EQ2330 – Image and Video Processing

Assignment 3

The following preparation assignment is to be solved before the next exercise session indicated by the due date of the assignment. You bring your solution to the exercise session and one of your peers will correct it during that session. After that you will discuss the correction with your peers and resolve any open questions. If necessary, the teaching assistant can help you. It is required to solve all the assignments and correct at least one peer solution of each assignment in order to pass the course.

Problem

The problem is on representation of images in the frequency domain and frequency domain filtering.

1. Figure 1 shows four 512×512 images in the top row (A-D) and the magnitude of their DFT's in the bottom row (1-4). Your task is to pair the original images with their corresponding spectra. For each pair, you must motivate how you come to your conclusions. All the spectra have been zoomed by the same amount for better visibility.

2. A simple camera is based on a 512×512 array of sensors. Experiments show that images produced by the camera suffer from severe additive distortion, which can be represented by the function $q(x, y)$. A plot of $q(x, y)$ is given in Figure 2 below.

   a) Describe the main characteristics of the function $q(x, y)$ and also sketch the magnitude of the DFT of $q(x, y)$. Make sure to label the axis properly.

   b) Propose a method to suppress the distortion in an image produced by the sensor. Give values for system parameters, and clearly state all assumptions you need to make.

3. For an $N \times N$ image, the discrete two dimensional Fourier transform is given by

$$F(u, v) = \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x, y) \exp(-j2\pi \frac{ux + vy}{N}).$$

(i) explain where the DC value is located in the transform domain in the above formulation of the transform.

(ii) You have multiplied $f(x, y)$ by $(-1)^{x+y}$. Explain what happens to $|F(u, v)|$.

(iii) Figure 3 shows an input image and an output image obtained by processing the input with the shown block diagram. Describe the operation denoted by "?" (give an equation!). (IDFT denotes inverse DFT.)

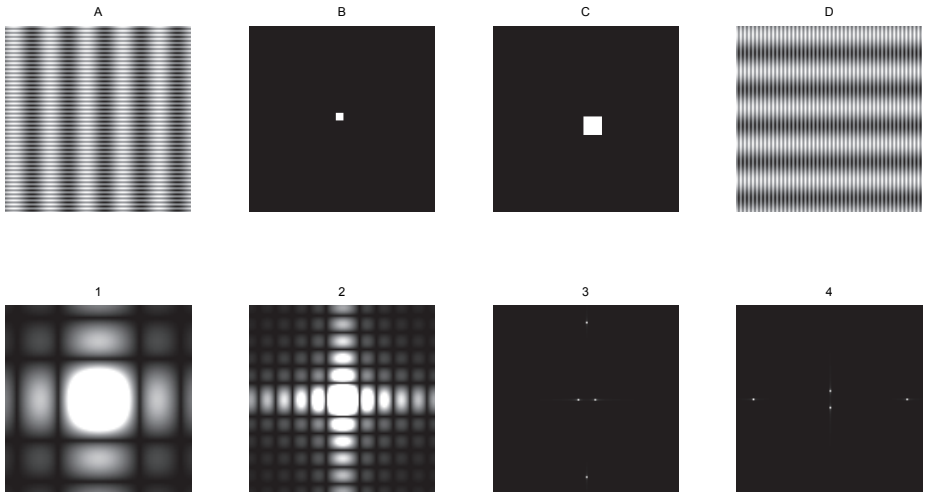

Figure 1: Original images (A-D) and DFT spectra (1-4).

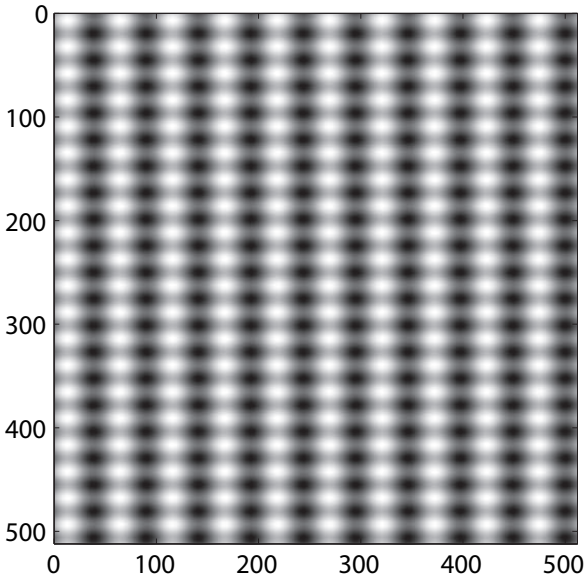

Figure 2: Additive distortion $q(x, y)$.

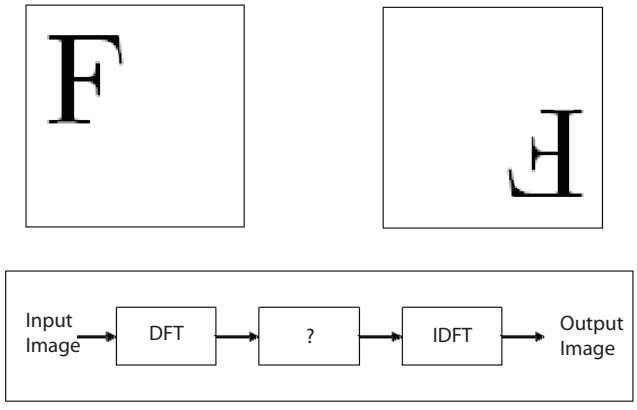

Figure 3: Images and block diagram for problem 3.