CLASSIFICATION OF EARTH SURFACE SEGMENTS USING CLUSTER ANALYSIS AND ARTIFICIAL NEURAL NETWORK

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Abstract

The objective of this work is to segment multispectral satellite images into various classes such as Water, Vegetation and Land using clustering technique . The experimentation has been done using the satellite images of Dharwad area of Karnataka state in India acquired by Linear Imaging Self Scanning (LISS-III)from Indian Remote Sensing satellite (IRS) The Artificial Neural Network (ANN) classifier is used for the classification . 96.30% of accuracy is achieved by selecting Region of Interest (ROI) from each cluster of the image formed by K means clustering technique and validated by using ground truth, which demonstrate the effectiveness of the method.

Introduction

The ultimate source of data for studying spatial and temporal variability of the environmental parameter is offered through remote sensing. Application of remote sensing includes creating of mapping product for defense and civil applications, the natural calamities are evaluated, the land use and urban planning are monitored, the assessment of soil and crop yield [17].

These remote sensing data will be raw in nature. Which means no inferences can be drawn from these images. To analyze these images, image processing techniques to be applied. The image classification of remote sensing images can be comprised of both image processing and classification techniques. Generally, the classification is nothing but the process assigning pixels of an image to classes. The identical groups of pixels are assembled into different classes that match the informational categories of user interest by comparing pixels to one another and to those of the identical pixels. The Classification groups the pixels to represent land cover features the features could be forested, urban, agriculture and other type of features**.**

The segmentation of an image is an important part of image analysis and pattern recognition. That has a wide application in remote sensing. The classification itself may be the object of the analysis in some cases. For example, classification of land use from remotely sensed data yields a map like image as the final product of the analysis The image classification therefore plays an important tool for identifying the digital images.

Multispectral Image

The set of multiband sensors(less than 10 bands) produces the sensor of a multi-spectral imaging system. The recorded radiation of a multispectral imaging system is within a narrow range of wavelength as compared to panchromatic imaging system for each band. Both intensity and spectral information of the result are observed on the resulting image

LISS-III image:

LISS-III is a multi-spectral camera operating in four spectral bands, in which two visible bands(Green, Red), one Near Infrared (NIR) regions and one in the Short Wave infrared (SWIR) region, The new feature of LISS-III camera is the SWIR band(1.55-1.7 micron), which is not available in IRS-1C/1D and also it provides data with a spatial resolution of 23.5 m..

Artificial Neural Network (ANN) Classifier is being for classification. This computational system resembles the structure and processing method and learning ability of a biological brain..

In this paper, the objective is the digital image analysis of satellite images using clustering technique for identifying Vegetation, Water and Land area segments. LISS-III multispectral images of Dharwad area of Karnataka state in India acquired by IRS satellite are used for experimentation. The results are validated by using ground truth

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Literature Survey

In the present era of globalization, due to the deterioration of natural resources and human health, the conservation of environment and environmental changes are of great concern [4]. The land use and land cover study of the earth surface has become a challenging task. The conventional method of gathering the information manually and analyzing is a time-consuming complex task. Remote sensing technology offers the benefit of practical and economical means for an accurate classification of land cover[5]. Digital Image Processing

is an effective tool in performing these kinds of tasks efficiently on the images captured by satellites orbiting the earth[6]. Texture plays very important in classifying the earth surface into various categories like Land surface, Water bodies, Settlements, etc. Various texture classification algorithms, e.g. KNN and ANN, are implemented to determine the various segments of interest on the earth. In [1,2,7], satellite images are analyzed using LVQ and ANN classifier to classify statistical features obtained from RGB spectral information. As the land use and land cover change temporally, such changes in environmental conditions over the years are understood from the correlation between the multi temporal data[3-6].

Image segmentation is one of major problems of concern in image processing. The objective of image segmentation is to classify the classes of the input image using its features. There are different approaches for classification such as K nearest neighbor (KNN), Adaptive boost (Adaboosted), Artificial Neural Network (ANN), Support Vector Machine (SVM)[19]. In this paper ANN method is used for segmenting the given image into three categories. Viz; Water, Vegetation and Land

The ANN model resembles the human brain style. It has been used for many applications. The researchers have developed various ANN's structure in accordant with their problem. In each case, the network should be trained then it can be used for image classification.

