# EE5176: Computational Photography

## Programming Assignment 2

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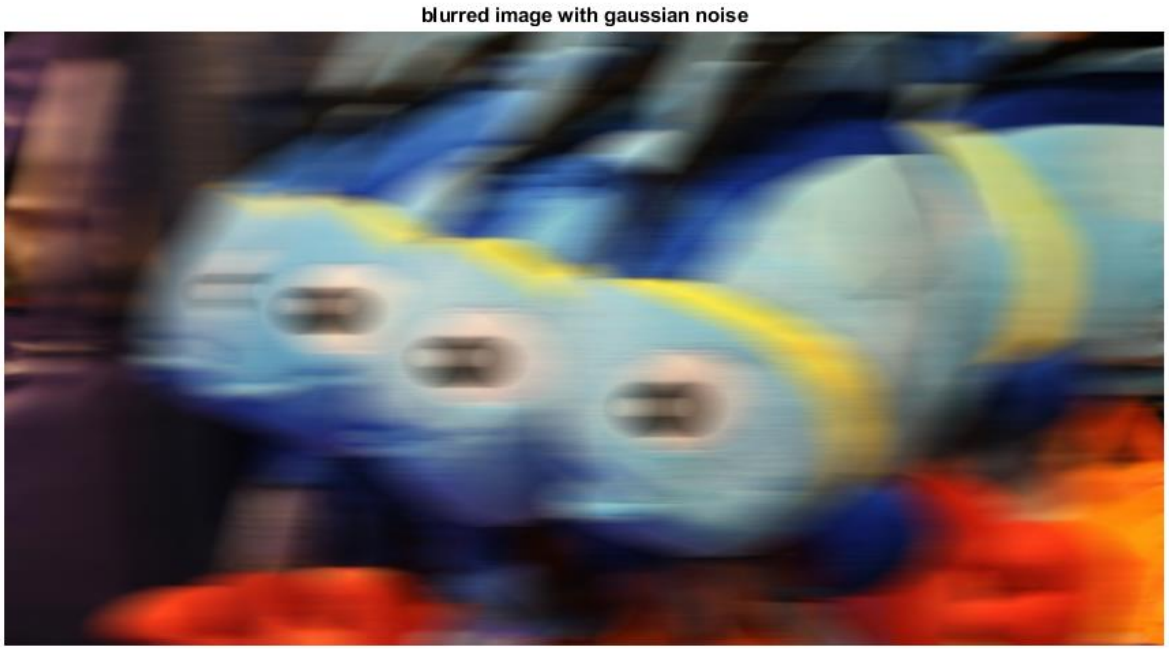
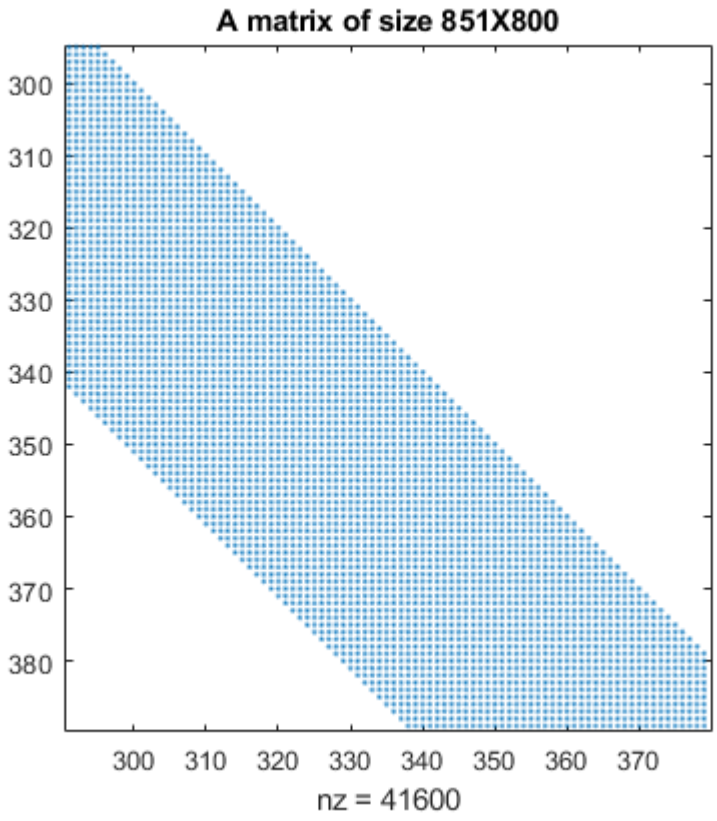
1. **Motion blurring with conventional camera**
   a) Blurring using full exposure for 52 seconds.

