Classification of LISS-III images using LVQ

Mr. Anand Upadhyay[1],Dr.(Mr.) Santosh Kumar Singh[2],Mr. Rajesh Gupta[3], Mr. Dayashankar Gupta[4]
Assistant Professor[1],Head of IT Department[2],Post Graduate Students[3,4]
Thakur college of Science and Commerce
Thakur village,Kandivali(E),Mumbai-400101

***Abstract*— The Classification of land cover and land use satellite image is important application of remote sensing and satellite image classification. The data acquired over various parts of Mumbai region is LISS-III. In, this paper the proposed classifier is LVQ based artificial neural network which is developed using MATLAB. It is supervised classification technique applied on the LISS-III satellite images. The classification accuracy is calculated after applying the LVQ artificial neural network using the confusion matrix and Kappa co-efficient. The classification accuracy of the proposed classifier is 94.79% and the Kappa coefficient is 0.9255 respectively.**

***Keywords*— LVQ(Learning vector quantization), Remopte Sensing , Artificial neural network,Supervised Classification**

I. INTRODUCTION

The remote sensing is widely used technology. In remote sensing there is the satellite which is far away from the earth surface and has high power camera with high resolution. The satellite camera is very powerful; it captures the images of the various parts of the earth surface. So, these particular images are used for different purposes by different organization, agencies and other research organization for their study and planning of different resources. The one of the very important application of remote sensing is land use and land cover classification in which with help of satellite images and classification method the use of land and land covers are analyzed. In, this analysis the researcher are try to find out the change in land and land cover with different types of object's i.e. water, human settlements, agriculture, forest and wetland etc. [13] The Classification is one of the very important applications of satellite image processing but the very difficult part of the classification is to decide the appropriate characteristics based on that the classifier is going to classify the different classes from each other. Classification is nothing more that the partition of observation space into the disjoint region. There are different classifications methods are available for the classification of land use and land cover classification but basically all the different types of classifiers are broadly divided into two categories. The first category is known as the supervised classification technique in which the classifiers uses the past data or the training set and based on that the classifier is capable to classify the unknown data into the different classes. In the second category there is no involvement of the past data or the training set here the classifier classified the data based on the similarities or based on their nearest relation within the same class. In, this classification technique the LVQ (learning vector quantization) which is one of the types of the artificial neural network is used to classify the LISS-III satellite images into different classes which are water, forest, mangroves and settlements. The learning vector quantization uses the supervised classification techniques to classify the data into different classes.

II. SURVEY AND FIELD STUDY

The supervised classification techniques required the training sets of the data of the different classes so the training set data should be the actual characteristics which properly describe the specific class so for that reason we required the survey and the field work to collect the training sample. The survey and field study plays very important role in case of satellite image classification. In the survey and field study the area or region which we want to classify that survived and the analyst tries to locate these areas on the LISS-III data. These areas are known as "training sites" [2]. These data are used to guide or train the classifier and then classifier is able to classify the unknown data based on the train data sets. Here, the data is collected by maps, and personal experience.

III. STUDY AREA AND CHARACTERSTICS

The Resourcesat - 1 is designed to provide multispectral, monoscopic and stereoscopic imageries of the earth's surface with its advanced on-board sensors. Indian Remote Sensing (IRS-P6) satellite gives LISS-III (Linear Imaging and Self Scanning Sensor) data. Classified land use and land cover map generated from LISS-III data is used to assess the land cover by human settlement, water, forest and mangroves. The data set of Mumbai region acquired for this research was collected via IRS-P6 resourcesat-1 satellites using LISS-III sensors in the multispectral mode by NRSA, Hyderabad, Andhra Pradesh (A.P), India. The LISS-III is a multi-spectral camera operating in four spectral bands. The LISS-III data sets consist of four different bands which are 0.52-0.59 microns (B2), 0.62-0.68 microns (B3), 0.77-0.86 microns (B4) and 1.55-1.70 microns (B5) of images. There are three bands in the visible and one near infrared. LISS-III provides data with a spatial resolution of 23.5 m unlike in IRS-P6 (where the spatial resolution is 70.5 m).The LISS-III data sets are widely used for Land use/ Land cover, Urban planning, biodiversity characterization, Forest survey, wet land mapping, environmental impact, crop acreage and production estimation of major crops, drought monitoring and assessment based on vegetation condition, snowmelt run off estimation and so on [3].

