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Hyperspectral Image Classification based on Sparse and Smooth Low-Rank Analysis with Deep CNN

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ABSTRACT: Hyperspectral images are widely used in the fields of precision agriculture, forestry monitoring, absorption band mapping techniques on Mars and terrestrial drill core applications. Among these applications, hyperspectral image classification (HSIC) is the most fundamental research that has attracted more and more attention. In this project, a Deep CNN system embedded with an extracted Sparse and Smooth Low-Rank analysis (SSLR) feature is proposed for HSI classification that utilizes the semantic information of the HSI. First, a series of hash functions are constructed to enhance the presentation of the locality and discriminability of classes. Next, design a Deep CNN framework with seven hidden layers to obtain the hierarchical feature maps with both spectral and spatial information for classification. The extensive experiments on real hyperspectral images results demonstrate that the proposed Deep CNN network can effectively improve the classification accuracy after the embedding of the extracted semantic features.

KEYWORDS: hyperspectral image classification (HSIC), Sparse and Smooth Low-Rank(SSLR).

I. INTRODUCTION

Due to the continuous spectral channels with rich spectral information and high-resolution spatial structure, hyperspectral images are widely used in the fields of precision agriculture, forestry monitoring, absorption band mapping techniques on Mars and terrestrial drill core applications. Among these applications, hyperspectral image classification (HSIC) is the most fundamental research that has attracted more and more attention. In recent years, with the booming of artificial intelligence and big data theory a set of hyperspectral image classification methods based on manifold learning and sparse theory have achieved satisfactory performance. However, these methods produce classification results using mechanism of shallow layer, cannot deal with the complex classification problem. Deep learning (DL) allows the computer to automatically extract deep features and more abstract features to improve the accuracy of the classification and has been widely used in HSIC fields. As the most popular and successful DL framework, convolutional neural network (CNN) utilizes a series of hidden layers to extract hierarchical features that has proved to be effective in HSIC.

II. REVIEW OF LITERATURE

AN IMPROVED ANT COLONY OPTIMIZATION ALGORITHM BASED ON HYBRID STRATEGIES FOR SCHEDULING PROBLEM

Propose an improved ant colony optimization (ICMPACO) algorithm based on the multi-population strategy, co-evolution mechanism, pheromone updating strategy, and pheromone diffusion mechanism is proposed to balance the convergence speed and solution diversity, and improve the optimization performance in solving the large-scale optimization problem. In the proposed ICMPACO algorithm, the optimization problem is divided into several sub-problems and the ants in the population are divided into elite ants and common ants in order to improve the convergence rate, and avoid falling into the local optimum value. The pheromone updating strategy is used to improve optimization ability. The pheromone diffusion mechanism is used to make the pheromone released by ants at a certain point, which gradually affects a certain range of adjacent regions. The co-evolution mechanism is used to interchange information among different sub-populations in order to implement information sharing. In order to verify the optimization performance of the ICMPACO algorithm, the traveling salesmen problem (TSP) and the actual gate

assignment problem are selected here. The experiment results show that the proposed ICMPACO algorithm can effectively obtain the best optimization value in solving TSP and effectively solve the gate assignment problem, obtain better assignment result, and it takes on better optimization ability and stability.

A MULTI-INDEX LEARNING APPROACH FOR CLASSIFICATION OF HIGH-RESOLUTION REMOTELY SENSED IMAGES OVER URBAN AREAS

It has been widely agreed that spatial features derived from textural, structural, and object-based methods are important information sources to complement spectral properties for accurate urban classification of high-resolution imagery. However, the spatial features always refer to a series of parameters, such as scales, directions, and statistical measures, leading to high-dimensional feature space. The high-dimensional space is almost impractical to deal with considering the huge storage and computational cost while processing high-resolution images. To this aim, propose a novel multi-index learning (MIL) method, where a set of low-dimensional information indices is used to represent the complex geospatial scenes in high-resolution images. Specifically, two categories of indices are proposed in the study: Primitive indices (PI): High-resolution urban scenes are represented using a group of primitives (e.g., building/shadow/vegetation) that are calculated automatically and rapidly; Variation indices (VI): A couple of spectral and spatial variation indices are proposed based on the 3D wavelet transformation in order to describe the local variation in the joint spectral-spatial domains. In this way, urban landscapes can be decomposed into a set of low-dimensional and semantic indices replacing the high-dimensional but low-level features (e.g., textures). The proposed MIL method is evaluated using various high-resolution images including GeoEye-1, QuickBird, WorldView-2, and ZY-3, as well as an elaborate comparison to the state-of-the-art image classification algorithms such as object-based analysis, and spectral-spatial approaches based on textural and morphological features.

