SPATIAL SHARPENING FILTERS :-

The main objective of sharpening is to highlight transitions in intensity.

* FIRST ORDER DERIVATIVE (OR) GRADIENT MASKING (OR) PRE-WITT MASKING

* Image differentiation enhances edges & other discontinuities & de-emphasizes areas with slowly varying intensities.

By using Gradient masking we find out the vertical & horizontal thick values only.

$$\text{Gradient function, } \nabla f = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

$$f(x,y) = \left[\left| \frac{\partial f}{\partial x} \right|^2 + \left| \frac{\partial f}{\partial y} \right|^2 \right]$$

* II - ORDER DERIVATIVE (OR) LAPLACIAN MASKING (OR) HIGH-PASS FILTER MASKING :-

By using II order we find thin lines of an image.

In this if one part gets highlighted then other parts are neglected. Usually centre part may be highlighted (or) dimmed than other pixel values.

Laplacian function, $\nabla^2 f = \dfrac{\partial^2 f}{\partial x^2} + \dfrac{\partial^2 f}{\partial y^2}$

Let the image is a 2-D image, then

$$\frac{\partial^2 f}{\partial x^2}(x,y) = f(x+1,y) + f(x-1,y) - 2f(x,y)$$

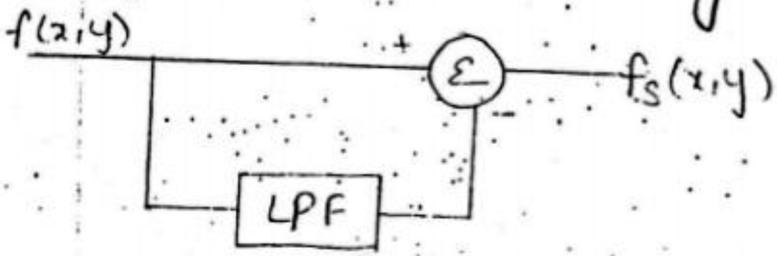
$$\frac{\partial^2 f}{\partial y^2}(x,y) = f(x,y+1) + f(x,y-1) - 2f(x,y)$$

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

* UNSHARP MASKING :-

The main objective of 'Unsharp masking' is to increase the contrast of an image.

The brightness can be increased by reducing the low pass components & enhancing high pass components



$$O/P \quad f_s(x,y) = f(x,y) - f_{LP}(x,y)$$

Unsharp masking involves the following steps:

1. Blurring the original image
2. Subtracting the blurred image from original. Image, and add masking to the original image

* HIGH BOOST FILTERING :-

For sharpening the image & to increase the centre pixel value we go for high boost filtering.

we know that

$$f_s(x,y) = A\, f(x,y) - f_{LP}(x,y)$$

$$= A\, f(x,y) + f(x,y) - f(x,y) - f_{LP}(x,y)$$

[Adding & Subtracting f(x,y)]

$$= (A-1)\, f(x,y) + f_s(x,y)$$

For the purpose of sharping we use Laplacian transform which takes the form

$$f_s(x,y) = (A-1)\, f(x,y) + \nabla^2 f$$

↳ Laplacian function.

* HOMO-MORPHIC FILTERING :-

Image is a combination of illumination & reflectance i.e.,

$$f(x,y) = i(x,y) \cdot r(x,y) \quad \text{--- } (1)$$

Reflection term contains high pass components & Illumination term Contains low pass components

Inorder to seperate low pass & high pass components we have to apply logarithm.

* SOBEAL MASKING :-

By using sobeal masking sharp edges can be found. It is also similar to Gradient filter but the centre part is doubled.

From the equations of I-order derivative, $\frac{\partial f}{\partial x}$ & $\frac{\partial f}{\partial y}$ becomes

$$\frac{\partial f}{\partial x} = (\omega_7 + 2\omega_8 + \omega_9) - (\omega_1 + 2\omega_2 + \omega_3)$$

$$\frac{\partial f}{\partial y} = (\omega_3 + 2\omega_6 + \omega_9) - (\omega_1 + 2\omega_4 + \omega_7)$$

From the above eqn's we can observe that the centre part is doubled.

$$f(x,y) = |(\omega_7 + 2\omega_8 + \omega_9) - (\omega_1 + 2\omega_2 + \omega_3)| + |(\omega_3 + 2\omega_6 + \omega_9) - (\omega_1 + 2\omega_4 + \omega_7)|$$

* ROBERT MASKING :-

This masking is also known as Gradient (or) First order filter.

In this masking we take the cross differences.

Let us consider an image $\begin{bmatrix} \omega_1 & \omega_2 & \omega_3 \\ \omega_4 & \omega_5 & \omega_6 \\ \omega_7 & \omega_8 & \omega_9 \end{bmatrix}$

Here $f(x,y) = \left[(\omega_9 - \omega_5)^2 + (\omega_8 - \omega_6)^2\right]^{1/2}$.

* By applying Robert masking we can find out the diagonal values i.e., 45° & -45°