DSE312 Computer Vision Mid-Semester Examination

(40 marks)

Part1: Written (20marks)

1. The intensity level of the same image is taken at level 12 and then at level 4. You want to process the image further, which one will you use and why? (1)

2. Using set theory concepts, explain on what basis can two regions be called connected set. (1)

3. The discrete form of convolution kernels are given as follows (a-e). What type of operations do you think they will be used for on an image? (3)

a)

1	1	1
1	−8	1
1	1	1

b)

−1	2	−1
2	−4	2
−1	2	−1

c)

1	2	1
2	4	2
1	2	1

d)

−1	−1	−1
0	0	0
1	1	1

e)

−1	0	1
−1	0	1
−1	0	1

4. How does the standard deviation parameter of the Gaussian filter affect the spatial filtering operation? (1)

5. The estimated calibration matrix using least squares estimation is given below. Compute the extrinsic and intrinsic parameters of the matrix M. (4)

$$\mathcal{M} = \begin{pmatrix} -2872.0 & 1744.3 & -138.7 & 77270.0 \\ -273.9 & -174.8 & -3287.5 & 94116.0 \\ -0.7380 & -0.6480 & -0.1883 & 75.633 \end{pmatrix}$$

6. Given two lines $u_1=(4,2,2)$ and $u_2=(6,5,1)$ find the the point of intersection in projective geometry. (2)

7. Given the projection matrix M, compute the image plane coordinate of a point at the world coordinate (4,0,0).(2)

$$M=\begin{bmatrix} 512 & -800 & 0 & 800 \\ 512 & 0 & -800 & 1600 \\ 1 & 0 & 0 & 0 \end{bmatrix}$$

8. You want to perform a smoothing operation using a Gaussian filter. What will you have if you smoothen the image repeatedly several times? (1)

9. When doing coordinate transformation such as translation, how is this operation carried out in Euclidean versus Homogeneous coordinate? (1)

10. Dilation followed by erosion is called (1)

a. Opening
b. Closing
c. Blurring
d. Translation

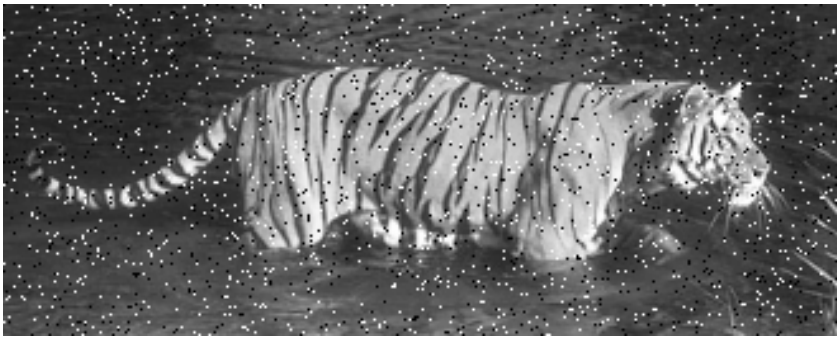
11. Opening and closing are each others (1)

a. Neighbours
b. Duals
c. Centers
d. Complements

12. Hit-or-miss transformation is used for shape (1)

a. Removal
b. Detection
c. Compression
d. Decompression

13. An image with a tiger is corrupted with noise. What type of noise is this and which type of filter is best suited for removing noise in this image?(1)



Part2: Programming Questions (20marks)

1. A zone plate image has been given. Please use the code or its equivalent to generate the image. You may use numpy or other python tools as well. (10)

$$g(\mathbf{x}) = g_0 \sin\left(\frac{k_m|\mathbf{x}|^2}{2r_m}\right)\left[\frac{1}{2}\tanh\left(\frac{r_m - |\mathbf{x}|}{w}\right) + \frac{1}{2}\right]$$

Steps (in Matlab):

```
N=501;

x2 = (N-1)/2;
x1 = -x2;
[x,y] = meshgrid(x1:x2);
r = hypot(x,y);

km = 0.7*pi;
rm = x2;
w = rm/10;
term1 = sin( (km * r.^2) / (2 * rm) );
term2 = 0.5*tanh((rm - r)/w) + 0.5;
g = term1 .* term2;
I = (g + 1)/2;
```

The image ‘I’ is your working image. (I <=1)

Perform the following operations on the generated image (I).

i. Read the image into a variable. Give the image dimensions. Convert the image to 'uint8' datatype. Make sure that your intensities are 0 to 255 (hint: you may simply multiply image by 255 and then convert to uint8, because 'I' ranges between $0 \leq I \leq 1$ (using: uint8(I.*255)) or use any other method). (1)

ii. Use 'imcrop' and crop the centre image of size 250X250, store this in variable 'I_cropped'. (1)

iii. Perform a lowpass image smoothing on 'I_cropped'. (1)

iv. Using a Laplacian kernel, find image edges on the de-noised image (on the result above) and support your answers with with plots and equations (pls keep the answers brief). (3)

v. Pick one of the following, produce the code and support your answers with with plots and equations (3):

   i. Produce an image using DOG operator on 'I_cropped'

   OR

   ii. Produce an image using LOG operator on 'I_cropped'

vi. Threshold the result from step iv. using Otsu's thresholding (1)

Show all intermediate steps (including image outputs) in your codes and explain the operations (very briefly). Make sure that your inputs are in binary image forms (else convert to binary) for the following questions:

2. The objects given in the binary image (Fig1) were identified, however, some of them have holes within. Apply the appropriate morphological methods to correct the image and explain your answer briefly. (3)

i. To the result, find the number of connected components within the image.

OR

ii. To the result, extract the boundary of each circle and plot on the result image.

(4)

3. In the given image (Fig2), find the total number of non-overlapping objects only. Assuming that all particles are of the same size (hint: take advantage of this feature), design a series of image processing steps that will give the number (3).