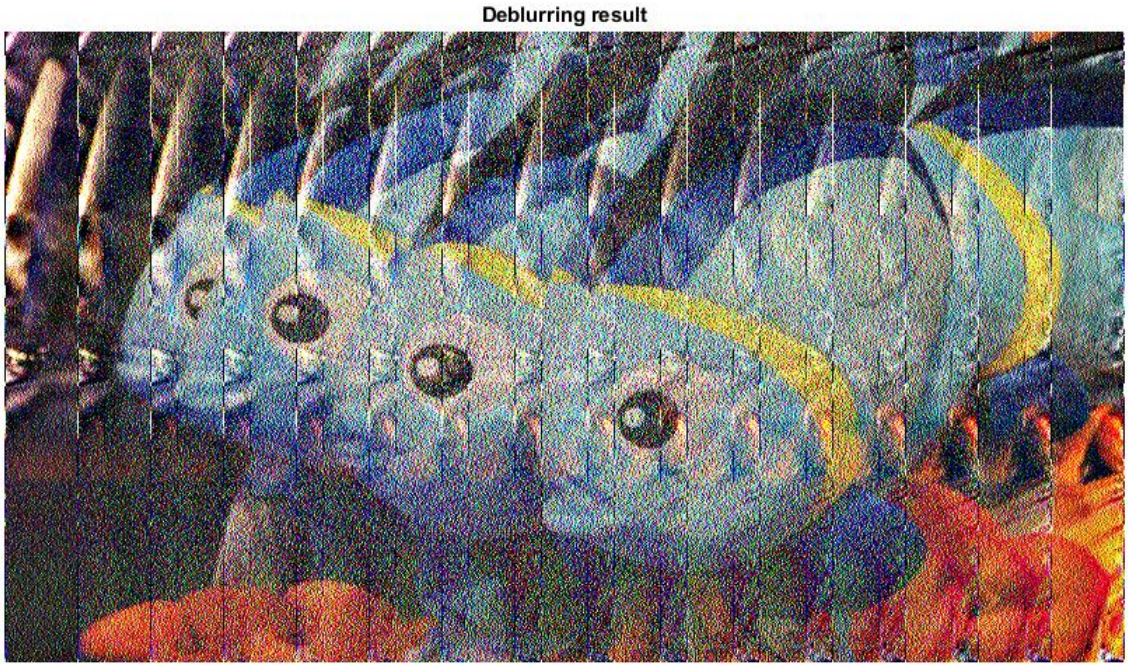



b) Blur matrix A of size 851X800




c) Result of deblurring using the above A matrix

RMSE: 41.25




d) When we deblur using a box window function, the high number of minimas in the Sinc() function in the frequency domain, causes peaks in the frequency domain of the deblurred image and hence, we observe the periodic vertical lines. The A matrix must also have a high condition number, hence its performance against noise is bad.

