Rajshahi University of Engineering & Technology

Heaven’s Light is Our Guide

Feature Mining for Effective Subspace Detection of Hyperspectral Image Classification

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Outline

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- Hyperspectral Images
- Objectives
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- Classification
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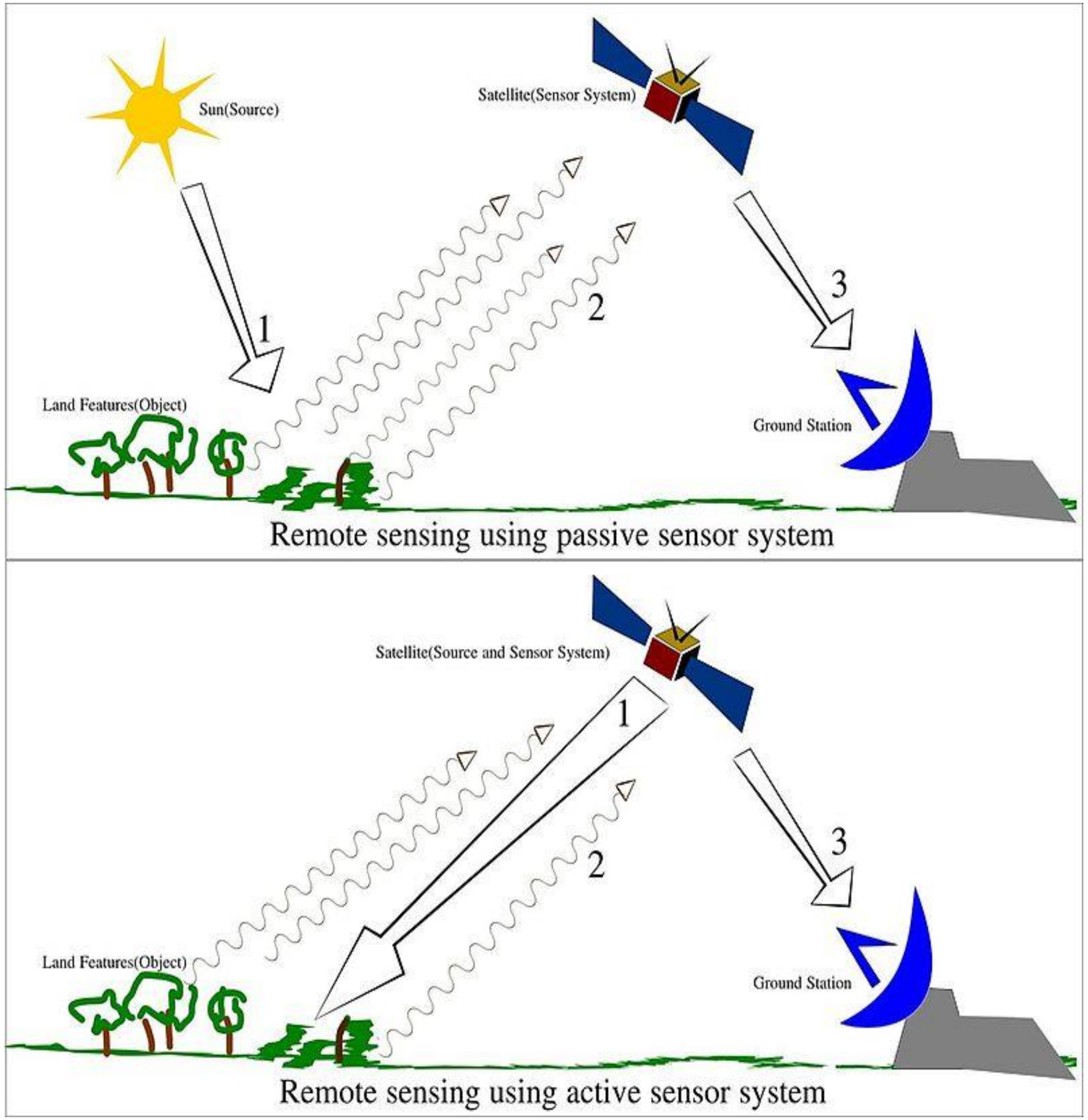
Remote Sensing

- ❖ What is remote sensing?
  - ❖ Acquisition of information about an object without making physical contact with the object
  - ❖ Used in geography, land surveying, military, intelligence and planning

- ❑ Types:
  - ❑ Passive Remote Sensing
  - ❑ Active Remote Sensing



Remote Sensing(Con't)