IV. ARTIFICIAL NEURAL NETWORK

The human brain consists of millions of biological neurons which helps human to understand the pattern and based on the pattern the human can remember the different things. So, an artificial neural network (ANN) is biologically inspired from the human biological neurons. The artificial neural network often called as "neural network". The artificial neural network is a mathematical model or computational model based on biological neural networks. The artificial neural network is capable to learn or understand the different types of pattern where there is no appropriate mathematical relationship's are not available for differentiation purpose of different classes. The artificial neural network consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. The artificial neural network is dynamic in the nature because in most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase [2][14].

LVQ(Learning vector quantization)

The LVQ stands for Learning Vector Quantization Networks which is one of the types of the artificial neural network. The LVQ neural network was created by Teuvo Kohonen. The Learning vector quantization is multinomial classifiers of a probabilistic type. The LVQ uses the supervised and competitive learning algorithm. The LVQ neural network same as like other neural network consist of the input layer, hidden layer and output layer simultaneously. In the LVQ neural network takes the input data from the input neurons and in the neurons of hidden layers it performs the clustering which is the type of the unsupervised classification but at the output layer it matches each input with the decided class labels which is called as the "codebook". So, internally the LVQ uses the clustering which will helps the LVQ to broadly and properly classify the input data to specific class. It also uses the concept of probabilistic learning with the principle of "Winner Takes All" which means in the hidden layer the neurons compete with each other and the neuron which has the high activation they all will survive and other will shut down.

The basic LVQ algorithm is a straightforward method for shifting the Voronoi cell boundaries to result in better classification. It starts from the trained SOM with input vectors x={x1, x2, x3….xn} and weights/Voronoi vectors wj= {w1, w2, w3….. wn}, and uses the classification labels of the inputs to find the best classification label for each wj.

The LVQ algorithm then checks the input classes against the Voronoi cell classes and moves the wj appropriately:

Algorithm:

IF (The input x and the associated weight w(x) (i.e. the weight of the winning output node I(x) have the same class label) THEN

{

Move them closer together by $\Delta w_{I(x)}(t) = \beta(t)(x - wI(x)(t))$.

} ELSE

IF (The input x and associated weight $w_{I(x)}$ have the different class labels) THEN

{

Move them apart by $\Delta w_{I(x)}(t) = -\beta(t)(x - wI(x)(t))$.

} ELSE

{

Weights wj corresponding to other input regions are left unchanged with $\Delta wj(t) = 0$.

}

Where β (t) is a learning rate and which decreases with the number of iterations/epochs of training [13].

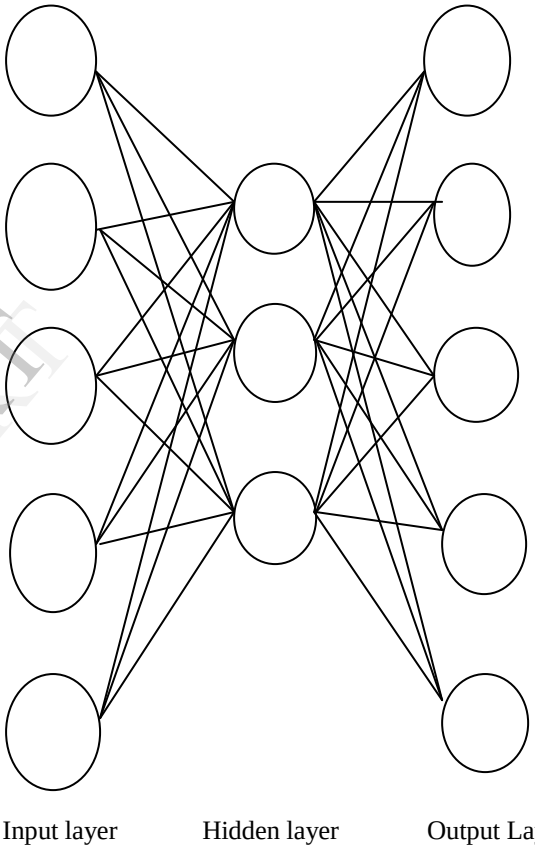

Fig. 1. Architecture of Learning Vector Quantization

V. METHODOLOGY

The algorithm is developed in MATLAB R2010. It uses a Learning vector quantization artificial neural network with LVQ1 algorithm. LISS-III satellite image consist of four different bands of images. Initially, before going to extract the feature of satellite image, all four different bands are stacked together to get the one RGB image. The following diagram represents the steps involved in satellite image classification.

