Practical Implementation of PCA on Satellite Images

Image Corresponding to First PC

R Band image after applying PCA does not carry any significant information about the region. It can be neglected for increasing classification accuracy.

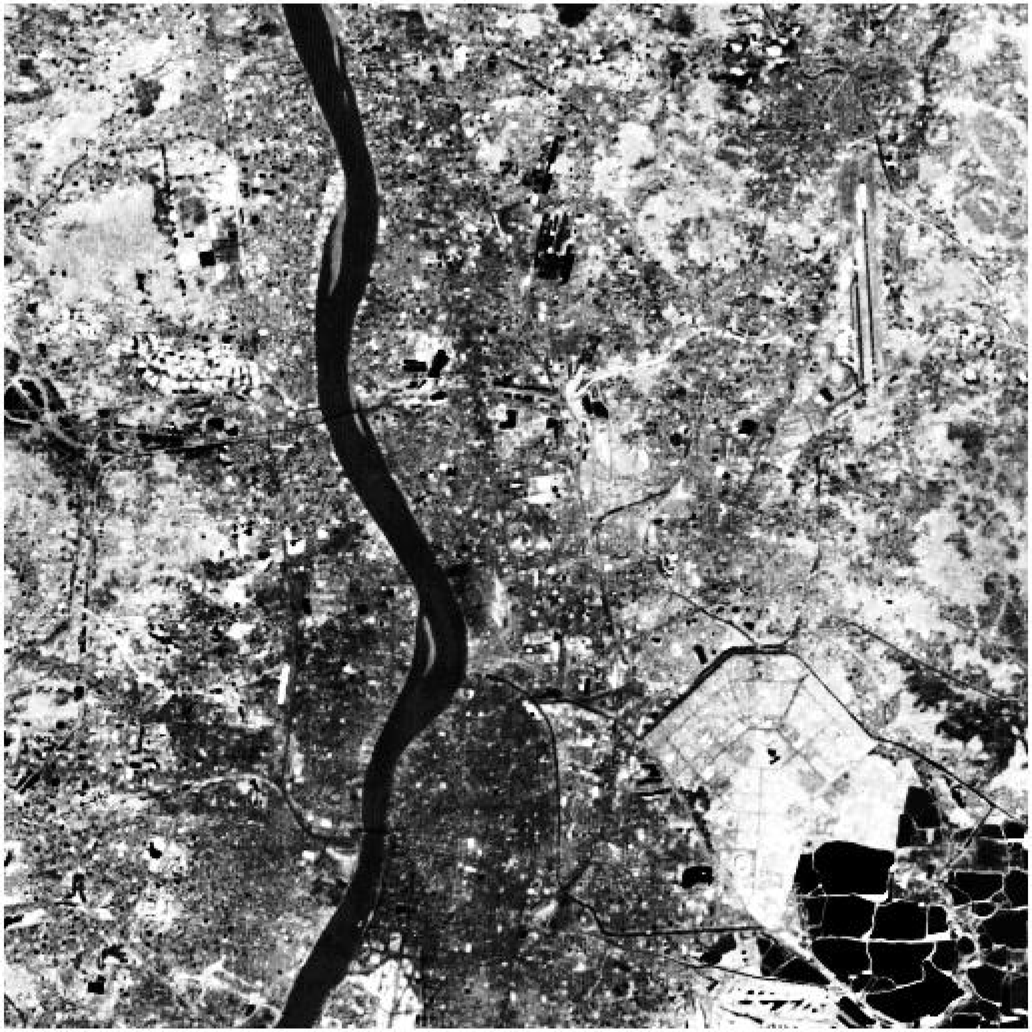
Image Corresponding to Second PC

G Band image after applying PCA does carry not much enough information about the region. It can also be neglected for increasing classification accuracy.

Image Corresponding to Third PC

B Band image after applying PCA carry most significant information about the region. Here Dimensionality reduction will ensure less computationally complexity.

Image Corresponding to Fourth PC



I Band image after applying PCA also carry most significant information about the region. Here Dimensionality reduction will ensure less computationally complexity.

Steps to be followed for Dimensionality reduction

- Find the Covariance matrix for 4 dimensional feature vector **(R, G, B, I)** being considered **512 *512** size image for taking feature values for all the Image band. The size of Covariance matrix : **4 * 4**. The Covariance Matrix is as follows:

Covariance Matrix →

	1	2	3	4
1	7.3905	6.3713	8.8583	2.0594
2	6.3713	6.6022	8.8505	3.5768
3	8.8583	8.8505	15.7501	3.9673
4	2.0594	3.5768	3.9673	37.8072

- Compute the Eigen Vector and Eigen Value of the Covariance Matrix. It is as follows:

Eigen Vector →

	1	2	3	4
1	0.5797	0.6532	0.4545	0.1749
2	-0.8049	0.3701	0.4154	0.2063
3	0.1222	-0.6605	0.6830	0.2867
4	0.0322	-0.0014	-0.3929	0.9190

Eigen Values →

Diagonal elements

	1	2	3	4
1	0.5264	0	0	0
2	0	2.0388	0	0
3	0	0	24.7450	0
4	0	0	0	40.2399

- For each Eigen value of the covariance matrix the corresponding Eigen vector has to be computed for R, G, B and I band Image.

- Apply Linear Transformation in the following manner

$$Y_k = \sum_{i=1}^{M} a_{ki} X_i$$

$$a_{ki} = Transformation\ Matrix$$

$$X_i = Feature\ vector$$

$$k = 1, 2, 3 \ldots \ldots \ldots .. M\ no\ of\ featurs$$

- **Principal Components :**

$$PC1 = \underline{a}_1{}^T \times \begin{pmatrix} X_1(i,j) \\ X_2(i,j) \\ X_3(i,j) \\ X_4(i,j) \end{pmatrix}$$

Scalar value 1 *4 4 *1

$$PC3 = \underline{a}_3{}^T \times \begin{pmatrix} X_1(i,j) \\ X_2(i,j) \\ X_3(i,j) \\ X_4(i,j) \end{pmatrix}$$

Scalar value 1 *4 4 *1

$$PC2 = \underline{a}_2{}^T \times \begin{pmatrix} X_1(i,j) \\ X_2(i,j) \\ X_3(i,j) \\ X_4(i,j) \end{pmatrix}$$

Scalar value 1 *4

$$PC4 = \underline{a}_4{}^T \times \begin{pmatrix} X_1(i,j) \\ X_2(i,j) \\ X_3(i,j) \\ X_4(i,j) \end{pmatrix}$$

Scalar value 1 *4 4 *1

Few Points to display output image

- Apply this command to display the **principal component(PC)** image for visualization purposes:

  imshow(histeq(uint8(out_img1)));

- If **sum of the Eigen values** = **Sum of the variance** (Diagonal element of covariance matrix) of the covariance matrix then the Eigen values for the corresponding covariance matrix is correct.