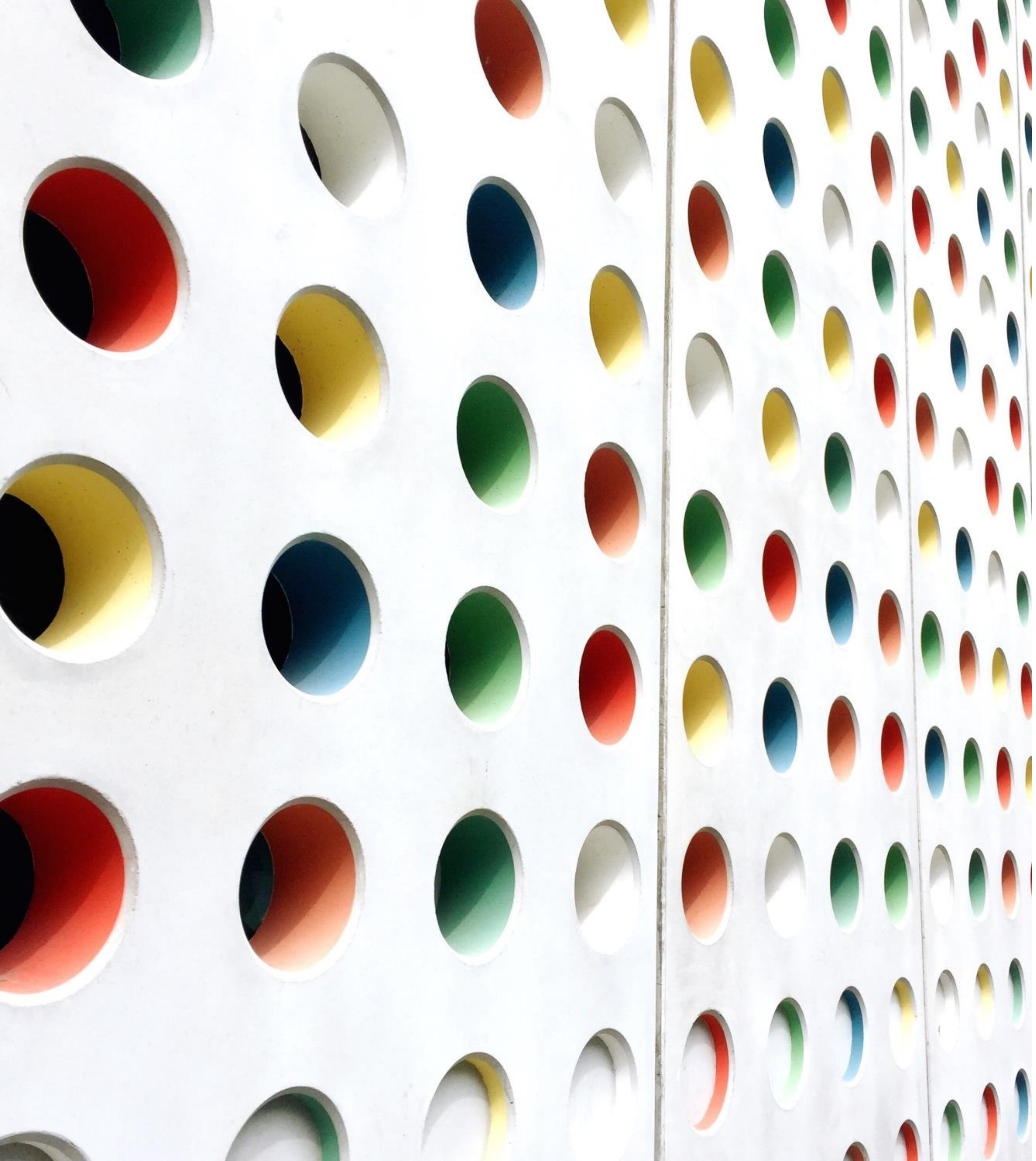

Computer Vision Homework One

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Requirements and Code

1. Load provided images into Python using OpenCV.
2. Print the sizes of the images.
3. Compute and print the average red, green, and blue value for each image.
4. Convert both images to grayscale.
5. Compute and display the element wise average of the grayscale images.
6. Compute and display the element wise max of the two grayscale images.
7. Compute and display the element wise absolute difference of the two grayscale images.

```python
# Matt Ferguson
# ECE 5554 Computer Vision Homework 1
import cv2
import numpy as np

# Requirement 1
image_1=cv2.imread(r'C:\Users\Matt\Desktop\Virginia Tech\animals.png')
image_2=cv2.imread(r'C:\Users\Matt\Desktop\Virginia Tech\stonehenge.png')
image_1=image_1.astype(np.float64)
image_2=image_2.astype(np.float64)


# Requirement 2
print(image_1.size)
print(image_2.size)
print(image_1.shape)
print(image_2.shape)

# Requirement 3
image_1_RGB_mean=np.mean(image_1, axis=(0, 1))
image_2_RGB_mean=np.mean(image_2,axis=(0,1))

# Requirement 4
gray_scale_1=np.mean(image_1,2)
gray_scale_2=np.mean(image_2,2)
gray_scale_1_write=gray_scale_1.astype(np.ubyte)
gray_scale_2_write=gray_scale_2.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_1.png', gray_scale_1_write)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_2.png', gray_scale_2_write)

# Requirement 5
gray_scale_mean=(gray_scale_1+gray_scale_2)/2
gray_scale_mean=gray_scale_mean.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_mean.png', gray_scale_mean)

# Requirement 6
gray_scale_max=np.maximum(gray_scale_1,gray_scale_2)
gray_scale_max=gray_scale_max.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_max.png', gray_scale_max)

# Requirement 7
gray_scale_absdif=np.abs(np.subtract(gray_scale_1,gray_scale_2))
gray_scale_absdif=gray_scale_absdif.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_absdif.png', gray_scale_absdif)
```