SALIENT BAND SELECTION FOR HYPERSPECTRAL IMAGE CLASSIFICATION VIA MANIFOLD RANKING

Saliency detection has been a hot topic in recent years, and many efforts have been devoted in this area. Unfortunately, the results of saliency detection can hardly be utilized in general applications. The primary reason, think, is unspecific definition of salient objects, which makes that the previously published methods cannot extend to practical applications. To solve this problem, claim that saliency should be defined in a context and the salient band selection in hyper spectral image (HSI) is introduced as an example. Unfortunately, the traditional salient band selection methods suffer from the problem of inappropriate measurement of band difference. To tackle this problem, propose to eliminate the drawbacks of traditional salient band selection methods by manifold ranking. It puts the band vectors in the more accurate manifold space and treats the saliency problem from a novel ranking perspective, which is considered to be the main contributions of this work.

SPECTRAL-SPATIAL FEATURE EXTRACTION FOR HYPERSPECTRAL IMAGE CLASSIFICATION: A DIMENSION REDUCTION AND DEEP LEARNING APPROACH

Propose a spectral-spatial feature based classification (SSFC) framework that jointly uses dimension reduction and deep learning techniques for spectral and spatial feature extraction, respectively. In this framework, a balanced local discriminant embedding algorithm is proposed for spectral feature extraction from high-dimensional hyperspectral data sets. In the meantime, convolutional neural network is utilized to automatically find spatial-related features at high levels. Then, the fusion feature is extracted by stacking spectral and spatial features together. Finally, the multiple-feature-based classifier is trained for image classification. Experimental results on well-known hyperspectral data sets show that the proposed SSFC method out performs other commonly used methods for hyperspectral image classification.

SVM- AND MRF-BASED METHOD FOR ACCURATE CLASSIFICATION OF HYPERSPECTRAL IMAGES

The high number of spectral bands acquired by hyper spectral sensors increases the capability to distinguish physical materials and objects, presenting new challenges to image analysis and classification. This letter presents a novel method for accurate spectral-spatial classification of hyperspectral images. The proposed technique consists of two steps. In the first step, a probabilistic support vector machine pixelwise classification of the hyperspectral image is applied. In the second step, spatial contextual information is used for refining the classification results obtained in the first step. This is achieved by means of a Markov random field regularization. Experimental results are presented for three hyperspectral airborne images and compared with those obtained by recently proposed advanced spectral-spatial classification techniques. The proposed method improves classification accuracies when compared to other classification approaches.

III. PROPOSED SYSTEM

A Deep CNN embedded with an extracted Sparse and Smooth Low-Rank analysis (SSLR) feature. Proposed for HIS classification that utilizes the semantic information of the HIS. Design a Deep CNN framework to obtain the hierarchical feature maps with both spectral and spatial information for classification. The advantages are High robustness of the proposed Deep CNN network, Classification accuracy is always high, Better performance for HIS classification.

