GNR 602 Programming Assignment

Implement a PCA based pan-sharpening algorithm.

Vivek Veer (200050158),
Poorna Teja (200050101),
Jithendra (200050068)

What is pan-sharpening

- Pan-sharpening is a technique used in remote sensing, satellite imagery to create a high-resolution color image by combining a high-resolution panchromatic (black and white) image with a lower resolution multispectral (colored) image.
- Pan-sharpening works by fusing the spatial resolution of the panchromatic image with the spectral information of the multispectral image. This is done by taking advantage of the fact that the panchromatic image has a higher spatial resolution than the multispectral image, while the multispectral image has better spatial resolution.

PCA based approach to pan-sharpening

- PCA (principal component analysis) is a mathematical method that identifies the most important patterns (principal components) in a dataset. In the context of multispectral images, PCA can be used to extract the most important spectral information from the image.
- To perform PCA-based pan-sharpening, the first principal component of the multispectral image is extracted and replaced with the panchromatic image. Inverse PCA transform is applied to get the pan-sharpened image.
- By replacing the first principal component with the panchromatic image, the new, pan-sharpened image retains the most important spectral information from the original multispectral image, while also having a higher spatial resolution.

Our Approach

- Georeferencing is essentially the process of taking a digital image or dataset and giving it a specific location on the earth's surface. This is important because it allows us to overlay this information on top of other maps or satellite images and make meaningful comparisons or analyses.
- Our algorithm employs the correlation between the panchromatic image and the luminosity values in the multispectral image to enhance the spatial resolution of the multispectral image while preserving the color information, through a combination of PCA transformation and appropriate scaling of the luminosity values.

Extracting the RGB bands out of MS geotiff image

```
from osgeo import gdal
import numpy as np
from PIL import Image

# Open the GeoTIFF file
src = gdal.Open("ms.tif")

# Get the RGB bands (bands 1, 2, and 3)
red_band = src.GetRasterBand(1).ReadAsArray()
green_band = src.GetRasterBand(2).ReadAsArray()
blue_band = src.GetRasterBand(3).ReadAsArray()
```

```
# Stack the bands into a 3D array and convert
to 8 bit pixel values
rgb = np.dstack((red_band, green_band,
blue_band))
rgb = (rgb / 8).astype(np.uint8)

# Create an Image object from the RGB array
image = Image.fromarray(rgb, 'RGB')

# Save the image to disk
image.save("rgb_image.png")
```

Similarly we have written code to generate grayscale images out of panchromatic geotiff image

Implemented Algorithm

```
multiband = imread('rgb.png');
uniband = imread('gray.png');
% upscale multiband image (again, color image and same size than original
% but less information)
interpolated=imresize(multiband,[size(uniband,1) size(uniband,2)]);
% reshape into a three-dimensional multivariate X = (R, G, B)
X=double(reshape(interpolated,numel(interpolated)/3,3));
% compute the components and the projections onto the PCA space
[C,Y]=pca(X);
% substitute the first projection by the uniband image (properly scaled in luminosity)
Z=Y;
Z(:,1)=(double(uniband(:)-min(uniband(:)))./double(max(uniband(:))-min(uniband(:))))*(max(Y(:,1))-m
in(Y(:,1)))+min(Y(:,1));
% Invert the projection and rescale luminosity (compute the pixels in the
% original (R, G, B) space
G=Z*C';
I = (G - min(G(:)))/(max(G(:))-min(G(:)));
% reshape from (R, G, B) multivariate to an RGB image
merged = reshape(I, size(interpolated));
imwrite(merged, 'merged.png');
```

Results

Refer to input & output folders of our github repository