APPLIED MATHEMATICS : HONS AM 793 Image processing

ASSIGNMENT 3: FREQUENCY FILTERING (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(a) Take the image `text.jpg` and blur it by convolving with the following 13×13 mask:

$$M = \frac{1}{169} \begin{bmatrix} 1 & 1 & ... & 1 \\ 1 & 1 & ... & 1 \\ \vdots & & \ddots & \end{bmatrix}$$

Call the result B. Take the same matrix M and pack it into a 512×512 matrix, call it M_0. Make sure that you pack it correctly so that the center of the mask matrix M lies at the position (257,257) in the larger matrix M_0.

Let H_0 be the Fourier transform of M_0. Then deconvolve B with H_0 and try to recover the original image in this way. You must choose a suitable threshold for suppressing the higher frequencies.

1(b) Redo this example with another blurring mask and another image of your own choice (You may try it with a colour image).

2 Apply the sharperning mask S below to the image `text.jpg` and obtain an edge image (i.e. you simply convolve it in physical space.) . Then pack S into a 512×512 matrix, and call it S_0. Obtain the Fourier transform of S_0, call it J_0. Then filter the image `text.jpg` with J_0, and show that you also obtain an edge image. Compare the two edge images. Note: It is best to display such an edge image that contain negative grey values as well in "embossed format" by adding 128 to every pixel so that both the positive and negative parts are visible.

$$S = \begin{bmatrix} -2 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

3(a) The image `Mariner4noise.jpg` was taken by the Mariner 4 spacecraft, launched on 28 November 1964 and it flew by Mars on 15 July 1965. It was one of the first images of the planet that clearly showed craters. It is a patch just south of the Amazonis Planitia, centered at 32.7 S, 162.7 W. However, the technology of those days was such that the transmission mode superimposed high-frequency periodic noise on the image.

Use suitable notch-filters (for removing the periodic signal) as well as suitable low-pass-filters for removing any high-frequency noise, if necessary, and improve the image.

3(b) (Optional, just for fun:) You may also check what this part of the planet looks like taken later with much better technology, by trying to find the patch on the HiRISE image library available at

https://www.uahirise.org/hiwish/browse

In order to help you locate it, the little hill in the north-east crater (marked with a cross in `Mariner4ImageMarkedWithCross.jpg` is at 161.71 W, 33.56 S (i.e. in terms of signed coordinates at -161.71, -33.56.). The name of the big flat crater encircled in blue has the name 'Mariner Crater'. (If you do this part, please add it also in your report. Although no. 3(b) counts no marks.)

4(a) Repeat for one of the images `blindstree.jpg`, `blindscity.jpg`, `blindsguitar.jpg`, `blindsnow.jpg`, or `sunsetthroughblinds.jpg` (you may choose). In this case the periodical 'noise' consists of a pattern of blinds that obscures the view. Also, these images are in colour. You must remove the noise on each colour panel using the same notch-filter.

4(b) Redo with an image of your own choice that is perturbed by a periodic pattern (periodic noise or a physical periodic pattern).
