Midterm Examination(Spring2024)

CS385: Computer Vision

Time: 2Hrs

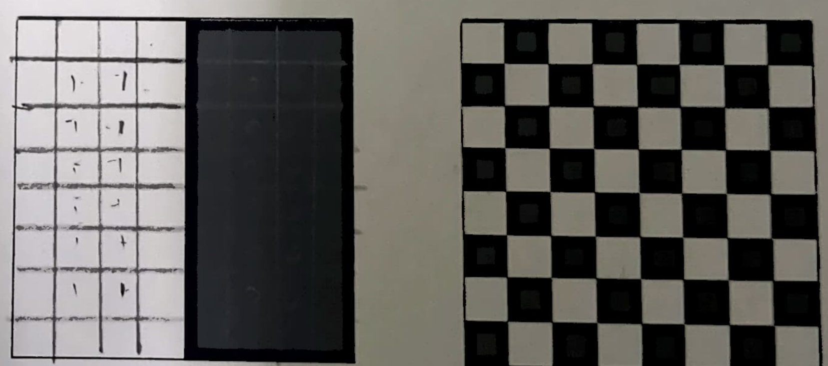
Max Marks: 100

Q1: Suppose that you have a gray image corrupted by salt-and-pepper noise, as shown in the matrix. (a)What is the filtered result after applying 3×3 box filter? Draw the matrix (b) What is the filtered result after applying 3×3 median filter? Draw the matrix (c) Compare the results you got from (a) and (b), explain why median filter is better in filteringout salt-and-pepper noise.

0.5	0.5	.05	0.5	0.5
0.5	**0.0**	**.05**	**0.5**	0.5
0.5	**0.5**	**.05**	**0.5**	0.5
0.5	**0.5**	**.05**	**1.0**	0.5
0.5	0.5	.05	0.5	0.5

(15 points)

Q2: The two images are shown. Compute their histograms. Both images have size 8 × 8, with black and white pixels. Suppose that both images are blurred with a 3×3 smoothing mask(box filter). Would the resultant histograms still be the same? Draw approximately the two histograms and explain your answer. [Note: the dark lines that appear around the two images are used to signify the boundaries of the images but are not part of them.]



(20 points)

Q3: Compute DFT of the sequence f =[2, 3, 4, 4] and plot magnitude and phase spectrum.

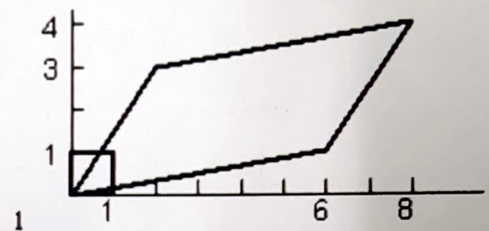
(10 points)

Q4: Find the convolution $f_1(t)*f_2(t)$; $f_1(t)= t^2$ and $f_2(t)= t^3$

(15 points)

Q5: A unit square is transformed by an affine transformation. The resulting position vectors are shown. Compute the transformation matrix in homogeneous form. **(15 points)**

$$[P*]=\begin{bmatrix} 0 & 2 & 8 & 6 \\ 0 & 3 & 4 & 1 \end{bmatrix}$$



Q6:

(a) For the 3 by 3 Image (I) highlighted window. compute the derivatives Ix and Iy using kernels d/dx =[-1, 0, 1]and d/dy=$[-1,0,1]^T$. No normalization (division by 2) is needed

(b) Compute the Harris Matrix based on the derivative matrices.

(c) Compute the Harris cornerness score C = det(H) – k* trace$(H)^2$ for k= 0.2 . What is your conclusion here? A corner? An edge? Or a flat area? Why?

0	0	1	4	9
1	0	5	7	11
1	4	9	12	16
3	8	11	14	16
8	10	15	16	20

(25 points)

