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Featured based Improved Classification of Satellite Image using LVQ Classifier

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***Abstract*—Remote sensing is one of the most major parts of advance image processing. The satellite image processing is used to acquire high resolution geo-spatial data of earth surface. The satellite images are used for different purposes i.e. land use and land cover classification, change detection, forecasting and monitoring purpose. There are many research aspect related to satellite image classification out of which accuracy is major issue. In this paper LVQ classifier is used to classify LISS-III satellite image for different land use and land covers theme. In this classification technique, two training data set are prepared to classify the satellite images. The first training data set consist of R, G, and B colour features whereas second training datasets consist of mean, variance, standard deviation, skewness and kurtosis. The LVQ classifier gives the accuracy of 88.99% when it is trained by colour feature vectors whereas it shows improved classification accuracy of 96.23% when it is trained by colour features along with statistical values of colour features. So, this studies shows that there is improvement of classification accuracy when numbers of feature vectors are improved.**

Keywords—Learning Vector Quantization (LVQ), Artificial Neural Network(ANN), LISS-III Satellite Image, kappa coefficient.

I. INTRODUCTION

Remote sensing is one of advancement of technology which is widely used in so many cases of day to day life. Today, due to remote sensing it is very easy to monitor borders, weather condition and other factors which were far away from human control. There are two types of remote sensing which are active and passive remote sensing; based on both techniques various remote sensing techniques are developed. These different techniques are used for various applications.The remote sensing satellite provides image of earth surface in different bands which varies in different wavelength of light. Such image data sets consist of various information related to various objects present at earthsurface. Land use and land cover classification is one of the techniques which are used to map different information using satellite image. The land use and land cover classification can be based on different themes i.e. soil moisture, agricultural production and types of soil. The different classification algorithms can be used to classify and generate thematic map of different land use and land cover classification but the problem with classification of satellite image are global classification techniques, parameters of classifiers and its accuracy. There are continuous studies and researches are going on to solve above problems, by considering this factor here feature based technique is suggested to improve accuracy of classifiers. It is observed from study and its implementation that if the feature vector of training data set is improved i.e. appropriate fittest feature vector or very concise statistical summarized feature vector then itimproves accuracy of classifiers. In, this classification technique learning vector quantization classifier is used for classification of LISS-III satellite image into different classes. LVQ is type of artificial neural network from various types of artificial neural network.

Here in classification there are two different types of training set are preparedfor classification of LISS-III satellite image. The first training data set consists of RGB colour feature vector of the images whereas second training data set consist of RGB colour feature along with its mean, variance, standard deviation, kurtosis and skewness of RGB colour feature vectors. The learning vector quantization classifier uses the supervised classification techniques to classify the data into different classes. The LVQ classifiers trained with both training file one by one and tested on testing dataset based on that accuracy of classifier calculated using confusion matrix. It shows improvised classification in case of second training dataset which consist of more training dataset features.

II. ARTIFICIAL NEURAL NETWORK

The concept of artificial neural network is derived from biological neural network from human brain. The human brain consist of neurons which is a type of cell consist of learning and based on that person canremember different types of things. The human neural networks are connected with each other through dendrites and transfers different signal which comes from different human input system i.e. ear, skin, tong and eye. Similarly artificial neural network consist of input, hidden and output layers. The nodes of different layers are connected with random weight at initial state and after learning these weights are adjusted in such way that for the specific input they will categories them in appropriate classes. The artificial neural network is used for various types of application. It is used for both supervised and un-supervised classification of data. There are different types of neural networks are available i.e. perceptron, multilayer perceptron, probabilistic neural network, self-organizing map and learning vector quantization.

III. LEARNING VECTOR QUANTIZATION

The LVQ stands for Learning Vector Quantization neural networks which is the types of the artificial neural network. The LVQ neural network was created by TeuvoKohonen. The LVQ is multinomial classifiers of a probabilistic type. It uses the supervised and competitive learning algorithm. The LVQ neural network is very similar to other type of artificial neural network. It has input layer, hidden and output layers simultaneously. The input layer of LVQ takes input and in neurons of hidden layer it performs clustering and later on at output layer it perform classification based on Euclidean distance. 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.

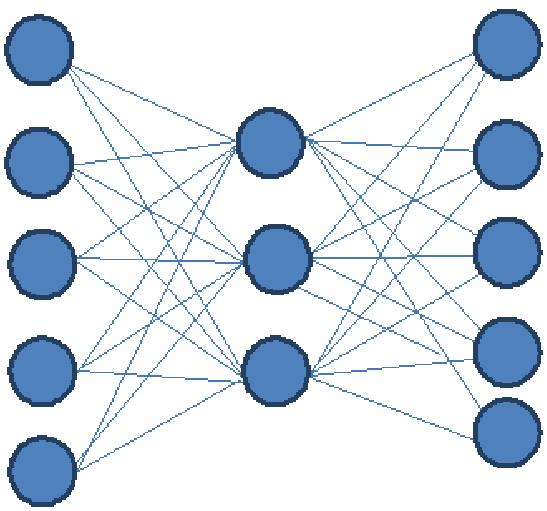

Fig. 1. Architecture of learning vector quantization

IV. METHODOLOGY

The methodology plays vital role any types of research. Here, in this research paper LISS-III satellite datasets are used along with learning vector quantization classification algorithm. The classification algorithm is implemented using MATLAB R2010A simulation toolbox. The methodology of satellite image classification consists of different steps. It starts with acquiring data, pre-processing, feature extraction, classifier design, training, testing, validation and accuracy assessment. The detail explanations of all these steps are as follows:

A. Data Acquired & pre-processing

The LISS-III satellite images are provided by IRS-P Resourcesat– 1 which is Indian satellite. LISS-III is multispectral datasets which is available in four different band2, band3, band4 and band5. The LISS-III image of Mumbai region is acquired for land use and land cover classification. The LISS-III satellite images are provided by NRSA(National Remote Sensing Center). The important step in image classification is to apply pre-processing for image enhancement. Here, histogram equalization is applied for enhancement process.

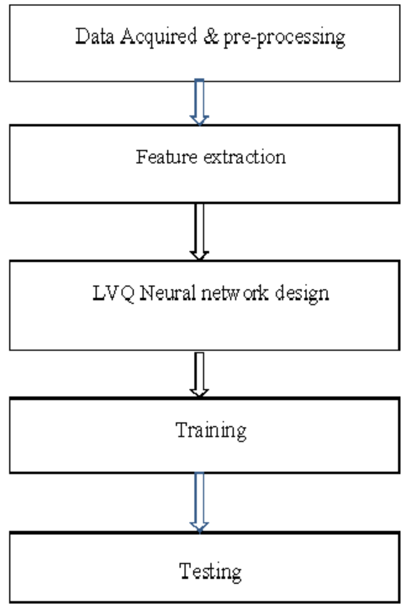

Fig. 2. Steps for classification of satellite image

B. Feature extraction

The next step is collection of features for classification of satellite images. Here, pixel based classification method is applied for classification of LISS-III satellite image. The three bands of LISS-III satellite images which are available in grey scale image that are stacked together to form RGB colour image. After stacking the LISS-III satellite image training data sets are prepared which consist of colour information along with its classes from which colour features belongs. There are two different training data sets are prepared where first training dataset consist of only red, green and blue colour information along with its classes whereas second training dataset consist of red, green, blue colour information along with mean, variance, standard deviation, kurtosis and skewness along with its classes information.

C. LVQ Neural network design

The Matlab simulation toolbox is designed for mathematical computational process, even it consists of various functions for mathematical operation. The two different learning vector quantization neural networks are implemented with three input node and other with four input node. There number of hidden nodes are five and one node, based on hypothesis here to show the impact of input feature vector just number of input nodes are increase and rest all the things are same. The learning vector quantization artificial neural network uses LVQ1 learning vector quantization learning algorithm.

D. *Training*

Training is fundamental concept in supervised learning based classification and learning vector quantization is supervised classification method. Here, two different training file are created during feature extraction process where first file consist of colour features whereas the second one consist of colour features along with statistical features i.e. mean, variance, standard deviation, kurtosis and skewness. The two different learning vector quantization neural networks are trained by two different training data sets for classification after training process they are ready for testing process.

E. *Testing*

Testing and validation are carried out on separate testing dataset file. After testing with help of confusion matrix and Kappa coefficient the accuracy of both leaning vector quantization neural network is calculated. The classified image of LISS-III satellite image is also generated for thematic map generation.

V. RESULT ANALYSIS

The accuracy calculation and its assessment plays vital role in any types of classification. The accuracy assessment reveals importance and strong role of classifier for that specific classification task. The accuracy assessment shows the impact of different classification factor on role of classification process. The confusion matrix is a very popular method calculation of accuracy of classification. The confusion matrix is also known an error matrix because its diagonal matrix shows correct classified data whereas non –diagonal elements shows misclassified data.

TABLE I. ACCURACY ASSESSMENT OF LVQ USING ONLY COLOUR FEATURE

Classes	Water	Forest	Land	Total	UserAcc.
Water	586	0	24	610	96.07%
Forest	59	69	18	146	47.26%
Land	20	0	323	343	94.17%
Total	665	69	365	1099	
ProducerAcc.	88.12%	100%	88.49%		88.99%

Accuracy= ((586+69+323)/1099)*100 =88.99%

TABLE II. ACCURACY ASSESSMENT OF LVQ USING COLOUR FEATURE ALONG WITH STATISTICAL FEATURE

Classes	Water	Forest	Land	Total	UserAcc.
Water	442	5	1	448	98.66%
Forest	0	217	6	223	97.30%
Land	18	14	463	495	93.54%
Total	460	336	470	1166	
ProducerAcc.	96.09%	64.58%	98.51%		96.23%

Accuracy= ((442+217+463)/1166)*100=96.23%

The above two different confusion matrix calculation tables shows accuracy assessment of LVQ which is trained with only colour feature and other shows accuracy of LVQ trained with colour feature along with its statistical values i.e. mean, variance, standard deviation, kurtosis and skewness. The LVQ which is trained only colour features shows accuracy of 88.99% whereas the LVQ which is trained with colour along with its statistical features shows the accuracy of 96.23 %. It gives clear explanation that when number of classification features is increased then it improves classification accuracy.