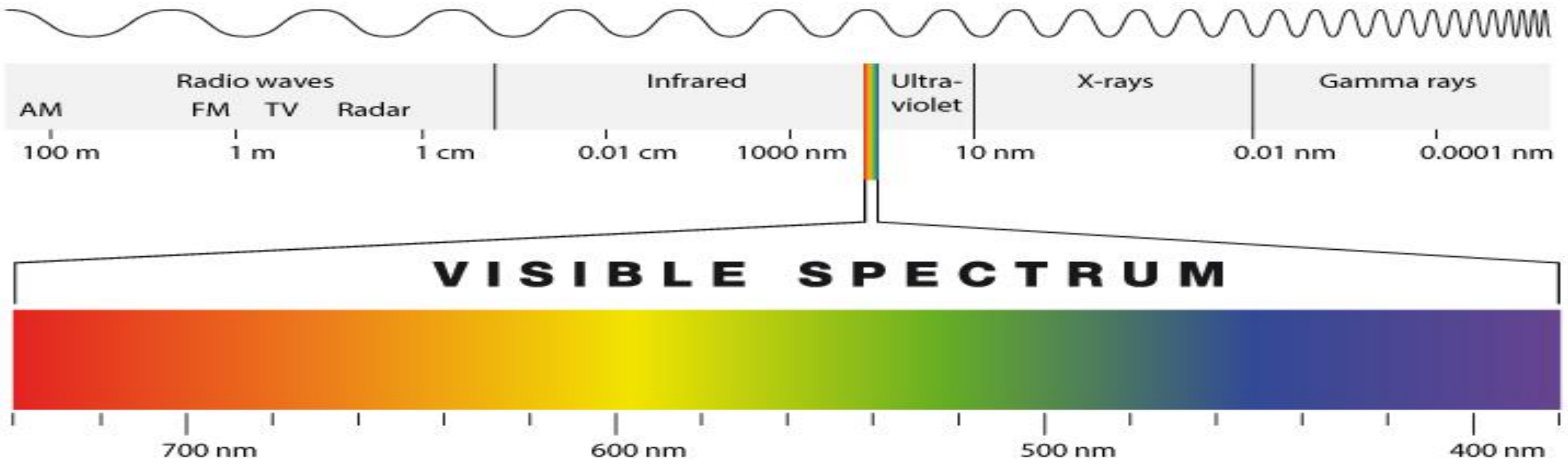


Figure: Electromagnetic Spectrum

Figure: Survilence aircraft

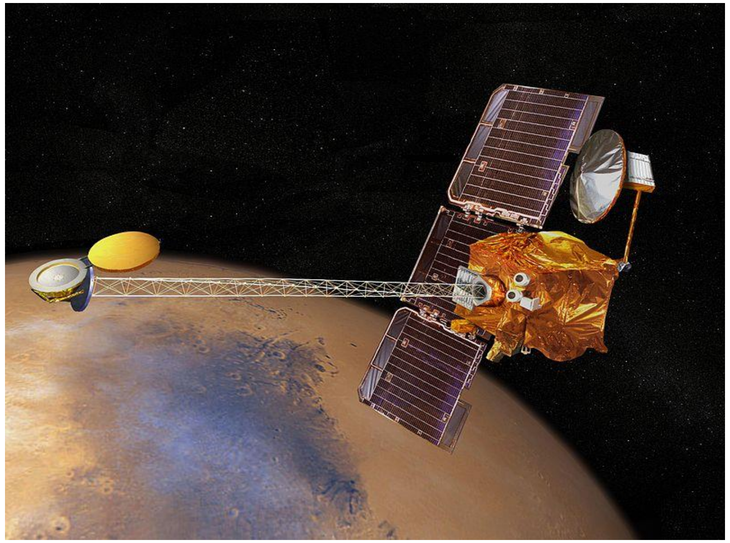


Figure: Remote sensing satellite

- ❖ Visible and infrared range of wavelengths represents only part of the story in remote sensing
- ❖ Can also image the earth in microwave range

