Botzer_AI879_HW_Q1_Week5

February 5, 2024

[ ]:

```
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# Date: 1/15/2024
# Class: Penn State - AI 879

# Explain what a steerable filter is and apply it to Migrant Mother and Penn State images
```

1 Question 1: Read the papers mentioned by Ex 3.12 from the Szeliski textbook and explain what a steerable filter is. But you don't need to implement any algorithm requested by Ex 3.12.

A steerable filter is a image filter that is designed to detect specific edges or orientations in an image. A Sobel filter is made up of two steerable filters, one in the horizontal and one in the vertical, [[1,2,1],[0,0,0],[-1,-2,-1]] and the transpose respectivly, which each pass over the image. This is a first-order derivative filter.

The Laplacian filter [[0,1,0],[1,-4,1],[0,1,0]] uses a second-order derivative to detect edges which allows it to detect the edges of an image in one pass. The Laplacian looks at inensity change and is susceptible to noise. A Gaussian filter is typically applied first to smooth the image and reduce noise.

The Gabor filter uses a Gaussian kernel which is modulated by a sinusoidal phase wave. The filter is made up of the wavelength of the phase wave, the orientatino of the wave, the phase offset, the S.D. of the Gaussian kernel itself, and the spatal aspect ratio. This modulation provides both real and imaginary parts.

2 Below is Q2 where I implement filters: Sobel, Gaussian, Gabor

[ ]:

```
# Imports for functions

# The scikit-image package provides a wide variety of filter applications
#  which reduce the need to write out the corr / conv matricies

import skimage as ski
import numpy as np
import matplotlib.pyplot as plt
```

```
# Check skimage version
print('skimage version: ', ski.__version__) # 0.22 is current stable release (1/
 ↪15/2024)
```

```
skimage version:  0.22.0
```

[ ]:

```
# Load in images

migrant = ski.io.imread('L01 Migrant Mother.png')
greatvalley = ski.io.imread('L01 greatvalley.jpg', as_gray=True)

# Convert these both to floats to make filters easier to deal with
migrant = ski.util.img_as_float(migrant)
greatvalley = ski.util.img_as_float(greatvalley)
```

[ ]:

```
migrant.shape
```

[ ]:

