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Analysis of Classified Satellite Images using different Neural Networks

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Abstract: The classification of multispectral satellite images using the various artificial neural network classifiers are discussed in this paper. Various methods have been used in the field of remote sensing that are doing image classification using significant concepts for high performance. The mean, variance and textural features extraction technique is used here. The extracted features are used for training the neural network. The back propagation, radial basis function and self organizing map are used for the classification of the multispectral satellite image. Ensemble techniques of bagging, boosting and Ada-Boosting are used for the same image for classification. The effect of the classification results based on the amount of training data shows that if the network is trained using 25% of the data from the actual size of the data then they are giving better or similar results as compared to the network with 50% of trained network. Parameters like overall accuracy, producer's accuracy, user's accuracy and Kappa coefficient are evaluated for the performance of the classifiers.

Keywords: Ensemble Classifiers, Producer's accuracy, User's accuracy, Kappa Coefficient.

I. INTRODUCTION

Each band of a multispectral satellite image is captured at different electromagnetic spectrum. Human eye fails to capture the information in them, so spectral imaging can be used for this. The use of computer based processing of these images is capable to identify the features in these images [1]. The classifier's accuracy may vary with features and classes for different classifier. Multiple classifier fusion have been tried for various field like pattern recognition, face recognition, handwriting recognition, image processing. The overall accuracy of the classification of image can be improved by using multiple classifiers. The classification of multispectral images of Owen Valley from LandSat images using different neural networks is discussed in this paper [2]. Organization of paper is done as follows: Supervised, unsupervised artificial neural networks and ensemble networks are introduced in Section II. The Pursuance criteria for classifiers are discussed in III. Results of different neural networks are discussed in section IV. Followed by conclusion in section V. on the methods used in the paper.

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II. SUPERVISED, UNSUPERVISED NEURAL NETWORK AND ENSEMBLE NETWORKS

A. Artificial Neural Network

Artificial neural networks are computer based smart networks that are efficient in processing the data in parallel. The different neural network classifiers are built on the basis of the architecture of the connection between the neurons and the number of neuron layers used in the network [3]. Multiple input feed forward networks are the commonly used network amongst them. The most important phases in neural network are training and testing phase. Supervised and unsupervised algorithms are the types of algorithm used in the classifier. If the neural networks are trained using features and target vectors then they are called supervised networks and when the network are trained without target vectors then they are termed as unsupervised networks. In the supervised techniques, error correction learning is done but there is an issue with the error convergence in this learning. So the weights of the neurons should be selected in a way that helps in minimizing the error. Backpropagation and radial basis function are the widely used supervised networks [4]. Whereas in the unsupervised learning, the classifier is based on use of the local information only. Here it self-organizes the data and detects emergent properties. Hebbian learning and competitive learning are used in unsupervised learning. Backpropagation is a supervised learning where the correct combination of weights is selected for a complex form of topology and can easily handle special networks. The efficiency of the network can be increased through the information in the system. The error function inclination should be assured at every iteration. Radial basis function(RBF) is a two layered feed forward network. The hidden layer between the input and output layer is implemented using radial basis function [5]. The output layer is a linear combination of weights of the hidden layer. Self organizing map (SOM) is an unsupervised learning that produces the low dimensional representation of the input [6]. It maintains the topological property of the input for conceptualizing the low dimensional data to high dimensional one.

B. Ensemble Classifiers

The advantage of combining similar or mixed networks is to achieve the better accuracy in the classification. By changing certain parameters like initial random weight, varying the topology of the network, varying the training network or training data can create a diverse network which is proved to be more efficient networks [7].

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Bagging and boosting are such networks in which the training data is modified by resampling. In bagging technique, diverse training sets are generated by resampling the data to train the ensemble network [8]. Bagging technique generates a new training set randomly for certain size that is equal to the actual training size, where the probability of selecting them is equal. The classified result is based on the maximum votes received for the class. In case of Boosting method, different subsets of training data are used in which weights are assigned and their value changes depending on the learning of classifier [8]. The resampling of data takes place based on the learning of preceding model as the training set of the model depends on preceding model. So Boosting technique requires a consecutive runs for several cycles and prediction is performed based on weighted vote. Adaptive Boosting or AdaBoost is used in the classification of a problem with more than 2 classes. Here the training set is based on the weight of probability of being selected for training [8]. Depending on the classification of the training data, the chance of being used again in the done. If it is corrected classified then chances of getting it in next cycle is reduced and if misclassified then chance of getting in next cycle is increased.

