Image Restoration

This exercise is intended to familiarize you with some basic concepts related to image restoration.

Exercises

1. Read in `samford.png` and convert to grayscale with rgb2gray. (Note that the pixel values of the image should lie within a $[0, 255]$ range, not a $[0, 1]$ range, if you read it in correctly. If the scaling is not correct, the noise and other values will be incorrect later in the project.)

   (a) Blur the image using FFTs with the kernel `ker = fspecial('disk',6)`, and include the result in your report.

   (b) Describe the differences between the blurred image and the original.

   (c) What aspects of this artificial blurring do not conform to real-life out-of-focus blurring for this image? Name at least two aspects.

2. Consider an inverse filter for the blurring operation above.

   (a) Make up a one-line command that will implement an inverse filter using FFTs given the blurred image and the kernel. Provide me with a copy of it. (You will have to nest several MATLAB commands.)

   (b) Invert the blurring operation performed in the previous step, and include the result in your report.

   (c) Is the result visually and numerically identical to the original? Should it be? Explain.

3. Explore the effect of noise:

   (a) Create a noise image using `5*randn(size(samford))` and add this to the blurred image created in the first step.

   (b) Deblur using the inverse filter from the step above. Describe the result.

   (c) What is the highest multiplier on `randn` that can be used while still making out the object in the restored image?

4. Consider a regularized inverse filter for the blurring operation above.

   (a) Make up your own short sequence of commands (or a one-line command) to implement regularized restoration in the frequency domain. (Do not use `deconvreg`.) Let L represent a convolution with `[ 0 1 0 ; 1 -4 1; 0 1 0]`. (You will need to take an FFT of this convolution kernel zeropadded to the size of the image.) Provide me a copy of the command sequence.

   (b) Use this sequence to deblur the blurred image with the noise term that was generated by `5*randn(size(samford))`.

   (c) Experiment with different values (different orders of magnitude) of `alpha` until you find the value that gives the most visually pleasing result. (Typical values fall in the interval $(0, 1]$.) What value did you choose?

   (d) How does the result compare to the inverse filter above?

   (e) Show in your report the best image obtained in this step.

Write a report that summarizes your findings. (You may use two pages if absolutely necessary, but one page is best. Images can be small.) Include at least one image or image comparison and one code snippet. If the project specifically asks that an image or code snippet be created, then you must include that. The memo should be written so that it makes sense without reference to the project instructions. Please number/letter your paragraphs corresponding to the project instructions.

Submit a PDF of your project memo on Canvas by class time on the due date.
NOTE: All out-of-class work is to be done **independently** and should represent your work alone. Sharing of programming tips and discussing general concepts is ok. Collaborating on experiments or code-writing is not. **Any** such collaboration on these assignments will be considered an act of dishonesty and will be treated accordingly. Memos may be checked using Turnitin (TM) for excessive similarity to one another and to documents available online.

For further help:

- Matlab Primer
- Matlab Documentation