University of California at Berkeley

Department of Computer Science and Electrical Engineering

CS-294-6 Computational Imaging

Mini Quiz 1 **2002 Jan. 28th**

Name: **email:**

Please write your answers on this sheet

Problem 1: An ill-posed problem may be a problem that (check all that apply):

(i) has no solution;

(ii) has an infinite number of solutions;

(iii) has solutions that depend sensitively on the data.

Problem 2: The arival of photons at a sensor is governed by a Poisson process with average rate $1,000,000$ photons/second. Suppose the sensor is read out and reset every $1/100$-th of a second. What is the average number of photons sensed, and what is the variance in that number?

If we consider the average to be the "signal" and the standard deviation the "noise," then what is the signal-to-noise ratio?

Problem 3: Suppose $y = \sin x$ for $-\pi/2 \le x \le \pi/2$, and that our task is to recover x from y. For what values of y is this problem ill-posed?

Problem 4: How many degrees of freedom are there to

(i) the family of lines in the plane?

(ii) the family of lines in space?

(iii) the family of unit vectors in space?

(iv) the points on a unit sphere?

(v) the translation of a rigid object in space?

(vi) the rotation of a rigid object in space?

Problem 5: Suppose a linear system modifies an image by convolving it by $g(x, y)$, and that we try to undo this effect by convolving the result with $h(x, y)$. How is $h(x, y)$ related to $g(x, y)$ if the final output is to be identical to the original image?

Let $G(u, v)$ be the Fourier Transform of $g(x, y)$. Suppose that $G(u_0, v_0) = 0$ for some frequency (u_0, v_0). Explain why it is not possible to completely undo the effect of convolving the image by $g(x, y)$.

Problem 6: If we have N unknowns and M independent constraint equations then the problem is

(i) underdetermined when ...

(ii) overdetermined when ...

Problem 7: How much light is lost when light passes through a thin layer of absorbing material. Assume the incident radiance is I_{IN} watts/m^2, the absorption density is μ and the thickness of the layer is δx. What is I_{OUT}?

Problem 8: Why can lenses or mirrors not be used to form images using X-rays and gamma-rays?

Problem 9: What advance in X-ray technology created the current interest in "cone beam reconstruction"?

Problem 10: Give one advantage of using light to probe the insides of a translucent object compared to say X-rays.