Concordia University

Department of Computer Science & Software Engineering

COMP 478/6771 Image Processing

Assignment 2 - Due Date: *October 18, 2022*

Part I: Theoretical questions

1. (**7 points**) In character recognition, text pages are reduced to binary form then followed by a thinning process that will reduce the characters to strings of binary 1s on a background of 0s. Due to noise the binarization and thinning processes could result in broken strings of 1s with gaps ranging from 1 to 5 pixels. The aim is to repair it so that there are no gaps in the strings of 1s. This is done as follows:

   Blur the binary image by an averaging filter then apply a thresholding method to convert it back to binary form. For this approach, please give the minimum size of the blurring mask and the minimum value of the threshold to accomplish the task.

2. (**7 points**) In class, we have seen Laplacian filters, such as the following

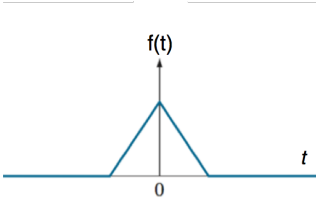
$$A=\begin{bmatrix}1 & 0 & 1\\ 0 & -4 & 0\\ 1 & 0 & 1\end{bmatrix},\quad B=\begin{bmatrix}0 & 1 & 0\\ 1 & -4 & 1\\ 0 & 1 & 0\end{bmatrix},\quad C=\begin{bmatrix}1 & 1 & 1\\ 1 & -8 & 1\\ 1 & 1 & 1\end{bmatrix}$$

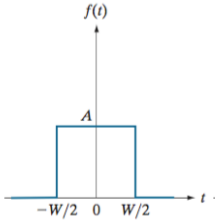
   Write down a 5-by-5 Laplacian-like filter with the center element equal to -16. What general rules should you follow to build such a filter? If we apply this filter to an image, do we get a sharper image compared to those images obtained with filter A, B, and C? Explain your answer.

2. Fourier Transform Questions:

   a) Study ***Example 4.1*** in the textbook, then follow the steps in that example to find the Fourier Transform of the function $f(t) = A$ for $0 \le t \le W$ and $f(t) = 0$ otherwise; where both A and W are constants. Explain the differences between your result and the result in Example 4.1. Consider the case where $A = W = 1$, what is the Fourier Transform of $f(t)$ in this case?

   b) Use the result of ***Example 4.1*** to find the Fourier Transform of the tent function. The tent function is shown below on the left. Note that the tent function is the convolution of two box functions shown in ***Fig. 4.4(a)*** (Right Image).





Part II: Programming questions – adaptive thresholding (22 points)

1. Download the image from the assignment folder then carry out the **adaptive thresholding** algorithm to binarize the text in the image without the shadow. Please show your results, discuss about your choice of parameters and filters, and compare your results with the ***adaptthresh()*** function in MATLAB.

> In ***adaptive threshold*** unlike fixed threshold, the threshold value at each pixel location depends on the neighboring pixel intensities. To calculate the threshold *T(x,y)*, the threshold value at pixel location *(x, y)* in the image, we perform the following steps:
>
> 1) A *m-by-m* region around the pixel location is selected. *m* is selected by the user.
> 2) The next step is to calculate the weighted average of the *m-by-m* region (averaging filter). You can choose any averaging filter of your choice and provide your reasons. We will denote the weighted average at location (x,y) by *WA(x, y)*.
> 3) The next step is to find the Threshold value *T(x, y)* by subtracting a constant parameter, ***c*** from the weighted average value *WA(x, y)* calculated for each pixel in the previous step. The threshold value *T(x, y)* at pixel location *(x, y)* is then calculated using the formula:
>
> $$T(x, y) = WA(x, y) - c$$
>
> Now you will just need to apply the threshold transfer function to obtain the result.