CS 6475 Final Exam

Due Dec 9 at 5pm **Points** 100 **Questions** 34
Available Dec 2 at 5pm - Dec 9 at 5pm 7 days **Time Limit** 150 Minutes
Allowed Attempts 2

Instructions

Computational Photography

Final Exam

Please read the following instructions carefully.

- You will have 2.5 hours to answer the questions.
- Except the first and the last question (which are worth 0.5 each), T/F questions are worth 1 point, and all other question are worth between 2 and 4 points
- Questions can be of multiple-choice, true/false, matching or fill-in-the-blank type. All your answers will be graded automatically. You will get some feedback at the end of the exam.

Important Note: If for some reason you get kicked out of your exam, try logging back into Canvas -->Quizzes and try to resume the exam. If you run into any other technical difficulties during the exam, send the Instructors a message on Piazza and we'll try to resolve your issue.

Best of luck!

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	51 minutes	75.43 out of 100
LATEST	Attempt 2	51 minutes	75.43 out of 100
	Attempt 1	144 minutes	69.78 out of 100

ⓘ Correct answers are hidden.

Score for this attempt: **75.43** out of 100
Submitted Dec 9 at 2:52pm
This attempt took 51 minutes.

Question 1

0.5 / 0.5 pts

I certify that:

- [x] I am the student who is enrolled in this class
- [x] I am aware of the Georgia Tech Honor Code (link (http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code)) and I affirm it here, as I take this exam.
- [x] I am talking this exam solely and entirely on my own, without any help from any other individual.
- [x] I will NOT print or save any part of this exam, for any purpose whatsoever.

Thanks.

Question 2

2 / 2 pts

[CP02a-1] Consider a Binary Image. The resolution of this image is height = 3456 and width = 5184. Assuming that 1 Kilobyte = 1024 bytes, what is the exact memory requirement of this image?

- ( ) 4374 Kilobytes
- ( ) 2.056 Megabytes
- ( ) More than 34,000,000 bits
- (•) 2187 Kilobytes

YES!

W x H x BitsPerPixelPerChannel x Number of Channels / 8192

8192 is the number of bits in a kilobyte.
1 BitsPerPixel for Binary Image
1 Number of Channels for Binary Image

Partial

Question 3

2.4 / 4 pts

[CP02b-2] Which of the following is an accurate description of an Image Histogram?

- [x] It plots the number of intensities for each pixel value.

  This is a nonsensical statement...

- [x] Can be separate for each channel.
- [x] Histograms show the intensity distribution of an image.
- [ ] Evaluating exposure saturation from histograms is less useful when using a raw image format (which captures the actual sensor responses) as the dynamic range of the displayed image may only be an approximation to that in the raw file.
- [ ] Should not ever be applied to subregions of images separately.
- [x] Photographers can use them as an aid to decide whether image detail has been lost to over or under exposure.
- [x] It plots the number of pixels at each intensity value.

Incorrect

Question 4

0 / 3 pts

[CP02c-2] Below is the function describing the "Overlay" blend mode:

$$f_{blend}(a,b) = \begin{cases} 2ab, & \text{if } a < 0.5 \\ 1 - 2(1-a)(1-b), & \text{otherwise} \end{cases}$$

Mark all of the true statements about the "Overlay" blend mode from the list below.

- [x] It combines the "Multiply" and the "Screen" blend modes depending on the pixel value of the bottom layer.
- [ ] It is the reason we see the green effect in the lecture videos.
- [ ] The parts of the top layer where the base layer is light become darker, and the parts where the base layer is dark become lighter.
- [x] It models the Dodge blend mode, well-known by dark room photographers.

Review Lecture "Digital Images" or Lecture 02-3

Question 5

3 / 3 pts

[CP02d1-1] Given the two attached images from the lectures, please explain the differences between them in terms of how they were generated from 3 different images.

Hint: Review the lectures where these images were used!

