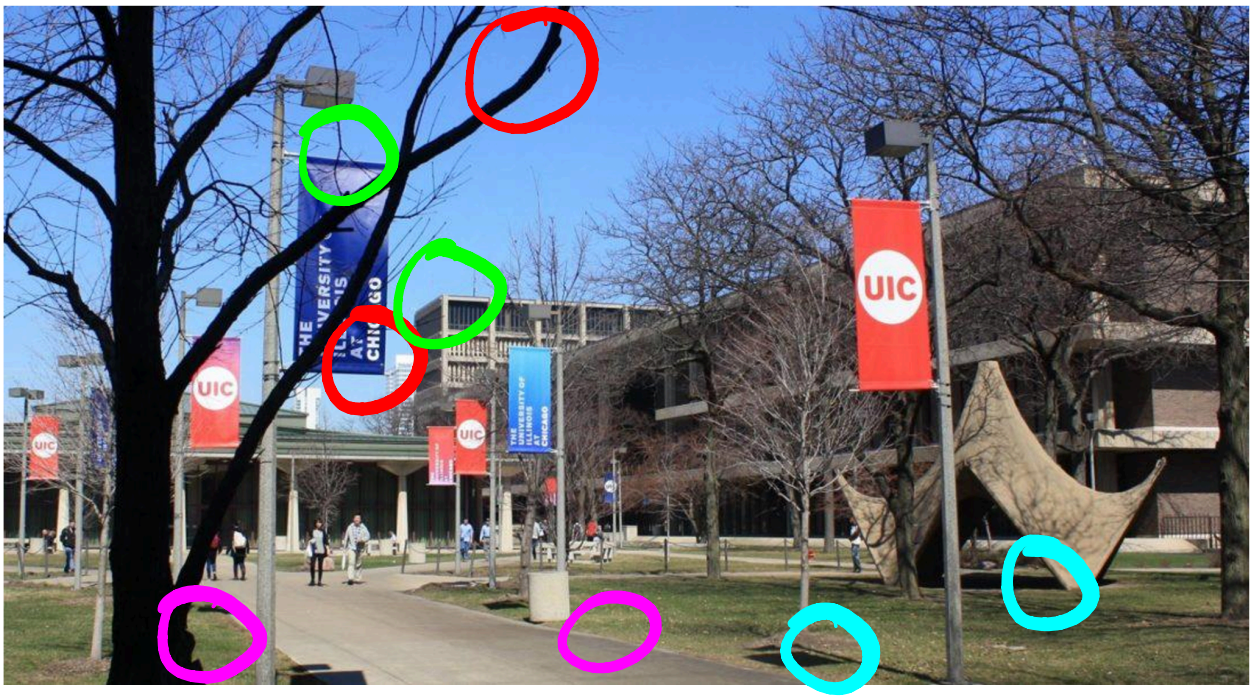
Gokhulnath Thirumaran
675086474

CS 415 Mini Project 2

1. Question Answering

Q1. Ans:

1. Edge is a change in the intensity or a contrast between the regions.
2. Surface normal discontinuity - SND
   Depth discontinuity - DD
   Surface color discontinuity - SCD
   Illumination discontinuity - ID



3. The direction of the change in intensity (i.e gradient) is perpendicular to the edge. That is, the gradient vector points towards the direction where the intensity changes the most, while the edge runs along the direction where the intensity remains constant.

Q2)

1	1	1	1	1
1	1	0	2	1
1	2	2	1	1
1	2	1	0	1
1	1	1	1	1

Central Region

1	0	2
2	2	1
2	1	0

To calculate Gradient, Magnitude & Direction

$$G_x(i,j) = \frac{I(i,j+1) - I(i,j-1)}{2}$$

$$G_y(i,j) = \frac{I(i+1,j) - I(i-1,j)}{2}$$

$$\text{Gradient Magnitude} = \sqrt{G_x^2 + G_y^2}$$

$$\text{Gradient Direction} = \theta = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

