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CLASSIFICATION OF IRS LISS-III IMAGE USING ARTIFICIAL NEURAL NETWORK

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Abstract: The LISS-III is Linear Imaginary of Self Scanning Sensor. It is a multi-spectral camera operating in four spectral bands. 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 classification of various land cover features using LISS-III data sets is an important application of remote sensing. The purpose of this paper is to develop a classifier which is use to classify the LISS-III satellite images into different classes as sweet water, salty water, forest, mangroves and settlement. The proposed classifier is developed using artificial neural network with back propagation of error in Matlab. It uses the supervised classification technique applied on the LISS-III IRS-P6 data set. The accuracy of the classifier is calculated using the confusion matrix and Kappa value. It is observed that the accuracy of the classifier is 86.96% and Kappa value is 0.8159 which is very good.

Keywords: LISS-III satellite Image, moments, neural network, and classification.

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INTRODUCTION

Classification is one of the most frequently encountered decision making tasks of human activity. A classification problem occurs when an object needs to be assigned into a predefined group or class based on a number of observed attributes related to that object. Many problems in business, science, industry, and medicine can be treated as classification problems. Traditional statistical classification procedures such as discriminate analysis are built on the Bayesian decision theory. In these procedures, an underlying probability model must be assumed in order to calculate the posterior probability upon which the classification decision is made. One major limitation of the statistical models is that they work well only based on the posterior probabilities or assumptions about different classes. The calculated assumption only helps to calculate or predict the classes of unknown data. The effectiveness of these Methods depends to a large extent on the various assumptions or conditions under which the models are developed. Users must have a good knowledge of both data properties and model capabilities before the models can be successfully applied. The LISS-III is provided by IRS-P6 IRS satellite which provides the more information about the earth surface. The classification of LISS-III satellite image plays very important role to study about forest, human settlements, development, climate changes and farming land.

There are two types of image classification techniques are which are known as supervised and unsupervised classification. An unsupervised classification technique, classifies the image automatically by finding the clusters based on certain criterion. On the other hand in supervised classification technique the location and the identity of some cover type, for example sweet water, salty water, forest, mangroves and settlements are known before[1]. Here, the data is collected by maps, and personal experience. The analyst tries to locate these areas on the LISS-III data. These areas are known as “training sites”. An analyst can guide a classifier with the help of these training sites to learn the relationship between the data and the classes. Neural networks have emerged as an important tool for Classification. The recent vast research activities in neural classification have established that neural networks are a promising alternative to various conventional classifications. Here in this paper the neural network based classifier implemented using the Matlab2010 for the classification of LISS-III satellite image.

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[2]. Classified land use and land cover map generated from LISS-III data is used to assess the land cover by human settlement, sweet water, salty 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 (MS) mode by NRSA, Hyderabad, Andhra Pradesh (A.P), India. The characteristics of IRS-P6, LISS-III data are summarized in Table1.

ARTIFICIAL NEURAL NETWORK

An artificial neural network (ANN), often just called a “neural network" (NN), is a mathematical model or computational model based on biological neural networks, in other words, is an emulation of biological neural system. It consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. 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].

Feed forward neural network with back propagations of error

The feed forward neural network is simplest type of artificial neural network. In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes. There are no cycles or loops in the network. The data processing can extend over multiple (layers of) units, but no feedback connections are present, that is, connections extending from outputs of units to inputs of units in the same layer or previous layers [1].

