Computer Vision 1 Exercises

These exercises are grouped into three parts. Part I contains routine exercises to help you understand the ideas directly presented in lectures. The exercises in Part II are designed to grow and deepen your understanding of principles that underpin computer vision. These exercises extend the lecture material and invite you to think about 'why' questions and about optimisations to what was lectured as well as alternatives to what was lectured. Part III are open-ended, stretching questions that you could tackle in your mini research project.

I hope you enjoy working through these questions, puzzles and research questions!

John Fawcett, July 2023

Part I

1. Give three everyday examples of humans using specular reflection to determine the composition or structure of a scene.
2. Give three everyday examples of humans using diffuse reflection to determine the composition or structure of a scene.
3. Do you think humans are good at determining the positions of unseen light sources using lighting and reflections? What about the colours of lights and objects?
4. Give three everyday examples of humans using texture to infer the composition or structure of a scene.
5. Why is noise a problem for edge detection?
6. Why do we need scale-space pyramids to be causal? That is, as we add detail, why is it important that edges seen at coarser levels of analysis are still present at finer levels?
7. Give three everyday examples of metaphysical knowledge that you use to understand the world around you.
8. What does it mean to say that human vision is *goal-driven*?
9. Explain why a 3D wireframe cube appears to be one of two equally valid interpretations, and our interpretation is stable until it suddenly 'flips' to the opposite interpretation.
10. Why is the second derivative preferred to the first derivative for edge detection?
11. Is there any point buying a high resolution camera for computer vision applications if the algorithm always begins by applying a blurring operator?
12. Which step in a Canny edge detector allows it to find detailed edges without also detecting a lot of noise?
13. Explain how Active Contours support the use case of *recognising* objects.
14. For a CCD of fixed resolution, describe the discrete steps in depth that can be distinguished using depth inference based on two calibrated cameras (slide 30).

Part II

1. Describe the image that would result from edge-detecting a frame of video from your computer's webcam.
2. In what sense is computer vision like "reverse computer graphics"?
3. Is it possible to reverse computer graphics? That is, can we determine a scene description from a ray-traced image?

Part III

1. Implement the line-thinning step from the Canny edge detector. (See the computer graphics textbook by Gonzales and Woods if you get stuck!)
2. Write a program to estimate the speed of motion of objects travelling past your computer's webcam.