End-Semester Examination (Spring 2024)
CS385: Computer Vision

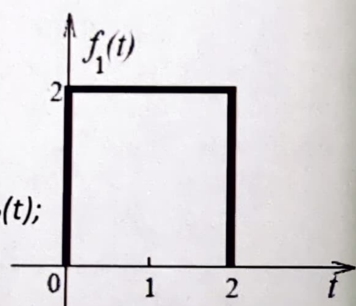
Time: 3Hrs
Max Marks: 100

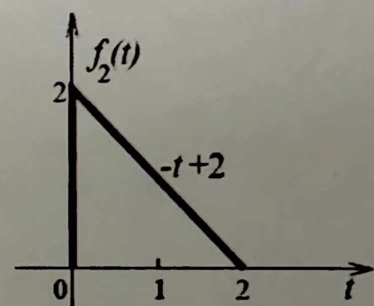
Q1: Suppose we have the following 2D image and k be the kernel. Compute ***X*k*** (2D Convolution of ***X*** and ***k***). You only need to compute the convolution of non-boundary points in **X**. **(15 points)**

$$X = \begin{bmatrix} -2 & 4 & 1 & 7 \\ -4 & 2 & 1 & 9 \\ 1 & 3 & 5 & 7 \\ 4 & 0 & 1 & 2 \end{bmatrix} \qquad k = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}$$

Q2: Find the convolution $f_1(t)*f_2(t)$;

(10 points)





Q3: Describe differential method (Lucas–Kanade) for optical flow estimation? What are the advantages and disadvantages of the method? **(15 points)**

Q4: What is the intrinsic parameter matrix for the camera, if its focal length in the x-direction is 1050 pixels, aspect ratio is 1.0606 and principal point is offset from the center (0, 0) of the image plane to the location (10,−5). Also computer the projection matrix if the extrinsic matrix is **[0.9 0.4 0.1732 2.2196; −0.4183 0.9043 0.0854 1.6464; −0.1225 −0.1493 0.9812 2.5224; 0 0 0 1]**. **(10 points)**

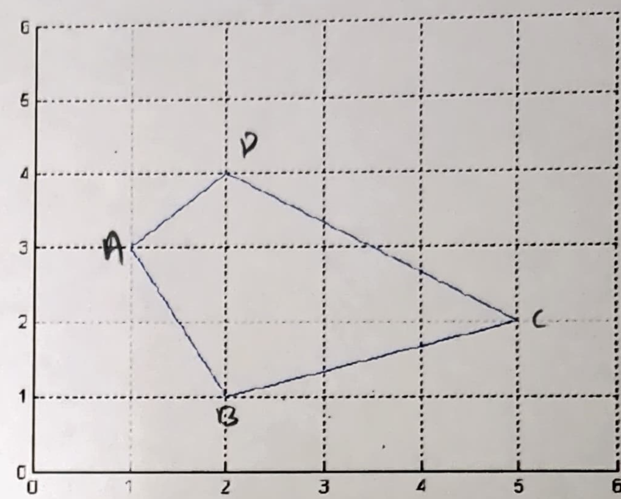
Q5: Suppose the baseline between 2 cameras is 2 meters, focal length (f) is 20 cm, disparity at pixel **p** is 4 pixels, and each pixel corresponds to 3 millimeters in the image plane. What is the depth of pixel **p** in the scene? **(10 points)**

Q6: When a rectangle is observed under pinhole perspective, the image will be arbitrary quadrilateral, and figure shows a projected rectangle. Answer the following questions using homogeneous representations.

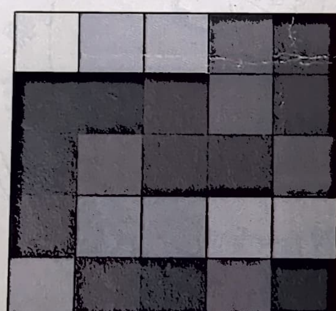
(a) Find the line equations (i.e. $ax + by + c = 0$) of the four edges

(b) Calculate the Euclidean coordinates of vanishing point for the image of each pair of parallel lines

(15 points)



Q7: The following figure shows a image with 5 different grey levels with values shown on the right figure. (a) Derive the probability of appearance for each intensity (grey) level. Calculate the entropy of this image. (b) Derive a Huffman code. (c) Calculate the average length of the fixed length code and that of the derived Huffman code. (d) Calculate the compression ratio and the relative coding redundancy. **(15 Points).**



180	160	160	140	120
110	110	120	140	120
110	140	120	120	140
120	160	160	170	170
170	120	110	140	110

Q8: A 2D geometric object is scaled relative to the point with coordinates (2,3) in the x-coordinate by 3 times and in the y-coordinate by 5 times. Then, the object is rotated about the origin by 90° in clockwise direction. Finally, the object is reflected through the y-axis. Write in a proper order the matrices constituting this transformation and final transformation matrix in homogeneous form.

(10 Points)