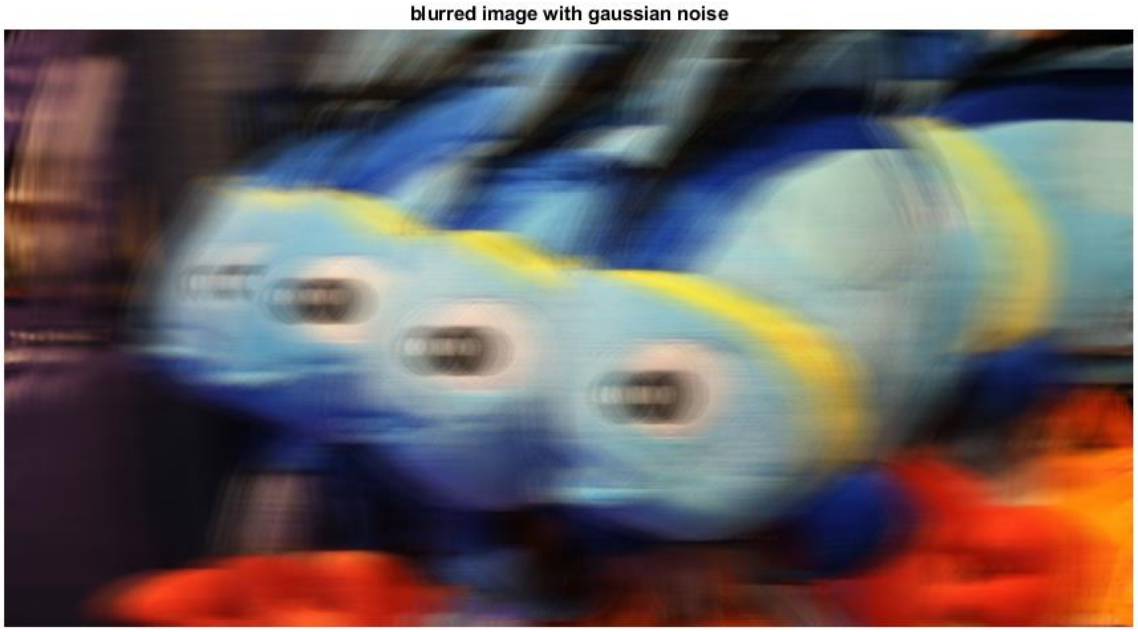
## 2. Motion deblurring with flutter shutter

a) Blurring the dolphin image using the below exposure codes

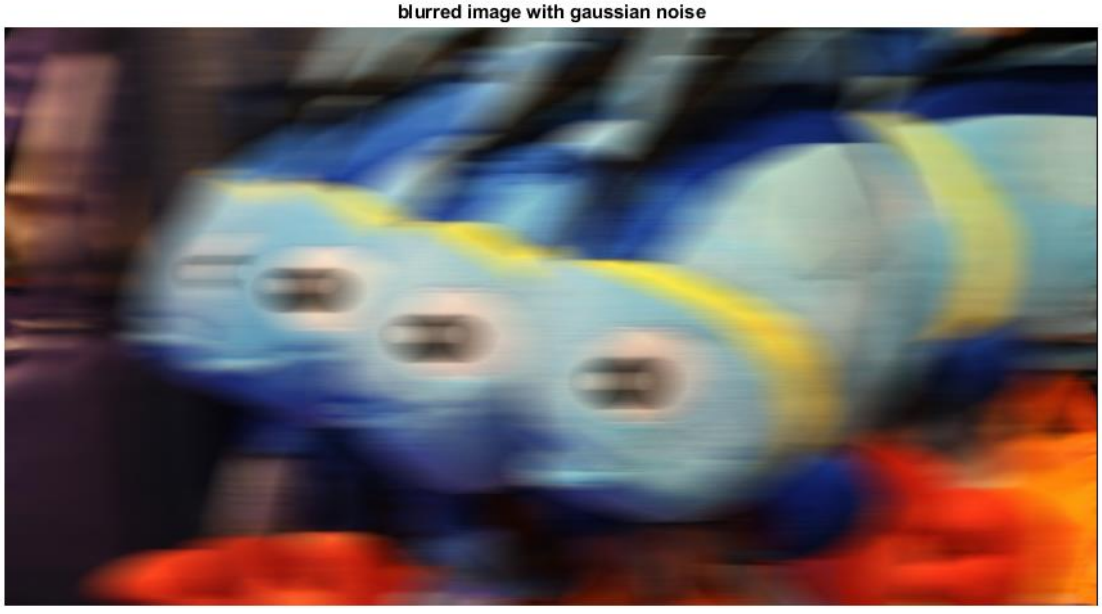
i) 1010000111000001010000110011110111010111001001100111

ii) 1010101010101010101010101010101010101010101010101010

i)

