

# Pixel Based Classification of Remotely Sensed Image using K- means and BPNN

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## Abstract

*This paper aims at performing unsupervised and supervised classification techniques on remotely sensed image and comparing their classification accuracy. The classification techniques used are, k-means for unsupervised and Back Propagation Neural Network (BPNN) for supervised. Remotely sensed images captured by Earth observing satellites have many spectral bands from electromagnetic spectrum. LANDSAT image with seven spectral bands is used as input image to both the classifiers. For BPNN, a multilayered architecture, having one input layer, one hidden layer and one output layer is used. Samples from each class are selected to train the network and pixel based classification is performed as each pixel is tested on the trained network and is classified to one of the classes. k-means is performed by arbitrarily selecting class centers or centroids from the image and then assigning each pixel to one of these classes based on its distance from the centroid [4]. Classification accuracy of both techniques is compared and it is observed based on the experiment results that BPNN performed better than k- means.*

**Keywords: Back Propagation Neural Network, Classification, k-means, Multispectral.**

## 1. Introduction

Planning and monitoring of land resources involves the use of remotely sensed images or satellite images. Satellite images aid in exploring the land features. Remote sensors used in satellites, capture images over different bands in electromagnetic spectrum and are not constrained only to the visible band. Thus, multispectral image is composite image having not just three bands (red, green, and blue) of visible range, but also bands from thermal, near and mid infrared region of electromagnetic spectrum. Each matrix in multispectral image represents the pixel values of image in a particular band of electromagnetic spectrum.

Different image processing operations are performed on remotely sensed images among which classification is one of the vital processes. Each class uniquely represents one of the different features of the land like water, soil, forest, vegetation etc. Classification is the process to categorize each pixel to one of the classes present in the image. The output of classification is a thematic image which helps in better understanding of the land cover.

In this paper, LANDSAT ETM+ image is used, which has seven bands. Multibandread function in Matlab is used to select three (4, 3, 2) out of seven multispectral bands. k- means and BPNN classification is performed on the same image and their results in the form of classification accuracy is compared to conclude which technique performs better.

The paper is structured into different sections. Section 2 gives design flow of classification process. Section 3 gives specifications of the image. Section 4, 5, 6 describes classification process, k-means and BPNN respectively. Section 7 shows experiment results and section 8 concludes the paper. Section 9 tells the future work.

## 2. Design Flow

The following diagram shows the basic flow of classification process. Green boxes show the steps in performing classification and blue boxes show input/output.

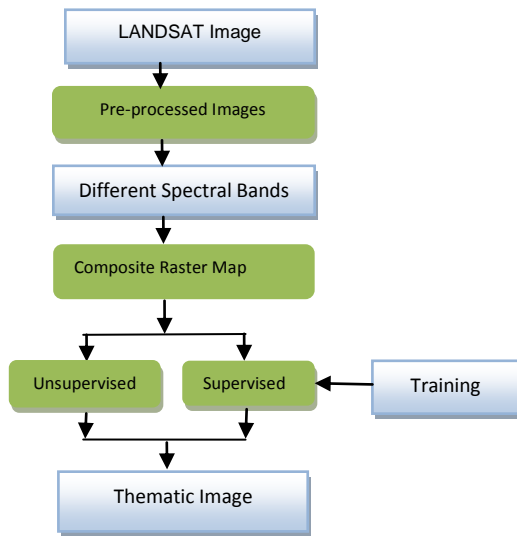


Figure 1: Classification process

### 3. Data Acquisition

LANDSAT 7 ETM+ image of Brazil is used as input image. It has seven spectral bands and each band has 30 meter spatial resolution. Image dimensions are 169 × 169 with TIFF extension. The image after selecting bands 4, 3, 2 is as follows:

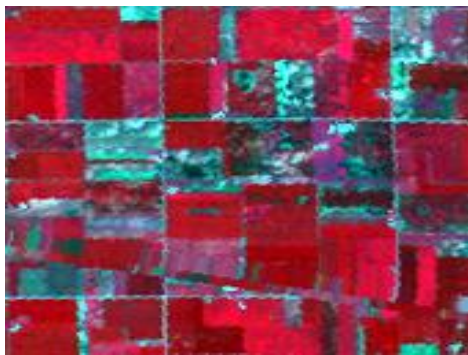


Figure 2: Unclassified image of Brazil with spectral bands 4, 3, 2

Ground truth data in the form of thematic image was available with input image as follows:

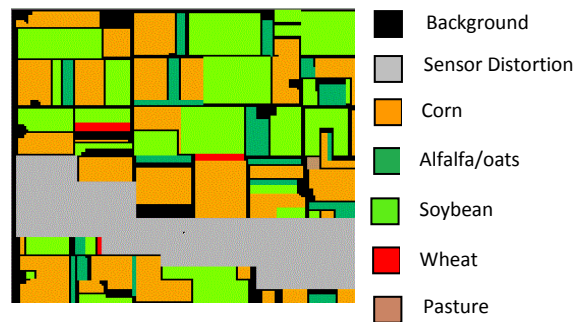


Figure 3: Ground truth data

### 4. Classification

Classification of remotely sensed image is the process of categorizing the pixels of the image into one of the land cover classes. Classification process can be unsupervised or supervised.

