Image Enhancement Sample Exam Problems

1. (i) Knowing that adding uncorrelated images convolves their histograms, how would you expect the contrast of the sum of two uncorrelated images to compare with the contrast of its component images? Justify your answer.

   (ii) Consider an $N \times N$ image $f(x,y)$. From $f(x,y)$ create an image

   $$g(x,y) = -2f(x,y) + f(x,y-1) + f(x,y+1).$$

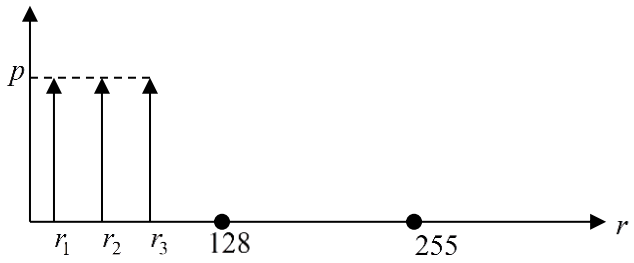
   Comment on the histogram of $g(x,y)$ in relation to the histogram of $f(x,y)$.

2. Propose a method that uses variable size spatial filters to reduce background noise without blurring the image significantly.

3. Why are bandpass filters useful in image processing? Justify your answer. Propose a method to obtain a bandpass filtered version of an image using spatial masks.

4. Propose a method that detects edges in an image along the directions $\pm 45^o$.

5. Consider a grey-level image $f(x,y)$ with histogram sketched below.



   (i) What can we say about $f(x,y)$?
   (ii) Propose an intensity transformation function which will improve the contrast of the image when it is used to modify the intensity of the image.
   (iii) Sketch the histogram of the transformed intensity.
   (iv) Calculate the mean and the variance of the two images.

6. Propose a method for spatially adaptive noise reduction in images, that exploits jointly the following two observations:
   a. Noise is typically less visible to human viewers in image regions of high detail, than in image regions of low detail.
   b. Noise is typically less visible to human viewers in bright areas than in dark areas.

7. An old movie is to be restored. Frames of the movie contain black spots which we wish to remove by median filtering. Figure 1 shows a representative example of a small region of a frame of the movie.

(i) Apply median filtering using a 3x3 window to the image of the figure below. Assume that pixel values are zero outside the image.

12	11	10	12	15
12	11	0	11	14
13	12	12	12	10
12	10	13	12	11

(ii) An alternative method of processing first applies a median filter with a window of 3 columns and 1 row, and then applies to the result of this median filtering with a 1 column by 3 row window. What is the result if this method is applied to the above image?

(ii) If the image contains rectangular objects with sharp corners, which of the two methods given in a) and b) above is best? Explain your answer.

(iii) If the black spots in the pixel frames are 2 x 2 pixels in size, which of the methods is best? Explain your answer.

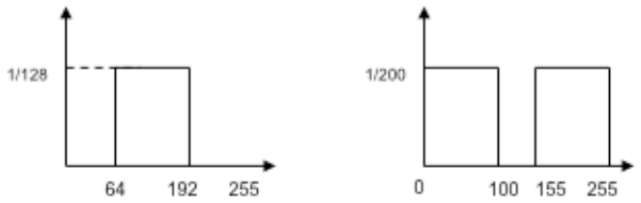
(iv) Even in regions without black spots median filtering will change the exact values of many pixels. Propose a method based on a 3x3 window in which pixels are left unchanged unless there is black spot.

8. We wish make a local threshold of an image $f(x,y)$ in order to find pixels which are significantly brighter than their surroundings. We create an output $g(x,y)$ such that

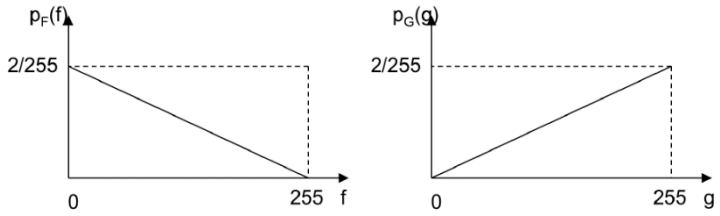
$$g(x,y)=\begin{cases}1, & f(x,y)>\text{mean}\{f(x,y)\}+T\\ 0, & \text{otherwise}\end{cases}$$

where $\text{mean}\{f(x,y)\}$ is the local mean averaged over a 5×5 pixel region, and T is an input parameter. Explain how you would implement the above process using standard linear convolution followed by thresholding. What is the convolution filter kernel that should be used?

9. The histograms of two images $f(x,y)$ and $g(x,y)$ are illustrated in figure below. Find and sketch the transformation function for each image that produces a histogram equalised image.



10. Suppose that an image $f(x,y)$ has a probability density function as the one shown on the left in figure below. We would like to modify it so that it has the probability density function given on the right. Derive the transformation function will accomplish this. For simplicity, assume both the original image and the modified image can take on grey levels in the continuous range of (0,255).



11. State which one of the following filters is nonlinear: High Boost Filter, Weighted Averaging Filter, Sobel Filter, Median Filter. Justify your answer with an example.

12. Explain which one of the following filters is commonly used for sharpening images: Averaging Filter, Differentiation Filter, Weighted Averaging Filter, Median Filter.