

# PCA

November 27, 2023

## 1 Import Packages

```
[1]: import numpy as np
import cv2
import os
import scipy.io as sio
from scipy import ndimage
from scipy import signal
import scipy.misc as misc
from PIL import Image
from IPython.display import display, HTML
```

## 2 Utils

```
[2]: def upsample_interp23(image, ratio):

    image = np.transpose(image, (2, 0, 1))

    b,r,c = image.shape

    CDF23 = 2*np.array([0.5, 0.305334091185, 0, -0.072698593239, 0, 0.
 ↪021809577942, 0, -0.005192756653, 0, 0.000807762146, 0, -0.000060081482])
    d = CDF23[::-1]
    CDF23 = np.insert(CDF23, 0, d[:-1])
    BaseCoeff = CDF23

    first = 1
    for z in range(1,int(np.log2(ratio))+1):
        I1LRU = np.zeros((b, 2**z*r, 2**z*c))
        if first:
            I1LRU[:, 1:I1LRU.shape[1]:2, 1:I1LRU.shape[2]:2]=image
            first = 0
        else:
            I1LRU[:,0:I1LRU.shape[1]:2,0:I1LRU.shape[2]:2]=image

        for ii in range(0,b):
            t = I1LRU[ii,:,:]
```

```

        for j in range(0,t.shape[0]):
            t[j,:]=ndimage.correlate(t[j,:],BaseCoeff,mode='wrap')
        for k in range(0,t.shape[1]):
            t[:,k]=ndimage.correlate(t[:,k],BaseCoeff,mode='wrap')
        I1LRU[ii,:,:]=t
    image = I1LRU

re_image=np.transpose(I1LRU, (1, 2, 0))

return re_image

```

### 3 PCA (Principal Component Analysis)

```

[3]: import numpy as np
#from utils import upsample_interp23
from sklearn.decomposition import PCA as princomp

def PCA(pan, hs):

    M, N, c = pan.shape
    m, n, C = hs.shape

    ratio = int(np.round(M/m))

    print('get sharpening ratio: ', ratio)
    assert int(np.round(M/m)) == int(np.round(N/n))

    image_hr = pan

    #upsample
    u_hs = upsample_interp23(hs, ratio)

    p = princomp(n_components=C)
    pca_hs = p.fit_transform(np.reshape(u_hs, (M*N, C)))

    pca_hs = np.reshape(pca_hs, (M, N, C))

    I = pca_hs[:, :, 0]

    image_hr = (image_hr - np.mean(image_hr))*np.std(I, ddof=1)/np.
    ↪std(image_hr, ddof=1)+np.mean(I)

    pca_hs[:, :, 0] = image_hr[:, :, 0]

    I_PCA = p.inverse_transform(pca_hs)

```

```

#equalization
I_PCA = I_PCA-np.mean(I_PCA, axis=(0, 1))+np.mean(u_hs)

#adjustment
I_PCA[I_PCA<0]=0
I_PCA[I_PCA>1]=1

return np.uint8(I_PCA*255)

```

## 4 Load Data

```

[4]: import imageio.v2 as imageio
import matplotlib.pyplot as plt

# Specify the path to your TIFF file
ms_tiff_path = 'PAirMax/GE_Lond_Urb/FR/MS_LR.tif'
pan_tiff_path = 'PAirMax/GE_Lond_Urb/FR/PAN.tif'

# Read the TIFF image
ms = imageio.imread(ms_tiff_path)
pan = imageio.imread(pan_tiff_path)

pan = np.expand_dims(pan, -1)
# ms= np.transpose(ms, (0, 1, 2))

print(pan.shape,ms.shape)

# Set the figure size
fig, axes = plt.subplots(1, 2, figsize=(14, 7)) # Adjust the figsize as needed

# Display the first image
axes[0].imshow(pan[:, :, :], cmap='gray') # Assuming the image is grayscale
axes[0].set_title('High Resolution Panchromatic Image')
axes[0].axis('off')

# Display the second image
axes[1].imshow(ms[:, :, 1], cmap='gray') # Assuming the image is grayscale
axes[1].set_title('Low Resolution Multispectral Image')
axes[1].axis('off')

# Adjust layout to prevent overlapping
plt.tight_layout()

# Show the plot
plt.show()

