Department of Electrical & Computer Engineering

McMaster University

COMP ENG 4TN4

Image Processing

Assignment 3

Due Date: 2022/2/13

Assessment: 4% of total course mark

Instructions:

- For coding problems, please include the results as well as the screenshots of codes in the report
- Please upload source codes along with the report in Avenue (1 zip/rar file including codes, results and 1 PDF report file)
- The report MUST be written in Latex
- The codes MUST be written in Python language
- Please write comments for your codes!
- The explaination about the code MUST be included in the report!

Theory (50 %)

1 Edge Detection, Sobel Operator, 20 %

Sobel operators are masks used to calculate approximations of the derivative in the x-direction and y-direction. Apply the Sobel operators to the given image. Approximate mangitude and phase of the gradient (∇G) at each pixel position. (Zero-Padding is NOT required for this question)

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

2 Edge Detection, Canny Operator, 20 %

Consider the following image:

$$\begin{bmatrix} 127 & 127 & 127 & 0 & 0 & 0 \\ 0 & 127 & 127 & 127 & 0 & 0 \\ 0 & 0 & 80 & 80 & 80 & 0 \\ 0 & 0 & 0 & 127 & 127 & 127 \\ 0 & 0 & 0 & 0 & 127 & 127 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad (1)$$

a) Compute the magnitude and angle of gradients using 3×3 Sobel operators (you need use zero padding)

b) Apply Non Maximum Suppression to the magnitude of gradients

c) Apply Hystresis thresholding (L=20, H=120) and label all pixels as either edge or non edge (1, 0).

d) Plot the block diagram of Canny operator.

e) Could we obtain an edge which has a width more than 1 using Canny operator? Why?

3 Convolution Theorem, 5 %

Explain Convolution Theorem. How could it be useful in template matching?

4 Sharpening an Image, 5 %

Assume we have a low pass gaussian filter (G). How can we obtain a high pass filter from it? Propose a solution using this high pass filter to make an image sharper.

Implementation (50 %)

1 DoG (20 %)

Use two Gaussian filters with suitable kernel sizes to to extract the license plate and remove most of the background for "lp.jpg".

1.1

Apply canny operator on the image to extract the edges. Try to remove the noise by preprocess the image using a gaussian filter. Try to keep the license plate letters and numbers while removing other parts of the backgrounds by adjusting two thresholds in Canny operator.

2

Which of the previous methods do you think is more useful to remove the background when we do have information about the scale our object? Why?

3 Template Matching (30 %)

Write a program that takes a template and an image. Then perform template matching using normalized cross correlation. Visualize heat_map that shows the probability of having circle (using template "circle.bmp") in "messi.jpg". Where is the peak in the heat_map and what does it show? You can use the edge of the image using Canny operator to get a better result.

3.1

Compare your function with "matchTemplate" function in OpenCV. You should normalize the output matrix of "matchTemplate". Set the fourth argument of method "matchTemplate" to "CV_TM_CCOEFF_NORMED".

3.2

Propose a solution to find circles at different scales. Now implement your solution and find "circle.bmp" on the resized "messi.jpg" with scale factor "2" to show your method works.
