CS 280 FINAL EXAM, 1230-330pm, May 10, 1996

Make sure you have both pages of this exam. Each question is worth 20 points. Good luck.

1. Prove that under perspective projection, the image of a plane has a vanishing line, the *horizon*, that depends only on the surface normal $\mathbf{n}$ but not on the distance of the plane from the origin.

2. Prove that for any two mutually visible points x and y in space, the radiance leaving point x in the direction of point y is the same as the radiance impinging on point y from the direction of point x.

3. Junctions can be localized by finding the point that minimizes the sum of perpendicular distances to all lines in a given image neighborhood. Formulate this as a least squares problem and derive its solution in terms of inverting a windowed image second moment matrix.

4. Show how the Bayesian formulation of teh problem of

5. Suppose that a color–sensing system has three types of sensors and that the spectral sensitivity of each type is a sum of scaled versions of the human cone sensitivities. Show that two metameric colors (i.e. colors which appear identical to human observers) will produce identical signals in the sensors.

6. Consider the line drawing of a smooth curved surface which occludes itself along a limb curve. Prove that, under orthographic projection, the surface normal is perpendicular to the projection of the limb curve in the image plane. Give an example to show that the limb curve need not be perpendicular to the line of sight.

7. Consider a binocular viewing geometry where both the eyes are fixating at a point straight ahead (gaze angle = 0). Show that the disparity is $I\Delta z/z^2$ where I is the interocular distance and z is the fixation distance.

8. This exercise is aimed at testing your understanding of epipolar geometry. If the displacement between the two camera positions is given by $(\mathbf{R}, \mathbf{t})$, show that the corresponding points $\mathbf{x}$, $\mathbf{x}'$ in the two image

planes satisfy a relation of the form $\mathbf{x}^{\mathbf{T}}\mathbf{M}\mathbf{x}' = 0$. Here $\mathbf{x}$, $\mathbf{x}'$ are in homogeneous coordinates.

9. Derive a differential technique for estimating the 1–D affine transform between two 1–D signals f and g. It is known that f is a scaled copy of g i.e. $f(x) = g(ax)$ with $a \approx 1$. You are given the values $f(x_i)$, $g(x_i)$ at a series of grid points x_i.

10. For the following object recognition techniques:

    (a) The alignment method due to Huttenlocher and Ullman.

    (b) The appearance-based approach based on principal component analysis.

    indicate a class of objects for which

    - technique a. works but b. does not.
    - technique b. works but a. does not.
    - neither is likely to work.

11. In this exercise we will study the optimum Bayes classifier for a simple two class problem. The two classes have the same prior probabilities. We are asked to classify on the basis of the measurement of the scalar feature x. It is known that the probability density distribution for the value of the feature x

    - Given that the object is from class 1, follows a Gaussian distribution with mean μ_1 and variance σ_1^2.
    - Given that the object is from class 2, follows a Gaussian distribution with mean μ_2 and variance σ_2^2.

    What is the optimum Bayes decision rule for this problem? The Bayes risk?