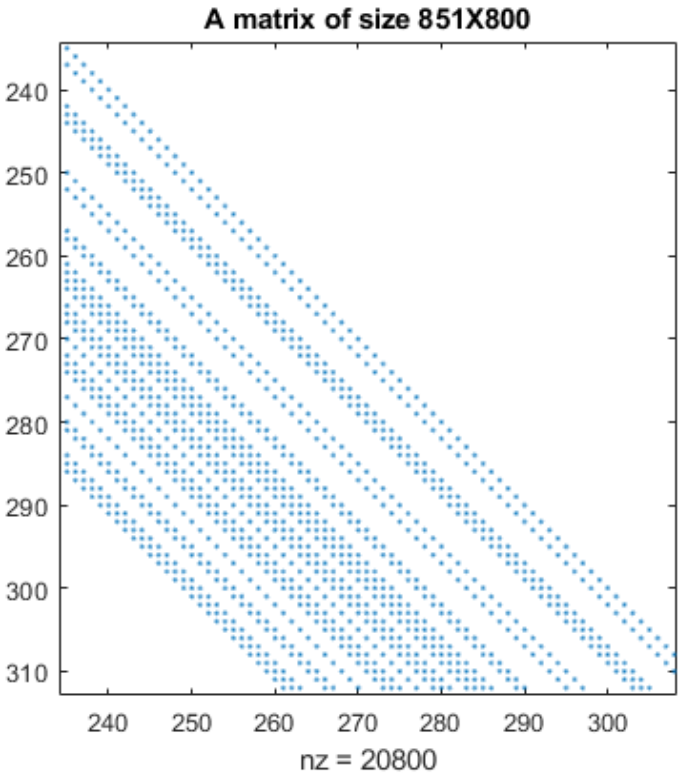



ii)

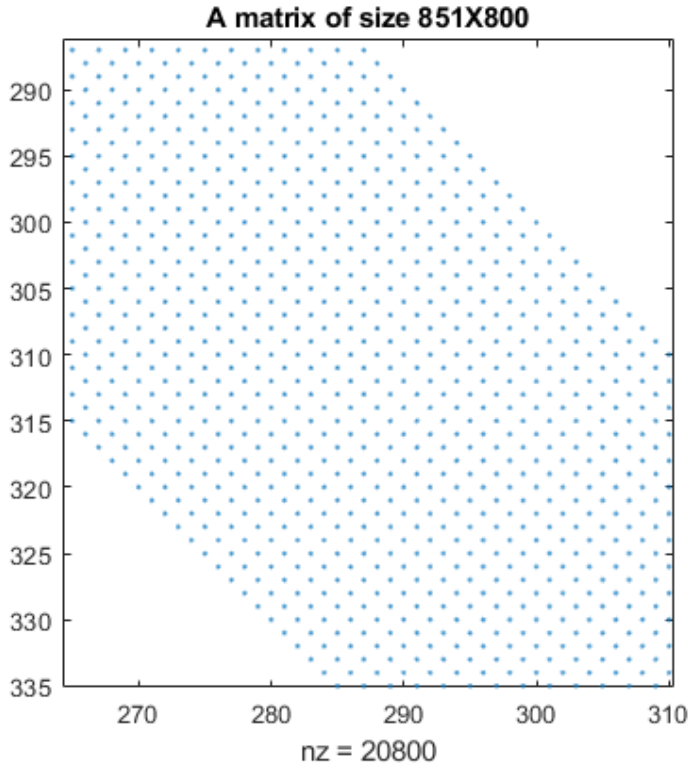


b) Formation of blur matrices A for different exposure codes

i)

