Solutions to Numerical Questions

1. Watershed Algorithm: Pixel Flooding

Given a 5x5 grayscale image matrix:

[100 150 180 200 220]

[90 120 170 190 210]

[80 100 140 160 190]

[60 70 110 130 160]

[50 60 100 120 140]

Solution:

1. Local Minima (Markers):

- The local minima are the lowest points that will act as markers for flooding.

- From the matrix, the local minima are: 50, 60.

2. Applying Watershed Algorithm:

- The matrix is segmented by 'flooding' the image, separating distinct regions around the markers (50, 60).

- Resulting regions might include: [50, 60, 70] forming one region, [100, 150, 180] forming another, etc.

2. Canny Edge Detection: Gradient Calculation

Given a 3x3 image patch:

[50 50 60]

[100 200 150]

[70 120 90]

Solution:

1. Gradients using Sobel Operator:

- Gx = (-1*50 + 0*50 + 1*60) + (-2*100 + 0*200 + 2*150) + (-1*70 + 0*120 + 1*90)

  = (-50 + 60) + (-200 + 300) + (-70 + 90) = 30 + 100 + 20 = 150

- Gy = (-1*50 - 2*50 - 1*60) + (0*100 + 0*200 + 0*150) + (1*70 + 2*120 + 1*90)

  = (-50 - 100 - 60) + (70 + 240 + 90) = -210 + 400 = 190

2. Edge Strength (Magnitude):

- Magnitude = sqrt(Gx^2 + Gy^2) = sqrt(150^2 + 190^2) = sqrt(22500 + 36100) = sqrt(58600) = approx 242

3. Thresholding:

- Since the magnitude (242) is greater than the threshold (150), the central pixel (200) is classified as an edge.

3. Sobel Edge Detection: Image Gradients

Given a 3x3 image patch:

[40 50 60]

[80 90 100]

[120 130 140]

Solution:

1. Gradients using Sobel Operator:

- Gx = (-1*40 + 0*50 + 1*60) + (-2*80 + 0*90 + 2*100) + (-1*120 + 0*130 + 1*140)

  = (-40 + 60) + (-160 + 200) + (-120 + 140) = 20 + 40 + 20 = 80

- Gy = (-1*40 - 2*50 - 1*60) + (0*80 + 0*90 + 0*100) + (1*120 + 2*130 + 1*140)

  = (-40 - 100 - 60) + (120 + 260 + 140) = -200 + 520 = 320

2. Gradient Magnitude:

- Magnitude = sqrt(Gx^2 + Gy^2) = sqrt(80^2 + 320^2) = sqrt(6400 + 102400) = sqrt(108800) = approx 330