Hyperspectral Images

Figure: Two dimensional projection of Hyperspectral cube

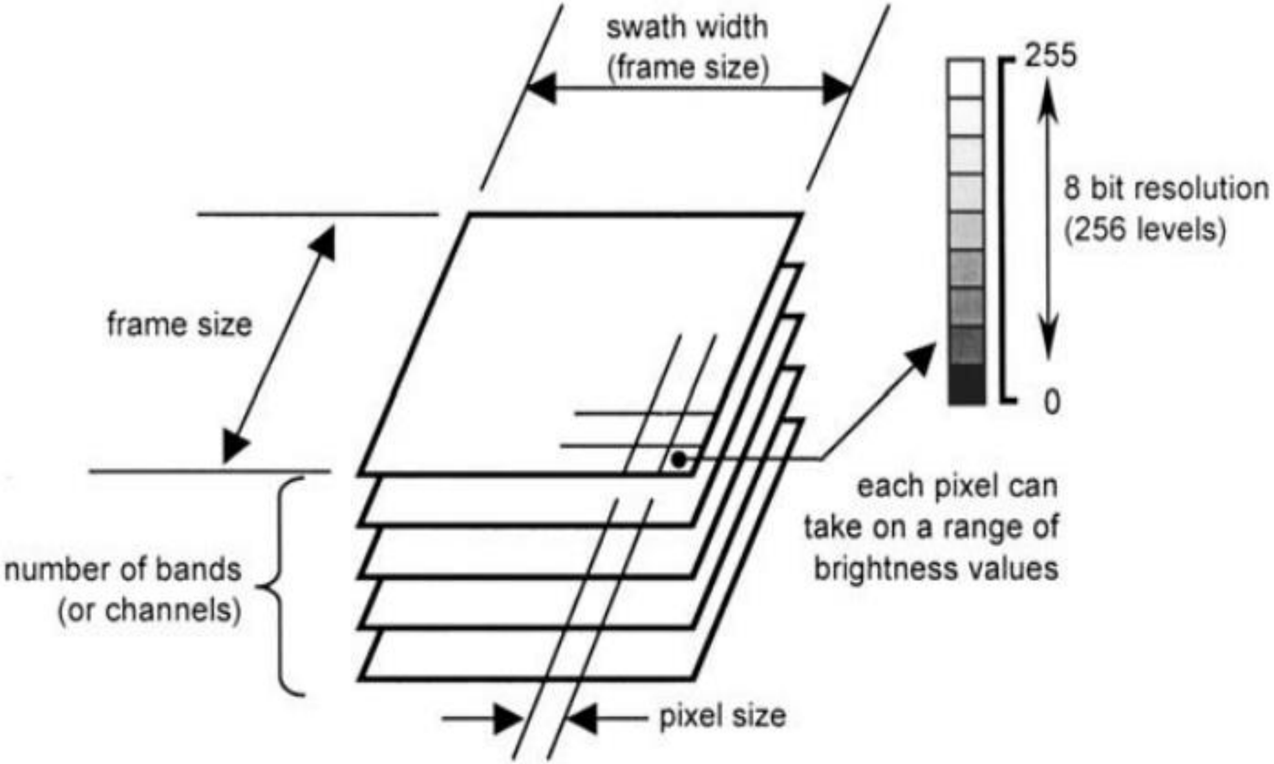


Figure: Technical characteristics of digital image data[2]

Challenges with Hyperspectral Images

- ❖ Curse of dimensionality
- ❖ High correlation among data
- ❖ All the feature are not equally important

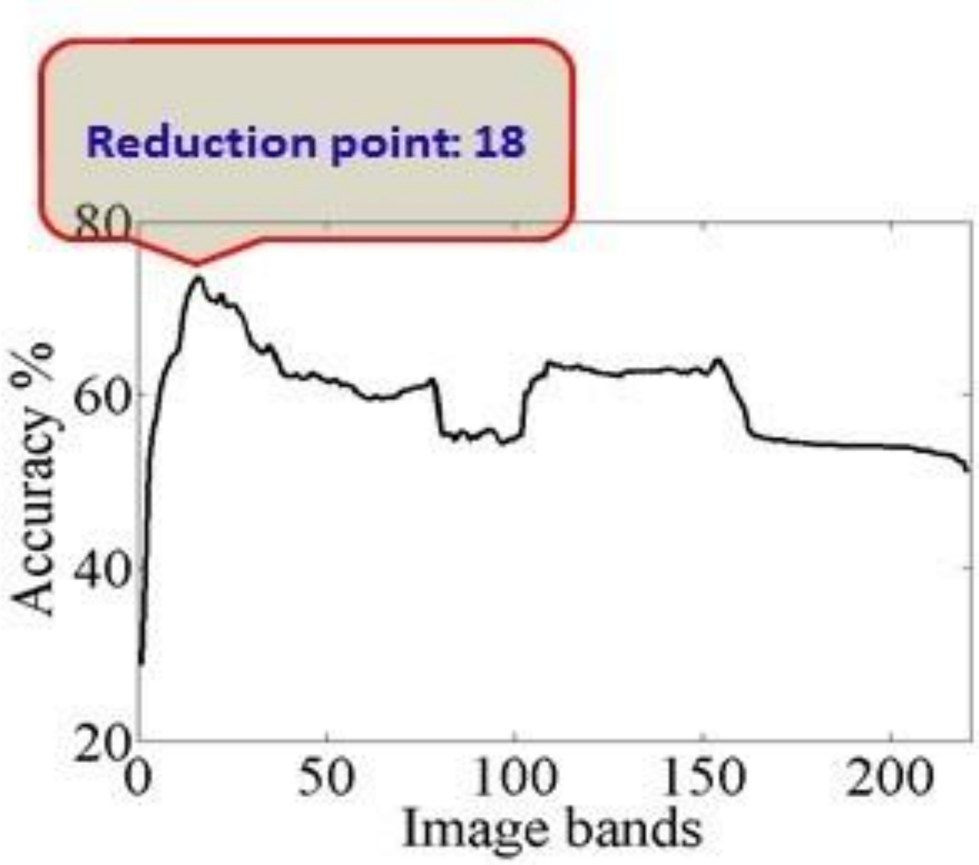


Figure: Curse of dimensionality [4]