Image DS-1:

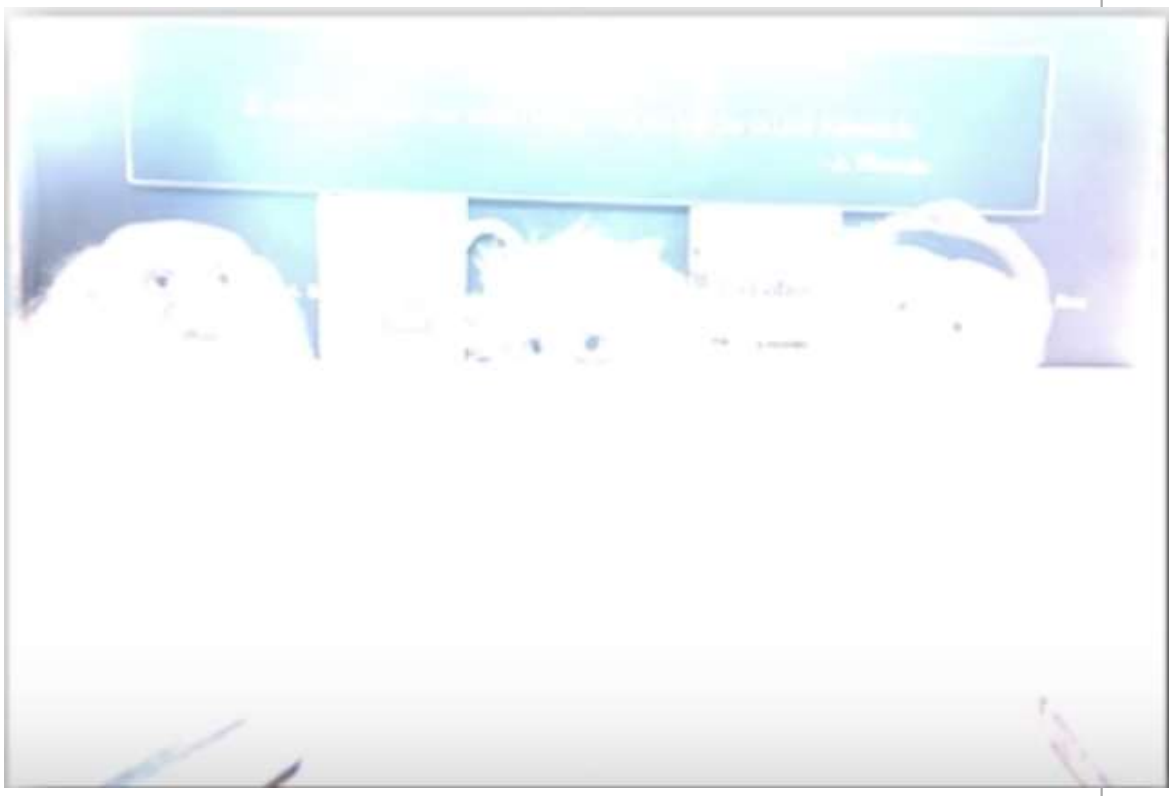

Image DS-2:

- DS-1 image is an overexposed image, while DS-2 is NOT.

DS-1 image is 3 images added without any correction, while DS-2 is DS-1 with histogram equalization.

DS-1 image an image without any Bayer corrections, while DS-2 is after Bayer correction has been applied.

DS-1 image is 3 images added without any correction, while DS-2 is the same 3 images added with 1/3 weight factor (ie., 0.33*I1 + 0.33*I2 + 0.33*I3).

Question 6

1 / 1 pts

[CP02d2-3] Converting images from integer to floating point data types completely eliminates the possibility of arithmetic overflow and underflow in computational photography.

True

False

Correct! All fixed-width precision data types suffer from over and underflow, but converting to float is usually good enough

Question 7

3 / 3 pts

[CP02e1-1] Select all the correct statements below.

Convolution is...

- [x] an operation that calculates the area of overlap between two functions.
- [ ] a measure of similarity of two waveforms.
- [x] equivalent to cross-correlation when the kernel is both horizontally and vertically symmetrical.
- [x] Commutative: $F * G = G * F$

Question 8

3 / 3 pts

[CP02e2-1] Select all the choices below which are correct given the following equation.

$$G[i,j] = \frac{1}{(2k+1)^2} \sum_{u=-k}^{k} \sum_{v=-k}^{k} F[i+u, j+v]$$

- [ ] This equation only applies Gaussian kernels, as weights are distributed across the neighborhood.
- [x] This is the equation for cross-correlation with uniform weights over a neighborhood of pixels, where k is the size of the neighborhood (above, below, left, right).
- [ ] This is the equation for convolution with uniform weights over a neighborhood of pixels, where *k* is the size of the neighborhood (above, below, left, right).
- [x] This equation only applies to square or average smoothing, as weights are equally distributed across the neighborhood.
- [ ] This is the general form of an equation for convolution over a neighborhood of pixels, where *k* is the size of the neighborhood (above, below, left, right).

Incorrect

Question 9

0 / 3 pts

[CP02g-1] Select all of the true statements about image gradients from the list below.

