COT 4930 COT 5930 EEL 4930 EEL 5661 Robotic Applications Fall 2022

Homework 4

Machine Vision

Choose any 4 (out of 6 questions) for the homework's 20 (G) or 25 (UG) points. There is a bonus of up to 2.5 points for each additional problem solved. The maximum grade for HW4 can reach 25 (G) or 30 (UG).

Most problems feature an analytical part, involving small synthetic images, taken from the Fall 2021 final exam. The image in each such problem has origin (0,0) is in the upper left corner. The u-axis goes from left to right, and the v-axis goes from top to bottom. Every one of these problems involves some analysis of a real image, as well.

Problem 1: A perspective camera has a focal length of f = 14 [mm]. Choose some reasonable values for the size of a pixel and for the number of pixels (W and H). A 10 x 10 x 10 [cm] box is standing parallel to the camera at a distance of 2.5 [m] along the optical axis.

1.1 How long (in [mm]) is an edge of the box as it is showed in the image? Explain your calculations and demonstrate using MATLAB Machine Vision Toolbox (MVTB). Plot how the box shows up on the image of the camera.

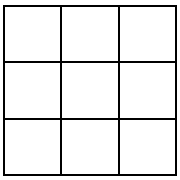
1.2 If the box is displaced along the world's X axis, how long can it be displaced before leaving the camera's field of view? Demonstrate using MVTB.

Problem 2:

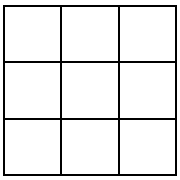
2.1 An image of 3 x 3 pixels has 4 grey levels {0, 1, 2, 3}. It is known that the binary image has 2 labels and a corner point. The greyscale image histogram is given by the table:

# Pixels	4	1	0	4
Grey level	0	1	2	3

Create the original image (there can be many correct solutions) and explain briefly.



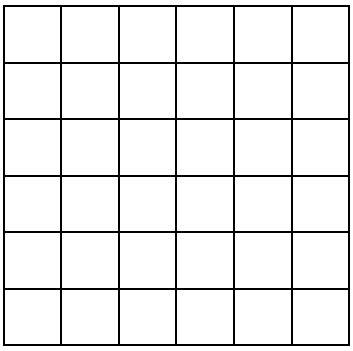
Create a binary image of the original image and explain briefly how you obtained it.



2.2 Load and display the color MVTB image named “shapes.png”. Plot and explain the three histograms of this color image. Using MATLAB label each shape.

Problem 3:

3.1 Create a 6 x 6 binary image that has 4 labeled regions. Region 1 is the parent of the other three 2-pixels white regions. Explain briefly.



3.2 Pick up one of the white regions of (3.1) and calculate its m_{02} moment.

3.3 Load and display the BW MVTB image titled “shark2.png”. Using moments analysis find the position and orientation of each of the two sharks.

Problem 4:

4.1 A corner detector, based on Moravec’s algorithm, scans the binary image (below). How many corners does it find? Explain briefly.

0	1	0	0
1	1	1	0
0	1	0	0
0	0	0	0

4.2 Load and display a grey version of the image titled “eiffel-1.png”. Use Harris’ corner detector to detect all the corners.

Problem 5:

5.1 A Sobel edge detector is applied to the binary image below. How many edges are produced? A Hough Transform is then used to choose the best line. What are the ρ and θ parameters of the best line? Explain briefly.

0	1	0	0
0	1	1	0
0	0	1	0
0	0	1	0

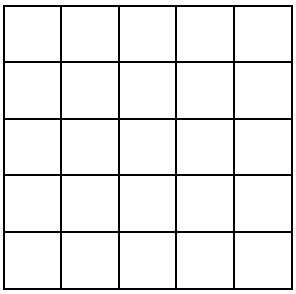
5.2 Load and display a grey version of the image titled “notre-dame.jpg”. Using Hough Transform find straight lines in the image.

Problem 6: Consider the 5 x 5 binary image and the 1x3 structuring image (below).

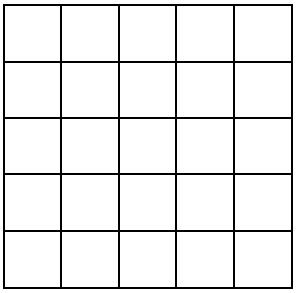
0	1	1	1	1
1	1	0	0	0
1	1	0	0	0
0	0	0	1	0
0	0	0	1	0

1	1	1

6.1 Perform manually a dilation morphological operation, and briefly explain your calculations.



6.2 Follow up (6.1) by an erosion morphological operation on the result of 6.1, and briefly explain your calculations. How is the sequence of actions called – opening or closing?



6.3 Load and display the grey version of the image titled “adelson.png”. Let a structuring image be a square of size 150 pixels. Using MATLAB demonstrate the opening of the original image. Then demonstrate the closing of the original image.