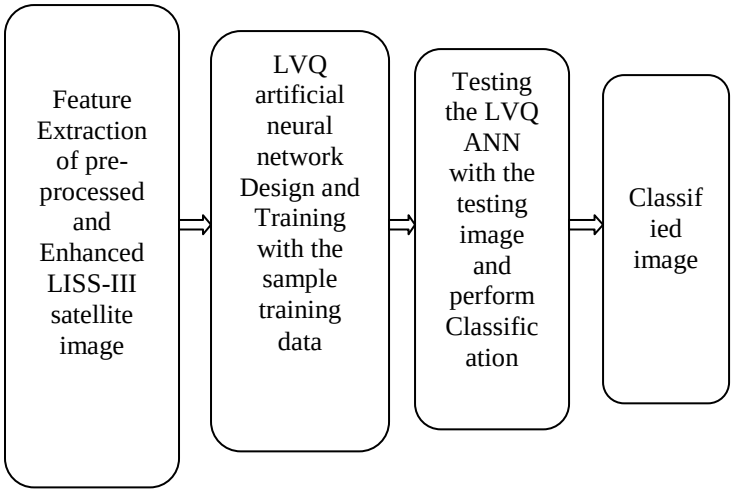

Fig. 2. LVQ Classification Methodology

A. *Feature Extraction*

In order to classify the satellite images, the first step is feature extraction. Here the pixel based classification methodology is adopted so from each class area region the training samples are collected in the characteristics of the R (Red), G (Green) and B (Blue) pixel value of each pixel. The training pixels are collected from the different regions of the image for the specific class and that class is assigned by the unique value. Based on the features of known classes the LVQ artificial neural network is trained. During testing when the features are provided for pixels which are not having the classes then it will give the class based on their learning.

B. *LVQ Artificial Neural Network Design*

The Matlab is very powerful mathematical computational model which provides the tool for LVQ artificial neural network based classification. The LVQ artificial neural network is designed by using the LVQ neural network toolbox. The data sets are preprocessed as the Matlab toolbox required. The LVQ artificial neural network object in the Matlab toolbox expects the samples along columns and its features along rows. Our dataset has its samples along rows and its features along columns. After preprocessing of sample data the next step is to create a LVQ artificial neural network (LVQ2) that will learn to identify the classes. Since the LVQ neural network starts with random initial weights, the results will differ. The LVQ neural network is trained to avoid this randomness. A 1-hidden layer LVQ neural network is created with 4 neurons in the hidden layer. After all these setting the network is ready to be trained. The samples data set is automatically divided into training, validation and test sets. The training set is used to teach the network. Training continues as long as the network continues improving on the validation set. The test set provides a completely independent measure of network accuracy.

C. *Classification*

The LVQ neural networks which are trained with training data sets are used to classify the desired image. The trained LVQ neural network is ready to classify the desired image. The testing can be done with a separate testing set which is created while creating training set and based on that the classification accuracy calculated using confusion matrix and Kappa coefficients.

VI. DATA AQUIRED

LISS-III data set of Indian region is freely available online. LISS-III data sets are available in four different bands. The data is acquired in April 2013.The field work is carried out in the month of July and september2013.

VII. RESULT

The Neural Network trained with sample data. After training, the testing is done using testing dataset and the accuracy assessment is done through the confusion matrix and Kappa co-efficient. The neural network is used to classify the desired image. The confusion matrix and kappa coefficient are for the data set which is tested by LVQ neural network which is trained with the training data set.

TABLE I. CONFUSION MATRIX

Accuracy= (546/576)*100;
=94.79

Classes	Water	Forest	Mang roves	settle ment	Total	Users Acc (%)
Water	219	0	3	0	222	98.65
Forest	1	183	13	1	198	92.42
Mangroves	0	10	71	2	83	85.54
settlement	0	0	0	73	73	100
Total	220	193	87	76	546	
Producers Acc (%)	99.55	94.82	81.61	96.05		94.79%

=:95%

$$\hat{k} = \frac{N\sum_{i=1}^{r} xii - \sum_{i=1}^{r}(Xi + * X + i)}{N2 - \sum_{i=1}^{r}(X\,i + * X + i)}$$

K=0.9255(Very Good)

