A Novel Approach to Implement Feature Extraction of Hyperspectral Images

1Mr. Amol D. Sardare, Prof. Vijaya. K. Shandilya2
1Information Technology, Amravati , Sipna COET, Amravati, India
2Computer Science and Engineering, Amravati , Sipna COET, Amravati, India

Abstract

Feature extraction is known to be an effective way in both reducing computational complexity and increasing accuracy of Hyperspectral image classification. In this thesis work, a simple yet quite powerful feature extraction method is proposed. First, the hyper spectral image is partitioned into multiple subsets of adjacent hyper spectral bands. Then, the bands in each subset are processed by using image fusion. The fused bands are processed with recursive filtering to get the resulting features for classification. Experiments are performed on different hyperspectral images, with the support vector machines (SVMs) serving as the classifier. By using the proposed method, the accuracy of the SVM classifier can be improved significantly. The method is design to get performance in terms of classification accuracy and computational efficiency.

Keywords: Hyperspectral Images, Feature Extraction, Image Fusion, Recursive Filtering, Image Classification

1.INTRODUCTION

Work on Hyper-spectral images is in recent trend, the high spectral images are extracted with hyper-spectral satellite sensors, such as the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). Before use of hyper spectral images, from the 1970s, multispectral images are in use.

Hyper spectral images are spectrally over determined; they provide sample spectral information to identify and distinguish between spectrally similar (but unique) materials. Hyper spectral image also provides the potential for more accurate and detailed information extraction than is possible with other types of remotely sensed data. Hyper spectral Images also provide detailed spectral information regarding the physical nature of the materials and thus can be used to distinguish different landscapes.

However, for developing efficient methods to process hyper spectral images with more than 100 channels is a difficult objective. The high dimensionality are also brings the problem named as “Hughes phenomenon” which will influence the classification performance. In order to solve these problems, feature selection and extraction are known to be important techniques in hyper spectral image classification.

2. LITERATURE SURVEY

M. Pal and G. M. Foody [1] authors proposed a system SVM based features selection methods classification of hyper spectral data. But, they were not attended Recursive filtering.

S. B. Serpico and G. Moser [2] authors introduced a system for classification purposes they used a method Extraction of spectral channels a procedure to extract spectral channels of variable bandwidths and spectral positions from the hyper spectral image for optimize the accuracy for a specific classification problem. But, the Computational accuracy is very less, taking more time for classification of data.

S. Backer, P. Kempeneers, W. Debruyne, and P. Scheunders [3] they adapted a system on a Spectral classification based on band selection technique, they explained hyper spectral remote sensing where sensor acquire reflectance values at many various wavelength bands for covering a spectral interval. But, the Complexity of data is very high.

L. Bruzzone and C. Persello [4] presented a system on a approach to feature selection for the classification of hyper spectral images. The feature selection is accomplished by defining multi objective criteria on function made up of two terms: 1) a term that measures the class separability and 2) a term that evaluates the spatial invariance of the selected features. But, they were not attended Feature selection and feature extraction.

M. Pedergnana, P. R. Marpu, M. D. Mura, J. A. Benediktsson, and L. Bruzzone [5] was introduced a system based on Optimal feature selection in attribute profiles based on genetic algorithms. But, their Computational times are more and also not attending classifier for classification of data.

J. Benediktsson, M. Pesaresi, and K. Amason [5] proposed a system based on Morphological transformations based Classification and feature extraction. Classification of panchromatic high-resolution data from urban areas using morphological and neural approaches was proposed by. But, their Computational efficiency and computational accuracy are very less.

K. He, J. Sun, and X. Tang [7] the author proposed a removal of Single image haze. They introduced a simple image prior which can be used in dark channel prior. But, their Computational time is more.

C. H. Lin, J. S. Tsai, and C. T. Chiu [8] a system based on switching bilateral filter (SBF) with a texture and noise detector for universal noise removal Operation. But, their Computational complexity is more and computational accuracy is very less.