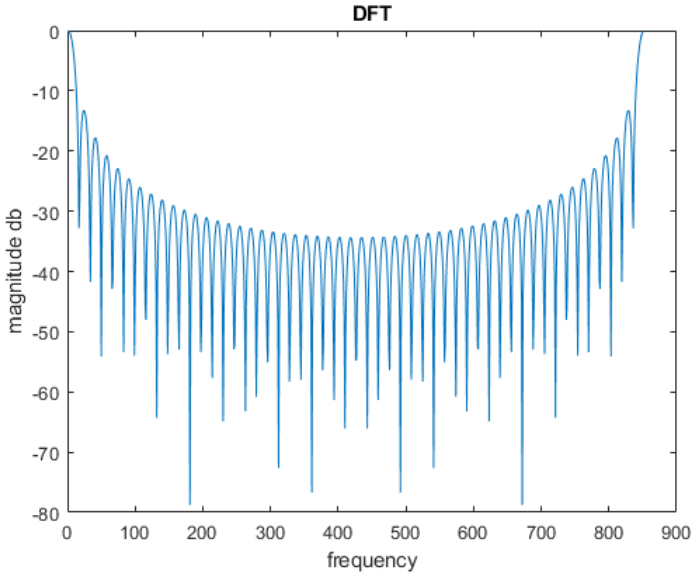



ii)

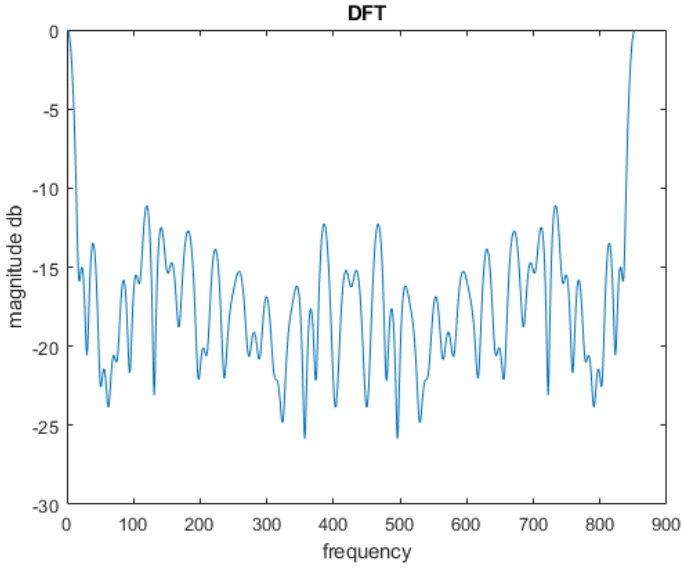



c) Plotting and comparing the DFTs of the conventional and flutter shutter codes.

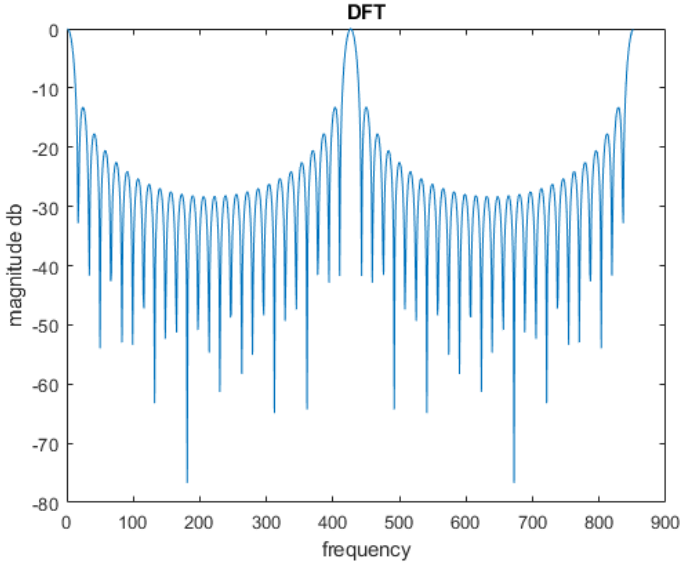
Conventional box window:




i)




ii)



d) Results of deblurring using the A matrices

i)


ii)


e) Calculating RMSE of the both the deblurred images

i) RMSE: 4.0871

ii) RMSE: 24.2398

The first exposure code was a flutter shutter code and the second code was just a high pass filter. Since the high pass filter like the conventional box window had steep minimas in the frequency domain, the resulting deblurred images turned out to have periodic vertical lines and be unstable. Hence, there is a difference in the deblurred images and also in the RMSE results.