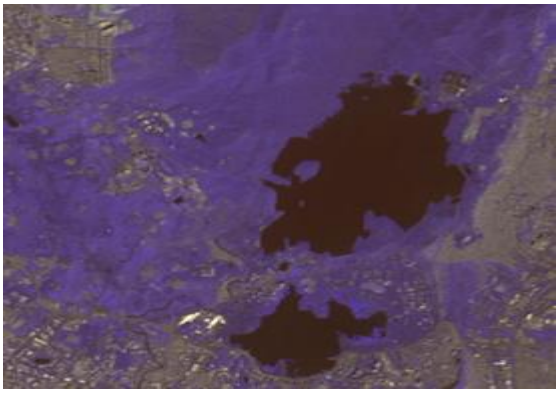

Fig. 3. False colour image before classification

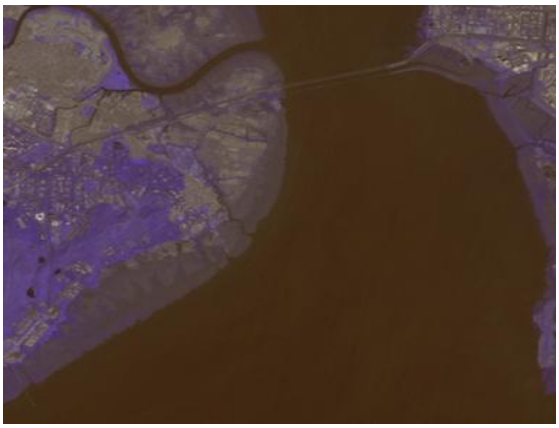

Fig. 4. False colour image before classification

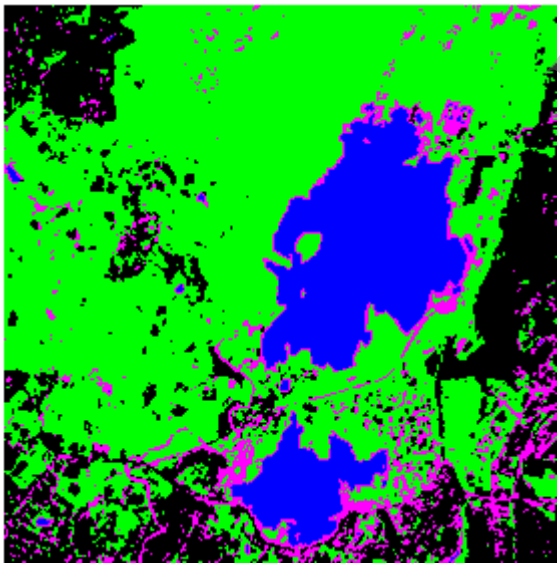

Fig. 5. Colour Image After Classification

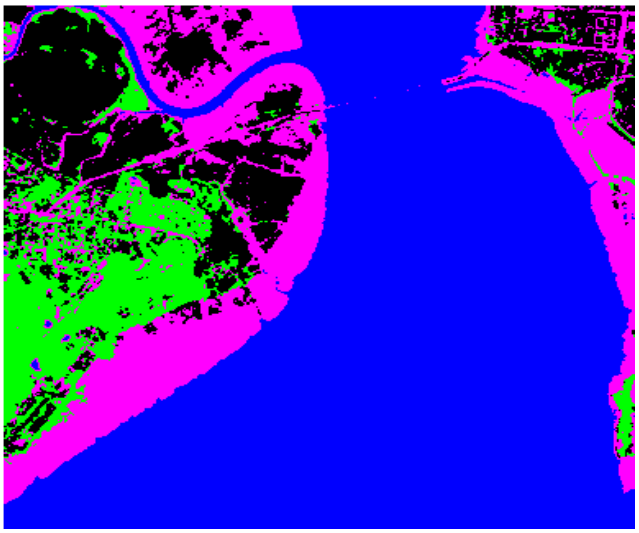

Fig. 6. Colour Image After Classification

Fig. 7. Colour Image After Classification

VIII. CONCLUSION

In this paper learning vector quantization artificial neural network has been used for classifying LISS-III satellite image. Here, from the above confusion matrix and kappa value calculated it has found that the accuracy of classifier of the image is 94.79% and Kappa coefficient 0.9255 respectively. So, it is concluded that LVQ is also one of the good classifier to classify the satellite image for the classification purpose.

IX. FUTURE ENHANCEMENT

The LVQ is one of the good classification techniques which we can use for the other classification problem. It can also success fully apply on other types of the satellite images for the classification purposes. The classification accuracy of LVQ is also compared with the other classifiers in the future.

X. ACKNOWLEGEMENT

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