III. PURSUANCE CRITERIA FOR CLASSIFIERS

The following Pursuance criteria of overall accuracy, Produce's and User accuracy of each class along with Kappa coefficient for classifiers are used on the single and ensemble classifiers

i. $$\text{Overall Accuracy} = \frac{\text{no.of test pixels correctlty classified}}{\text{no. of test pixels}}$$

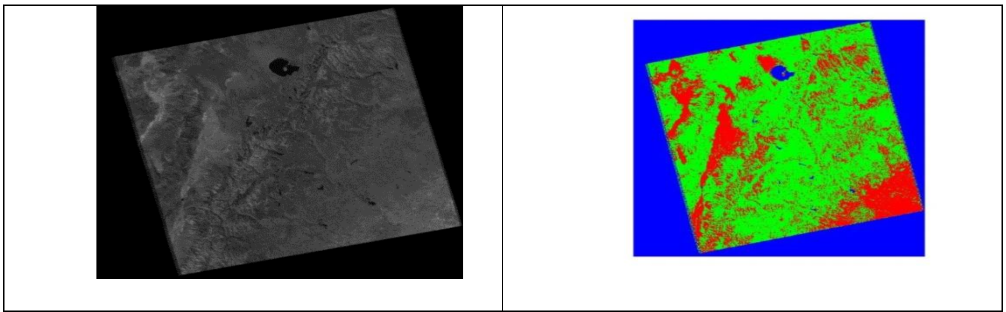
ii. $$\text{Producer's accuracy} = \frac{\text{no. of test pixels correctly classified in that class}}{\text{no. of test pixels selected for that class}}$$

iii. $$\text{User's accuracy} = \frac{\text{no. of test pixels correctly classified in that class}}{\text{no. of pixels assigned to that class by the classifier}}$$

iv. $$\textit{Kappa Coefficient} = \frac{\text{difference between relative observed rater dataset and hypothetical probability of agreement rater}}{1 - \text{hypothetical probability of agreement rater}}$$

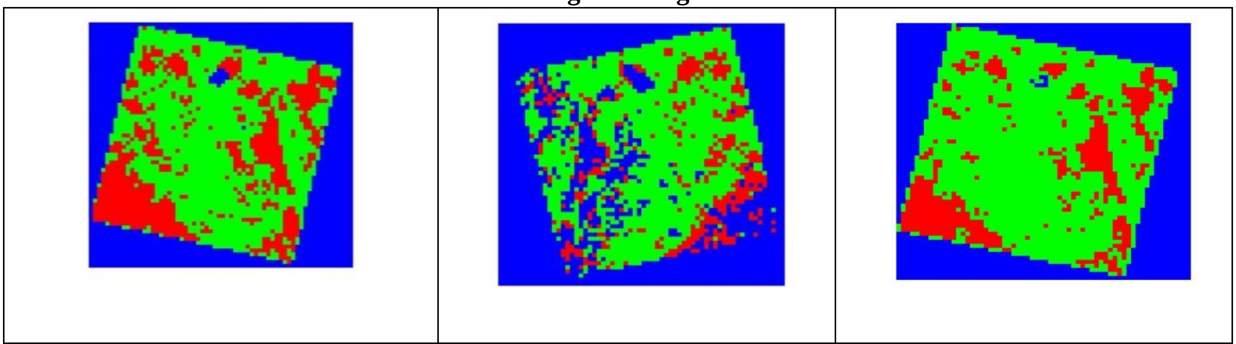
IV.RESULTS AND DISCUSSION

The Landsat image of Owen valley is shown in figure 1(a).This satellite image is classified into three classes with red (land), green(forest) and blue(water body). Using multispectral image pixel intensity the RGB equivalent image is obtained. The obtained RGB equivalent is shown in Fig. 1(b). The shape, texture, size characteristics can be interpreted visually through the RGB image. The classified image of Owen valley using the basic artificial neural network with supervised learning using back propagation algorithm and radial basis function and with unsupervised learning using self organizing map is shown in figure2. The classified image is giving better results for the back propagation network and self organizing map as compared to the radial basis function.