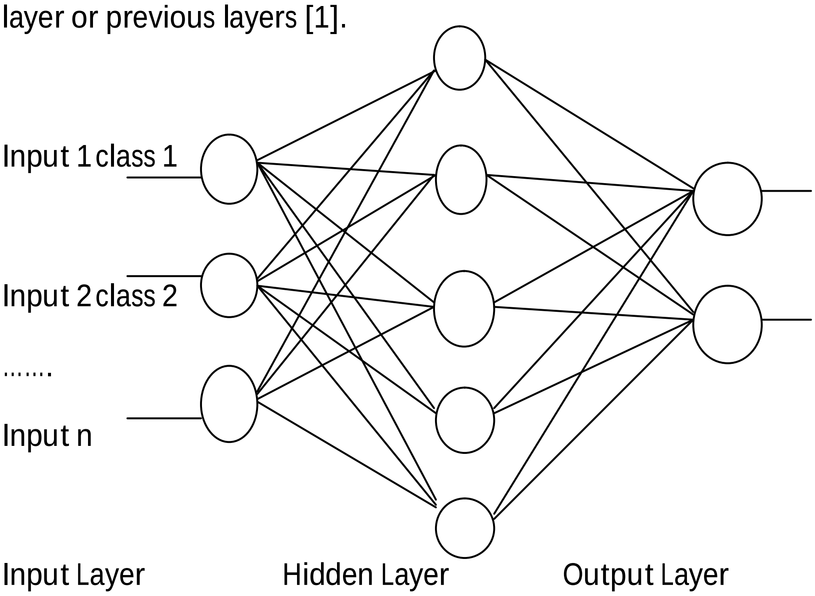

Fig.1 Architecture of Artificial Neural Network

Table.1 Characteristics of IRS-P6 Satellite Image

Specification	Resorceset-1,LISS-III
Special Resolution in nadir	23.5m
Swath	141 km
Repetetivity	24days
Spectral Bands	0.52-0.59 microns(B2) 0.62-0.68 microns(B3) 0.77-0.86 microns(B4) 1.55-1.70 microns(B5)
Quantization	7 Bits SWIR band has 10 bit quantization, selected 7 bits out of 10 bits will be transmitted by the data handling system
No. of gains	4 for B2, B3 and B4. For B5 (Dynamic range obtained by sliding 7 bits out of 10 bits)
Primary Application	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.

Feed forward neural network using back propogation of error algorithm.

- Decide input, target and testing data.
- Initialize the weight and bias.
- Calculate the feed forward Neural Network output.
- Match the output with target.
- Calculate the error= difference between actual & desired output.

- Update all the weight and bias of the Neural Network.
- Repeat the steps until the error will not reduced.

Training of artificial neural networks

A neural network has to be configured such that the application of a set of inputs produces (either 'direct' or via a relaxation process) the desired set of outputs. Various methods to set the strengths of the connections exist. One way is to set the weights explicitly, using a priori knowledge. Another way is to 'train' the neural network by feeding it teaching patterns and letting it change its weights according to some learning rule. Supervised learning or Associative learning in which the network is trained by providing it with input and matching output patterns. These input-output pairs can be provided by an external teacher, or by the system which contains the neural network.

Methodology

The algorithm is developed in MATLAB R2010. It uses a feed forward 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 flow chart represents the steps involved in satellite image classification.

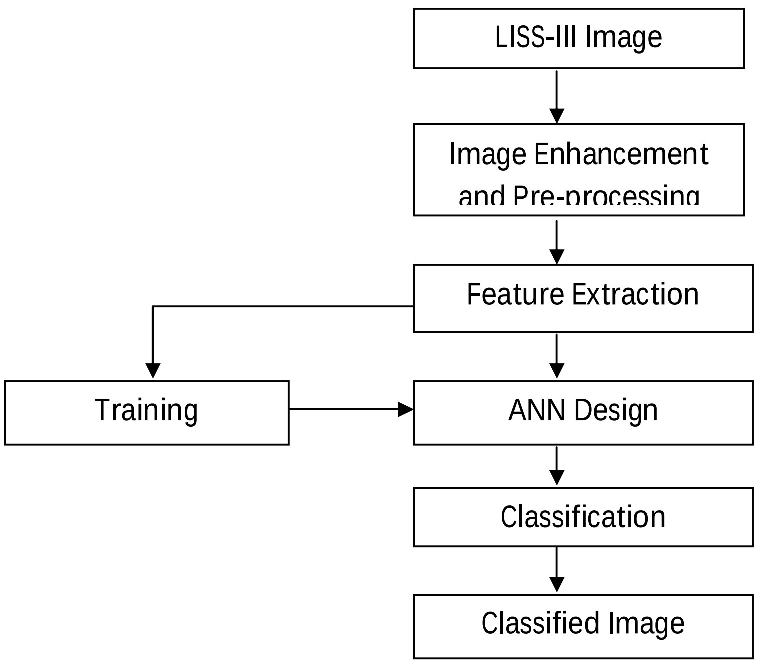

Fig.1 Flow chart

Feature Extraction

In order to classify the satellite images, the first step is feature extraction. Based on the features of known classes the neural network is trained. During testing when the features are provided for pixels which are not having the class then it will give the class based on their learning. In feature extraction, certain features are calculated for each pixel. The network is trained by computing the input matrix and the target vector. The input matrix is obtained from the features and the target vector is manually calculated. Once training is completed, the network is simulated with an input image, for which classification should take place, to specify human settlements, sweet water, salty water, forest and mangroves. For a color image, each pixel has RGB values associated to it. To extract these values, the function IMPIXEL is used which returns the red, green, and blue color values of specified image pixels.