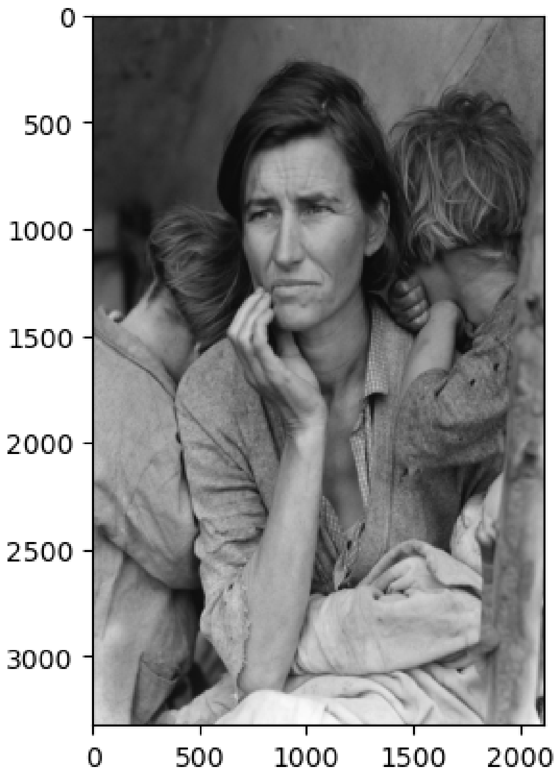
```
(3324, 2112, 3)
```

[ ]:

```
plt.imshow(migrant)
```

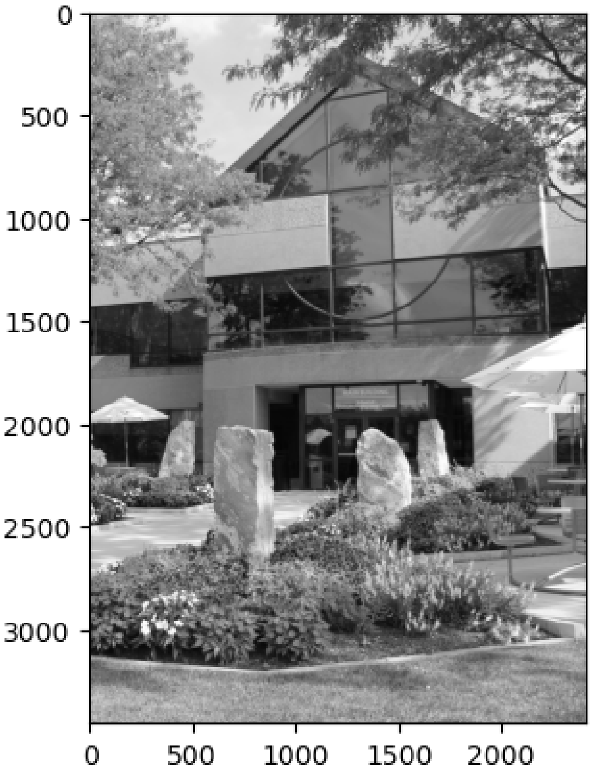
[ ]:

```
<matplotlib.image.AxesImage at 0x1ac64320440>
```



[ ]:
```
plt.imshow(greatvalley, cmap='gray')
```

[ ]:
```
<matplotlib.image.AxesImage at 0x1ac6549c410>
```



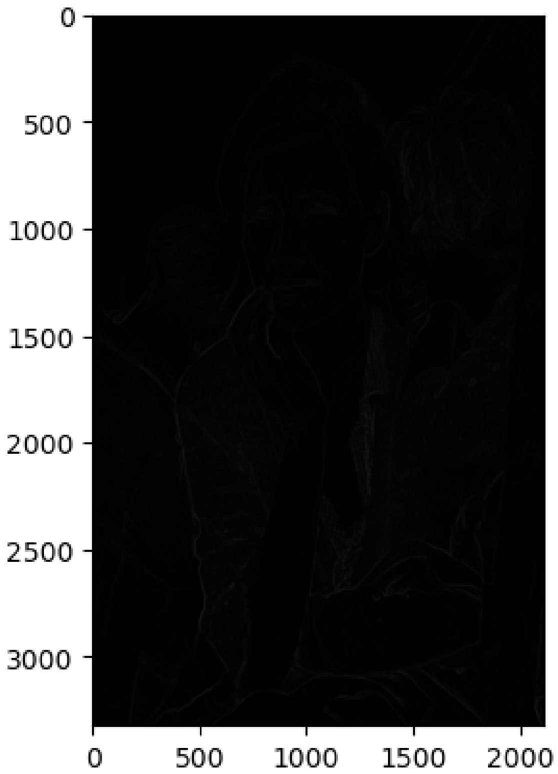
3 Sobel Edge Detection Filter

[ ]:
```
# The Sobel detection filter for each image

migrant_sobel = ski.filters.sobel(migrant)
greatvalley_sobel = ski.filters.sobel(greatvalley)
```