Further to Land Use and Land Cover, images of agriculture crops also can be classified for the purpose variation in crop pattern, crop yield and healthiness of the crop. Object based, pixel based[8-14] methods are used classify the texture of different classes. Pixels of the same spectral signatures are grouped to form objects by extracting the features such as statistical and Harlick features and using classifiers, namely, maximum likelihood, minimum distance, KNN, for the classification

Neural Network model

The neural network architecture with multilayer preceptor model is shown in fig1 below. It consists of three stages, they are Input layer, Hidden layers and output layer. The input is given to input layer, which travels through hidden layers to produce the output in output layer. There can be only one input and output layers, but there can be more than one hidden layers. These networks are very popular. The objective of network is to interpret some relation between input and output patterns .

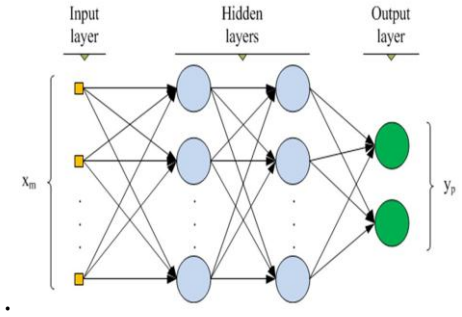

Fig1. Neural Network model

Materials Used

Indian remote sensing satellite provides high spectral resolution LISS-III data with the scale of 1:50000 on topographic map. Segmented regions from LISS-III data is used to segment agriculture land

The study area is about 26.5km^2 located near Dharwad, Karnataka,India. This is an agriculture area representing vegetation land, water bodies and barren land. The study area was visited to determine ground truth of land use which is used to validate the classification procedure

The multispectral images of Dharwad area of Karnataka state in India acquired by IRS-1C satellite on 8th Oct 2008 are considered. Each image is of size 1155X1155 pixels and consists of 4 bands, namely, Green(freq:520-600nm), Red(freq:630-690nm), Near Near Infra Red (NIR)(freq:760-900nm) and Short Wave Infra Red(SWIR) (freq:1.55-1.77micron). Radiometric resolution is 8 bit. Radiometric and geometric corrections were previously carried out by the distributor. No atmosphere corrections were needed. Also a geo referencing process was carried out.

The image considered for the experiment is shown in fig 3. Since image consists of color bands NIR and SWIR which are invisible to human eyes. The image has to converted in to False color composite (FCC) as shown in fig4.

The image dataset comprising these 121 images is used for experimentation of the proposed method.

Proposed Methodology

The goal of this study is to segment the earth surface into three different segments such as vegetation, water and land using Artificial Neural Network. Training images are divided into three clusters using K-means clustering technique. 20 images from each band are considered for training purpose. Each image is divided to three clusters. From each cluster Region of Interest (ROI) of 3X3 pixels are extracted. The

neural network is trained using training areas. These ROI s are converted into CSV(comma separated value) file. This .CSV file is used to store training areas and the corresponding class. The entire image is converted to .CSV file once the neural network is trained, for example if the size of the ROI in LISS image with 4 bands is 3 rows and 3columns then the .CSV file will have 4 columns and 9 rows. Each row will be one pixel of the image and each column will be one band. First column will be band2(Green) band, 2nd will be band3(Red) , 3rd will be band4 (Near Infra Red) and. fourth band will be band5(Shortwave Infra Red). Once the CSV file for the entire image is ready it is given to the trained neural network. Total 180 samples for each class collected. This method is explained through the flow chart in fig2 below

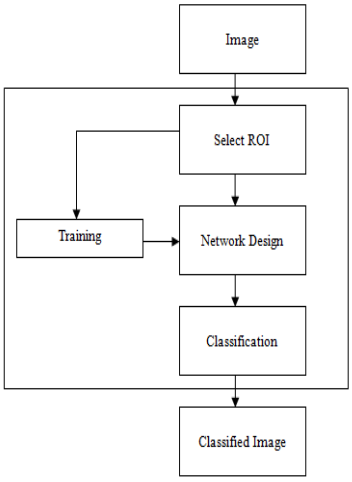

Fig 2. Flowchart for Flow chart for satellite image classification using neural networks

Implementation details:

The experiment is carried out using Matlab2013 version 8.10 with 64 bits. The feed forward back propagation network is being designed for network.