X. Kang, S. Li, and J. A. Bendiktsson [9] authors proposed a system based on the integration of spatial context in the classification of hyper spectral images is
known to be an effective way in improving classification accuracy. But, they were not attended Recursive filtering. In this thesis I am attending SVM classifier for classification of data as well as also attending Recursive filtering.

From the above discussion and literature survey about feature extraction of hyperspectral images, I concluded that its having some limitations such as some authors does not attending Recursive filtering, without attending feature selection and extraction, author classify the hyperspectral images, also requiring more computational time and computational complexity, Computational efficiency and accuracy are very less.

From above point to motivate me for implementing a novel approach to implement feature extraction of hyperspectral images from covering all above limitation which can be used to reduced computational time and computational complexity. Also, increasing computational efficiency and accuracy

3. ANALYSIS OF PROBLEM

High spectral resolution images such as the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). Hyper spectral Images provide detailed spectral information regarding the physical nature of the materials and thus can be used to distinguish different landscapes. However, developing efficient methods to process hyper spectral images with more than 100 channels is a difficult objective.

Hyper spectral images contain thousands of bands that provide the highest class separability form that finding the best subset is the major problem. Selecting the best subset of data without disturbing the physical meaning of the data. The preservation of the spatial information is also quite important for feature selection and performing selection on the hyper spectral image.

Hyper spectral images shows detailed information about spectral images so the resulting expected outcomes are taking too many times so it suffering from the high dimensions of the data and increasing the computational complexity of the data. To reduce dimensions of data and complexity of data is the major problem.

The fused images do not shows the expected resulting features classification map. Also the resulted classifier map suffered from less computational accuracy and computational efficiency. To increase the computational accuracy and computational efficiency is the main challenge.

4. SYSTEM DESIGN AND IMPLEMENTATION

4.1 Objectives

Our objective is to reduce the computational dimensionality, computational time and computational time and increase the accuracy of the data and efficiency of data by the use of recursive filtering to combine spatial information into the resulting features. The proposed method carried out by using feature extraction and classification approach consists of following steps

- The hyper spectral image are partition into multiple subsets of adjacent bands,
- The adjacent bands are fuse in each subset,
- Perform Recursive filtering
- Perform Classification.

Proposed system will mainly deal with following research techniques to successful completion of the system. The following Fig.4.1 shows the flow Block diagram of proposed system to implement feature extraction of hyperspectral images by using Image Fusion and Recursive Filtering with the support of SVM classifier.

- Project Flow

Image input (Hyperspectral images)

Band Partitions

Fuse the adjacent band into each subset

Perform Recursive Filtering

Perform Test Image classification

Expected Classification Map

Fig. 4.1.Block Diagram of Proposed Approach

4.2 Module

This project consists of following modules are as follows.

Module I: Input Test Images

In this work, I am using more than one Hyperspectral Images as a input test images. The input hyperspectral images will be same or as different hyperspectral images for extracting feature of hyperspectral images.

Module II: Band partitioning

After loading of the hyperspectral images then hyperspectral images are spectrally partitioned into $4^{	ext{th}}$ subsets of adjacent bands i.e, Band 1, Band 2, Band 3, Band 4. Out of, First two Band partition i.e, band 1 and Band 2 from Hyperspectral image 1 and Last two Band partition i.e, band 3 and Band 4 from Hyperspectral image 2.

Module III: Fuse the adjacent Band

After the band portioning of the Hyperspectral image, then the adjacent bands in the $4^{	ext{th}}$ subset are fused by Image Fusion techniques such as Brovey Transformation and Principle Component Analysis.

In this work I used two Image Fusion Techniques such as Brovey Transformation and Principle Component Analysis.
Brovey Transformation
The Brovey Transformation, which are established and promoted by an American scientist Brovey, the BT is also called the color normalization transform because it involves a red-green-blue (RGB) color transform method. It is a simple method for combining data from different sensors. It is a combination of arithmetic operations and normalizes the spectral bands before they are multiplied with the Hyperspectral image. It retains the corresponding spectral feature of each pixel, and transforms all the luminance information into a hyperspectral image of high resolution.