- [ ] The Prewitt, Sobel, and Roberts kernels are used to reduce noise sensitivity in edge detection.

- [x] The method of finite differences is the only exact operator to calculate image gradients.

  Finite differences are used to **approximate** derivatives for discrete functions.

- [ ] Edges in images are usually aligned with the local gradient direction.

- [x] Gradient calculations are very sensitive to noise in the image.

See lecture "Groups of Pixels" and Lecture 02-6 on Udacity

Question 10

4 / 4 pts

[CP03a-2] Select all of the true statements about pinhole photography from the list below.

- [x] Usually suffers from low light because of the size of the opening / aperture.
- [x] Ideally, has virtually no geometric distortion; straight lines remain straight.
- [ ] Usually suffers from motion blur.
- [x] Has infinite depth of field. Everything is in focus.

Question 11

4 / 4 pts

[CP03b-1] Select all of the true statements about aperture from the list below. Recall that the aperture number N relates the area of an aperture opening A and the focal length f according to the equation:

$$A = \pi\left(\frac{f}{2N}\right)^2$$

- [ ] The diameter of the opening is simply f/2N (from the above equation of Area of the opening, which is usually in the shape of a circle).
- [x] Doubling N reduces Area by 4 times, and therefore reduces light by 4 times.

  See Lecture "Camera Sensors" or lecture 03-3. Note the lecture had this equation incorrect, but you should know better! (It was fixed in the slides shared afterwards).
- [x] The amount of light that falls on a sensor or film in a camera is proportional to the area of the aperture opening, is referred to as IRRADIANCE and is measured in amount of light on a unit area of sensor per second.
- [x] The aperture number, or f-number (N), is designed to give irradiance irrespective of the lens in use.

A low f-number (N) on a lens usually means it has a BIG lens. This is especially noticeable for Telephoto lenses, which have larger focal lengths. [A 800mm lens of f-number 4, will have 100mm aperture radius]

Question 12

4 / 4 pts

[CP03c-2] Select all of the true statements about lenses from the following list.

- [x] The Combined Focal length of a compound lens can vary and depends on the distance between the lenses and their individual focal lengths.
- [x] Focal length is a fixed parameter for simple lenses.
- [ ] Field of view (FOV) of a lens only depends on the Focal Length because the sensor is placed on the focal plane of the lens.
- [x] A lens only forms a focused image on a screen placed at the focal length of the lens, otherwise the image formed is unfocused and suffers from optical blur.

Partial

Question 13

1.33 / 4 pts

[CP04a1-1] Choose all of the correct factors to consider to choose the optimal window size for image blending from the following list:

- [x] To avoid ghosting: Window ≤ 2× size of smallest prominent “feature”

- [ ] Image frequency content should occupy one “octave” (power of 2)
- [x] Largest frequency ≤ 2 × size of smallest frequency
- [x] To avoid seams: Window = size of smallest prominent “feature”

Incorrect

Question 14

0 / 3 pts

[CP04a2-2] Choose all of the statements that are CORRECT about a Laplacian Pyramid from the list below:

Each Laplacian is computed using

- [x] $L_l = g_l - \text{REDUCE}(g_{l+1})$

EXPAND, not REDUCE

- [ ] Each Laplacian Image in the Pyramid is a difference between two levels of a Gaussian Pyramid
- [x] A Laplacian Pyramid is a series of “error” images, L_0, L_1, L_2, ...

A Laplacian is simply computed using

- [ ] $L_k = \text{REDUCE}(g_{k-1})$

Please review Lecture 04-3

Incorrect

Question 15

0 / 4 pts

[CP04a3-1] Which of the following statements are TRUE for using Cuts vs. Blending images?

- [x] Using Cuts is better when there is motion that causes ghosting, as the same object will have moved to another point in the image during blending.
- [ ] Cuts are like median filtering as they give you an exact pixel value from one of the images, whereas blending merges pixel values between images.
- [ ] Seam Carving is not similar in terms of computation to Cuts. Cuts are used to merge two images. Seams remove a set of pixels from the same image, and the methods are completely different.
- [x] Using Cuts is better when there are too many objects in the image and registration is hard.

See Lecture 04-4

Question 16

1 / 1 pts

[CP04a4-1] Higher layers in a Gaussian pyramid (i.e., smaller frames) contain the higher frequency components of the image in the frequency domain.

- (•) false
- ( ) true

Correct! Successive applications of Gaussian (low-pass) filters progressively eliminates high frequencies by one octave per application, so the highest level of the pyramid contains the lowest frequency content.

