Target Class Oriented Subspace Detection for Effective Hyperspectral Image Classification

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Objectives

To Achieve high classification accuracy in hyperspectral image classification.We proposed a target class oriented feature reduction method which incorporates the normalized Mutual Information (NMI) over PCA images to maximize the relevance of the selected subspace.

1. Ground object detection
2. Achive high classification accuracy
3. Minimize curse of dimensionality problems

Introduction

In recent years, the hyperspectral image sensor has developed into one of the most powerful and fastest growing technologies in the area of remote sensing. This sensors provides data cube which contains rich information for wide range of application including effective land cover detection and classification. But this large data presents some challenges while classifying into constituesnt objects.We proposed a method called TCOSD to overcome the challenges while identifying one ground object at a time e.g. forest.

Proposed Method

The Proposed method is summarised as follows:

1. Perform PCA and generate new features
2. Extract the training data and training label
3. Consider one class as target at a time, i.e, make a class as target and all other class as background.
4. Apply NMI between the training labels and the principal components.
5. Select the best principal component based on the high value of NMI. List the selected subset.
6. Apply the Eq. (1) for selecting multiple features based on NMI for the target class.
7. Apply the selected features to the KSVM classifier.
8. Repeat step 3 to 6 by making another class as target and the remaining as background.

$$\hat{R}(\mathbf{Y}_i, k) = \hat{I}(\mathbf{Y}_i, \mathbf{C}) - \frac{1}{k} \sum_{\mathbf{Y} = S_k} \hat{I}(\mathbf{Y}_i, \mathbf{Y}), \mathbf{Y}_i \notin S_k \quad (1)$$

We call this method as Target Class Oriented Subspace Detection (TCOSD).

Results

Method	C	γ
Org+NMI	10	2.44
PCA	19	2.40
PCA+NMI	16	0.7
TCOSD	5	0.75

Table 3: Details of parameter for KSVM(RBF kernel)

Target class	Order of selected features
Hay-windrowed	PC: 4,1,17,5,12,3,16,2
Soybean-notil	PC: 1,17,16,11,20,14,13,3
Woods	PC: 1,16,17,3,15,11,5,20
Wheat	PC: 6,19,17,3,12,16,11,5
Grass/trees	PC: 4,9,5,6,16,17,2,1
Soybean-min	PC: 1,17,16,3,5,12,11,9
Corn-min	PC: 1,17,16,5,11,3,20,19
Stone-steel	PC: 3,4,1,17,16,10,5,11
Alfalfa	PC: 4,17,15,20,3,16,6,12
Grass/Pasture	PC: 9,3,17,6,16,11,1,15
Corn-notill	PC: 1,17,2,16,11,18,20,19
Soybean-clean	PC: 1,15,17,3,16,20,12,11
Corn	PC: 1,19,17,16,18,8,11,3
Bldg-Grass	PC: 15,16,17,3,18,11,19,4

Table 4: Selected features with the proposed method

Experimental Dataset

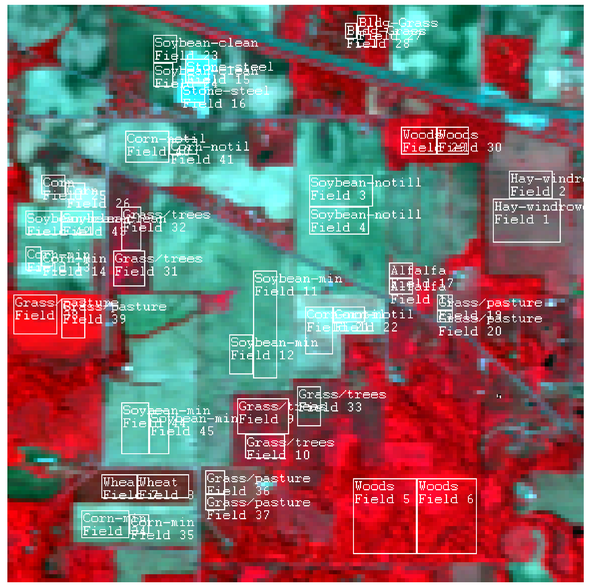

Figure 1: AVIRIS 92AV3C Dataset

The Indian Pines scene contains two-thirds agriculture, and one-third forest or other natural perennial vegetation.

Class name	Train	Test
Hay-windrowed	187	77
Soybean-notil	128	105
Woods	367	341
Wheat	54	78
Grass/trees	249	115
Soybean-min	253	115
Corn-min	253	115
Stone-steel	36	30
Alfalfa	24	24
Grass/Pasture	156	92
Corn-notill	172	60
Soybean-clean	96	78
Corn	30	15
Bldg-Grass	40	12
Total	1900	1179

Table 1: Details of the train and test samples

Conclusion

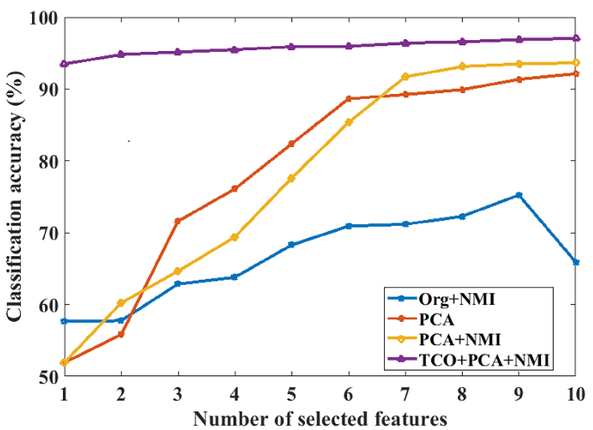

Figure 2: Classification result of AVIRIS 92AV3C

- It is clear that the proposed method is able to identify a better subspace which can offer the best classification accuracy among the standard approaches examined.
- This is because the proposed method selects the most relevant subset of images for required classes.

Method	Classification Result
Org+NMI	72.26%
PCA	89.90%
PCA+NMI	93.12%
TCOSD	96.57%

Table 2: Classification result for 8 features

References

[1] M. A. Hossain, X. Jia, and M. Pickering. Subspace detection using a mutual information measure for hyperspectral image classification. *IEEE Geoscience and Remote Sensing Letters*, 11(2):424–428, Feb 2014.

[2] M. A. Hossain, X. Jia, and M. Pickering. Improved feature selection based on a mutual information measure for hyperspectral image classification, 07 2011.

Future Research

This method needs some further improvement to handle the complex class relationships where only a few feature may not capable to complete the task.

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