(1)

Canny Edge Detection

It is an edge detection algorithm that uses a multi-stage algorithm to detect a wide range of edges in images.

Here I have considered Natural Science Center building of gsu. Having image size of 2048 × 1536.
As mentioned in the problem I have considered a patch 5×5 for the Natural Science Center.

I am considering the 5×5 patches (27, 30)

142	142	142	142	142
142	142	142	142	142
140	140	140	140	140
140	140	140	140	140
140	140	140	140	140

We smoothen the obtained patch using gaussian filter

$$g(x,y) = \frac{1}{2\pi\sigma^2} e\left(\frac{-(x^2+y^2)}{2\sigma^2}\right)$$

$$= \left(\frac{1}{\sqrt{2\pi}\sigma}\left(e^{-\left(\frac{x^2}{2\sigma^2}\right)}\right)\right) \cdot \left(\frac{1}{\sqrt{2\pi}\sigma}\left(e^{-\left(\frac{y^2}{2\sigma^2}\right)}\right)\right)$$

$x = 140 \quad y = 142 \quad \pi = 3.14 \quad \sigma = 2$

$$6.28 \; e^{\frac{(-((140)^2+(142)^2)}{2\times 4}}$$

$$6.28 \; e^{\frac{(-4920)}{2\times 4}}$$

$$= -1.7 \times 6.28$$

$$= -10.7$$

we compute the gradient of the gaussian function and find its derivative

$\nabla g * I$

$g \rightarrow$ gaussian function

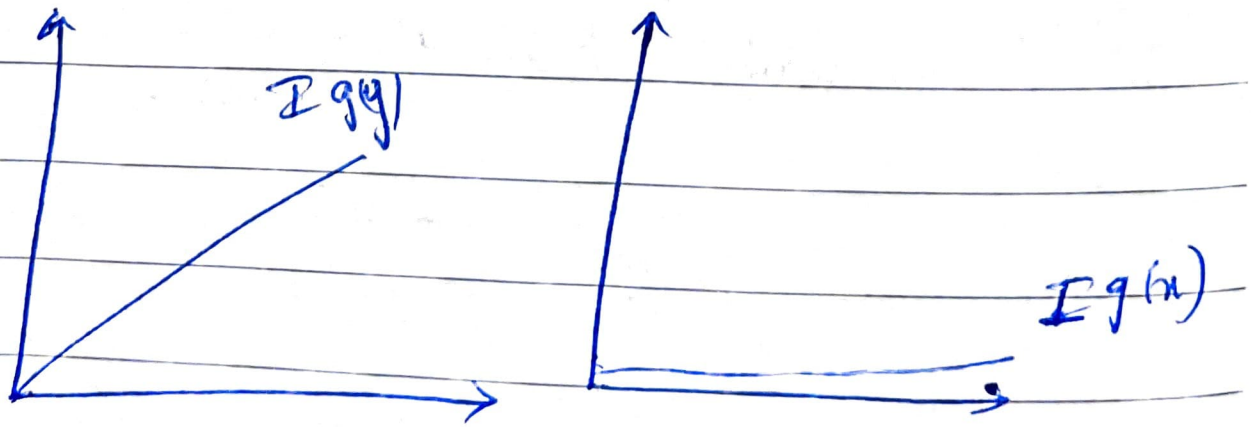
$I \rightarrow$ Image

Using this derivative we will find the magnitude and orientation at each pixel.

$|\nabla g * I|$

Calculating the orientation

$$\overline{N} = \frac{\nabla g * I}{|\nabla g * I|}$$



If the gradient (or) at the pixel is high then we declare it as an edge pixel

If the gradient (or) at the pixel is low then we declare it as an non edge pixel.

We consider the pixels closet to the gradient direction to estimate the non maximum suppression.

Now we compute gradient orientation let us consider the angle to be 'θ'

$$\theta = \arctan^2\left(\frac{y_{cord}}{x_{cord}}\right)$$

$$\theta = \text{arc}\tan^2\left(\frac{142}{140}\right)$$

$$= (\tan^2)^{-1}(1.01)$$

$$= 0.47$$

All pixels have intensity which are weak and help us identify the non relevant pixels.

From this we get the pixel value of the detected edge as follows

$$\begin{pmatrix} 0.4 & 0 & 0 & 0 & 0 \\ 0 & 0.2 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0.63 \\ 0 & 0 & 1 & 1 & 0 \\ 0.35 & 0 & 0 & 0 & 0.7 \end{pmatrix}$$