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CLASSIFICATION AND DETECTION OF HYPERSPECTRAL IMAGES

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***Abstract*— Recently, many neural network has been extensively applied to hyperspectral image (HSI) for classification and they had shown promising results on various visual tasks. However, its success is greatly attributed to numerous labeled samples, whose acquisition costs a large amount of time and money. In order to improve the classification performance while reducing the labeling cost, we are using convolutional neural network for classification of hyperspectral Images. Both spectral and spatial features are considered for classification of hyperspectral images. Mostly, spectral features are used for classification to improve the accuracy of the classification. Convolutional neural network achieves the highest accuracy of 98% in the classification of hyperspectral images compared with other methods. In this, classification process we are using principle component. PCA is a very powerful technique for hyperspectral classification. PCA cuts down the calculation time of classification by the significant amount and also reduces the amount of data to be handled. The PCA preprocessing gives rather acceptable and accurate classification results. The main purpose of classification of hyperspectral images is to assign a class label to each pixel. And calculation of accuracy of classification and displaying the classified image. The results of the classification model, we get many images such as ground truth image, preprocessing image, gray scale image, training map, testing image, classified image and segmented image. The classified is obtained at the 74% accuracy and the segmented image is obtained at 83% accuracy.**

***Keywords*—** Convolutional neural networks(CNNs), hyperspectral imagery(HSI), classification.

I. INTRODUCTION

Hyperspectral imaging collects and processes information across the electromagnetic spectrum. Hyperspectral images can be captured by sensors. Hyperspectral images contain lots of continuous narrow bands each will represent the imaging at some frequency. The hyperspectral image is divided into a small number of patches. CNN constructs the high level spectral and spatial features of each patch, and the multilayer perceptron helps in the classification of image features into different classes.

Hyperspectral images can have more than one spectral bands. Hyperspectral images contains spectral and spatial data. The spatial and spectral information is efficiently used to identify the materials and objects on the earth surface. The spectral signatures are modelled in such a way that they will differentiate the various objects and materials. It is possible to see the identification of different materials, objects and surface ground cover classes based

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on their reflectance properties as a classification task, i.e. the classification of image pixels based on their spectral characteristics. Most of the classifier uses the spectral features and does not consider the spatial features to perform the classification and to recognize the various objects on the image.

In our project, we are using CNN algorithm for classification. CNN is termed as convolutional neural network. Convolution neural network (CNN) is the most standard deep learning algorithm for image classification and image recognition problems. Along with these applications, CNN is mostly used to recognize human faces and do the classification process on objects. CNN constructs the high level spectral and spatial features of each patch, and the multilayer perceptron helps in the classification of image features into different classes. Simulation results show that CNN archives the highest classification accuracy of the hyperspectral image compared with other classifiers. Any colored image is divided in to three layers: red, green and blue. Mathematical operations such as convolutions and pooling are used to create new layers.Convolutional are used to remove functionality and pooling is used to reduce the network's complexity. For classification, the output matrix is flatted to one layer and attached to a completely connected layer.

We are using MATLAB software 2021 for the classification of hyperspectral images. Simulation results shows that hyperspectral neural network using CNN achieves highest classification accuracy of 98.28% compared to other methods and CNN consumes more computation time. And also CNN avoids usage of an edge preserving filter.

The classification is used in the collection of data such as land use, water pollution detection, mineral exploration and so on. In this classification, it will categorize every pixel vector in to a discrete set of meaningful classes. Classification of hyperspectral imaging had some applications, such as agriculture, environmental science, astronomy, surveillance, astronomy and biomedical imaging. However, the classification of the hyperspectral images had some problems, they are high dimensionality, the small number of samples which have been labelled, and significant spatial variation of spectral signatures.

The organization of the paper is given as follows: Section I deals with the introduction, section II reviews the existing work for classification of hyperspectral images. Section III describes the methodology. Results are discussed in Section IV. Section V gives conclusion and future scope of hyperspectral image classification.

