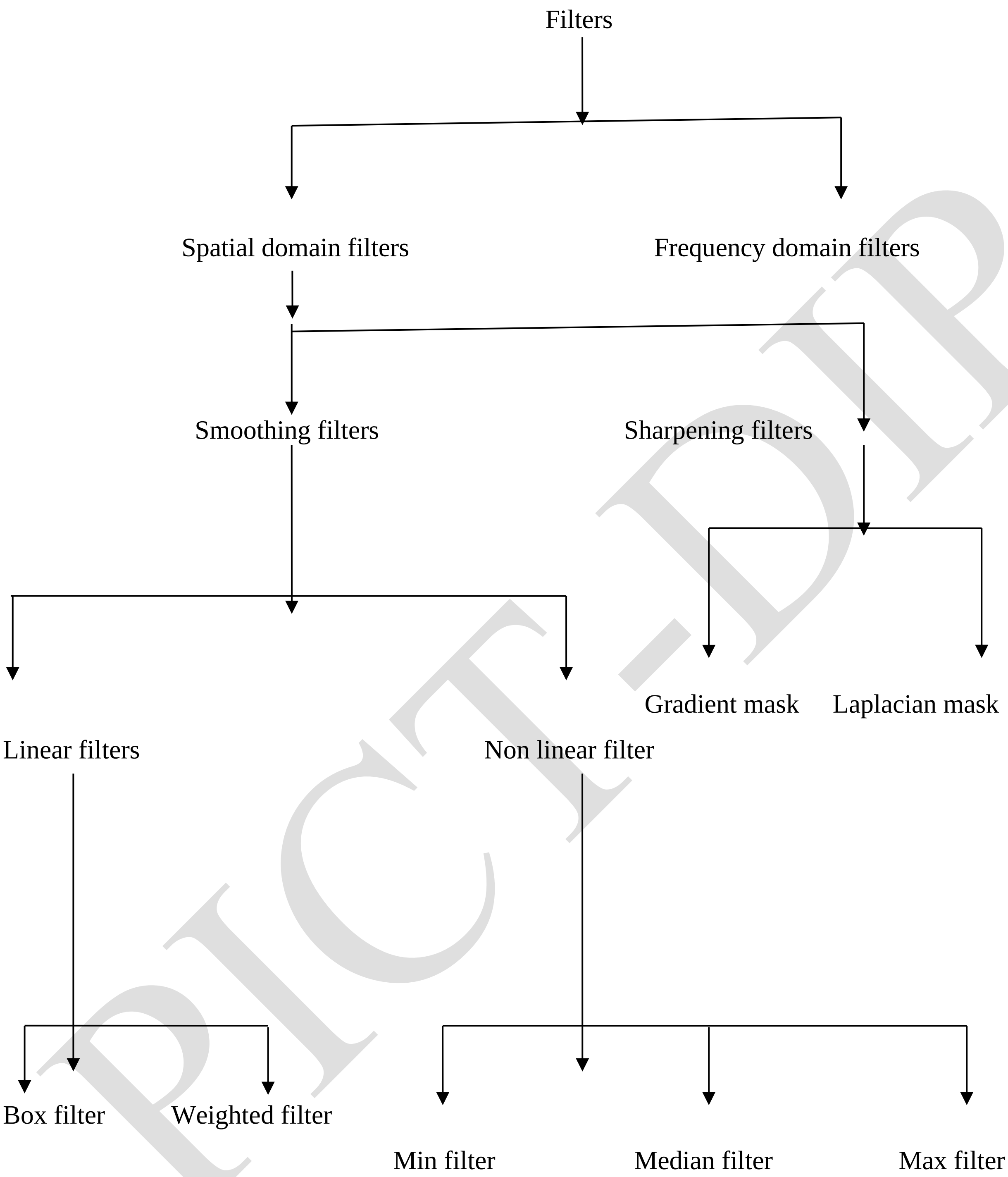

Fig: 5.2 Filter Classifications

$$\frac{1}{9}\times\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix}$$

Box filter

$$\frac{1}{16}\times\begin{bmatrix}1 & 2 & 1\\ 2 & 4 & 2\\ 1 & 2 & 1\end{bmatrix}$$

Weighted average filter

Fig: 5.3 Smoothing Filter Mask

5.2.2 Smoothing non-linear filters (Order-Statistics Filters)

Order-statistics filters are nonlinear spatial filters whose response is based on ordering (ranking) the pixels contained in the image area encompassed by the filter, and then replacing the value of the center pixel with the value determined by the ranking result. There are median filters, Max and Min filters.

Median Filter:

A median filter smoothens the image by utilizing the median of the neighbourhood .Median filter replaces the value of pixels by the median of the intensity values in the neighbourhood of that pixel. They are quite popular because, for certain types of random noise, they provide excellent noise reduction capabilities with considerably less blurring than linear smoothing filters of similar size. Median filters are particularly effective in the presence of impulse noise, also called as salt and pepper noise.

5.3 Algorithm:

5.4 Conclusion:

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5.5 References:

i. GonzalezR, Woods R, “Digital image processing”, Pearson Prentice Hall, 2008.

ii. GonzalezR, 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)