Unsupervised classification does not require any prior information about the classes contained in the image. Cluster centers or centroids are selected from the image by analyzing the natural groupings present among the pixels. Distance of each pixel with these centroids is calculated and pixel is assigned to the cluster which is closest. New centroids are computed and process repeats until no significant change is observed.

Supervised Classification works in two phases, training and testing. In training phase, sample data of each class is collected from the ground data available. Using these sample pixels, the architecture used to implement supervised classification is trained. In testing phase, each pixel of the input image is tested on the trained architecture and is classified into one of the land cover classes present in the ground data.

### 5.K-means Classification

K-means is unsupervised approach of classification process. Initially, seven cluster centers or centroids are selected from the image, arbitrarily. Euclidian distance of each pixel with each centroid is calculated according to following equation as in [5]:

$$E = \sum_{i=1}^K \sum_{j=1}^{n_i} \|x_{ij} - z_i\|^2$$

where  $K$  is number of clusters,  $x_{ij}$  represents the  $j^{\text{th}}$  point in the  $i^{\text{th}}$  cluster,  $z_i$  is centroid of the  $i^{\text{th}}$  cluster, and  $n_i$  is the number of pixels in that cluster. The notation  $\|x_{ij} - z_i\|$  stands for the distance between  $x_{ij}$  and  $z_i$ . Distance of each pixel with the centroid is computed and is assigned to the nearest centroid. New centroids are computed from the clusters, and the process repeats till there is no significant change between two consecutive steps [5]. Thus, all pixels are categorized into their respective classes.

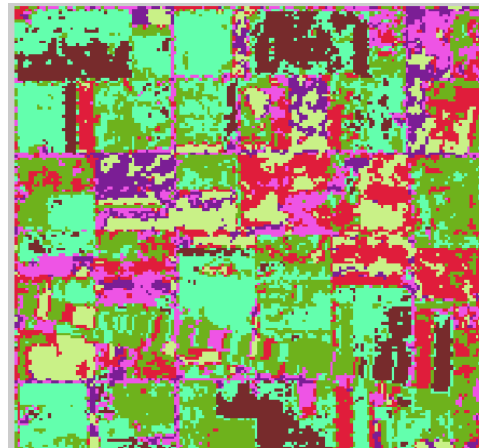
## 6. BPNN

A multilayered architecture which has three layers, namely, input, hidden and output is used. Nodes are present in each layer which is used to communicate between the layers. Nodes of two neighboring layers are connected but there is no connection between nodes of the same layer [6]. Each node is associated with a weight which is activated from the output activation of nodes in previous layer [1]. A set of input and output patterns for each class is selected from the ground truth data. Training of the architecture is done by passing these sample pixels of each class to the input layer. The connections of the network are adjusted so that the activation of the output node matches the desired output. At each step error is computed which tells the difference in current output and desired output. The error is propagated back into the network and weights of the nodes are adjusted [6]. This process repeats until the error is insignificant. After training the network, testing of each pixel is performed. Image is passed into the input layer, pixel by pixel and each pixel is classified into one of the classes.

The image used in the study has seven classes, which is evident from ground truth data. The architecture used has input and output layer and one hidden layer in between. The number of nodes in input, hidden and output layer is 7, 3 and 7 respectively. Sample pixels from each class are given as input into the network during training phase. And in testing phase all pixels of the image are tested on the network and classified into their respective classes.

## 7. Experiment Results

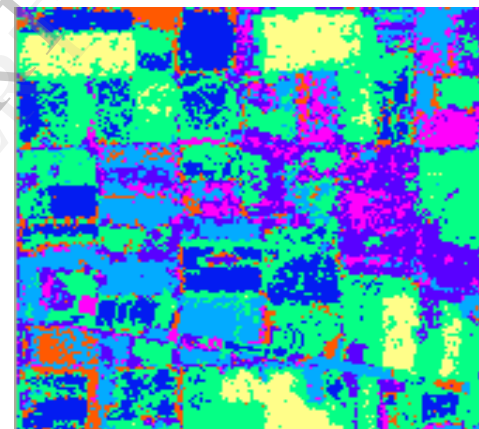
K-means classification is performed and the resultant image after classification is as follows:



**Figure 4: K-means classified image**

Classification Accuracy for k-means where  $k=7$  is 63.3%.

Resultant image after performing BPNN Classification is as follows:



**Figure 5: BPNN classified image**

BPNN gives 80.5% classification accuracy.

## 8. Conclusion

Experimental results show that k-means gave 63.3% where as BPNN gave 80.5% classification accuracy. Thus, for the given remotely sensed image with land cover maps, learning method such as BPNN gave better results than k-means.

## 9. Future Work

Pixel by pixel classification of large images takes lot of time. Therefore, it is desirable to reduce the dimension of the image by extracting the relevant features [3] and then performing the classification.

The image used in this paper was multispectral having seven bands. Further enhancement would be to apply these classification techniques on an image having large number of bands i.e. hyperspectral image.

## 10. References

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