Mid-Term Examination: ESE 558 Digital Image Processing

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This test is open-text books. No other reference materials are allowed. Note: RK and GW respectively denote the text books by Rosenfeld & Kak and Gonzalez & Woods. In answering the following questions write down all the important steps to get full credit.

1. *(5+5+5 points) RK, Ch. 2, Mathematical Preliminaries*
   (a) RK, Excercise 3, page 17. Start from the definition of Fourier transform.
   (b) RK, page 24: Prove Equation (42).
   (c) Image Sensing Model: In a CCD camera, $f(x, y)$ is a continuous function that specifies the light energy incident at a point (x, y) per unit area per unit time on the 2D planar CCD array. The output signal of each CCD element is equal to the integral of the light energy incident on the photosensitive surface of the element in one unit time. Assume the CCD elements to be noise-free. The geometry of the CCD array is shown in Fig. 1. The discretely sampled output (before quantization) of the CCD array is denoted by $g(m, n)$. Derive an explicit mathematical expression for $g(m, n)$ in terms of $f(x, y)$.

2. *10 points, Random Fields*
   RK, Excercise 7, page 45.

3. *(5+5 points) GW, Ch. 2, Imaging Geometry*
   (a) GW, Excercise 2.17, page 79.
   (b) For the stereo camera shown in Fig. 2.21, page 69 in GW, you are given that the baseline B is 50.0 mm, focal length λ is 35.0 mm, image coordinates on the left camera (x_1, y_1) is (0.1,0.2) mm, and the disparity $x_2 - x_1$ is 0.15 mm. Find the world coordinates (X_1, Y_1, Z_1) and (X_2, Y_2, Z_2) of the corresponding world point.

4. *(5 points) Histogram Specification*
   (a) GW, Excercise 4.4 on page 249.
   (b) The brightness of a point in the input image for part (a) is 0.5. What is the brightness of the same point in the output image?

5. *(2+3points) GW, Ch 4, Color Models*
   (a) A color digital image represented in RGB model has 8 bits/pixel in each color band. The color of a pixel is (50,100,200). Find the values of the pixel in the YIQ and HSI models.
   (b) For each of the 4 color models– RGB, CMY, YIQ, & HSI– specify an application area where it is suited and a reason why it is more suitable than other models.