II. LITERATURE REVIEW

This section we will give a brief introduction of the latest methods for HSI classification. And some strategies are used for reference in our model

Going Deeper with Contextual CNN for Hyperspectral Image Classification [1] In this paper, they described a novel deep convolutional neural network (DCNN) that is deeper and wider than other existing deep networks for hyperspectral image classification. The current state-of-the-work approaches in CNN-based hyperspectral image classification, the proposed network, called contextual deep CNN, can optimally explore local contextual interactions by jointly exploiting local spatio-spectral relationships of neighboring individual pixel vectors.

Preprocessing of Hyperspectral image data [2] The most important characteristic of the HSI is the combination of imaging and spectral detection techniques, while imaging the spatial features of the target, dozens of or even hundreds of narrow bands are scattered for each spatial pixel for continuous spectral coverage. The data so formed can be visually described as "three-dimensional data blocks," as shown in Figure 1(a). Where x and y represent two-dimensional planar pixel information coordinate axes and the third dimension (λ-axis) is a wavelength information coordinate axis. The single pixel with spectrum bands is labeled as a category's samples for training.

Multitask Deep Learning with Spectral Knowledge for Hyperspectral Image Classification [3] had proposed a multitask deep learning method for classification of multiple hyperspectral data in a single training. Deep learning models have achieved promising results on hyperspectral image classification, but their performance highly rely on sufficient labeled samples, which are scarce on hyperspectral images. However, samples from multiple data sets might be sufficient to train one deep learning model, thereby improving its performance.

Hyperspectral Image Classification Using Convolutional Neural Networks and Multiple Feature Learning [4] They proposed a novel that takes advantage of both CNNs and multiple feature learning to better predict the class labels for HSI pixels. They built a novel CNN architecture with various features extracted from the raw imagery as input. The network generates the corresponding relevant feature maps for the input, and the generated feature maps are fed into a concatenating layer to form a joint feature map. The obtained joint feature map is then input to the subsequent layers to predict the final labels for each hyperspectral pixel. The results of the CNN-based multi-feature learning framework improves the classification accuracy significantly.

Three-Dimensional Fourier Scattering Transform and Classification of Hyperspectral Images [5] In this paper they had proposed a three-dimensional Fourier scattering transform for HSI classification. This method has the neural network like benefits of hierarchical feature extraction while bypassing the training process which is computationally expensive in both the amount of required training data and training time. The three dimensional time-frequency features are well suited for HSI data since they decompose the HSI into multi-frequency bands and remove small perturbations such as noise. The 3D FST is particularly effective when there is limited training data. As supported by the experimental results, 3D FST achieved SoA performance on benchmark datasets, all while executing within a few minutes on a conventional GPU, and using a simple linear SVM for classification.

Overall, various neural networks, machine learning, deep learning are widely studied in hyperspectral image classification, and there are many resources available for those interested in learning more about the techniques and their applications.

III. IMETHODOLOGY

In this section we will describe the methodology used in Classification of hyperspectral images using convoluted neural networks as shown in the figure below.

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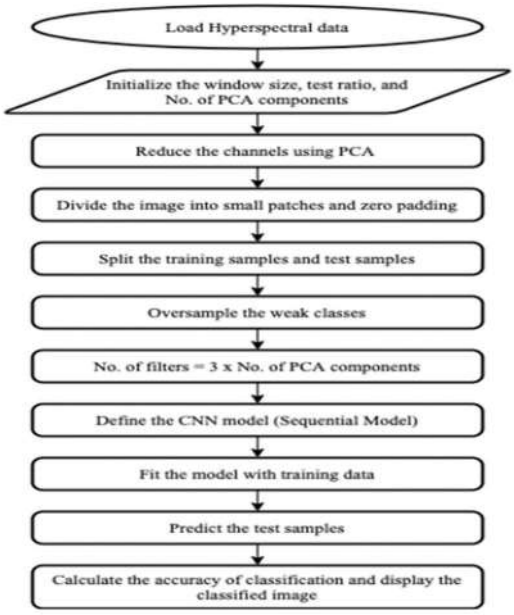

