Homework 11

Submission instructions.

- Submissions are due on Thursday 11/21 at 7.00pm ET == 4.00pm PT
- Please upload scans of your solution in GradeScope (via Canvas)
- Please ensure that your scans are readable.

Instructions

- Please show all necessary steps to get the final answer. However, there is no need to be overly elaborate. Crisp and complete answers.
- For all MATLAB problems, include all code written to generate solutions.
- Please post all questions on the discussion board on the Piazza course website, rather than email-ing the course staff. This will allow other students with the same question to see the response and any ensuing discussion.
- **If you feel some information is missing, you are welcome to make reasonable assumptions and proceed. Sometimes the omissions are intentional. Needless to say, only reasonable assumptions will be accepted.**

1. We are going to explore multi-image deblurring in this HW.

   You have an unknown sharp image $\mathbf{x}$ and you obtain two blurred images $\mathbf{y}_1$ and $\mathbf{y}_2$ such that

   $$\mathbf{y}_1 = \mathbf{k}_1 * \mathbf{x} + \mathbf{n}_1$$
   $$\mathbf{y}_2 = \mathbf{k}_2 * \mathbf{x} + \mathbf{n}_2$$

   Here, $\mathbf{n}_1$ and $\mathbf{n}_2$ are additive white noise, whose elements have mean zero and variance σ^2. We do not know anything about σ^2.

   Suppose that $\mathbf{y} = \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \end{bmatrix}$, and then $\mathbf{n} = \begin{bmatrix} \mathbf{n}_1 \\ \mathbf{n}_2 \end{bmatrix}$, and we can write $\mathbf{y} = A(\mathbf{x}) + \mathbf{n}$.

   (Deliverable 1) Provide mathematical expressions for the operator A and A^*.

   (Deliverable 2) Provide MATLAB functions that implement A and A^*

   (Deliverable 3) In `hw11.mat`, you are given two blurred images corresponding to $\mathbf{y}_1$ and $\mathbf{y}_2$, along with kernels $\mathbf{k}_1$ and $\mathbf{k}_2$. Deblur them jointly. Provide code and the deblurred

output. You are welcome to use any method we have developed in class or prior HWs. But you are restricted to using your code or code that we provided as part of HW/recitations.

(Deliverable 4) Deblur $\mathbf{y}_1$ and $\mathbf{y}_2$ separately to obtain two different estimates of $\mathbf{x}$. Provide code and deblurred outputs. Use the same method as in Deliverable 3.

Some Notes:

- We expect you to optimize the parameters in your chosen method for good reconstructions
- If you try more than one approach, then please only report the one that gave the best visual quality in reconstructions
- For what it is worth, $\mathbf{y}_1$ and $\mathbf{y}_2$ were generated using the following commands.

  for ch=1:3 y1(:, :, ch) = conv2(x0(:, :, ch), k1, 'valid'); end y1 = y1 + randn(size(y1))*sigma;

2. **(0.1 points)** How many hours did this homework take?