1 Introduction

In Chapter 4 we will provide an explicit description of the blurring matrix $A$ defined by the linear model $b = Ax + e$, where $b$ is the vector that represents the noisy recorded image $B$. We will also see how the structure of $A$ depends on the imposed boundary conditions (Zero, Periodic, Reflexive) and the type of PSF (separable or non separable). Moreover we study how $A$ can be represented as a Kronecker product and how the Kronecker product is constructed by the PSF. Finally, for spatially invariant PSFs the authors describe three fast algorithms for computing a spectral decomposition or an SVD. In Challenge 9 we construct different blurred images for different noise levels by using the FFT and DFT algorithms. Then from these blurred images we compute the naive solution. Finally, in Challenge 10 we construct the matrix $A$ for a small separable PSF array by using the Kronecker decomposition function. Then we examine the time needed to compute the singular values and eigenvalues of $A$, using FFT, DCT and the built in functions eig and svd.

Note: Code available at http://www.math.umbc.edu/~bmaria2/
2 Challenge 9

For the exact image `iograyBorder.tif` (Fig 1) we use the Moffat blur ($s_1 = s_2$, $\beta=3$) together with the bordering approach from section 4.6 to generate a PSF array. Then using DCT and FFT fast algorithms we create the blurred image $B$ (Fig 2). Finally we compute the naive solution.

![Exact image iograyBorder.tif](image1)

Figure 1: Exact image `iograyBorder.tif`

![Figure 2](image2)

(a) Blurred image $B$  (b) $X_{naive}$

Figure 2: The left image $B$ was created via a larger image followed by extraction of the central part and by adding one percent Gaussian white noise. The right image $X_{naive}$ obtained by using fast algorithm DCT.

From figures 2 and 3 we can observe that using reflexive boundary conditions we obtain better results for $X_{naive}$. 
Figure 3: The left image $B$ was created via a larger image followed by extraction of the central part and by adding one percent Gaussian white noise. The right image $X_{naive}$ obtained by using fast algorithm FFT.

References