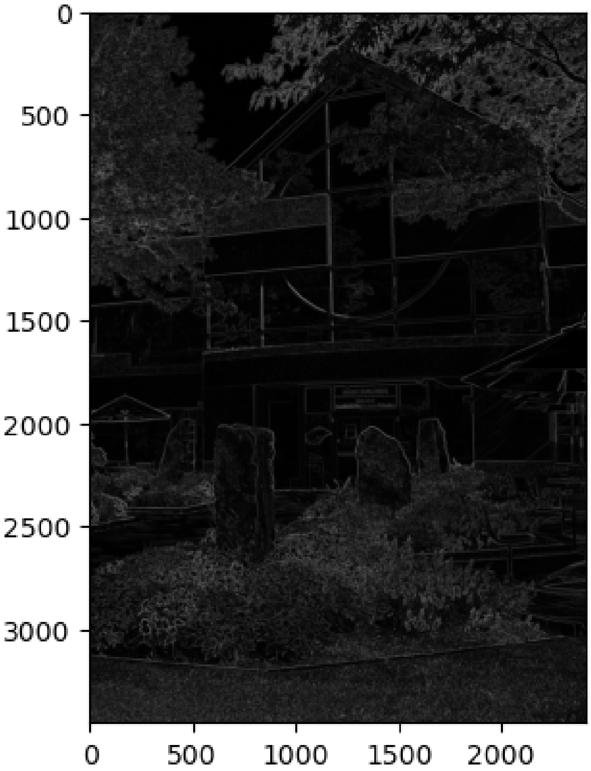
[ ]:
```
plt.imshow(migrant_sobel)
```

[ ]:
```
<matplotlib.image.AxesImage at 0x1ac654a36e0>
```



```
[ ]: plt.imshow(greatvalley_sobel, cmap='gray')
```

```
[ ]: <matplotlib.image.AxesImage at 0x1ac0a181610>
```



4 Laplacian Filter

[ ]:
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# The Laplacian filter
#  Requires the smoothing of the image with a Gaussian

# Using the matlab default of 0.5 or the scikit-image default of 1.0
#  did not allow the edges to be resolved in the Laplace image.
#  Blurring the image further with a high sigma allowed the edges to be seen.

migrant_gaussed = ski.filters.gaussian(migrant, sigma=1, channel_axis=-1)
```

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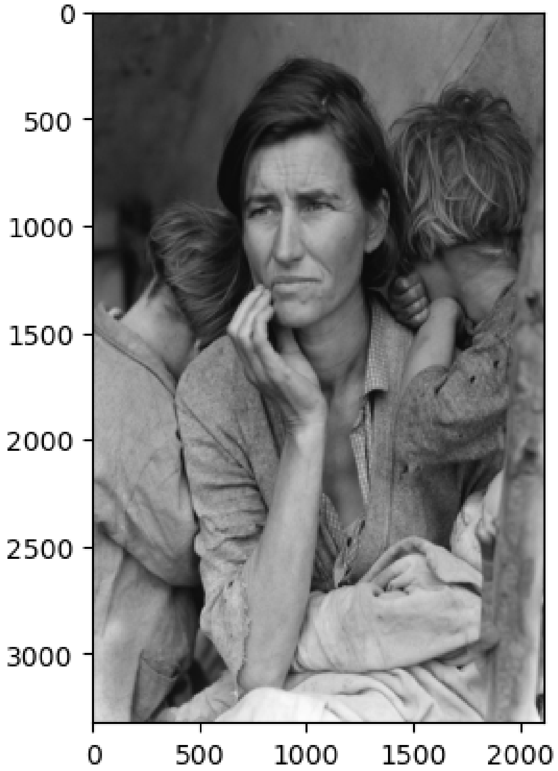
```
plt.imshow(migrant_gaussed)
```

[ ]:
```
<matplotlib.image.AxesImage at 0x1ac1440b7a0>
```



5 Gabor Filter

[ ]:
```
# Convert to grayscale for Gabor filter
migrant_gray = ski.color.rgb2gray(migrant)

