CS 534 Midterm Exam Preparation

1. **Introduction**
   Will *not* cover the two intro papers assigned. Will *not* cover the Introduction powerpoint slides.

2. **Digital Camera and Photography Concepts**
   Responsible for Chapters 2 and 3 in "Photography" by London et al. Will cover the powerpoint slides on digital cameras. *Important topics*: aperture, shutter speed, focal length, f-number, reciprocity, EV, ISO, depth of field, exposure, shutter priority, aperture priority, pinhole camera optics, field of view, perspective vs. viewpoint, thin lens formula, defocus blur, circle of confusion.

3. **Matlab**
   Nothing on Matlab.

4. **Image Filters**
   Responsible for the main ideas in Szeliski Chapter 3.1, 3.2, and 10.3.1 except nothing on padding, steerable filters, summed area table, integral image, or recursive filtering. Includes material in the powerpoint slides except nothing on illusions, Matlab, filter banks, or hybrid images. *Important topics*: image correlation (cross-correlation) filtering definition, box filter, sharpening filter, unsharp masking, convolution, properties of linear filters, Gaussian filter, shift invariance, isotropic, cascading Gaussian filters, separability, median filter.

5. **Texture Synthesis**
   Responsible for the main ideas in the paper "Image quilting for texture synthesis and transfer." Includes the powerpoint slides except nothing on "accelerating texture synthesis," multi-scale texture synthesis, image analogies, or rendering images using objects as primitives. *Important topics*: Markov Random Field (MRF) model of texture, stationarity, Efros and Leung algorithm, sum of squared difference (SSD) measure of matching two windows, dependency on order of filling, Gaussian pyramids: definition and how to construct, Image Quilting algorithm, finding minimal error boundary using dynamic programming, texture transfer.

6. **Video Texture**
   Nothing on this topic.

7. **Image Resizing and Image Completion**
   Responsible for the main ideas in the assigned papers "Seam carving for content-aware image resizing" and "Scene completion using millions of photographs." Covers the powerpoint slides except nothing on "image completion with structure propagation" or Gabor filter. *Important topics*: seam carving algorithm, dynamic programming, Criminisi image completion algorithm, Hays and Efros image completion algorithm, GIST image descriptor.

8. **Panoramas**
   Responsible for the main ideas in the two assigned papers "Video mosaics for virtual environments" and "Recognizing panoramas." Covers material in the powerpoint slides except nothing on direct method for alignment, 2D rigid warp mosaics, global image registration, cylindrical panoramas, cylindrical projection, illusions, simultaneous contrast, mixing gradients in Poisson blending, feature-space outlier rejection, probabilistic model for verifying an image match, bundle adjustment,

discovering panoramas in videos, panoramic video textures, gigapixel panoramas, or unwrap mosaics. *Important topics*: When can two images be aligned and why, homogeneous coordinates, converting between homogeneous and Cartesian coordinates, using homogeneous coordinates to do 2D transformations, homography, projective transformation, affine transformation, similarity transformation, camera perspective projection matrix, projective camera model, affine camera model, perspective warp, panorama mosaicing algorithm steps, feature-based alignment, solving for homography matrix, warping methods, bilinear pixel interpolation, blending methods by averaging, weighted averaging, and Laplacian pyramids, edge detection, image gradient, scale-space problem, Laplacian edge detector, Laplacian-of-Gaussian, Difference-of-Gaussian, Laplacian pyramid, gradient domain (Poisson) blending algorithm, RANSAC algorithm.

9. **Multi-Perspective Images**
   Nothing on this topic.

10. **Feature Point Detection and Matching**
    Responsible for the "Local features tutorial" handout. Includes topics in the powerpoint slides except nothing on affine invariant detection, M-estimators, or least median of squares. *Important topics*: Harris corner point detector, SIFT interest point detector, SIFT feature point descriptor.

Sample Questions

1. Why does a pinhole camera have all points in focus but a real camera with a lens does not? Give your answer in terms of the thin lens formula and the "circle of confusion."

2. Define a 3 x 3 box filter. Is it separable? If so, what does it separate into? If not, why not?

3. Suppose we have two triangles: ABC is an equilateral triangle and DEF is a right triangle. What is the most specific type of transformation that will map A to D, B to E, and C to F? Translation, rotation, similarity, affine, or projective?

4. What property of the coefficients of a discrete approximation of a Gaussian filter ensures that regions of uniform intensity are unchanged by smoothing using this Gaussian?

5. How is SSD matching used in the Efros and Leung texture synthesis algorithm to synthesize a pixel in say the center of the output image? What is a main disadvantage if the neighborhood size used is (a) too small or (b) too large? How could the ideas behind the SIFT keypoint detector be used to select a good neighborhood size?