IMAGE PROCESSING (RRY025)

One of the Exams in 2013/2014

1 IMAGE ENHANCEMENT [13 points]

(a) [2p] How can you sharpen an image?

(b) [2p] How can you high-boost it?

(c) [2p] How can you detect the edges?

(d) [2p] Is there any relation between edge detection and sharpening? Discuss!

(e) [5p] You have an image and compute its fast Fourier transform. Analysing the transformed image, you find that its phase is entirely noisy, and that the noise is uniformly distributed. You also find that even the amplitude of the transformed image is entirely noisy, but now the noise has a Rayleigh probability distribution:

$$p(x) = \frac{x}{\sigma^2}\,\mathrm{e}^{-x^2/2\sigma^2} \qquad \text{if, and only if,} \quad x \geq 0\,. \tag{1}$$

You then analyse the Fourier power spectrum of the original image. What will be the probability distribution of the noise in this case? This problem is simpler than it looks!

2 MISCELLANEA [17 points]

(a) [6p (up to 1p for each question)] You have an image polluted by additive white Gaussian noise, and compute its fast Fourier transform. What type of noise do you have in the real and imaginary parts of the transformed image? And why? If you compute the Fourier power spectrum of the original image, will you have the same type of noise as in the Fourier transformed image, or not? And why? If your answer is no . . . , then what are the main characteristics of such a type of noise? And how does it compare with Poissonian noise?

(b) [8p (up to 1p for each question)] You have a noisy image, which you want to de-noise using the fast wavelet transform. Unfortunately, your toolbox has only three wavelets (but is reliable :-)

- `W1`: orthogonal, with 2 vanishing moments.
- `W2`: bi-orthogonal; the decomposition wavelet has 8 vanishing moments, and looks very different from the reconstruction wavelet.
- `W3`: bi-orthogonal; the decomposition wavelet has 4 vanishing moments, and looks very similar to the reconstruction wavelet.

Which wavelet would you use? And why? Do your answers depend on the type of noise? How would you de-noise the image if it is contaminated by salt-and-pepper noise? And if it is polluted by speckle noise? And why? Suppose now that the original image is not noisy. Which wavelet (`W1`, `W2` or `W3`) would you use for pre-compressing the image? And why?

(c) [3p] In your opinion, what is the most interesting topic of the course? Explain how important this topic is in the context of image processing, and how important it is for your studies/job.