Principle Component Analysis
It is a mathematical tool from applied linear algebra. It is a simple non-parametric method of extracting relevant information from confusing data sets. PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension.

Module IV: Perform Recursive filtering
After fusing hyperspectral image by using Brovey Transformation and Principle Component Analysis Image Fusion Techniques then I used Transform domain Recursive Filtering for filtering the fused image. Recursive Filtering is performed on each fused band to obtain the kth feature.

Recursive filters are an efficient way of achieving a long impulse response, without having to perform a long convolution. They execute very rapidly, but have less performance and flexibility than other digital filters. Recursive filters are also called Infinite Impulse Response (IIR) filters, since their impulse responses are composed of decaying exponentials. This distinguishes them from digital filters carried out by convolution, called Finite Impulse Response (FIR) filters.

Module V Perform Classification:
In this work, I am using SVM classifier. The SVM classifier is utilized for the classification of the Image Fusion and Recursive Filtering features. The SVM classifier is one of the most widely used pixel wise classifiers and has, in particular, shown a good performance in terms of classification accuracy.

Furthermore, the SVM classifier has a major advantage, i.e., robust to the dimension of data sets. Therefore, in this situation, the classification result of the SVM method for an original data set can be considered in providing the best pixel wise classification results.

5. RESULTS ANALYSIS
This chapter put focus on result of proposed feature extraction of hyperspectral images. For the experimental purpose, I am using three different hyperspectral data sets i.e, Example 1, Example 2 and Example 3.
Teak Plantation (Green) Area Count 510412 (51.1230%)
Other (Blue) Area Count 162865 (16.2946%)

Time needed: 11.0719 s.

5.3 Data set Example 3

The Evaluation Results contains Example 3
Orange Plantation (Red) Area Count 302906 (30.3391%)
Teak Plantation (Green) Area Count 404931 (40.5580%)
Other (Blue) Area Count 290563 (29.1029%)
Time needed: 11.0379 s.

5.4 Comparison of Three different data sets (Example)
From the above experiment results, I am Comparing Three different data sets (Example) in Table 5.4.1

<table>
<thead>
<tr>
<th>Data Sets</th>
<th>Orange Plantation (Red) Area Count</th>
<th>Teak Plantation (Green) Area Count</th>
<th>Other (Blue) Area Count</th>
<th>Time needed in seconds (Accuracy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>317965 (31.8475 %)</td>
<td>293571 (29.4041 %)</td>
<td>386864 (38.7484 %)</td>
<td>11.9130</td>
</tr>
<tr>
<td>Example 2</td>
<td>325303 (32.5824 %)</td>
<td>510412 (51.1230 %)</td>
<td>162685 (16.2946 %)</td>
<td>11.0719</td>
</tr>
<tr>
<td>Example 3</td>
<td>302906 (30.3391 %)</td>
<td>404931 (40.5580 %)</td>
<td>290563 (29.1029 %)</td>
<td>11.0379</td>
</tr>
</tbody>
</table>

The comparing three different data sets, I concluded that the Evaluating Results for Classified Map/Image such as counting Area for Orange Plantation (Red), Teak Plantation (Green) and Other (Blue) is taking very less time in second’s means that by using the proposed method we can increase computational accuracy and its efficiency.

6. CONCLUSION

In this paper, a novel approach for hyperspectral image feature extraction has been proposed. The proposed system is based on the application of Image Fusion to reduce the dimension of the data, the use of recursive filtering to combine spatial information into the resulting Image fusion and Recursive Filtering features. Experiments have been carried out on three different real hyperspectral images. The results of the experiments show the effectiveness of the proposed method.

Also the proposed method has presented several other advantages:
1) The feature can be preserving the physical meaning of the hyperspectral data.
2) It is time efficient, and
3) Although the classification accuracy obtained by the Image fusion and Recursive Filtering is influenced by the number of features and the parameters of the recursive filter.

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References
[6]. J. Benediktsson, M. Pesaresi, and K. Amason, “Classification and feature extraction for remote