Fig.1 Flow chart

Initially we load hyperspectral data I.e. we used Indian pines data set for the classification and then we initialize the window size i.e. the image consists of how many number of rows and columns, we also give the test ratio and we select the number of principle components that we are going to classify from the given data. As we know that hyperspectral images contain large amount of spectral bands, now after this based on the number of principle components only the spectral bands which contain the principle components are selected there by reducing the channel. Now the reduced data is splitted into test and training samples and then we oversample the weak classes to improve the clarity of classification. We use filters to filter out the principle components for analysis. Here in this model the filters used are 3 times of the number of principle components. The above all steps are used for preprocessing. Now we design a sequential convoluted neural network model. We give training data or images to the model. The models is trained to learn the underlining relationships between the data. we give test data and the model classifies the images and we also calculate the accuracy of the trained model.

IV. RESULTS AND DISCUSSION

These are the results of the hyperspectral image classification using CNN

1. The image is classified at 0.74, it mean the model correctly classified 74% of the pixels in the hyperspectral image.

2. At 0.83,we get segmented image where overall accuracy of the hyperspectal image is classified.

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Fig.2 Gray scale image

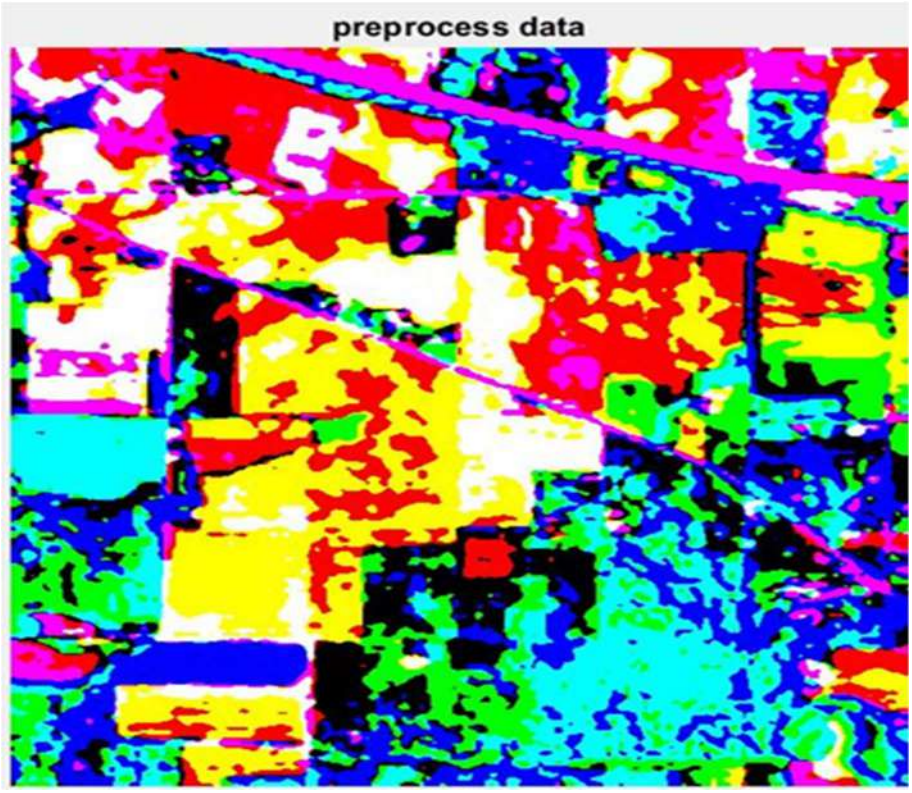

Fig.3 Preprocessed image

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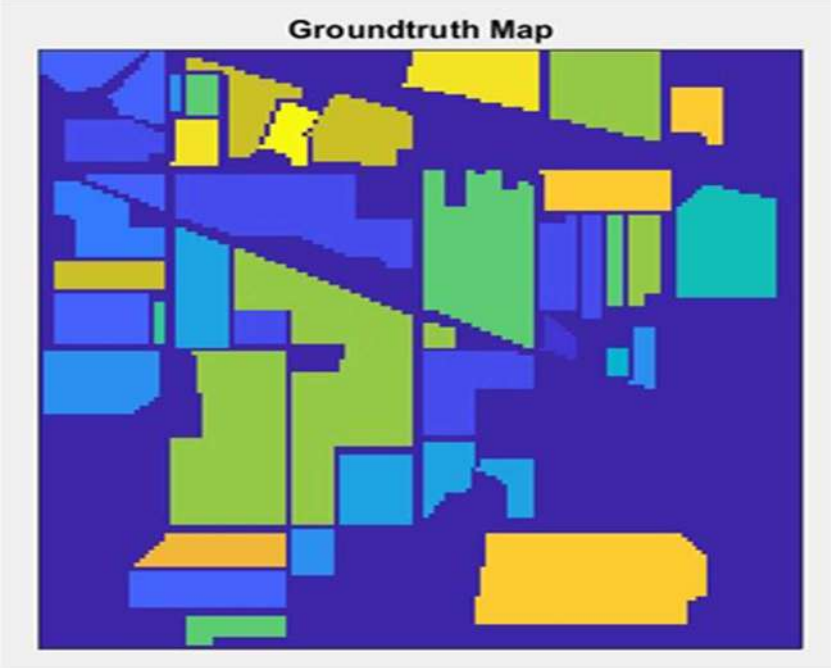

Fig.4 Ground truth image

The above picture shows the pre-processed image and ground truth images Ground truth of a satellite image means the collection of information at a particular location. It allows satellite image data to be related to real features and materials on the ground. This information is frequently used for calibration of remote sensing data and compares the result with ground truth.

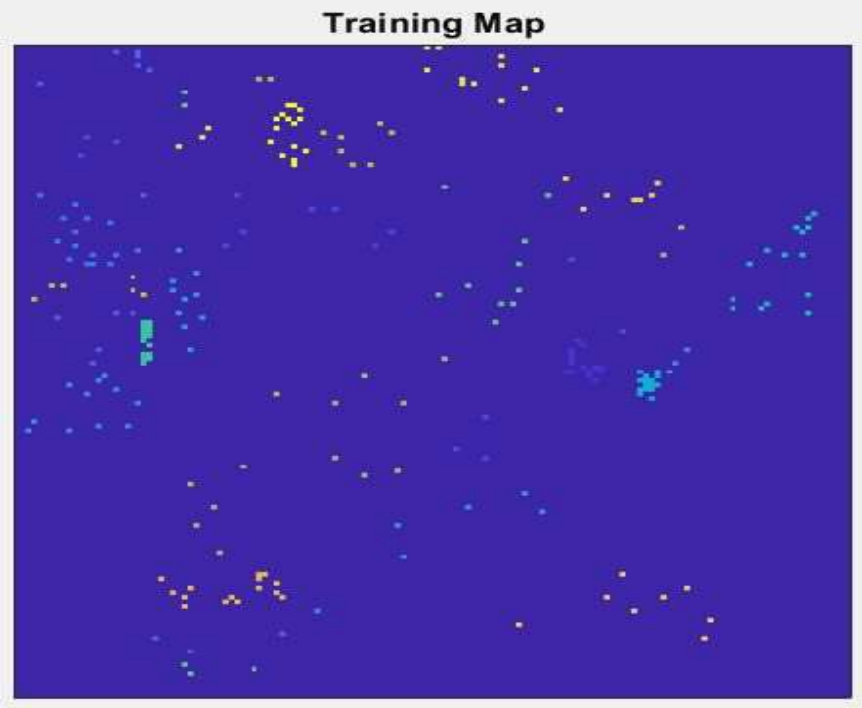

Fig.5 Training map image

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The above picture gives us the training image the we are using for training our CNN algorithm.

Fig.6 Test map image

The above image gives us the test image. We are using to test the algorithm whether it can classify the given image.