Motivations and Objectives

- Extract only relevant features
- Address curse of dimensionality
- Improve classification accuracy

Proposed Method

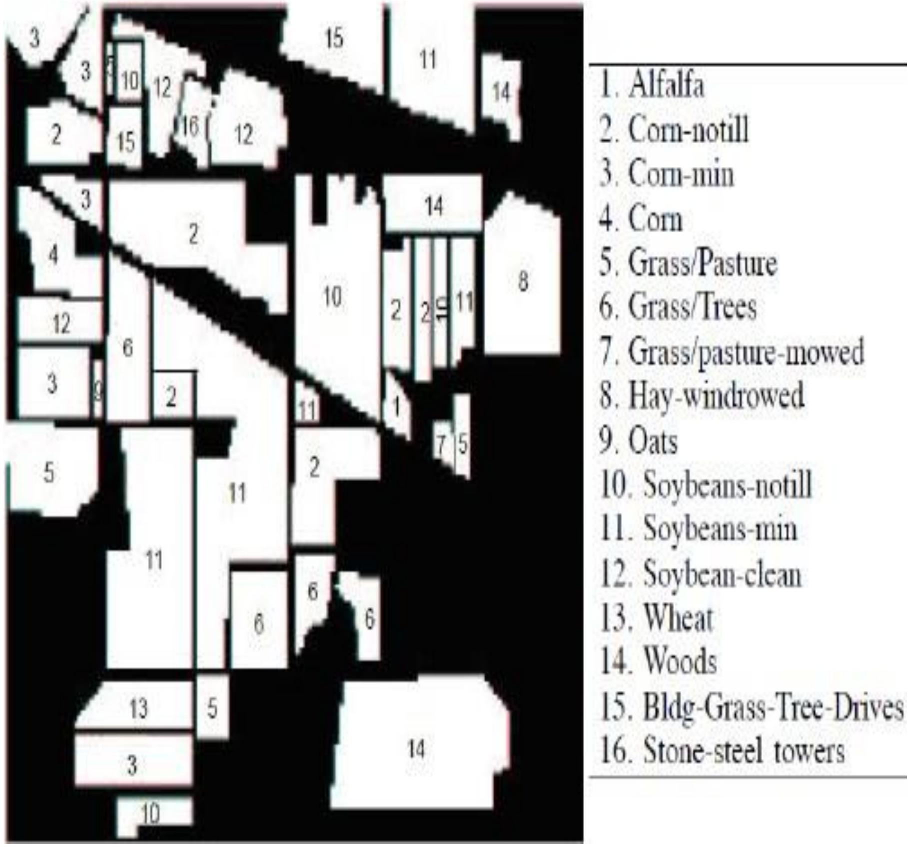
Collaboration of feature mining and classification

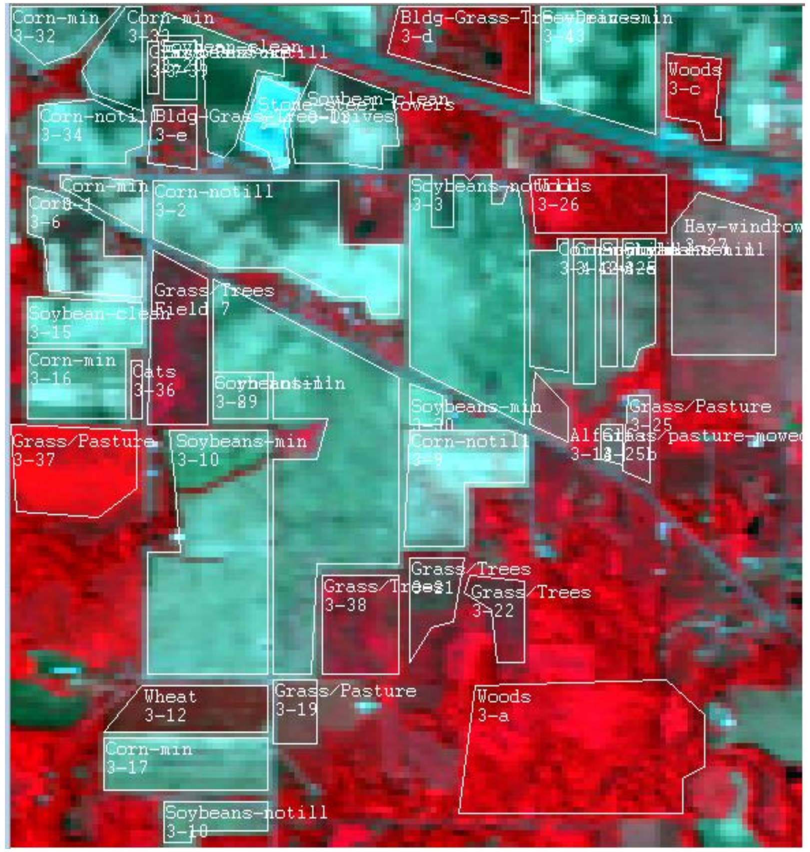
- **Feature Extraction:**
  Principal Component Analysis(PCA)
- **Feature Selection:**
  Mutual Information(MI)
- **Classification:**
  Support Vector Machine(SVM)

