EE6310 Image and Video Processing, Spring 2023

Indian Institute of Technology Hyderabad
Homework 4, Assigned 21.03.2023, Due **11:59 pm on 30.03.2023.**

Persistent questioning and healthy inquisitiveness are the first requisite for acquiring learning of any kind. –Mahatma Gandhi

Remarks:

- Please use the *lighthouse.png* and the template (*template.png*) uploaded along with this assignment.

1 Edge Detection

In this problem, you will write a program to compute the edge map of an image. See Remarks for image.

1.1 Gradient Edge Detectors (10)

1. Use the following gradient operators:
   (a) Centered 2-D differencing.
   (b) Roberts operator.
   (c) Prewitt operator.
   (d) Sobel operator.
2. Estimate gradient magnitude using the following definitions:
   (a) $M(i,j) = \sqrt{\Delta_x^2(i,j) + \Delta_y^2(i,j)}$
   (b) $M(i,j) = |\Delta_x(i,j)| + |\Delta_y(i,j)|$
   (c) $M(i,j) = \max\{|\Delta_x(i,j)|, |\Delta_y(i,j)|\}$
3. Threshold the magnitude map using an empirical threshold τ to find the edge map E.

1.2 Laplacian Edge Detectors (5)

1. Compute the Laplacian using the convolution template

$$\begin{bmatrix} 0 & +1 & 0 \\ +1 & -4 & +1 \\ 0 & +1 & 0 \end{bmatrix}$$

2. Compute the edge map E as the output of a zero crossing detector.

1.3 Laplacian of Gaussian (LoG) (5)

LoG was motivated by the sensitivity of gradient and Laplacian edge detectors noise. In the problem, you will implement an edge detector using the LoG operator. Work with the *lighthouse.png* image that is corrupted with AWGN whose $\sigma_n = 10$. Experiment with different values of σ for the Gaussian pre-filter and compute the edge map E after zero crossing detection. Compare your result with gradient based techniques implemented above and verify the robustness of LoG.

2 Template Matching (10)

In this problem, you will write a program to implement template matching using the normalized cross-correlation metric defined in class. Use the definition of $\hat{C}_{\mathbf{B_T} \diamond \mathbf{I}(i,j), \mathbf{T}}$ from slides. See Remarks for image and template.

1. Find the normalized cross correlation image.
2. What is a good threshold to detect a match?
3. Now add Gaussian noise to the template with $\sigma = 1, 3, 5, 10$. Repeat steps (1) and (2) at each noise level. How does the threshold change as noise increases?

4. Rotate the image at the following angles $\theta = 5^o, 10^o, 15^o$. Repeat steps (1) and (2) at each angle. How does the threshold change as rotation increases?

5. Implement rotation using the rotation matrix

$$\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

and a suitable interpolation technique.