Image Loading

```
# Requirement 1
image_1=cv2.imread(r'C:\Users\Matt\Desktop\Virginia Tech\animals.png')
image_2=cv2.imread(r'C:\Users\Matt\Desktop\Virginia Tech\stonehenge.png')
image_1=image_1.astype(np.double)
image_2=image_2.astype(np.double)
```

Here we load image 1 and 2 into Python using OpenCV.

Size and Shape Prints

In:

```
# Requirement 2
print(image_1.size)
print(image_2.size)
print(image_1.shape)
print(image_2.shape)
```

Out:

```
In [7]: runfile('C:/Users/Matt/Desktop/Python/CV_HW_1.py', wdir='C:/Users/Matt/Desktop/Python')
2359296
2359296
(768, 1024, 3)
(768, 1024, 3)
```

- Image 1 is an array of shape (768, 1024, 3) giving it a size of 2359296 elements.
- Image 2 is an array of shape (768, 1024, 3) giving it a size of 2359296 elements.
- There are 768 by 1024 pixels or 786432 pixels in both images with 3 RGB values per pixel.

Flattened RGB Plane Means

```
# Requirement 3
image_1_RGB_mean=np.mean(image_1, axis=(0, 1))
image_2_RGB_mean=np.mean(image_2,axis=(0,1))
```

- The average we are computing is along the first two axes, meaning we are computing the average red, green, and blue pixel intensity for the square of pixels.
- Image 1 has a mean of (128.49, 100.51, 92.87). Image 1 is a picture of a pig over a red brick factory in a rusty field, so it makes sense that red has the highest average intensity.
- Image 2 has a mean of (90.04, 90.04, 90.04) which is an entirely expected outcome given that image 2 is a grayscale image of Stonehenge.

Grayscale Conversion

We convert each image to gray scale by computing the mean of each pixels RGB values. Note image 2 does not change as it was grayscale before our operation.

```
# Requirement 4
gray_scale_1=np.mean(image_1,2)
gray_scale_2=np.mean(image_2,2)
gray_scale_1_write=gray_scale_1.astype(np.ubyte)
gray_scale_2_write=gray_scale_2.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_1.png', gray_scale_1_write)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_2.png', gray_scale_2_write)
```

Element Wise Average

```
# Requirement 5
gray_scale_mean=(gray_scale_1+gray_scale_2)/2
gray_scale_mean=gray_scale_mean.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_mean.png', gray_scale_mean)
```

The average intensity for the grayscales of image 1 and 2 is computed. We sum the grayscale value of image 1 and image 2 element wise and divide by 2 to compute the average intensity for that pixel location. We can see both the pig over the factory and Stonehenge appearing in this image but with reduced clarity in comparison to our input images. Many details are lost or blended yet others are not.

Element Wise Max

```
# Requirement 6
gray_scale_max=np.maximum(gray_scale_1,gray_scale_2)
gray_scale_max=gray_scale_max.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_max.png', gray_scale_max)
```

The max intensity for the grayscale versions of image 1 and 2 is computed element wise. We take the maximum intensity value of the two images at every pixel location and use it as the value of the same pixel location in the image on the right. The image appears lighter than the average of the images as we are selecting the maximum intensity for a given pixel location. We can observe that the white clouds overhanging the factory are well preserved whereas the parts of the factory cast in dark shadows are largely lost.

Element Wise Absolute Difference

```
# Requirement 7
gray_scale_absdif=np.abs(np.subtract(gray_scale_1,gray_scale_2))
gray_scale_absdif=gray_scale_absdif.astype(np.ubyte)
cv2.imwrite(r'C:\Users\Matt\Desktop\Virginia Tech\gray_scale_absdif.png', gray_scale_absdif)
```

The absolute difference of intensity for the grayscales of image 1 and 2 is computed. We subtract the intensities of the grayscale image 1 and 2 and then take the absolute value of that difference. The image is overall darker as subtraction will lead to lower average intensity values. Subtraction causes elements (or pixel locations) with similar intensities to become dark and elements with large differences in intensity to become light. We can see the brightest cloud at the middle upper-right of the image is a result of the high intensity cloud being subtracted by the piece of stone henge cast in low intensity dark shadow. The rest of the image is largely dark due to the more typical contrast element wise resulting in a low absolute difference.