f) Conventional box window: RMSE: 19.3936

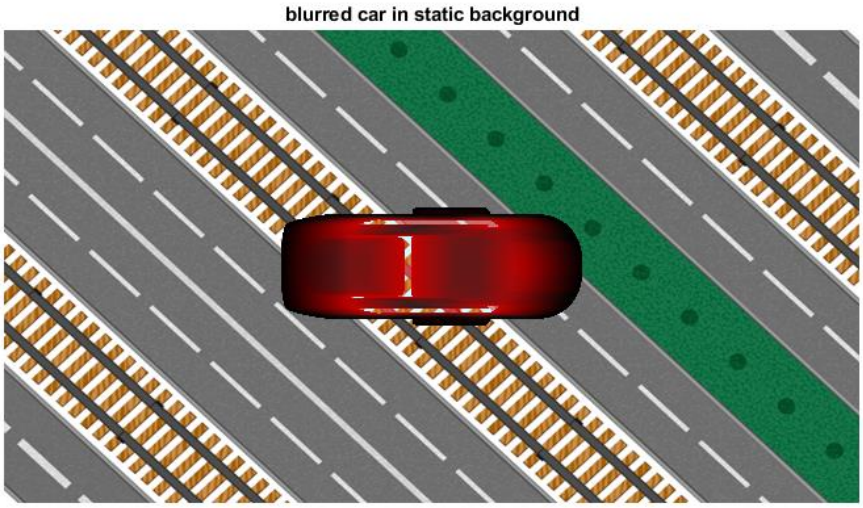

i) RMSE: 1.7082


ii) RMSE: 15.1206

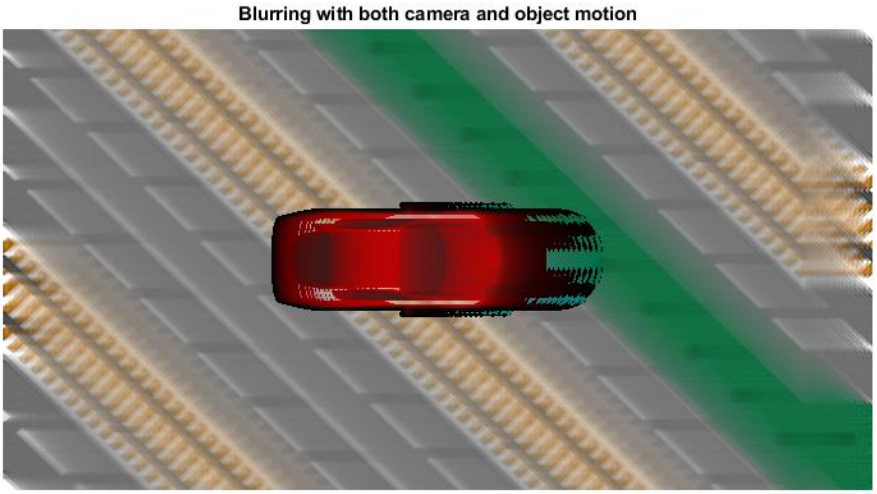
In the absence of noise, the deblurred results are much clearer and they have much lower RMSE values which means they have better performance. When looking at the corresponding deblurring results of the noisy and noiseless blurred images, there is huge difference in the noise levels of the outputs.

## 3. Deblurring with motion invariant photography

a) Blurring only the red car and keeping static background




b) Blurring with parabolic translation




c) In (a), only the car undergoes motion, hence only the car is blurred while the background is static and clear. In (b), the background undergoes a parabolic translation and a relative translation is calculated with respect to the background assuming the car goes right at 1 pixel per second. Hence, both the background and car are blurred.

d) Plotting the parabolic translation PSF