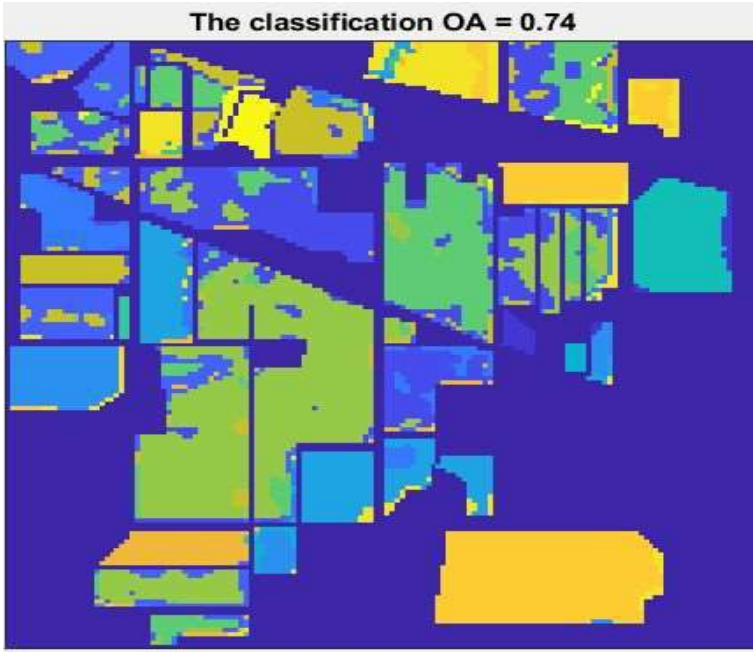

Fig.7 Classified image

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The above image is a classified image whose OA is 0.74 . OA stands for Overall Accuracy, which is a commonly used metric to evaluate the performance of classification models. The value of 0.74 indicates that the model correctly classified 74% of the pixels in the hyperspectral image.

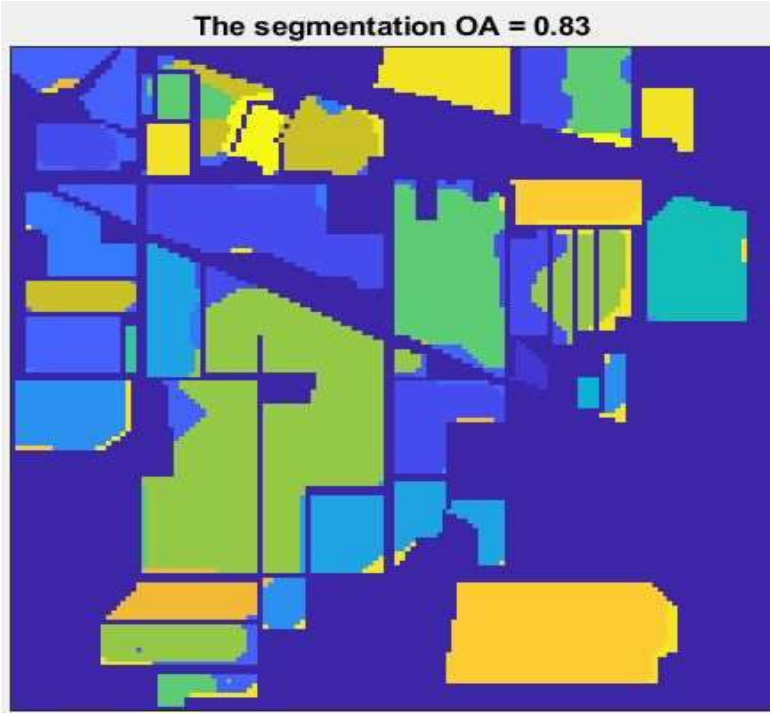

Fig.8 Segmented image

In the above figure, OA = 0.83 indicates that the model was able to correctly classify 83% of the pixels in the hyperspectral image.

V. CONCLUSION

Hyperspectral Image is well-known for the identification of the objects on the earth surface. In this we are classifying spectral and spatial features. Mostly spectral features are used rather than spatial features because to recognize the various objects on the image .CNN is the most standard deep learning algorithm for image classification and image recognition process.

Simulation results shows that hyperspectral neural network using CNN achieves highest classification accuracy of 98.28% compared to other methods and CNN consumes more computation time. And also CNN avoids usage of an edge preserving filter.

Furthermore, recent researches in deep learning have indicated that unsupervised learning can be employed to train CNNs, reducing the requirement of labelled samples significantly. Deep learning, especially deep CNNs, should have great potentiality for HSI classification in the future.

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