CS-543: Computer Vision Instructor: D.A. Forsyth

Homework 1

Instructions

This homework is a check, and should be done individually. It is due in two weeks from handout, i.e. 17 Feb 2009. Submit by emailing a PDF to Alex.

Question 1:

We write a perspective camera in homogeneous coordinates as $\mathcal{CME}$, where $\mathcal{C}$ represents camera intrinsics, $\mathcal{M}$ is the matrix

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

and $\mathcal{E}$ is a rotation and translation.

- A family of lines is given by $\mathbf{x} + t\mathbf{v}$, where the fourth homogeneous coordinate of $\mathbf{v}$ is zero; $\mathbf{x}$ chooses the line and t varies along the line. Write an expression for the vanishing point of this family, in *camera* coordinates?
- A plane is given by $\mathbf{x} + s\mathbf{v} + t\mathbf{w}$ where the fourth homogeneous coordinate of $\mathbf{v}$ and $\mathbf{w}$ is zero; $\mathbf{x}$ is a point on the plane and s, t vary on the plane. Write an expression for the horizon of this plane, in *camera* coordinates?
- A sphere is viewed in this perspective camera. Show that its contour generator is always a circle.
- A sphere is viewed in this perspective camera. Show that its outline is a conic section.
- A sphere is viewed in a perspective camera. In a practical camera, could its outline be an ellipse? a parabola? a hyperbola? why?

Question 2:

For each of the arrows in figure **??**, name the reasons the pixel near the end of the arrow has its brightness value and explain very briefly. The arrow pointing to milk is pointing to the thin bright line at the edge of the piece of apple; the arrow pointing to the spoon handle is pointing to the bright area on the handle.

Question 3:

We would like to make a photometric stereo reconstruction using three lights. Describe how to use an object of known shape to calibrate the source vectors.

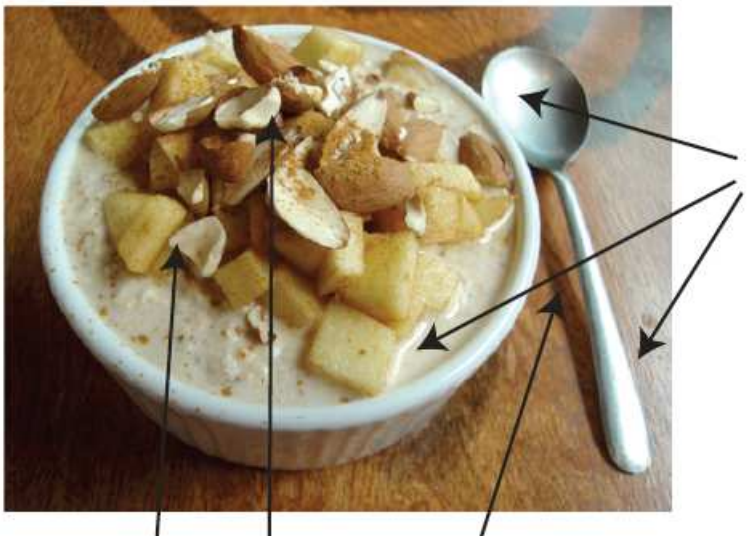

Figure 1: A bowl of cereal