Detection of Discontinuities.

The Various techniques based on gray-level discontinuity are given below.

(i) Detection of isolated Points
(ii) Detection of line.
(iii) Detection of edges.

The way to look for discontinuities is to run a mask through the image. The representation of mask is given below.

W_1	W_2	W_3
W_4	W_5	W_6
W_7	W_8	W_9

$W_i \rightarrow$ Coefficient in the mask.

$z_i \rightarrow$ Gray level of the Pixel associated with mask Coefficient W_i.

$R \rightarrow$ The response of mask at any Point in an image.

$$R = W_1 z_1 + W_2 z_2 + W_3 z_3 + \dots\dots + W_9 z_9$$

$$\boxed{R = \sum_{i=1}^{9} W_i z_i}$$

It involves Computing Sum of Products of the Co-efficients with the gray levels Contained in the region encompassed by the mask.

The response of the mask is defined with respect to its Center location when the mask is Centered on a boundary Pixel. The response is Calculated by using appropriate partial neighbourhood.

1. Point Detection:-

-1	-1	-1
-1	8	-1
-1	-1	-1

This mask is used to detect the isolated Points due to noise or interference. It Consists of Co-efficients '-1' everywhere except the Center (Center Co-efficient is 8). The Sum of all the Co-efficients is 0.

When the mask is placed over an image, it Covers the Pixels in an image. The average response to the mask is given as R.

$$R = \frac{1}{9}(w_1 z_1 + w_2 z_2 + \cdots + w_9 z_9)$$

$$\boxed{R = \frac{1}{9} \sum_{i=1}^{9} w_i z_i}$$

If the mask is over a Uniform intensity area, then, the response due to this mask

is 0 (Zero). Because, there are no isolated Pixels with different gray level values.

If the isolated Points are just below the Center of the mask, then, the average response will be maximum. The same mask is used for high frequency Spatial filtering.

2. Line Detection:-

The next level of Complexity is detection of lines in an image.

-1	-1	-1
2	2	2
-1	-1	-1

This mask is moved around an image. It respond more Strongly to lines Oriented horizontally.

The response is maximum when the line Passes through the middle row of the mask with Constant background. When the mask is moved over an image which Consists of all '1's as background and with a lie of different gray level '5's. Then the response due to the first mask is Computed as,

$$(1*-1) + (1*-1) + (1*-1) + (5*2) + (5*2) + (5*2) + (1*-1) + (1*-1) + (1*-1) = 24$$

-1	2	-1
-1	2	-1
-1	2	-1

⇒ This mask gives high response to Vertical lines.

-1	-1	2
-1	2	-1
2	-1	-1

⇒ This mask gives high response to the lines in the $+45^\circ$ direction.

2	-1	-1
-1	2	-1
-1	-1	2

⇒ This mask gives high response to the lines in the -45° direction.

3. Edge Detection:-

→ Edge detection is used for detecting meaningful discontinuities in gray level. First and Second Order digital derivatives are implemented to detect the edges in an image.

Edge:-

→ Edge detection is used for image Segmentation and data extraction in areas

Such as image Processing, Computer Vision, and machine Vision.

* Common edge detection algorithms include Sobels, Prewitt, Roberts, and Laplacian Operators.

* First Order derivatives Such as Robert-Cross, Prewitt, and Sobel operators are Preferred for thicker lines.

* Second Order derivatives (laplacian) are used for detecting thinner lines.

* Discontinuity in the image intensity Can be.

1. Step Discontinuities.
2. Line Discontinuities.

1. Step Discontinuities:-

→ where the image intensity abruptly Changes from one value on one side of the discontinuity to a different value on the opposite side.

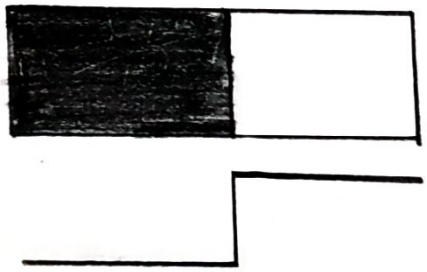
2. Line Discontinuities:-

→ where the image intensity abruptly Changes value but then returns to the

Starting Value within Some Short distance.

→ In real images both Step and line edges are rare, because of loco-frequency Components

→ Step edges become ramp edges. and line edges become roof edges.

(1) Step Edges :-

→ A Step edge involves a transition between two intensity levels occurring ideally over the distance of 1 Pixel.