IRS LISS-III Images Classification using Artificial Neural Network

Mr. Anand Upadhyay, Dr. Santosh Kumar Singh, Mr. Kuldeep Kandwal, Mr. Sachin Kambli

Abstract— **Remote Sensing has been globally and widely used for knowledge elicitation of earth's surface and atmosphere. Land use and land cover mapping is one of the widely used applications of remote sensing. It is a method for acquiring geo-spatial information from satellite data. Here we have attempted to solve the land use and land cover problem by image classification using the artificial neural network. 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 95.17% and Kappa value is 0.9289 which is very good.**

Index Terms— **LISS-III satellite image, neural network, remote sensing, land use and land cover and image classification**

I. INTRODUCTION

The Earth is constantly under observation from number of satellites orbiting the planet and collecting data. They are engaged in obtaining information about something without being in direct contact with it. This process is called "Remote Sensing" [1].Now-a-days the field of Remote Sensing and GIS has become exciting and glamorous with rapidly expanding opportunities. There are many organizations spending large amounts of money on remote sensing and GIS. These fields are so important in recent years because of now-a-days scientists, researchers, students, and even common people are showing great interest for better understanding of our environment. Development in complicated space technology which can provide large volume of spatial data, along with declining costs of computer hardware and software has made Remote Sensing and GIS affordable to not only complex environmental/spatial situation but also affordable to an increasingly wider audience[2].

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Mr.Anand Upadhyay, Department of IT, Thakur College of Science and Commerce, Mumbai, India

Dr(Mr.)Santosh Kumar Singh, Department of IT, Thakur College of Science and Commerce, Mumbai, India.

Mr.Kuldeep Kandwal, Department of Mathematics, Thakur College of Science and Commerce, Mumbai, India

Mr.Sachin Kambli, Department of Computer Science, Thakur College of Science and Commerce, Mumbai, India

Classification is the most important digital image processing step in remote sensing. Land cover and land use mapping is an important application area of remote sensing discipline and Classification is the preferential step for producing thematic spatial information from satellite image data. There is Artificial Intelligence and Data mining algorithms such as Artificial Neural Network (ANN), Decision Tree (DT), Support Vector Machine (SVM), Maximum likelihood Classifier (MLC) and Genetic Algorithm (GA) have been used widely for different classification problems in many disciplines successfully. Artificial neural network is an innovative Artificial Intelligence technique that was born out of biological insights of the incredible abilities of biological neurons solves their simple classification and decision problem [1].

In the various data analysis technique, feed forward artificial neural network classification is a supervised machine learning technique which makes predictions about future class instances by mapping instances of testing data to the predefined class labels which is learn from the supplied instances of classes with class labels. In the present work we analyze the voluminous LISS-III satellite data set which 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. Here feed forward back propagation model of artificial neural network is used to classify the LISS-III data set in different classes. A lot of research papers have discussed the classification analysis. One of important the key issue of applying the feed forward back propagation model which is suitable to classify the data set where no mathematical relationship is applicable.

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 [3].

The rest of the paper is organized as follows: Section 2 gives the idea about the study area and its characteristics. Section 3 explains about AAN, section 4 explains about the methodology, section 5, 6, 7 explains about result, conclusion and acknowledgement respectively.

II. study area and characteristics

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 [4]. 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 [4].

Table (I) 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.

III. artificial neural network

Artificial neural network is a system whose architecture is modeled after the human brain. It typically consists of many hundreds of simple processing units, which are wired together in a complex communication network. Each processing unit is known as "Node" which behaves like a "Neuron" of human brain. Each node is connected to other nodes by varying strength of connections. The strength of connection is changed after the training of the neural network which is very different from the traditional computers. 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 [3].

A. Feed forward neural network with back propagation of error

The artificial neural network has different types of network model. The feed forward neural network is simplest type of artificial neural network. The feed forward neural network consists of three different layers which are input, hidden and output layers. In feed forward neural network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes [3]. 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.

B. Feed forward neural network using back propagation 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.

C. Training of artificial neural networks

The human brain learns from the experiences and in an unknown situation it applies the knowledge of old experience. The neural network does not follow any logical or rule based algorithms. The artificial neural network learns from the new technique which is called as the adjustments (change) of the weight. 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.

IV. 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 (Fig.1) represents the steps involved in satellite image classification.

A. 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 [4]. 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 which are red, green, blue colors of each pixel of image and with respect to colors information there statistical information such as mean, median, mode, variance and standard deviation 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 and for the other statistical information the Matlab functions are used. Let A be the specified row vector of color feature then the following functions are used to calculate the values are:

1) Mean

Mean is most basic of all statistical measure. Means are often used in geometry and analysis; a wide range of means have been developed for these purposes. In contest of image processing filtering using mean is classified as spatial filtering and used for noise reduction [3]. E.g. Men=mean (A)

2) Median

Median is measure of intensity level of pixel which is separating the high intensity value pixels from lower intensity value pixels. It is a type of order-statistic filter. The most popular and useful of the rank filters is the median filter [3]. E.g. Med=median (A)

