

Task 4: Digital Image Processing & Camera Sensor and Digital Image

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Question 1

Q.001: Print "info" and identify what kind of information (metadata) is stored in the image?

info

The metadata that is stored is of a standard Exif which provides information on the format of images (such as size, number of pixels, resolution, etc).

Q.002: Run the above code using the color image and compare their results.

MaxSampleValue in the "pout.tif" image was 255 and in the "board.tif" colour image it was [255 255 255]. In addition ColorType was 'grayscale' for the "pout.tif" image, but "trueColor" for the "board.tif" image. Also the grayResponseUnit was 0.1 for the gray image and 0.01 units for the colour image (much lower for colour image).

Q.005: When do we use impixel?

The function impixel is more versatile and can accept vectors of locations as arguments instead of just values of locations.

Q.008: Please check what the 'nearest' option is.

'nearest' refers to nearest-neighbor interpolation. This is the fastest method, but it has the lowest quality because when an image is increased in size, it averages the two adjacent pixel values in the pixel matrix to come up with the additional pixels required for the increased image (bigger images require larger pixel arrays).

Q.009: Please check that how the code reproduce or reduce the pixels in the original image

When an image gets increased in size (ex resized or increased in size by 2, the pixel matrix is increased by 2). The extra rows and columns of pixels get the 'nearest' value interpolated between the neighboring pixel values. When an image is decreased in size, the pixel matrix shrinks, and a lot of pixel values are eliminated (for ex a 4x4 matrix shrinks to 2x2 matrix eliminates 12 pixel values).

Q.010: Are high resolution images always high quality? Do high-quality photos have high resolution?

High resolution images are not always high quality. Quality of the image depends on the value of the pixels. So if an image is reduced in size, a bunch of pixel values are lost, and when increased in size again, the added interpolated pixel values are not the original ones resulting in a blurrier image than the original one. Resolution alone just speaks to number of pixels - not their values.

Q.013: With this result, please estimate the filesize of a 8,688 x 5,792 image stored as tif (lossless compression)?

The size of the image in bytes after loading into workspace (assuming bitDepth=8)=50320896.

Q.016: What is the difference between im2double and double?

im2double(I) converts the image I to double precision. I can be a grayscale intensity image, a truecolor image, or a binary image. im2double rescales the output from integer data types to the range [0, 1] without actually changing the meaning of the colours. While the function double just converts to double precision (without changing the image range).

Question 2

Q1. What is a good image sensor? Why are the high-end DSLR cameras expensive?

The most important aspect of a good image sensor is its size. The bigger the sensor, the more light it can capture, and thus the better quality images. In addition, image quality depends on how many millions of pixels (light-sensitive photosites) fit on it, and the size of those pixels. The main reason why DSLR cameras are expensive is because they have big image sensors which are able to capture more information than cameras with smaller image sensors. DSLR's larger number of photosites would be capable of turning out photos with better dynamic range, less noise and improved low light performance than its smaller-sensored sibling (<https://newatlas.com/camera-sensor-size-guide/26684/>).

Q2. What is the difference between optical and digital zooms?

The optical zoom is achieved by using your camera's lens. The digital zoom, on the other hand, is achieved by cropping and enlarging the image once it has been captured by the digital camera's sensor. Digital zoom is essentially a built-in image processing in the camera. The same result can be achieved by using an image editing application such as Photoshop once the images have been transferred onto a computer. Using Photoshop or another image editing application, one has more control over what part of the image is cropped and enlarged, making it the preferred method of achieving digital zoom of images. Digital zoom often results in lower quality pictures when it is enabled on your camera. Optical zoom is the preferred zoom. (<https://etc.usf.edu/techease/win/images/what-is-the-difference-between-optical-and-digital-zoom/>)

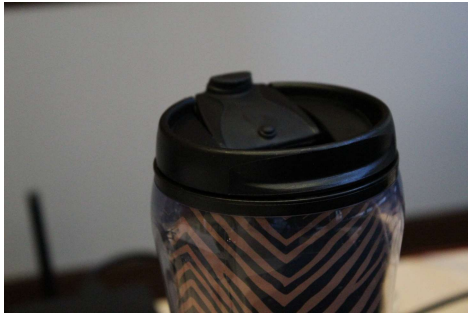

Q3. Why did the apple make "stove-top" iPhone 11?

Apple introduced three lenses with the iPhone 11 (making it look like a stove-top). The lenses are Ultra Wide, Wide, and Telephoto lenses. The wide lens is a regular lens (x1), the Ultra Wide lens is for capturing a wider field of view, and the Telephoto allows for a 2x optical zoom. Since Apple wanted to minimize the size of the camera, it decided to break apart the different camera components but at the same time maximize image quality.

Q4. Shutter speed (Exposure time)

Shutter speed (or exposure time) depends on how long the sensor is exposed to light - or how long the shutter of a camera is open. The longer the shutter speed (or exposure time) the more bright the image appears. Longer exposure time is suitable for darker environments, but at the same time this method is sensitive to motion (motion makes image with long exposure look blurry - because it is easier to distort an image when the shutter is open for a long period of time).



The following images were taken by the instructor because my phone camera does not have the option of changing the shutter speed (I have a Google Pixel 3).

