

博士班基本學科考試：數位影像處理

2006 年 10 月

1. (20%) Fourier transform transforms a digital image from the image space domain to the frequency domain. Figure 1 shows a principal sketch of how the Fourier transform can be used together with two different filters to generate filtered images. (i) Explain Figure 1. (ii) Explain the three types of filters, i.e., ideal, Butterworth, and Gaussian, that can be used here for the two different filters. If possible, try to write down their mathematical expression.

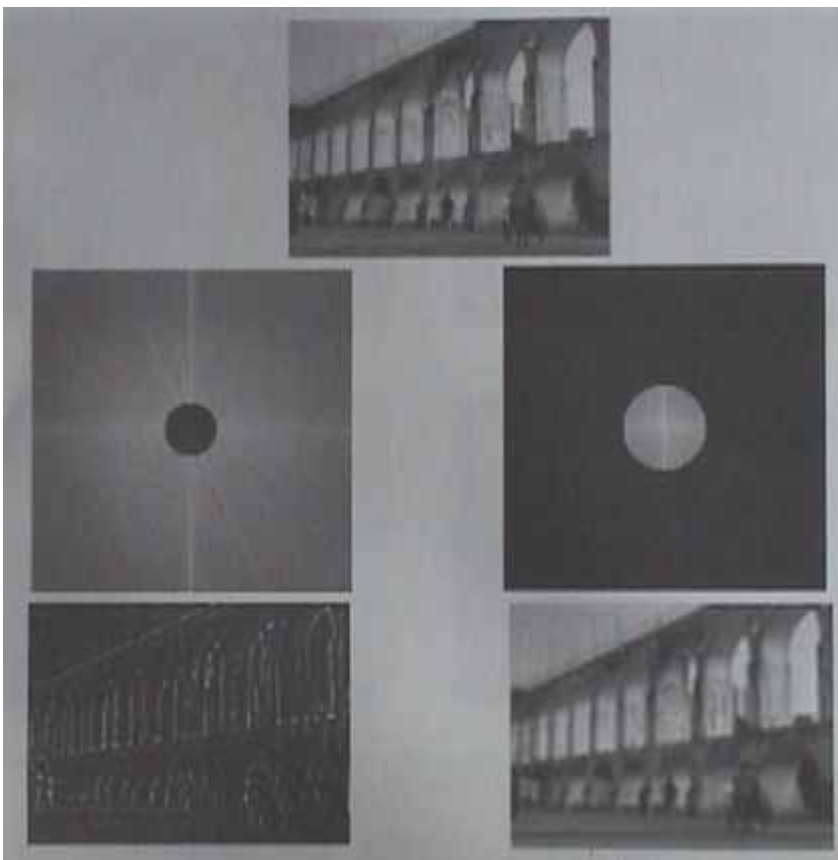


Figure 1

2. (20%) Consider an image $I(x,y)$ of $N \times N$. Let $f(x,y)$ denote the filtered result of $I(x,y)$. What are the adaptive mean filter and the adaptive median filter? Explain how they work. When are they useful? Why? (Note: You have to define every notation you use in your answer.)

3. (20%) You have the job of designing an algorithm that will count the number of objects with holes and the number of objects without holes in images of the kind shown here. Assume that the images are binary with 0 corresponding to black and 1 corresponding to white. The imaging system is of low quality and produces images that are corrupted with salt and pepper noise. The objects do not overlap or touch, but may be close to each other in any direction. They may be of any shape or size. The algorithm should not be confused by the salt and pepper noise, and should not count noise pixels as objects. Write a pseudo-code description of your algorithm. You may also include a block diagram and other information to make it understandable to a programmer. State any assumptions you make, such as: "Objects must contain at least 50 pixels."

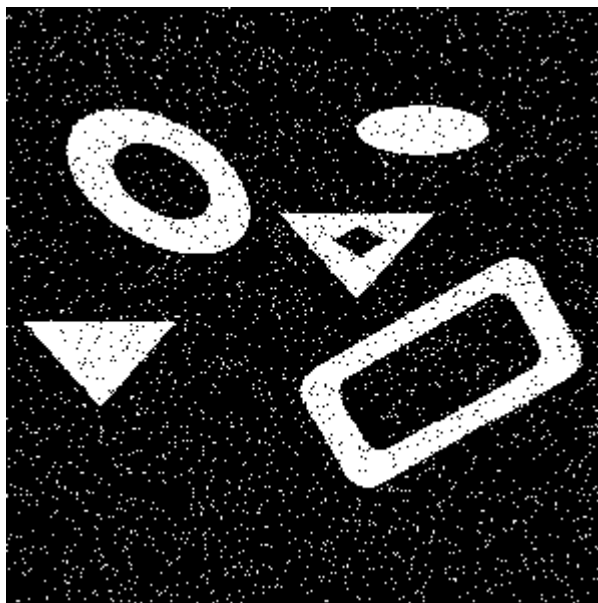


Figure 2

4. (10%) What is the inverse filter? What is the Wiener filter? When does the Wiener filter reduce to the inverse filter?
5. (10%) A telescope in an orbiting observatory is used to produce images on a high-resolution CCD array. It has been found that the images are a little blurry due to optical effects in the telescope. You have been called in as an image processing expert to devise a method to sharpen the digital images. Describe how you would go about solving the problem, given that the only images you can obtain are of astronomical objects. You cannot modify the telescope in any way. The only option is to process the digital images.
6. (20%) What is full-scale histogram stretch? What is histogram equalization? What is their difference when used for image enhancement?