migrant_gray.shape
```

[ ]:
```
(3324, 2112)
```

[ ]:
```
# Apply the Gabor filter
migrant_gabor = ski.filters.gabor(migrant_gray , frequency=0.5)
```

[ ]:
```
# See the output
migrant_gabor
```

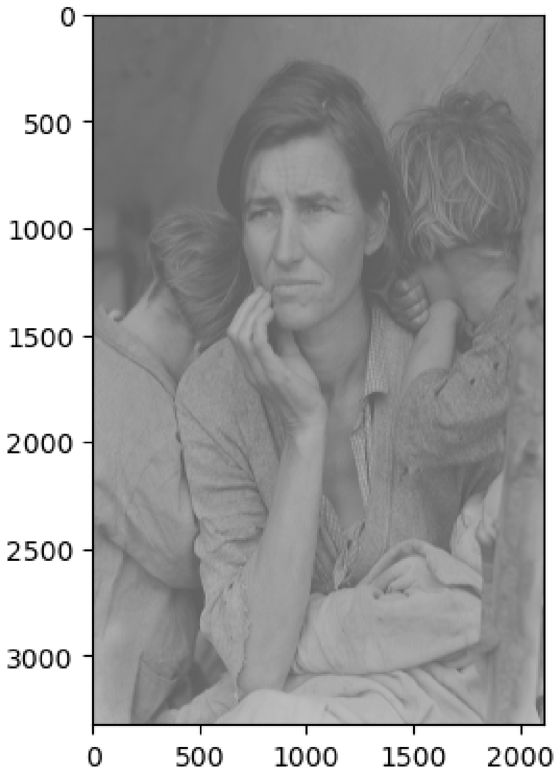
[ ]:
```
(array([[0.00103089, 0.00011036, 0.00171854, …, 0.0019543 , 0.00207712,
          0.00256046],
         [0.00101417, 0.00018185, 0.00160159, …, 0.00194112, 0.00218843,
          0.00242238],
         [0.00095952, 0.0004186 , 0.00121719, …, 0.00183671, 0.00234839,
          0.00224328],
         …,
         [0.00352134, 0.00325613, 0.00420614, …, 0.00327484, 0.00250004,
          0.00302401],
         [0.00352761, 0.00324288, 0.00421541, …, 0.00331782, 0.00257402,
          0.00298725],
         [0.00352802, 0.00324203, 0.004216  , …, 0.00327207, 0.00266832,
          0.00295317]]),
  array([[0., 0., 0., …, 0., 0., 0.],
         [0., 0., 0., …, 0., 0., 0.],
         [0., 0., 0., …, 0., 0., 0.],
         …,
         [0., 0., 0., …, 0., 0., 0.],
         [0., 0., 0., …, 0., 0., 0.],
         [0., 0., 0., …, 0., 0., 0.]]))
```

[ ]:

```python
# Real Parts of the Gabor
plt.imshow(migrant_gabor[0], cmap='gray')
```

[ ]:

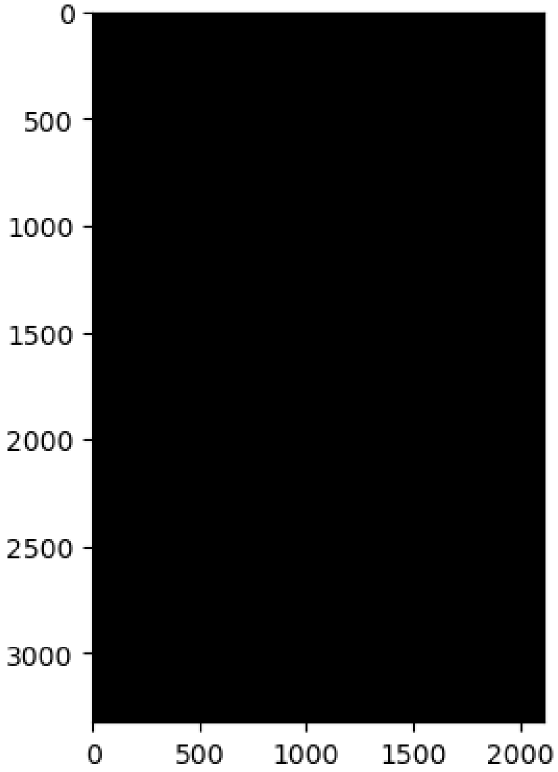
```
<matplotlib.image.AxesImage at 0x1ac143d9220>
```



[ ]:

```python
# Imaginary parts of the Gabor
plt.imshow(migrant_gabor[1], cmap='gray')
```

```
[ ]: <matplotlib.image.AxesImage at 0x1ac142c9a90>
```


0
500
1000
1500
2000
2500
3000
0
500
1000
1500
2000