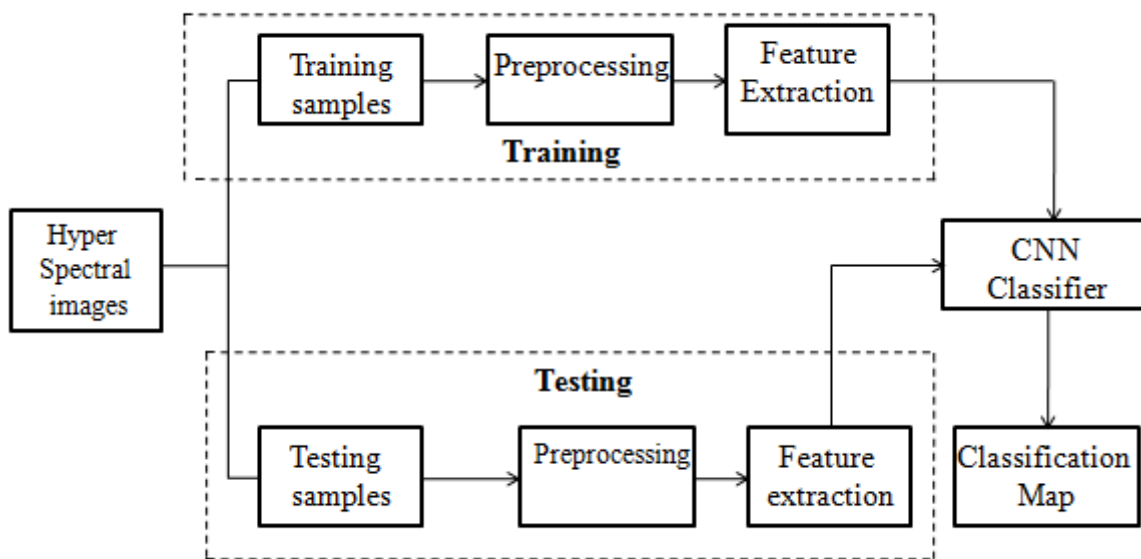


Fig 3.1 System Architecture of Proposed System

The hyperspectral classification task by embedding a semantic feature map into the Deep CNN network to promote classification and recognition. First, the semantic features present the similarities of the same class which are extracted by hashing learning, and then the features are embedded in the original hyperspectral image for Deep CNN classification. Next, the flow of the proposed Deep CNN classification method based on the space-spectrum combination can be simply summarized as follows. In order to improve the accuracy and the convergence speed of the model, the input hyperspectral data needs to be normalized, then the deep feature maps are extracted through a convolution layer and the nonlinear features are obtained after an activation function. Next the deconvolution layer is used to enhance the feature downsampled by pooling layer, and finally the two fully connection layers finish the feature mapping and the deep features are converted to the softmax classifiers.

- 1) Here present a new semantic feature extraction method by considering the locality and discriminative learning subspace between feature categories, and using compact codes semantically to encode the hyperspectral data. With the defined within-class and intraclass similarity constraints, the extracted features provide salient classification information for the followed Deep CNN framework by maximizing the sample center distance.
- 2) Besides the spectral and spatial information, the proposed Deep CNN classification architecture achieves powerful distinguishing ability from different classes by utilizing the extracted semantic features merged in the original HSI cube, and it explored the convolutional features and semantic contextual information simultaneously.
- 3) A simpler Deep CNN network including two convolutional layers is adopted for HSI classification, and the deconvolution layer is designed to enhance the deep features that improve the robustness of the classification framework. Besides, to demonstrate the performance of the deconvolution layer and the pre-processed hashing procedure, also designed other several Deep CNN architectures to evaluate the classification performance correspondingly.