Data Set for Analysis

Data Set:
220 Band AVIRIS Hyperspectral Image
Date:
June 12, 1992 Indian Pine Test Site 3
Version 1.0

- Dataset: AVIRIS 92AV3C
- Spectral Resolution:
  0.4μ m-2.5 μ m
- Spatial Resolution: 30m
- Band: 220
- Classes:16
- Pixels: 145 x 145





Feature Extraction

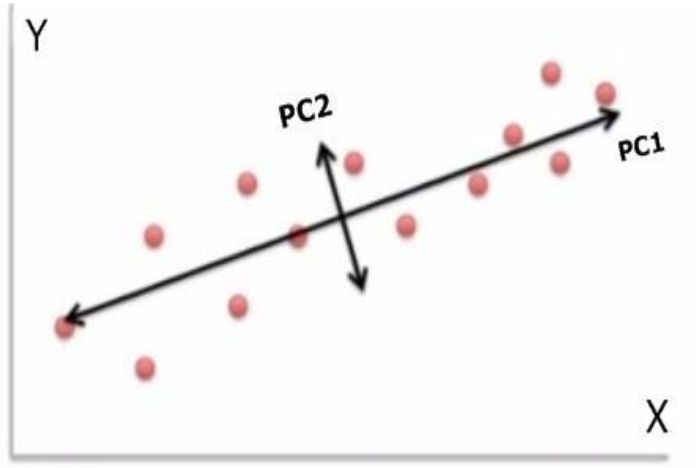
- Feature means unique measurable characteristics of an image/observed object.
- Feature extraction means creating new features which have the essence of original features.
- Feature extraction helps to obtain relevant information from large dataset.

Principal Component Analysis(PCA)

- Only relevant features are obtained
- Dimensionality reduced
- Increase classification accuracy

Feature extraction using Principal Component Analysis(PCA)

- Principal Component Analysis (PCA) is a process of reduction input dimensionality.
- Transformed data is a set of orthogonal uncorrelated variables called principal components(PC)



Feature extraction using Principal Component Analysis(PCA)(Con’t)