(a) (b)

Figure.1 Landsat Image Owen valley satellite image of band 4. (a) Original Image [9] (b) RGB equivalent of the original Image



(a) (b) (c)

Figure.2 Classified Images of Owen Valley using (a) Backpropagation neural network (BPN) (b) Radial Basis Function (RBF) (c) Self Organizing Map (SOM)

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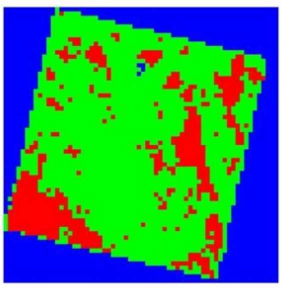
The overall accuracy, Producer's accuracy for three classes, User's accuracy for three classes and Kappa coefficient of the Owen Valley image using Back propagation, Radial Basis Function and Self Organizing map with training data of 25% and 50% is shown in Table 1. It is seen that by using the 25% of the training data for the backpropagation network that gives a good classified output, the classification result for overall accuracy is just 1 % less as compared to 50% training data.

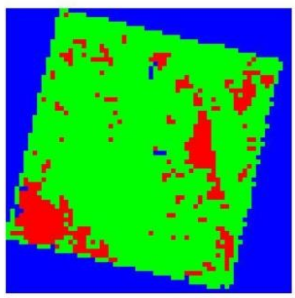
Table 1: Comparison results for various criteria and classes for different neural network.

Algorithm	BPN		RBF		SOM		Bagging with 3 BPN	Bagging with 3 diff n/w	Boosting	AdaBoost
	50% training	25% training	50% training	25% training	50% training	25% training				
overall accuracy	88.03	87.07	82.09	71.35	88.05	88.05	87.98	85.43	87.89	88.00
producer Class1 accuracy	96.67	99.01	98.17	99.99	96.75	96.75	96.61	94.21	96.69	96.77
producer class2 accuracy	89.69	81.40	81.18	66.23	89.77	89.77	89.62	94.13	89.76	90.41
producer class3 accuracy	65.62	75.08	49.93	22.43	65.38	65.38	65.67	45.94	64.64	63.51
user class1 accuracy	98.93	96.46	82.72	64.13	98.88	98.88	98.86	98.71	98.31	98.77
user class2 accuracy	83.80	88.15	83.91	89.60	83.78	83.78	83.81	77.47	83.95	83.33
user class3 accuracy	74.49	66.67	73.56	52.36	74.67	74.67	74.32	78.60	74.28	75.56
Kappa Coefficient	87.82	86.82	81.87	71.22	87.84	87.84	87.77	85.25	87.68	87.79

The classified output image using ensemble neural network techniques are shown below: Bagging with three back propagation network figure 3(a), Bagging using three different neural network figure 3(b), Boosting figure 3(c) and Adaptive Boosting figure 3(d) .



(a)



(b)

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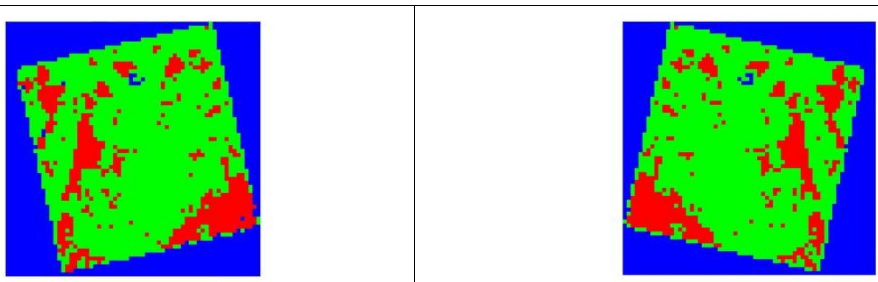

(c)	(d)

Figure.3 Classified Image using ensemble neural networks (a) Bagging with 3 backpropagation networks (b) Bagging with 3 different neural networks (c) Boosting network (d) Adaptive Boosting

V.CONCLUSION

In this paper, the performance of single artificial neural network with ensemble network and the training dataset percentage is compered. The overall accuracy of supervised radial basis function is 71.35% as compared to the ensemble network of Bagging, boosting and AdaBoost with 87.98%, 87.89% and 88% respectively. The average producer's accuracy of three classes approximately same for the ensemble networks whereas the average user's accuracy improves as compared to single neural networks. The Kappa coefficient with 50% training data for single neural network is same as 25% training data for ensemble network. The performance of ensemble methods of Bagging, Boosting and Ad boosting is similar. In this paper single hidden layer with neural network is used. The hidden layers can be increased in the network in future scope.

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