```

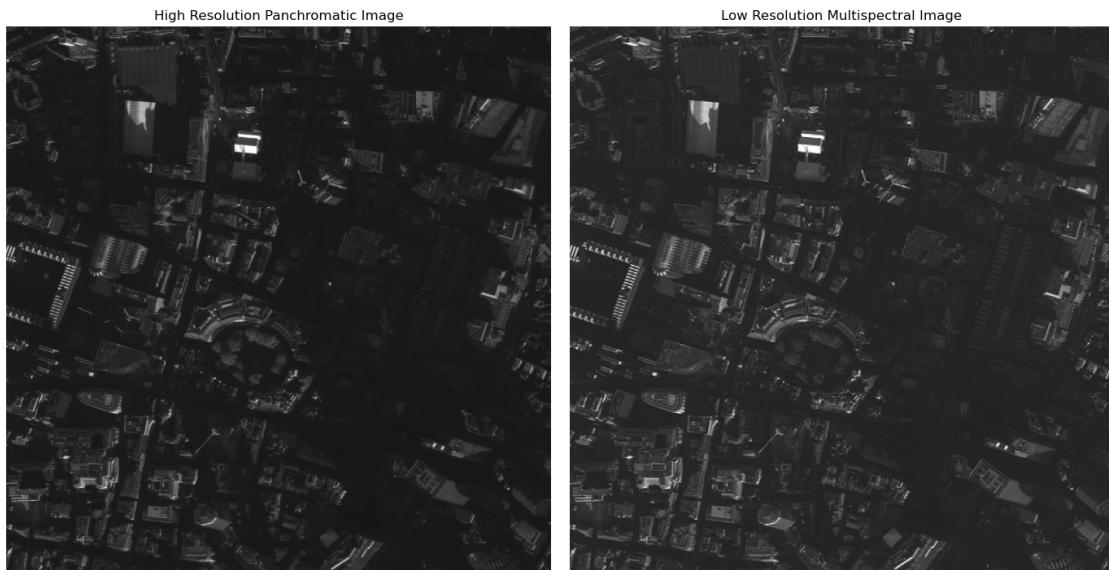
```

# preprocess
# pan = np.expand_dims(pan, -1)
# ms= np.transpose(ms, (1, 2, 0))

max_patch, min_patch = np.max(ms, axis=(0,1)), np.min(ms, axis=(0,1))
ms = np.float32(ms-min_patch) / (max_patch - min_patch)
max_patch, min_patch = np.max(pan, axis=(0,1)), np.min(pan, axis=(0,1))
pan = np.float32(pan-min_patch) / (max_patch - min_patch)

```

(2048, 2048, 1) (512, 512, 4)



## 5 Apply PCA Algorithm

```

[5]: fused_img = PCA(pan[:, :, :], ms[:, :, :])
print(pan.shape,ms.shape,fused_img.shape)

save_dir='./results/'
if not os.path.isdir(save_dir):
    os.makedirs(save_dir)

cv2.imwrite(save_dir+'GSA.tiff', fused_img[:, :, [0,1,3]])

```

get sharpening ratio: 4  
(2048, 2048, 1) (512, 512, 4) (2048, 2048, 4)