Question 17

3 / 3 pts

[CP04a5-2] In a Laplacian pyramid blending, Burt & Adelson assumed _____ to extrapolate at the image boundaries.

- The second derivative is linear
- The border pixels are constant
- None of the Above
- (selected) The first derivative is constant
- The border pixels are reflected

Question 18

4 / 4 pts

[CP04b1-2] Please select the correct characteristics of Good Features

- Frequency - How many similar features are there.
- Dominant -- Give a strong response to x-correlation
- (checked) Compactness and efficiency -- Many fewer features than image pixels
- (checked) Saliency/Matchability -- Distinctive description

- [ ] Size -- Relatively size of the feature in the image;

- [x] Repeatability/Precision -- Find the same feature despite geometric and photometric transformations

Question 19

3 / 3 pts

[CP04b2-2] Which of the following is CORRECT about the Harris Detector?

- [x] Harris detectors are NOT Invariant to Image Scale changes. One needs to use a scale-space representation using Pyramids to detect features at different scales.

- [ ] Harris detectors are Invariant to Image Scale changes

- [x] Harris detectors are Invariant to Rotation.

- [x] Harris detectors are Invariant to Translation.

- [ ] Harris detectors are NOT Invariant to Image Intensity Variations.

- [ ] Harris detectors are NOT Invariant to Image Scale changes. One needs to use Fourier transforms to convert the image into the Frequency domain and model the variations.

Question 20

4 / 4 pts

[CP05a1-1] Which of the follow are true statements about Affine Transformation?

- [ ] 4 Degrees of Freedom
- [x] 6 Degrees of Freedom
- [ ] 2 Point Correspondences Needed
- [x] Only the top two rows of the transformation matrix need to be computed to model this transformation.
- [x] 3 Point Correspondences Needed for computation.
- [ ] Only the leftmost two columns of the transformation matrix need to be computed to model this transformation.

Partial

Question 21

2.67 / 4 pts

[CP05b2-2] Determine which of the following statements are CORRECT about a stereo method to compute depth or disparity in a scene

- [x] A simple stereo system used to compute 3D scene geometry assumes that there are two cameras of the same focal length translated by a small distance.
- [ ] The disparity computed for a stereo pair is usually smaller for closer surfaces than farther ones. This is due to parallax in the scene.
- [x] The epipolar constraint for computing disparity simplifies how corresponding pixels are detected in a stereo pair.
- [ ] Epipolar constraint is also used in the case of a Kinect RGBD sensor, as the 2nd camera is replaced by a IR light source.

Incorrect

Question 22

0 / 1 pts

[CP05b3-2] The only reason that planar projection cannot be used to produce 360 degree panoramas is because of the alignment error accumulated by pairwise concatenation of homographies.

- (•) True
- ( ) False

Review Szileski text, lectures, and “Recognizing Panoramas” by Brown & Lowe.

Question 23

3 / 3 pts

[CP05b4-2] Because planar projection panoramas preserve straight lines, you only need a _____ transform to align the images.

- ( ) Rotation
- ( ) Translation
- ( ) None of the Above
- (•) Perspective
- ( ) Affine

Correct! Affine preserves straight lines, but also preserve parallel lines (which are not preserved in planar projection panoramas).

Question 24

3 / 3 pts

[CP05b5-3] The HDR process described by Debevec & Malik requires at least _____ measurements to ensure a sufficiently overdetermined system of equations to recover the irradiance values and response curve. (Let N = number of pixels; P = number of images; Z_{max} = max pixel value; Z_{min} = min pixel value)

- None of the Above
- 255
- 256
- (●) N(P-1) > (Zmax - Zmin)
- N * (Zmax - Zmin)

Question 25

1 / 1 pts

[CP05b6-1] CCD camera sensors typically respond linearly to irradiance E.

- (●) True
- False

Correct! Nonlinearities in the response curve (such as those that occur when pixel values are saturated) are typically introduced by post-processing or signal clipping.

Question 26

2 / 2 pts

[CP06a-2] What is the approximate minimum video frame rate for humans to perceive flicker-free motion?

- 29.97 frames/second
- (•) 24 frames/second
- 30 frames/second
- 12 frames/second
- 25 frames/second

Question 27

4 / 4 pts

[CP06b-2] Select the statements from the following which are correct for the concept of Video Textures.

- [x] Video Textures can be applied to sub-regions of images, like video sprites.
- [ ] Video Textures only work when there is an image texture in a video.
- [ ] Crossfading and blending create too much blur and should never be used for video textures.

- [x] The primary concept that supports Video Texture analysis is that similar frames repeat in videos.

