2007 Paper 9 Question 6

Computer Vision

(*a*) Briefly define each of the following concepts as it relates to vision:

(*i*) active contour; [2 marks]

(*ii*) Hadamard's criteria for well-posed problems; [2 marks]

(*iii*) functional streaming; [2 marks]

(*iv*) reflectance map; [2 marks]

(*v*) Bayesian prior. [2 marks]

(*b*) What is accomplished by the lateral signal flows within both plexiform layers of the mammalian retina, in terms of spatial and temporal image processing and coding? [3 marks]

(*c*) Give finite difference operators that could be applied to 1-dimensional discrete data (such as a row of pixels) in order to approximate the 1st and 2nd derivatives, $\frac{d}{dx}$ and $\frac{d^2}{dx^2}$. How would your finite difference operators actually be applied to the row of pixels? What is the benefit of using a 2nd finite difference (or derivative) instead of a 1st finite difference (or derivative) for edge detection? [3 marks]

(*d*) Explain the formal mathematical similarity between the "eigenface" representation for face recognition, and an ordinary Fourier transform, in the following respects:

(*i*) Why are they both called linear transforms, and what is the "inner product" operation in each case? [1 mark]

(*ii*) What is a projection coefficient and an expansion coefficient in each case? [1 mark]

(*iii*) What is the orthogonal basis in each case, and what is meant by orthogonality? [1 mark]

(*iv*) Finally, contrast the two in terms of the use of a data-dependent or a data-independent (universal) expansion basis. [1 mark]