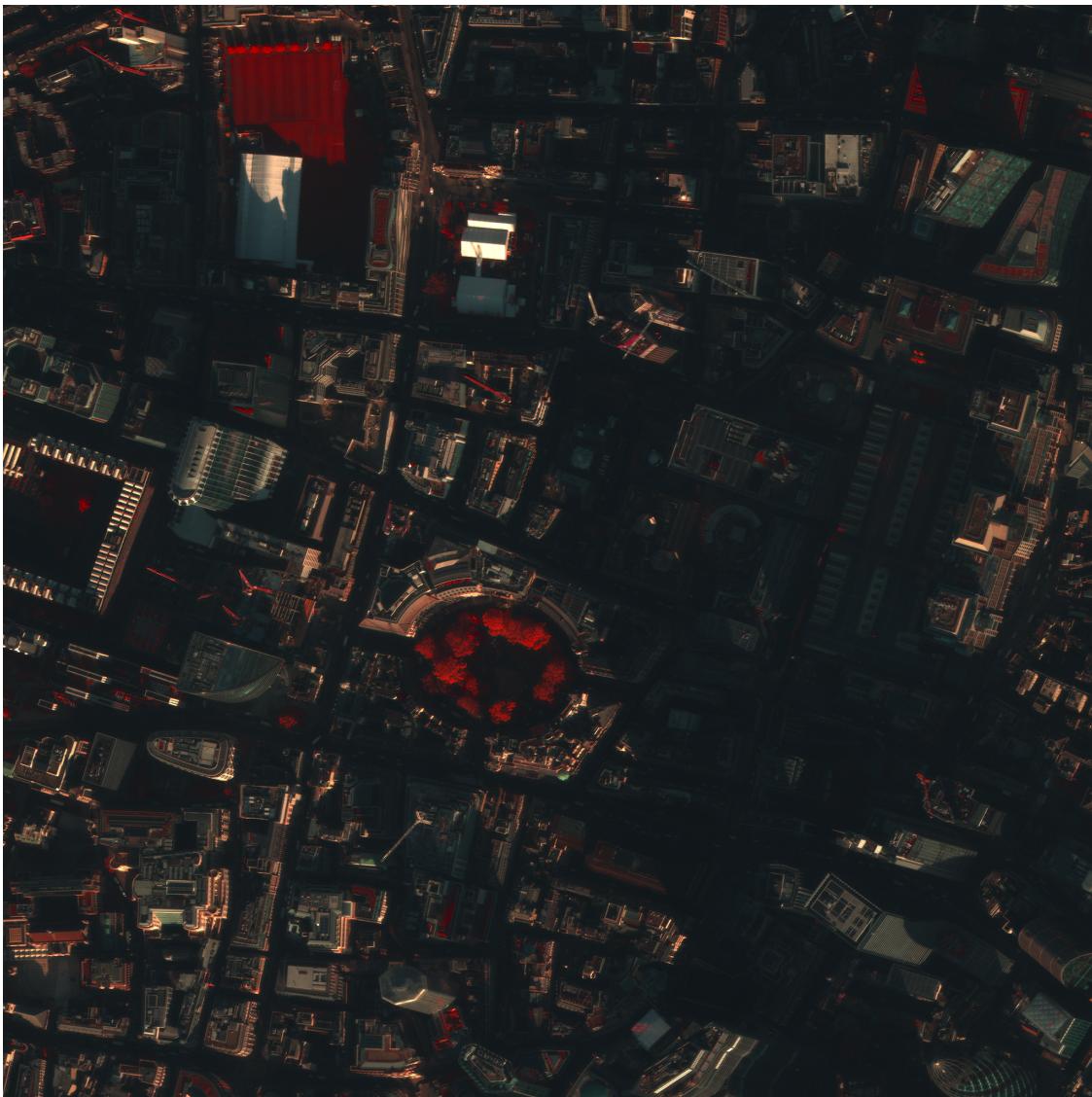
[5]: True

## 6 Printing Resulting Image

```
[6]: # Specify the path to your TIFF image
image_path = 'results/GSA.tiff'

# Open the TIFF image using PIL
image = Image.open(image_path)

# Display the image in the Jupyter Notebook with a centered title
display(image)
display(HTML("<div style='text-align: center;'><h1>High Resolution<br>Multispectral Image</h1></div>"))
```



<IPython.core.display.HTML object>