CoE 3SK3 Course Project 3

Image Deblurring

Due date: April 5, 2024.

A camera-captured image cannot record the world at a single instant of time. Instead, the image represents the scene over the period of exposure time. If objects in a scene and/or the camera moves, an image of that scene is the result of integrating all positions of those objects and/or camera's viewpoints, over the exposure duration. Consequently, any object moving with respect to the camera will look blurred or smeared along the direction of relative motion. The image degradation of blurring may occur on moving objects, or on background and static objects if the camera is moving.

Image blur can also be caused by camera lens out of focus.

The image blurring can be modeled by a linear system: B = AX, where vector B is the blurred image, vector X is the original sharp image, and matrix A represents the blurring operation.

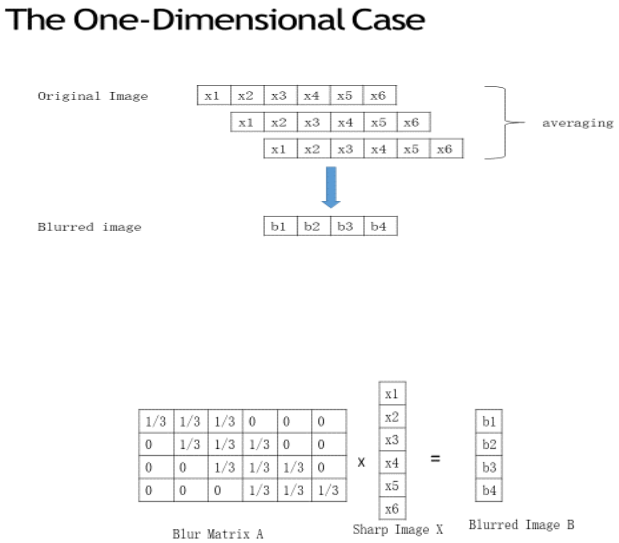
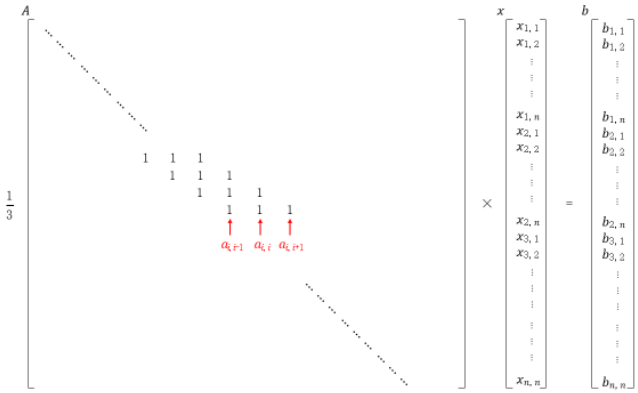
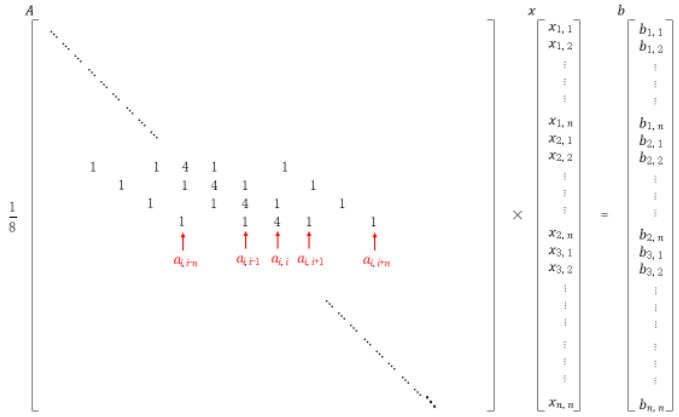


Illustration for two-dimensional image case



Horizontal motion blur



Out-of-focus blur

The task of this project is to recover sharp image X from the blurred version B, given the blurring operator A.

Requirements:

a) Solve the image deblurring problem by the LU decomposition method for a given blurring operator A, including both motion blur and out of focus blur. Directly using matrix inverse function of any math library to compute $X = A^{-1}B$ is NOT acceptable.

b) Make your program as efficient as possible. What is the number of operations needed to deblur an image?

c) Find and understand what happens if there are small errors in the blur kernel matrix A.

d) Submit a written project report together with the well-documented software code. The written report must justify your algorithm design, include a detailed complexity analysis, and discuss the effects of errors in the blur kernel matrix A.

e) The project is to be performed by individual.