

T-61.5100 Digital image processing, Exercise 4/07

Image enhancement in the frequency domain II

1. Under what conditions does the Butterworth lowpass filter

$$H(u, v) = \frac{1}{1 + [D(u, v)/D_0]^{2n}}$$

(where $D(u, v) = \sqrt{u^2 + v^2}$) become an ideal lowpass filter?

2. Investigate what the Butterworth low-pass filters look like in the spatial domain. Let the cutoff frequency be $D_0 = N/6$. Generate the spatial masks of size 3×3 and 5×5 of order $n = 1$ ja $n = 2$.
3. A popular procedure for image enhancement combines high-frequency emphasis and histogram equalization to achieve edge sharpening and contrast enhancement.
 - (a) Prove whether or not it matters which process is applied first.
 - (b) If the order does matter, give a rationale for using one or the other method first.
4. Suppose that you are given a set of images generated by an experiment dealing with the analysis of stellar events. Each image contains a set of bright, widely scattered dots corresponding to stars in a sparsely occupied section of the universe. The problem is that the stars are barely visible, owing to superimposed illumination resulting from atmospheric dispersion. If these images are modeled as the product of a constant illumination component with a set of impulses, give an enhancement procedure based on homomorphic filtering designed to bring out the image components due to the stars themselves.
5. Images generated by an electronic microscope are being inspected. In order to simplify the inspection task, digital image enhancement is used. When a representative set of images is examined, following problems are found:
 - (a) bright, isolated dots that are of no interest
 - (b) lack of sharpness
 - (c) not enough contrast in some images
 - (d) shifts in the average grey-level value, when this value should be K to perform correctly certain intensity measurements.

Image enhancement will be used to correct all these problems. In addition, all grey levels in the band between I_1 and I_2 will be colored in constant red, while keeping normal tonality in the remaining grey levels. Propose a sequence of processing steps to achieve the desired goal.