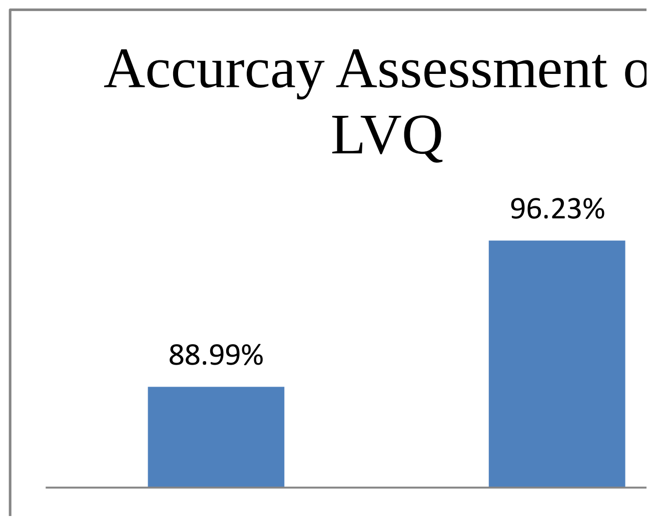

Fig. 3. Comparative analysis of LVQ classification accuracy

The above graphical comparative analysis show the comparison between two different types of learning vector quantization classifiers which are trained with two different types of training datasets. It clearly specifies that if there is need of improvising classification accuracy then statistical features is one option out of many other options.

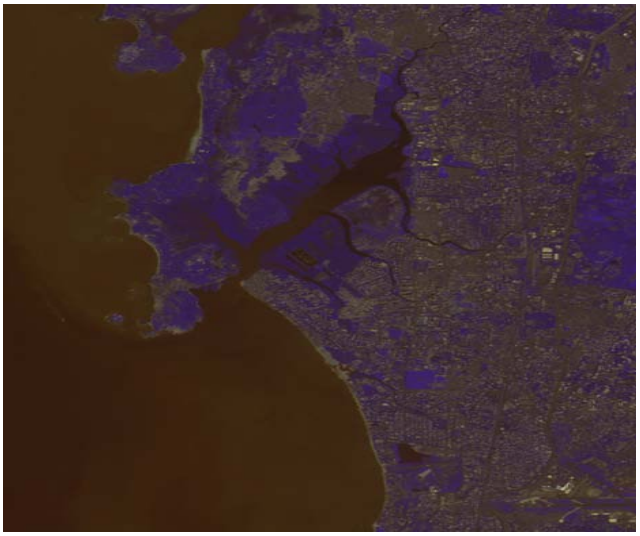

Fig. 4. LISS-III satellite image before classification

VI. Conclusion

The LISS-III satellite image classification is successfully implemented using learning vector quantization. The classification based on LVQ is implemented with two different ways. In one way it is trained and tested with only colour features of satellite image whereas on other way it is trained and tested with colour features along with its statistical feature vectors. The accuracy of first LVQ is 88.99% which is trained with colour features only whereas the second LVQ shows accuracy of 96.23% which is improvised compare to the first LVQ artificial neural network which is trained with only colour feature vectors. The implementation of such type of proposed method shows that the increase in number of vector also increases the accuracy of classifiers because it has more option of features vectors to understand proper bifurcation among different classes.

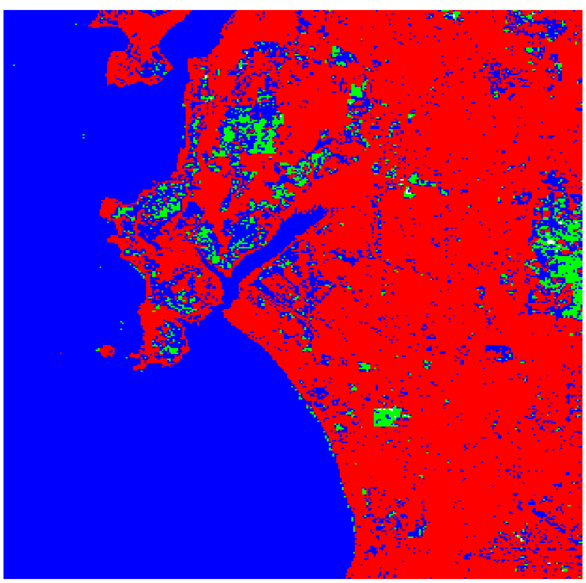

Fig. 5. LISS-III image after classification

VII. Future Work

The classification of LISS-III satellite image using LVQ neural network is applied to get thematic map of land use and land cover classification. The proposed method can be applied in future for other themes too. For future research purpose the improvement can make by selected some other types of more advance feature vectors. The suggestedmethod can be tested for some other classification techniques to make proposed hypothesis as universal hypothesis of all other classifiers also.

Acknowledgment

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