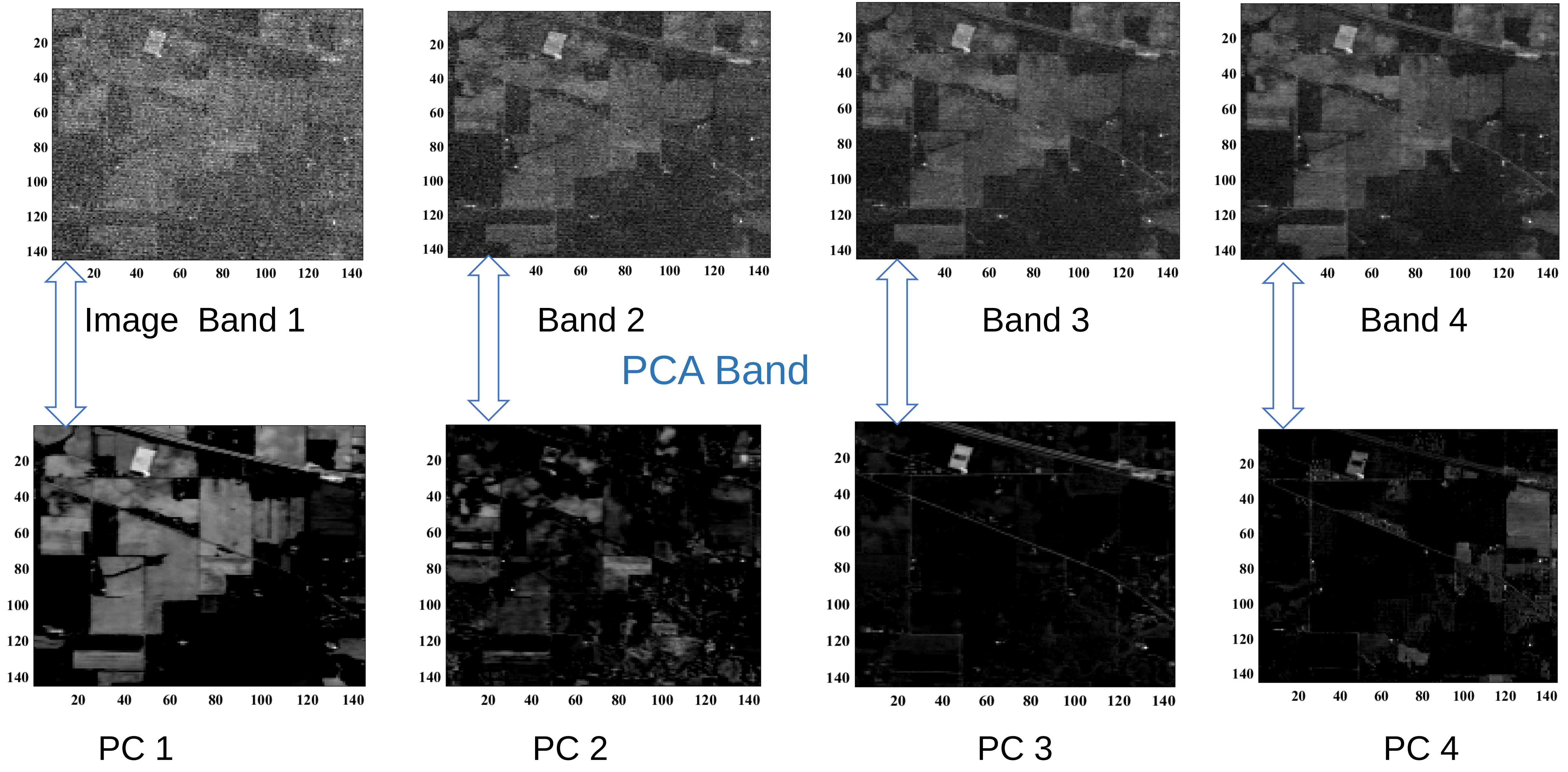
All the steps we need to perform Principal Component Analysis[1]:

- **Step 1:** Input the image
- **Step 2:** Subtract the mean
- **Step 3:** Calculate the covariance matrix
- **Step 4:** Calculate the eigenvectors and eigenvalues of the covariance matrix
- **Step 5:** Choose components and forming a feature vector

  FeatureVector = (eig1 eig2 eig3…eign)
- **Step 6:** Derive the new data set

  FinalData = RowFeatureVector x RowDataAdjust

Original Band



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Result Principal Component Analysis(PCA)

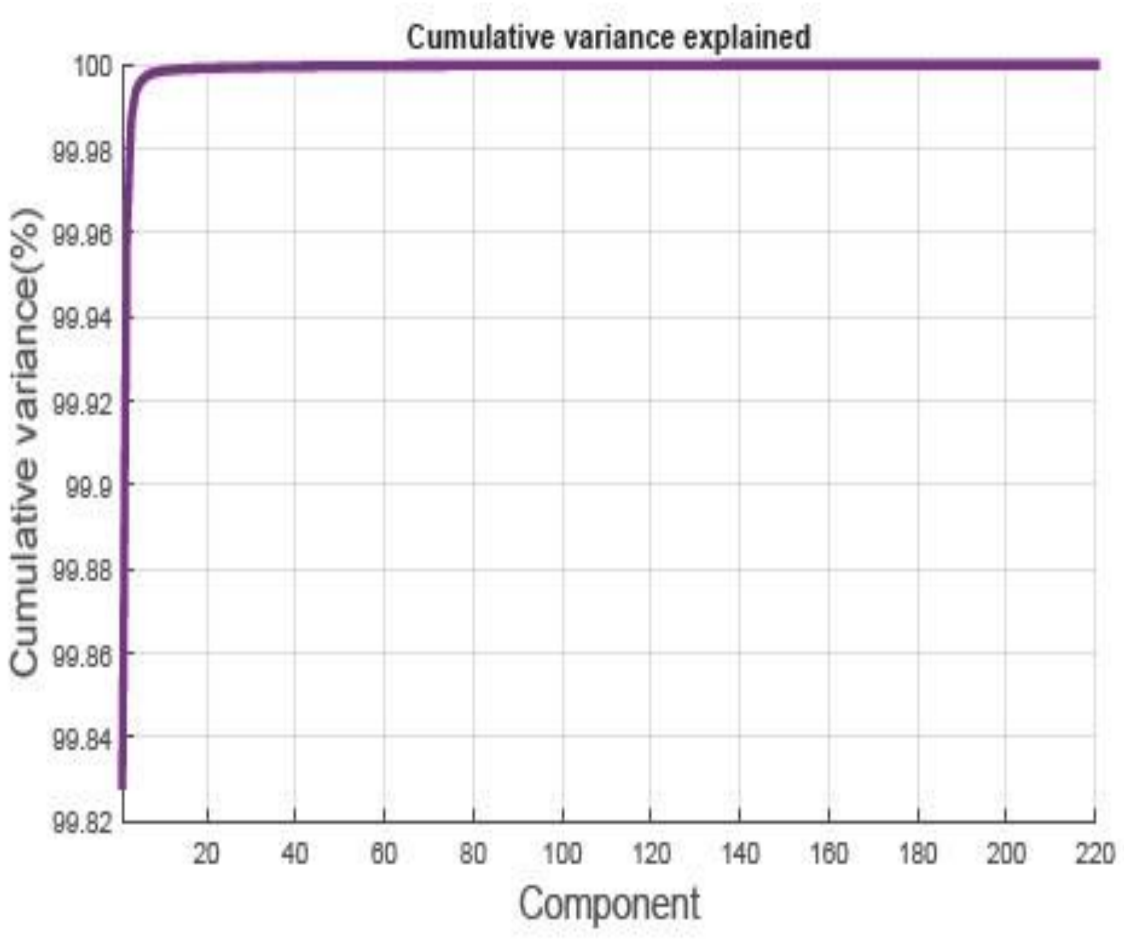
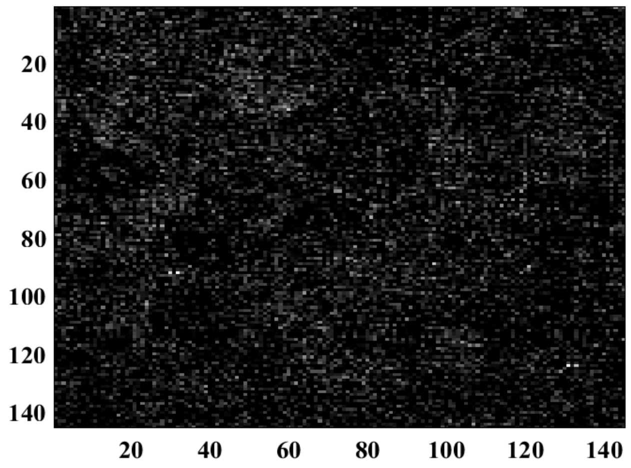