Design of Network:

The neural network in this work is designed with 3 layers. Namely, the input layer consists of 4 neurons corresponding to four input bands. Second the hidden layer consisting of 15 neurons. Finally, the output layer, consists of 3 output neuron specifying the output class of a Region of Interest. The input features propagate into the hidden layer and finally to the output neuron, which gives the output class.

Accuracy Assessment

The accuracy of the segmentation is assessed through confusion matrix. The overall accuracy is computed by dividing experimental numbers of observed numbers of clusters to the number of agriculture, urban and water body clusters present in the actual output.

Results and Discussion

The input images considered for the experiment is as shown in fig 3. Since the image consists invisible bands such as NIR and SWIR, the image is converted to False color composite as shown in fig 4. The final segmented image is as shown in fig 5. The overall result tabulated in Table.1 that is compared with ground truth. The percentage of classification is tabulated in Table.2.

Total testing samples: 81

Table1: Confusion Matrix

	Water	Vegetation	Land	Producer's accuracy
Water	19	1	0	20
Vegetation	0	26	0	26
Land	1	1	33	35
User Accuracy	21	26	34	81

Table2: Percentage of Classification

	Water	Vegetation	Land	Producer's Acuuracy
Water	23.45	1.23	0	24.70
Vegetation	0	32.10	0	32.10
Land	1.23	1.23	40.74	41.97
User Accuracy	24.68	34.56	40.74	

Table3: The performance of proposed method with other methods

Method	Accuracy	Features extracted
Proposed method(ANN Classifiers)	96.30%	Region of Interest
KNN Classifier[16]	95%	Statistical Features

Classification percentage : 96.30%
Misclassification percentage :3.70%

The results of the proposed method show that , using Region of Interest of clusters as input to the neural network yield the accuracy of 96.30%

Conclusion:

In this paper, the digital image analysis of satellite images using clustering techniques for identifying Vegetation, Water and Land area segments is investigated. The experimentation has been done using Linear Imaging Self Scanning (LISS-III) multispectral images acquired by IRS satellite. The region of Interest of 3X3 is extracted from each cluster. The Back propagation algorithm is used for classification. The validation of the experimental results is done by using ground truth. It is observed that the proposed method yields a comparable performance at reduced computational cost

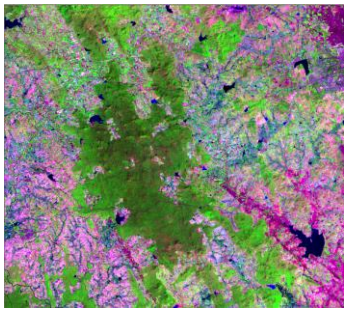

Fig 3. Input LISS—III image

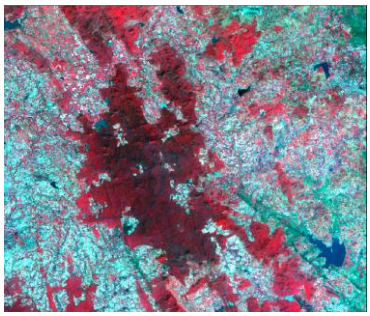

Fig 4:FCC image of Fig1

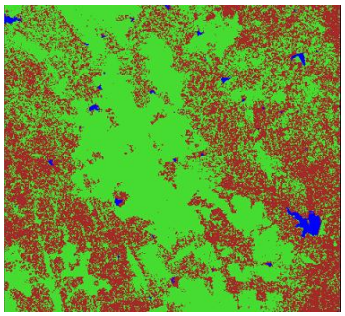

Fig 5:Image after classification

.Acknowledgement:

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