2004 Paper 8 Question 11

Computer Vision

(a) When defining and selecting which features to extract in a pattern classification problem, what is the goal for the statistical clustering behaviour of the data in terms of the variances within and amongst the different classes? [2 marks]

(b) Consider the following pair of filter kernels:

-1	-1	-1	-1	-1	-1
-1	-3	-4	-4	-3	-1
2	4	5	5	4	2
2	4	5	5	4	2
-1	-3	-4	-4	-3	-1
-1	-1	-1	-1	-1	-1

1	1	1	1	1	1
-1	-2	-3	-3	-2	-1
-1	-3	-4	-4	-3	-1
1	3	4	4	3	1
1	2	3	3	2	1
-1	-1	-1	-1	-1	-1

(i) Why do these kernels form a quadrature pair? [2 marks]

(ii) What is the "DC" response of each of the kernels, and what is the significance of this? [1 mark]

(iii) To which orientations and to what kinds of image structure are these filters most sensitive? [1 mark]

(iv) Mechanically how would these kernels be applied directly to an image for filtering or feature extraction? [1 mark]

(v) How could their respective Fourier Transforms alternatively be applied to an image, to achieve the same effect as in (iv)? [1 mark]

(vi) How could these kernels be combined to locate facial features? [2 marks]

(c) Explain why inferring object surface properties from image properties is, in general, an ill-posed problem. In the case of inferring the colours of objects from images of the objects, how does knowledge of the properties of the illuminant affect the status of the problem and its solubility? [5 marks]

(d) Explain and illustrate the "Paradox of Cognitive Penetrance" as it relates to computer vision algorithms that we know how to construct, compared with the algorithms underlying human visual competence. Discuss how human visual illusions may relate to this paradox. Comment on the significance of this paradox for computer vision research. [5 marks]