- [x] Though L1 and L2 similarity metrics are discussed for generating video textures, other similarity metrics can also be used to compare frames.

Partial

Question 28

1.33 / 4 pts

[CP06c1-1] Which of the following statements is true about the Video Stabilization system discussed in lecture 06-3?

- [ ] Rolling shutter can be removed by adding median filtering in time.

- [ ] It is a 3D camera path stabilization method, where a 3D path is computed and then a smoothing process applied.

- [x] Rolling shutter adds unwanted non-rigid motion in the video due to a delay in readout from photosites.

- [x] Cropping is used to crop the view, which avoids dealing with hole filling. When the whole frame is aligned, we may see regions with no pixels from the original video as the camera shakes.

- [ ] It is a 2D camera path stabilization method, where only estimates of 2D motion are used, then constrained using cropping.

- [x] Cropping is used to crop the view, which avoids problems with a rolling shutter.

- [ ] It is a 2D camera path stabilization method, where only estimates of 2D motion are used, then constrained using standard notions of camera movements like pan or dolly.

Partial

Question 29

3.2 / 4 pts

[CP07b1-2] Which of the following statements are correct about Epsilon or Coded Photography?

- [x] Coded Photography takes standard pictures, except with an encoding that adds additional functionality.
- [x] A coded shutter essentially changes the shutter opening to provide variations in captured image, which can then be computationally adapted.
- [ ] Low light and image resolution are the primary limitation of adding codings to cameras as shown in lecture 07-3
- [ ] Epsilon Photography has very limited data compression needs, as it stores only the necessary parts of the images.
- [x] Coded Photography and Epsilon Photography have similar goals; encoding variation in an image to capture more detail.
- [x] Coded photography uses a "code" to encode variations in an image (or video) in neighboring pixels. Epsilon photography just captures all variations and tends to deal with it in a post-processing.

Question 30

4 / 4 pts

[CP07b2-2] Which of the following statements are CORRECT about a Light field Camera?

- [x] A plenoptic or a light field camera attempts to capture a light field rather than pixels. The captured light field can be rendered as a traditional image in pixels as a post-capture step.
- [ ] Panoramas can't be represented using the plenoptic function.
- [x] One can build a light field camera, capable of depth, focus, and illumination estimation by combining a lens and micro-lens array system.
- [x] A hologram is represented as a 7-D Light Field.

Partial

Question 31

1.5 / 3 pts

[CP08-4] Which of the follow applies to the concept of "Eulerian Video Magnification" concept from module 08?

- [ ] They use Laplacian Pyramids to capture the variations at different scales.
- [x] They note that decomposing a video sequence into spatial frequency bands reveals small motions that can be selectively magnified.
- [ ] Lagrangian methods are used to track motions.

Question 32

3 / 3 pts

[CP08-5] Which of the following applies the "Seam Carving" approach from Module 8?

- [x] A key insight is use of an Image Energy Measure and removing seams with lowest energy on a gradient-based energy measure, to reduce size of images.
- [x] Seam carving strikes the best balance between the demands for energy preservation and visual coherency.
- [ ] A key insight is the use of an Image Energy Measure and removing seams with high energy on a gradient-based energy measure, to reduce size of images.
- [x] Image retargeting to new aspect ratios is achieved by repeatedly carving out or inserting a combination of vertical and horizontal seams.

Question 33

3 / 3 pts

[CP08-6] Consider the paper on "Poisson Image Editing" in module 08. Which of the following relates to that effort?

- [ ] Spots and blemishes are removed from fur images by separating out the brightness component from details in a selected region and replacing the brightness by harmonic interpolation (solving a Laplace equation) of the brightness at the selection boundary.
- [ ] A system is introduced to edit an image via a sparse set of its edge elements (edgels).

- [x] Using this approach allows transferring objects to a new scene without any need for precise delineation of object boundaries.

- [x] The mathematical tool at the heart of the approach is the Poisson partial differential equation with Dirichlet boundary conditions which specifies the Laplacian of an unknown function over the domain of interest, along with the unknown function values over the boundary of the domain.

Question 34

0.5 / 0.5 pts

[Closing] Reminder and recertification on closing:

I certify that:

- [x] I am aware of the Georgia Tech Honor Code (**link (http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code)**) and I affirm it here, as I take this exam.

- [x] I took this exam solely and entirely on my own, without any help from any other individual.

- [x] I will not copy or print this exam for any reason!

- [x] I am the student who is enrolled in this class.

Thanks.

Quiz Score: **75.43** out of 100