~~Pixel at (0,0) = 1~~

Pixel at (1,1) = 1

$$G_x = \frac{I(1,2) - I(1,0)}{2} = \frac{0-1}{2} = -0.5$$

$$G_y = \frac{I(2,1) - I(0,1)}{2} = \frac{2-1}{2} = 0.5$$

$$\text{Mag} = \sqrt{(-0.5)^2 + (0.5)^2}$$

$$= \sqrt{0.25 + 0.25} = \sqrt{0.5}$$

$$\text{Direction} = \theta = \tan^{-1}\left(\frac{0.5}{-0.5}\right) = \tan^{-1}(-1)$$

$$= -\frac{\pi}{4}$$

Pixel at (1,2) = 0

$$G_x = \frac{I(1,3) - I(1,1)}{2} = \frac{2-1}{2} = 0.50$$

$$G_y = \frac{I(2,2) - I(0,2)}{2} = \frac{2-1}{2} = 0.50$$

$$\text{Mag} = \sqrt{(0.50)^2 + (0.50)^2} = \sqrt{0.5}$$

$$\theta = \tan^{-1}\left(\frac{0.5}{0.5}\right) = \tan^{-1}(1) = \pi/4$$

Pixel at (1,3) = 2

$$G_x = \frac{I(1,4) - I(1,2)}{2} = \frac{1-0}{2} = 0.50$$

$$G_y = \frac{I(2,3) - I(0,3)}{2} = \frac{1-1}{2} = 0$$

$$Mag = \sqrt{(0.50)^2 + 0^2} = 0.50$$

$$\theta = \tan^{-1}\left(\frac{0}{0.5}\right) = 0.$$

Pixel at (2,1) = 2

$$G_x = \frac{I(2,2) - I(2,0)}{2} = \frac{2-1}{2} = 0.50$$

$$G_y = \frac{I(3,1) - I(1,1)}{2} = \frac{2-1}{2} = 0.50$$

$$Mag = \sqrt{(0.50)^2 + (0.50)^2} = \sqrt{0.25 + 0.25}$$

$$= \sqrt{0.50}$$

$$\theta = \tan^{-1}\left(\frac{0.50}{0.50}\right) = \tan^{-1}(1) = \pi/4$$

Pixel at (2,2) = 2

$$G_x = \frac{I(2,3) - I(2,1)}{2} = \frac{1-2}{2} = -0.50$$

$$G_y = \frac{I(3,2) - I(1,2)}{2} = \frac{1-0}{2} = 0.50$$

$$Mag = \sqrt{(-0.50)^2 + (0.50)^2} = \sqrt{0.50}$$

$$\theta = \tan^{-1}\left(\frac{0.50}{-0.50}\right) = \tan^{-1}(-1) = -\pi/4$$

Pixel at (2,3) = 1

$$G_x = \frac{I(2,4) - I(2,2)}{2} = \frac{1-2}{2} = -0.50$$

$$G_y = \frac{I(3,3) - I(1,3)}{2} = \frac{0-2}{2} = -1.00$$

$$\text{Mag} = \sqrt{(-0.50)^2 + (-1.0)^2} = \sqrt{0.25+1}$$

$$= \sqrt{1.25}$$

$$\theta = \tan^{-1}\left(\frac{-1.0}{-0.5}\right) = \tan^{-1}(2) \approx 1.107$$

Pixel at (3,1) = 2

$$G_x = \frac{I(3,2) - I(3,0)}{2} = \frac{1-1}{2} = 0$$

$$G_y = \frac{I(4,1) - I(2,1)}{2} = \frac{1-2}{2} = -0.50$$

$$\text{Mag} = \sqrt{0^2 + (-0.5)^2} = 0.5$$

$$\theta = \tan^{-1}\left(\frac{-0.5}{0}\right) = \tan^{-1}(\infty) = \pi/2$$

Pixel at (3,2) = 1

$$G_x = \frac{I(3,3) - I(3,1)}{2} = \frac{0-2}{2} = -1.0$$

$$G_y = \frac{I(4,2) - I(2,2)}{2} = \frac{1-2}{2} = -0.5$$

$$\text{Mag} = \sqrt{(-1.1)^2 + (-0.5)^2} = \sqrt{1+0.25} = \sqrt{1.25}$$

$$\theta = \tan^{-1}\left(\frac{-0.5}{-1}\right) = \tan^{-1}(1/2) =$$

Pixel at (3,3) = 0

$$G_x = \frac{I(3,4) - I(3,2)}{2} = \frac{1-1}{2} = 0$$

$$G_y = \frac{I(4,3) - I(2,3)}{2} = \frac{1-1}{2} = 0$$

$$Mag = \sqrt{0^2+0^2} = 0$$

$$\theta = \tan^{-1}\left(\frac{0}{0}\right) = 0$$

Finally

$$G_x \begin{bmatrix} -0.5 & 0.5 & 0.5 \\ 0.5 & -0.5 & -0.5 \\ 0 & -1 & 0 \end{bmatrix} \quad G_y = \begin{bmatrix} 0.5 & 0.5 & 0 \\ 0.5 & 0.5 & -1 \\ -0.5 & -0.5 & 0 \end{bmatrix}$$

$$Mag = \begin{bmatrix} \sqrt{0.5} & \sqrt{0.5} & 0.5 \\ \sqrt{0.5} & \sqrt{0.5} & \sqrt{1.25} \\ 0.5 & \sqrt{1.25} & 0 \end{bmatrix} \quad \theta = \begin{bmatrix} -\pi/4 & \pi/4 & 0 \\ \pi/4 & -\pi/4 & \tan^{-1}(2) \\ \pi/2 & \tan^{-1}(\frac{1}{2}) & 0 \end{bmatrix}$$

03) For vertical lines the slope intercept will become unstable, tends to go ∞.