3) Mode

In statistics, the mode is the value that occurs most frequently. In image processing filter will each pixel value by its most common neighbor. This is a particularly useful filter for classification procedures where each pixel corresponds to an object which must be placed into a class; in remote sensing, for example, each class could be some type of terrain, crop type, water, etc [3]. E.g. Mod=mode (A)

4) Variance

The variance is a measure of how far a set of numbers is spread out. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value) [3]. E.g. V=var (A)

5) Standard Deviation

It is a most widely used measure of variability or diversity used in statistics. In terms of image processing it shows how much variation or "dispersion" exists from the average (mean, or expected value) [3]. E.g. SD =std (A)

B. 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 30 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.

C. 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.

V. Result

The result calculation and performance evaluation is very important phase of any classification process. Here, the Neural Network trained with sample data of the feature value. After training, in the testing phase we have the testing data set of the other images whose individual pixel features are calculated and used for the testing purpose. 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:

Table (II) Confusion Matrix

Class	Sweet water	Forest	Salty water	Mangroves	Urban	Total	User's acc
Sweet water	456	5	0	0	0	461	98.92%
Forest	9	36	8	0	0	53	67.92%
Salty water	4	0	108	12	1	125	86.4%
Mangroves	0	1	2	243	1	247	98.38%
Urban	0	0	0	4	84	88	95.45%
Total	469	42	118	259	86	974	
Producers acc	97.23%	85.71%	91.53%	93.82%	97.70%		95.17%

Accuracy= ((456+36+108+243+84)/974)*100;
=95.1745
=: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=0.9289

Kappa co-efficient value=0.9289(Very Good)

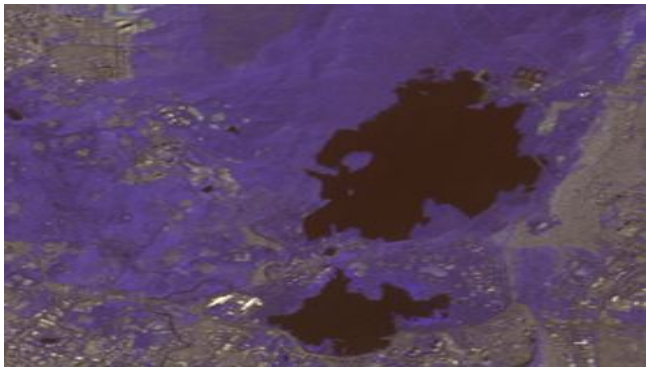


Figure (1): False color Image before Classificatio

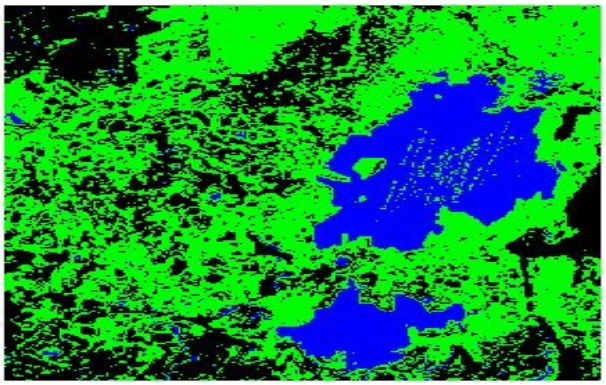


Figure (2): Color image after Classification

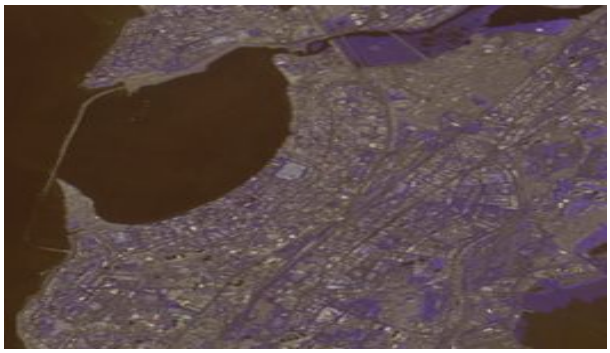
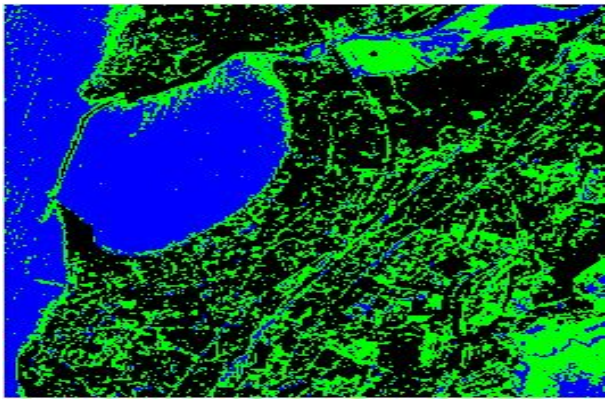


Figure (3): False color Image before Classification



Figure(4): Color image after Classification

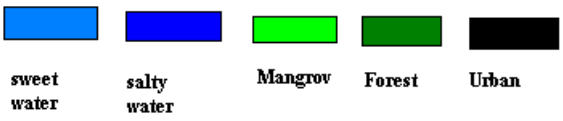


Figure (5): Index

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 95.17% and calculated Kappa value is 0.9289 which is very good for this classification. 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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