Computer Vision (CV)

Assignment 1 **Due Date: 5th Feb, 2020**
Max Marks: 170

Theory Questions:

Question 1: Find the convolution f*X: (Use both zero padding and replication of boundary pixels while performing convolution operation)
i) f = [1 2 1] and X = [0 1 2 3 4 4 1 5 6]
ii) f = [1 0;0 1] and X= [1 0 0; 0 0 1; 0 0 -1] **[10]**

Question 2: When computing image gradients, we first smooth the image and then compute the image gradients. What will happen if we compute the image gradient first and then smooth the resulting image gradients?

[5]

Question 3: Mathematically compute the steps of Canny edge detection by a suitable matrix example.

[10]

Question 5: While designing the pinhole camera, how did you find the perfect pinhole dimension. Can you specify the main advantage and disadvantage of a small pinhole in pinhole camera?

[5]

Question 6: Let the coordinates of two points be defined as A = [a1, a2, 1] and B = [b1, b2, 1]. A transform from A to B in the form of rotation by Θ, then a scaling by Sx in X-direction and a scaling Sy in Y-direction is described by the matrix [1 1 0; −1 1 0; 0 0 1]. Find Θ and (Sx,Sy).

[10]

Programming Questions

Question 1: Write a function that convolve an image with a given convolution filter.
Input: A grayscale image 'I0' and a convolution filter stored in matrix 'h'.
***Output*:** Image 'I1' of the same size as 'I0' which results from 'I0*h'..
Hint: You will need to handle boundary cases on the edges of the image. Do not use inbuilt functions, except reading the images.

[5 + 5 (if made generalized for any filter size)]

Question 2:
(i) Perform Gaussian filtering on image_1 with kernel size as 3x3, 5x5, 11x11, and 15x15. What is the effect of increasing the kernel size on the Gaussian filtering operation? For one of the filters, vary the σ parameter and show its effect.
(ii) For image_1, add salt and pepper noise as 10% of all pixels. Perform median filtering on the noisy image with kernel size as 3x3, 5x5, 11x11. What is the effect of increasing the kernel size on the median filtering operation?

[10+10+5 (if using the same function defined in question 1)]

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Question 3: Define a sharpening and edge detection filter discussed in class. Apply the filters on image_2 in a sequence and also one by one. Report all the results.

[20]

Question 4: Perform unsharp masking on image_3. Use Gaussian filter of size 7x7. Report all the intermediate results.

[15]

Question 5: For questions 1-4, use inbuilt functions to compute the results. Compare the outputs and explain the differences, if any!

[5]

Question 6: Let image_3 be I. Perform the following operation to image I:

$$I' = I + SP + L(I),$$

where, SP is salt and pepper noise while L(I) signifies the Laplacian filtering output of I.
Perform wavelet decomposition using either of the following wavelet filters:
(a) Haar
(b) db 9/7
and, remove the high frequency components to obtain a smooth image in spatial domain.

[10 + 5 (if every step is explained with intermediate outputs)]

[VIVA + REPORT : 20 + 20]

Submission Policy and Requirements

1. This is a graded assignment.
2. Apart from Questions 5-6, each programming task needs to be implemented from scratch.
3. The report should be detailed and clearly explaining every step you have followed.
4. Recommended programming languages: python+opencv.