Artificial Neural Network Design

The neural network is designed to be a feed forward back propagation network. Preprocess the data into a form that can be used with a neural network. The 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. Hence the matrices have to be transposed. After preprocessing of sample data the next step is to create a neural network (feed forward back propagation network) that will learn to identify the classes. Since the neural network starts with random initial weights, the results will differ slightly every time it is run. The random seed is set to avoid this randomness. A 1-hidden layer feed forward network is created with 20 neurons in the hidden layer. After all these setting the network is ready to be trained. The samples are 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.

Classification

The trained 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.

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.

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 output of the classified image and the accuracy assessment through confusion matrix are as follows [6]:

Table.2 Confusion Matrix for Mumbai Region LISS-III by ANN Classifier

	Sweet water	Forest	Salty water	Mangrove	Urban	User's Accuracy
Sweet water	39	30	2	1	0	54.16%
Forest	0	131	12	1	0	90.97%
Salty water	1	18	322	1	0	94.15%
Mangroves	0	5	18	102	6	77.86%
Urban	0	0	3	2	73	93.58%
Producer's Accuracy	97.5%	71.19%	90.19%	95.32%	92.40%	

Accuracy= ((39+131+322+102+73)/767)*100;

=86.96

=:87%

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

k = 0.8159(Very Good)

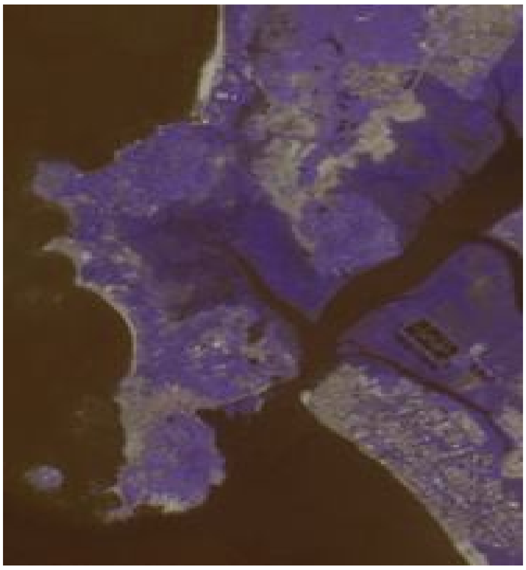

Fig. 2 Color Image after Classification

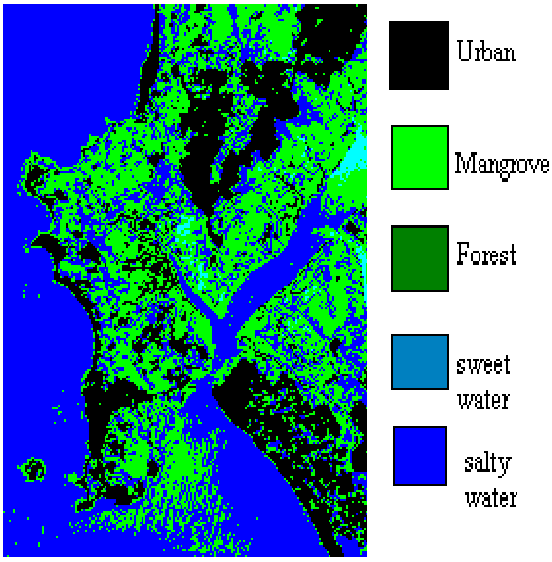

Fig. 1 False color before Classification

CONCLUSION

In this paper back propagation neural network has been used for classifying LISS-III satellite image and accuracy is calculated using confusion matrix and kappa co-efficient. The results show that the accuracy of the classified image is 86.96%. The accuracy can be increased by increasing the number of features and sample data. In future other statistical parameters are also used to improve classification accuracy. The accuracy can further be improved by using various techniques for classification, such as fuzzy logic and genetic algorithms with all these different feature values.

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