Breadth Exam Graphics/Image Processing Spring 2007

Each question below is worth the same amount of points, so be detailed on the questions that are not partitioned.

Question 1

a) 2p Explain, either in a mathematically precise way, or in an intuitive way, what the Fourier transform does on a 1-dimensional signal.
b) 2p Explain how this generalizes to a 2-dimensional signal (i.e. an image).
c) 2p How fast can the Fourier transform be computed for a 1-D signal and a 2-D signal sampled at n and (n x $n)$ points, respectively?

Question 2

a) 2p How does a transform-based image compression method, such as for example JPEG utilize a transform like the Fourier transform? (JPEG actually uses DCT, but the principle would be the same with Fourier transform).
b) 2p What is a convolution, and how is it computed (if done in a straightforward manner)?
c) 2p Explain how a convolution can be computed using the Fourier transform. How fast can this be done, and when is it an improvement over the straightforward computation?

Question 3

a) 2p What are the assumptions that lead to a pinhole camera model?
b) 4p How is the pinhole camera model manifested mathematically?
(Describe the computational process of projecting 3D coordinates into a 2D image.
If you can, use homogeneous coordinates and projection matrices. If not, it is ok to explicitly work with translation, translation and calibration of the camera)

Question 4

a) 2p What is aliasing (in the context of computer graphics)?
b) 2p Describe in detail a technique, of your own choosing, for avoiding aliasing.
c) 2p Assume you were given an image where 5% of the pixels where replaced by bright white due to shot-noise in the camera. Suggest a technique for noise removal and describe it in detail.

Question 5

6p Describe the process of rasterizing a triangle with a constant solid color, given the image coordinates of its three vertices. Use pseudo-code and figures as appropriate, and be detailed.

Question 6

6p Describe the process of depth triangulation, including the matching process, given two stereo images with known poses and calibration of the two cameras that captured the images.