Figure: Cumulative variance

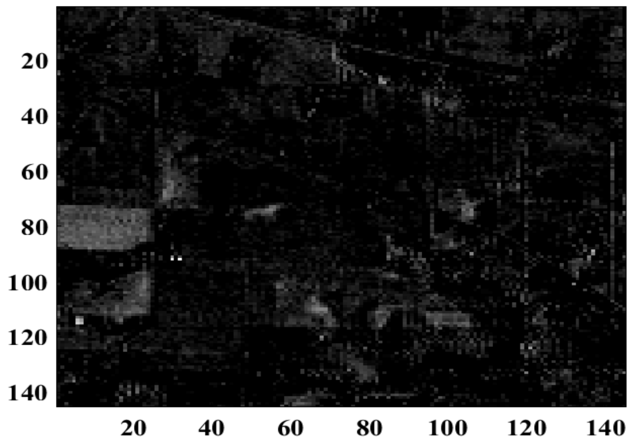
After principal component analysis first **14 band** or component has **99.80%** variance of the dataset.

Limitations Principal Component Analysis(PCA)

- PCA assumes that data is normal distributed and high variance data contains more information.
- Here though PC 8 has high variance but it contains less information of image contents.
- On the other hand PC 9 has low variance but it contains more information of image contents.
- This is the problem that I want to address in my future work.



PC 8



PC 9

Classification

One-against-one support vector machine (SVM)[3] classifier to classify 14 classes

Steps of classification:

Step 1: Get train and test data
Step 2: Scale data set into 0 to 1
Step 3: Calculate best c and gamma for RBF kernel of SVM

- 10 fold cross validation was used

Step 4: Train and Test SVM

- Radial basis function (RBF) kernel was used

Class Name	Train	Test
Alfalfa	12	12
Corn-notill	42	36
Corn-min	49	42
Corn	30	30
Grass/Pasture	49	42
Grass/Trees	48	48
Hay-windrowed	77	88
Soybeans-notill	117	117
Soybeans-min	120	84
Soybean-clean	54	54
Wheat	54	60
Woods	120	96
Bldg-Grass-Tree-Drives	63	48
Stone-steel towers	25	24

Table: Data set

Conclusion

- 14 class is selected
- Selecting first 14 features after applying PCA gives 80.40% accuracy

Data set	C	g
Original Data	10	2.85
PCA Data	10	0.83

Data set	Classification Result (First 14 features only)
Original Data	51.08%
PCA Data	80.40%