IV. RESULT AND DISCUSSION

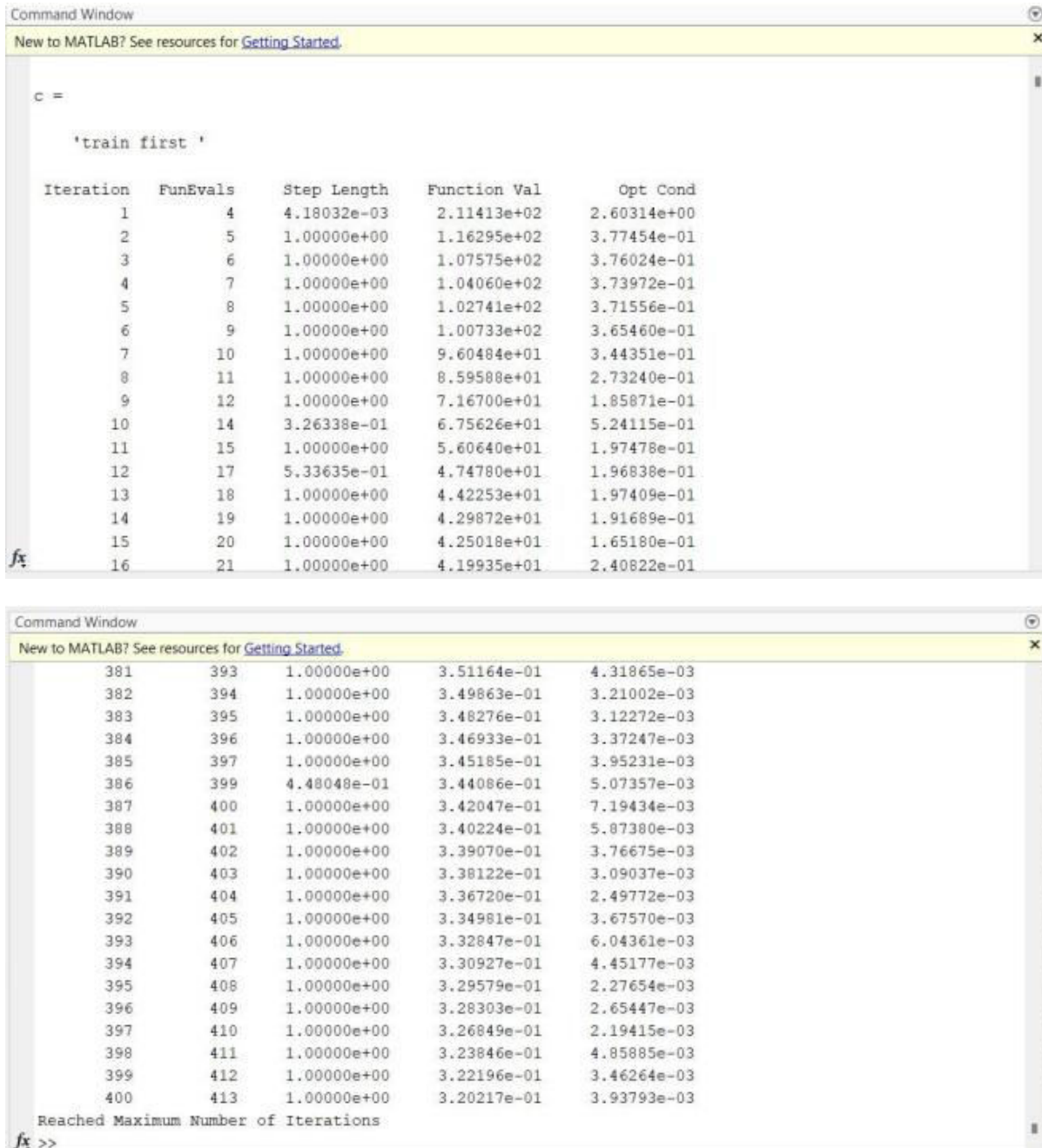







Fig 4.1 Training Process

Here the input image classes are trained. The 400 iteration process is needed to obtain the correct class output.



Fig 4.2 Classification Map

The different colors in the above Classification Map is represented in the below

-  - Represent Wheat
-  -Represent Soybean-Clean
-  - Represent Corn
-  - Represent Grass-trees
-  - Hay -Windrowed

The above fig 4.2 represents the final Classification Map for the hyperspectral image.

V. CONCLUSION AND FUTURE WORK

Thus, hyperspectral images are widely used in the fields of precision agriculture, forestry monitoring, absorption band mapping techniques on Mars and terrestrial drill core applications. Among these applications, hyperspectral image classification (HSIC) is the most fundamental research that has attracted more and more attention. In this project, a Deep CNN system embedded with an extracted Sparse and Smooth Low-Rank analysis (SSLR) feature is proposed for HSI classification that utilizes the semantic information of the HSI. First, a series of hash functions are constructed to enhance the presentation of the locality and discriminability of classes. Then, the SSLR calculated by the discriminative learning algorithm are combined into the original HSI. Next, design a Deep CNN framework with seven hidden layers

to obtain the hierarchical feature maps with both spectral and spatial information for classification. A deconvolution layer aims to improve the robustness of the proposed Deep CNN network and is used to enhance the expression of deep features. The proposed Deep CNN classification architecture achieves powerful distinguishing ability from different classes. The extensive experiments on real hyperspectral images results demonstrate that the proposed Deep CNN network can effectively improve the classification accuracy after the embedding of the extracted semantic features.

Furthermore the work will focus on extracting contextual features of hashing semantic feature hierarchically. The FCSN is simply composed of several residual blocks to facilitate converge. Demonstrate that FCSN with the proposed HSI cube generation method has robust generalization capability to changes of spatial land-cover distributions.

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