APPLIED MATHEMATICS : HONS AM 793 Image processing

ASSIGNMENT 2: SPATIAL METHODS (2022)

For this assignment you must write a short report in any word processor of your choice (MSWord, Latex, ...) where you explain your methods and show your results. All input and output images must be shown (preferably so that they can be compared on the same page). Add the code in an Appendix.

1 For the image `OnFerry.jpg`

   (a) brighten the image by a suitable gamma-transformation,

   (b) do histogram equalization of the image,

   (c) design a point transformation that will brighten the image in general but in addition do contrast stretching for the passengers and seats.

2 Do the same as 1(a), (b) and (c) for a grey-scale image of your choice. Choose a particular part of the image that you want to bring out.

3 Pick a grey-scale image of your own choice (preferably not too crowded with detail).

   (a) Use an $N \times N$ (N is odd) smoothing mask and illustrate smoothing on the image. Do not choose N too large.

   (b) Use the same $N \times N$ smoothing mask and apply unsharp-masking to the image, by subtracting the smoothed image from the original image and adding k times this to the original image. Choose the weight k suitably.

   (c) Redo (b) but now first design a single mask that will incorporate all the steps in one mask, and do only one mask convolution. Check that the result is exactly the same.

4 Take a color image of your choice that is under-illuminated.

   (a) Do histogram equalization separately on each of the colour matrices R, G, and B, and display the combined image. Why is this a bad choice?

   (b) Find the histogram equalization point transformation obtained from the intensity image (the mean of R, G and B) only. Apply this to each of R, G, and B, reassemble and display the result.

   (c) Do HSI conversion. Then do histogram equalization of all three matrices H, S, and I, and reassemble as an RGB image Display the result and explain.

   (d) Do histogram equalization only of the I-image, keeping the S- and H- images intact, reassemble as an RGB image, and display. Explain your result.

   Hint for MATLAB users: MATLAB has functions rgb2hsv and hsv2rgb, but beware that the maximum is sometimes 1 and not 255.

5 Write a program that will apply an $n \times n$ (n is odd) mask with order statistics to a grey scale image. Let $N = n^2$. The program must be general in the sense that it will be able to select the

s-th value of the N sorted values as output. For example, for $s = 1$ it will select the maximum, for $s = N$ it will output the minimum, and for $s = (N + 1)/2$ it will act as median order statistics filter.

(a) Apply this filter to the image WhatIsThis.jpg as a median mask and show the result. Then improve the image in any suitable way, using any of smoothing, sharpening, histogram equalization, order-statistics-filtering, in any suitable (and justifiable) order.

(b) Do the same with an image of your choice that is badly illuminated and corrupted with salt-and-pepper noise.

6 Gonzalez & Woods, 3rd Edition, Problems 3.2 and 3.14.

Not for handing in:

Other suggested problems from G&W, 3rd edition, but not for handing in: 3.7, 3.8, 3.21 and 3.27.

Code to be written, but not for handing in. (Get this ready because you will use this later.)

Write code that will convolve a general square mask M (of size $p \times p$ where p is odd) to a grey-scale image A of any rectangular size (normally larger than p). The code must have three options for treating boundaries: (a) convolution with zero-padding, (b) periodic convolution (in both directions), (c) zero derivative at the boundaries. Obtain some images that will illustrate these effects clearly.
