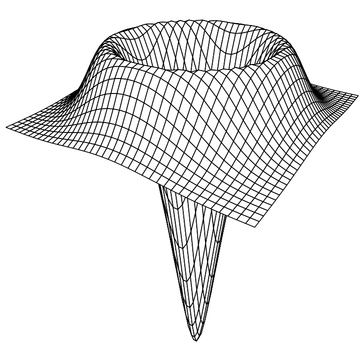
3 Computer Vision (JGD)

(*a*) In early stages of machine vision systems, the isotropic operator shown on the right is often applied to an image $I(x, y)$ in the following way: $[\nabla^2 G_\sigma(x, y)] * I(x, y)$



What is the purpose of this operation? Which class of neurones in the retina does it mimic?

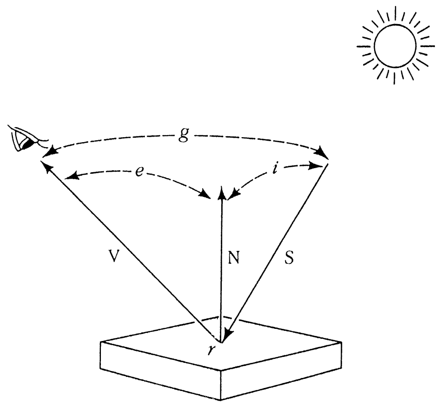
How would the results differ if instead this operation: $G_\sigma(x, y) * \nabla^2 I(x, y)$ were performed; and alternatively if this operation: $\nabla^2 [G_\sigma(x, y) * I(x, y)]$ were performed?

[4 marks]

(*b*) Explain the method of *Active Contours.* What are they used for, and how do they work? What underlying trade-off governs the solutions they generate? How is that trade-off controlled? What mathematical methods are deployed in the computational implementation of deformable models?

[4 marks]

(*c*) In relation to the image formation diagram shown on the right, explain: (*i*) the concept of a *reflectance map*; (*ii*) what is a *specular* surface; (*iii*) what is a *Lambertian* surface; and (*iv*) what is surface *albedo*. In explaining these concepts, give the defining relationships for the amount of light from a point source that is scattered in different directions by such illuminated surfaces, and describe the inferences that a vision system must make with them.



[4 marks]

(*d*) It can be said that the central problem of pattern recognition is the relative extent of within-class variability and between-class variability. Explain this issue in the context of facial recognition, treating separately the three problems of (*i*) *face detection* (distinguishing faces from non-faces); (*ii*) *face identification;* and (*iii*) *face interpretation* (classifying the expression and pose of the face). How does variability along some of these dimensions influence each of the three problems? Is within-class variability ever helpful, and between-class variability harmful, to the performance of the task?

[8 marks]