Metadata	Image 1	Image 2
Image		
Make	Canon	Canon
Model	Canon EOS Rebel T6	Canon EOS Rebel T6
Data and time	2019:01:30 11:18:40	2019:01:30 11:18:29
Image file type	JPEG	JPEG
Resolution	5184 x 3456	5184 x 3456
Focal length	55.0 mm	55.0 mm
Exposure	1/1800	1/10
ISO	6400	6400
F-number	5.6	5.6
GPS	N/A	N/A
Flash	Off, Did not fire	Off, Did not fire

Q5. Aperture



Aperture is a hole or an opening through which light travels. Different aperture denotes to different size of openings in the camera.

Since my smartphone only has one aperture (f/1.8), I used the instructors images to complete this part.

Metadata	Image 1	Image 2
Image		
Make	Canon	Canon
Model	Canon EOS Rebel T6	Canon EOS Rebel T6
Data and time	2019:02:04 11:50:47	2019:02:04 11:51:01
Image file type	JPEG	JPEG
Resolution	5184 x 3456	5184 x 3456
Focal length	55.0 mm	55.0 mm
Exposure	1/160	1/160
ISO	800	800
F-number	22	36
GPS	N/A	N/A
Flash	On, Fired	On, Fired


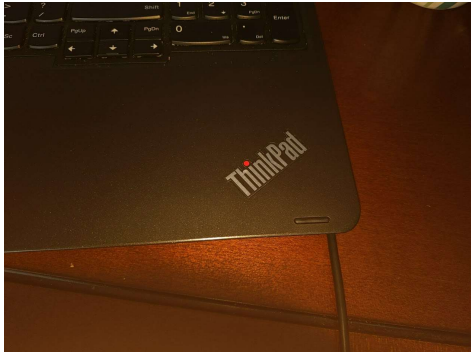
Q6. ISO

In digital photography and in the case of digital cameras, ISO sensitivity is a measure of the camera's ability to capture light (the higher the ISO the brighter the image appears). Digital cameras convert the light that falls on the image sensor into electrical signals for processing. ISO sensitivity is raised by amplifying the signal. In other words it is image post-processing. By amplifying the signal, noise is typically introduced.

Metadata	Image 1	Image 2
Image		
Make	Google	Google
Model	Pixel 3	Pixel 3
Data and time	2020:02:18 9:24	2020:02:18 9:24
Image file type	JPEG	JPEG
Resolution	2048 x 1536	2048 x 1536
Focal length	4.44 mm	4.44 mm
Exposure	1/24	1/24
ISO	596	260
F-number	f/1.8	f/1.8
GPS	On	On
Flash	Off, did not fire	Off, did not fire



Q7. Flash

Flash is simply additional light that the camera produces and illuminates the physical object while capturing the image. Just the introduction of flash alone does not have to do with image post-processing. However, flash typically distorts the natural look of the physical object because the flash looks artificial (due to lack or excess of shadows, reflection of the light - red eye effect etc).

Metadata	Image 1	Image 2
Image		
Make	Google	Google
Model	Pixel 3	Pixel 3
Data and time	2020:02:18 9:43	2020:02:18 9:43
Image file type	JPEG	JPEG
Resolution	2048 x 1536	2048 x 1536
Focal length	4.44 mm	4.44 mm
Exposure	1/30	1/30
ISO	99	99
F-number	f/1.8	f/1.8
GPS	On	On
Flash	Off, did not fire	On, Fired

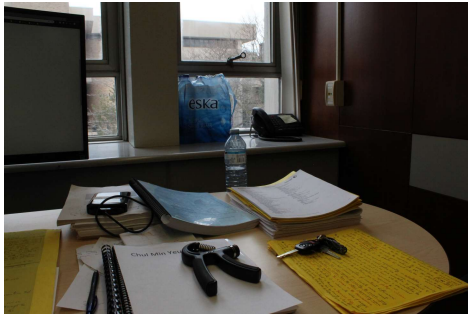

Q8. Focal length

Focal length is the optical distance from the point where light rays converge to form a sharp image of an object to the digital sensor. I used instructors images, because my cellphone camera does not have the option to change focal length.

Metadata	Image 1	Image 2
Image		
Make	Canon	Canon
Model	Canon EOS Rebel T6	Canon EOS Rebel T6
Data and time	2019:02:04 11:10:46	2019:02:04 11:10:54
Image file type	JPEG	JPEG
Resolution	5184 x 3456	5184 x 3456
Focal length	18.0 mm	49.0 mm
Exposure	1/1000	1/1000
ISO	6400	6400
F-number	5.6	5.6
GPS	N/A	N/A
Flash	Off, Did not fire	Off, Did not fire

Q9. Field of view

In photography, the field of view is that part of the world that is visible through the camera at a particular position and orientation in space; objects outside the FOV when the picture is taken are not recorded in the photograph. It is also expressed as the angle of view. The field of view is dependent on focal length (lens) and the size of the sensor. Typically, the smaller the sensor (as in case of smartphone cameras), the narrower the field of view because the focal length is smaller. I used the instructors images as the field of view (or angle of view) cannot be changed on my smartphone camera.

Metadata	Image 1	Image 2
Image		
Make	Canon	Canon
Model	Canon EOS Rebel T6	Canon EOS Rebel T6
Data and time	2019:02:04 11:55:37	2019:02:04 11:55:33
Image file type	JPEG	JPEG
Resolution	5184 x 3456	5184 x 3456
Focal length	18.0 mm	55.0 mm
Exposure	1/200	1/200
ISO	1600	1600
F-number	20	20
GPS	N/A	N/A
Flash	Off, Did not fire	Off, Did not fire