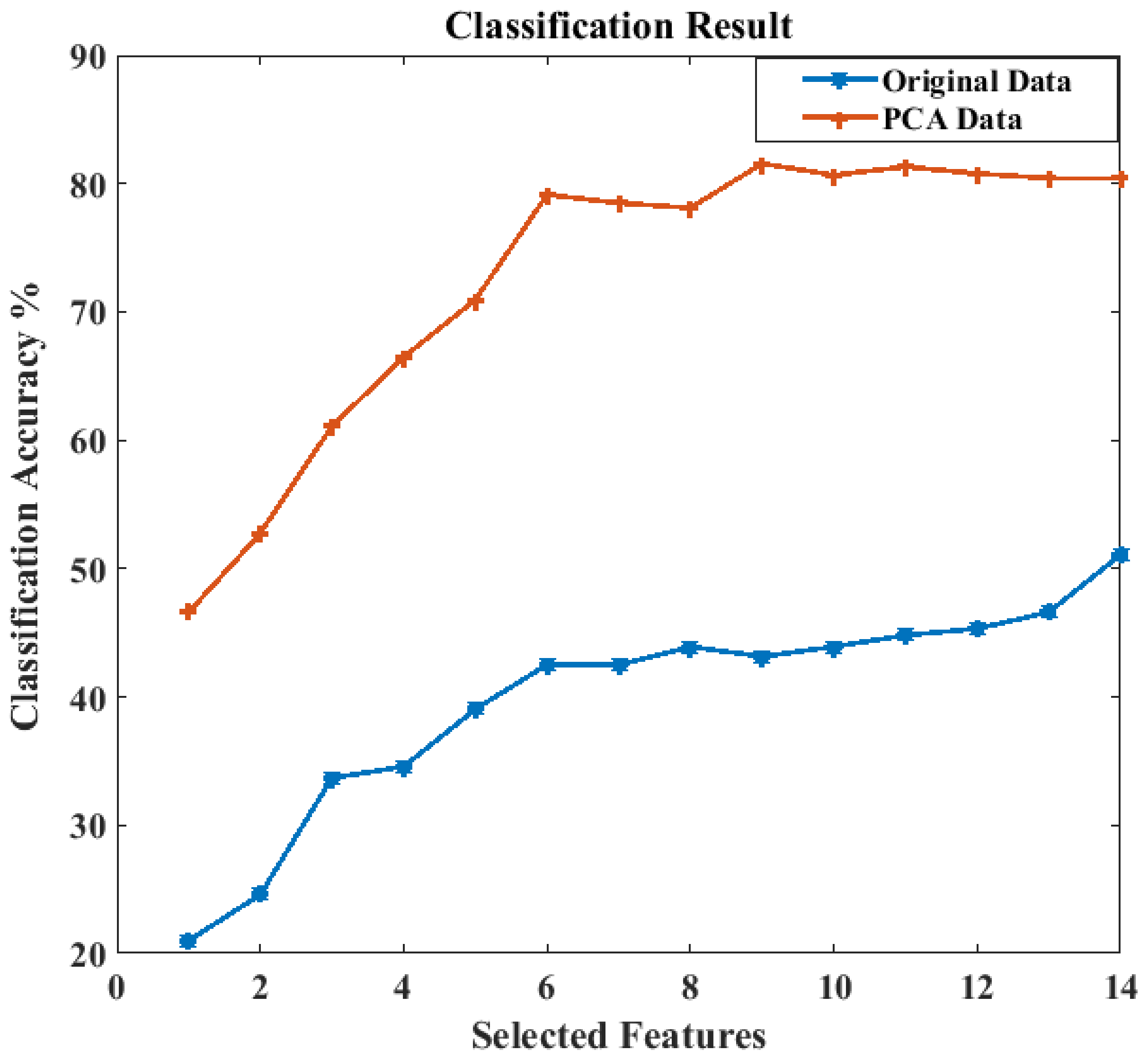


Figure: Comparison of classification result of original data and PCA data.

Future Work

- ❖ Subset features are selected after PCA
- ❖ Efficient feature selection technique can be applied for better classification accuracy like mutual information(MI)

Acknowledgement

Special thanks to
Professor Dr. David A. Landgrebe, Purdue University

References

[1]Lindsay I Smith, “A tutorial on Principal Component Analysis”, February 26,2002.

[2]John A. Richards and Xiuping Jia, Remote Sensing Digital Image Analysis 4th edition, Verlag: Springer 2006.

[3]Chih-Wei Hsu, Chih-Chung Chang, and Chih-Jen Lin,Department of Computer Science, National Taiwan University, Taipei 106, Taiwan,"A Practical Guide to Support Vector Classication", Initial version: 2003, Last updated: May 19, 2016.

[4]Md. Ali Hossain, Xiuping Jia, Senior Member, IEEE, and Mark Pickering, Member, IEEE, ”Subspace Detection Using a Mutual Information Measure for Hyperspectral Image Classification”

The End

Thank You