Thus, normal form is stable for all lines and it is easier to detect in different orientation.

2) P1)

L=5

H=30

Strong

weak

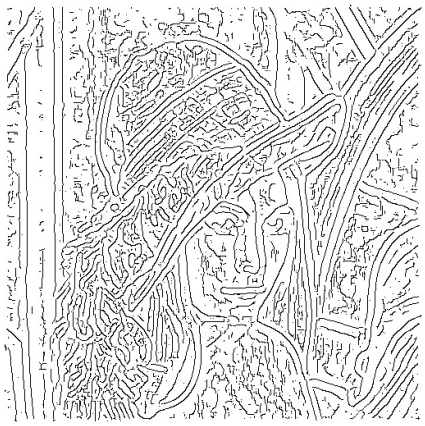
noise

L=1

H=30

Strong

weak



noise

L=5

H=50

strong

weak

noise

P2)

L=5

H=20

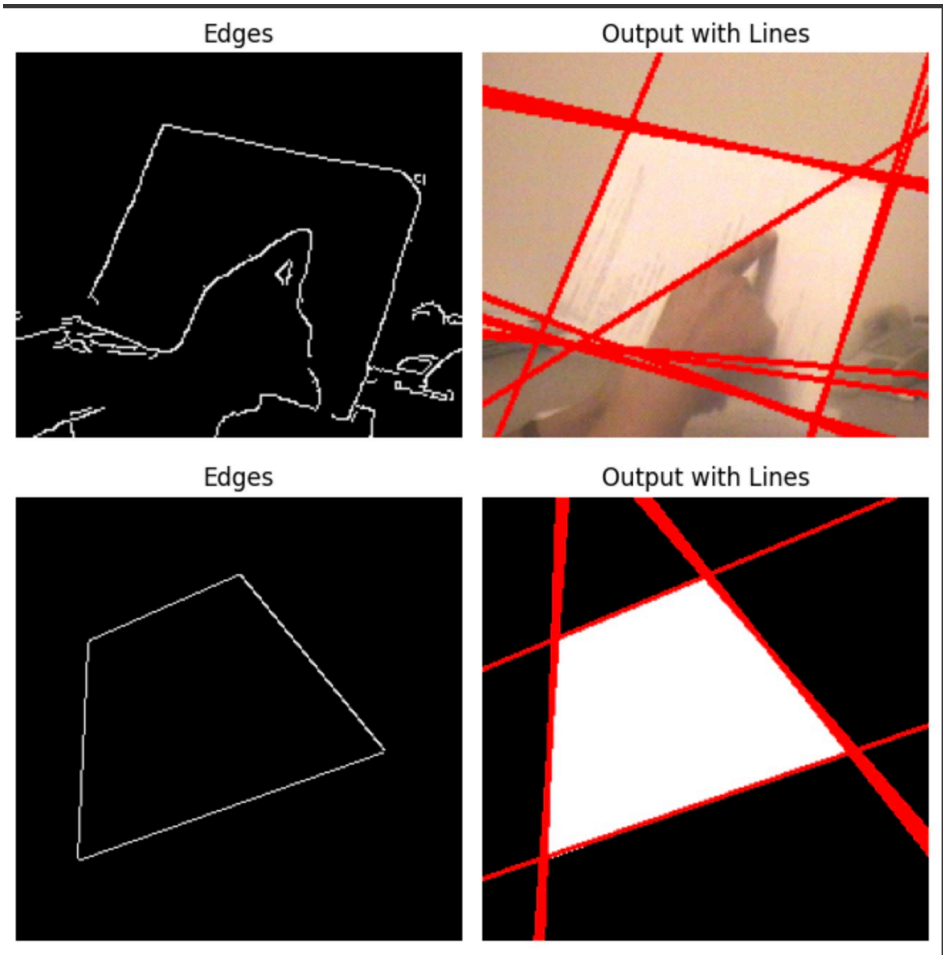
L=1

H=30

L=5

H=50

P3)



P4)