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Cluster Analysis of Satellite (LISS-III) Images of Earth surface

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Abstract: In this paper, the objective is the digital image analysis of satellite images using clustering technique for identifying Vegetation, Water and Land area segments. The experimentation has been done using Linear Imaging Self Scanning (LISS-III) multispectral images of Dharwad area of Karnataka state in India acquired by IRS satellite. The KNN classifier is used. The experimental results are obtained from band-wise information and validated by using ground truth, which demonstrate the effectiveness of the method.

Keywords: KNN Classifier, LISS multispectral image, Satellite image, IRS Satellite.

I. INTRODUCTION

Land use and land cover change is a primary driver of environmental change on Earth's surface and have significant implication on eco system health and sustainable land management. The strategic management of land use and land cover involves field monitoring every year. Discrimination of land into different segments via remote sensing is complex task, especially if vegetation patterns have similar spectral response. In such cases identification of different objects on earth surface could be improved by digital image processing of satellite images of Earth surface based on cluster analysis.

Texture analysis plays very important role in image processing, image classification and image interpretation of image data. From geological point of view, it is being increasingly used in the interpretation and understanding of terrain in a satellite imagery of an area, where an array or group of pixels characteristically represent the terrain.

In this paper, the objective is the digital image analysis of satellite images using clustering technique for identifying Vegetation, Water and Land area segments. Linear Imaging Self Scanning (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.

II. LITERATURE SURVEY

In the era globalization, natural and human induced environmental changes are of concern today because of deterioration of environment and human health [4]. The study of land used and land cover 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]. 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 methods[8-14] are used to 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

III. MATERIALS USED

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.

Linear Imaging Self Scanning (LISS-III) 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(520-600nm), Red(630-690nm), Near Infra Red(NIR:760-900nm) and Short Wave Infra Red (SWIR:1.55-1.77micron). Radiometric

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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 Fig.1 shows a typical LISS satellite imagery and its segmentation showing ground truth is indicated in the Fig.2.

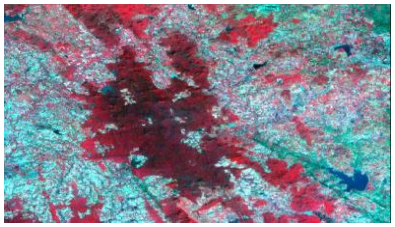

Fig. 1 An LISS Satellite Image

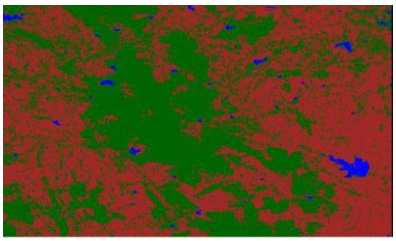

Fig. 2 Segmented Image showing ground truth of satellite image in the Fig.1

IV. PROPOSED METHODOLOGY

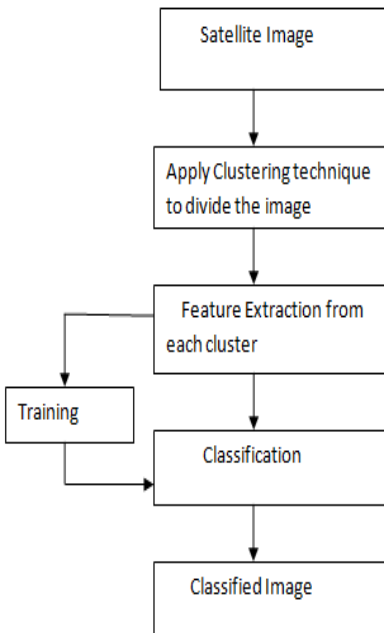

Fig. 3 Flow diagram proposed methodology

The proposed methodology consists of the following steps: (i) Image segmentation using K-means clustering technique, (ii) Statistical texture feature computation and (iii) Supervised classification of clusters based on statistical features using minimum distance and k-nn classifiers. The flow of the process is as shown in the Fig.3.

An image is segmented in to three clusters using K-means clustering algorithm, which gives the centroid of each cluster. The supervised classification consists of two phases, namely, training phase and testing phase. In the training phase, the statistical texture features up to four moments are computed from each cluster pertaining to vegetation, water body and land area based on ground truth, which are stored as the knowledge base.

The statistical texture features up to four moments are as follows [12]:

First Moment (M1):

$$\mu = \frac{1}{n}\sum_{i=1}^{n} Xi$$

Second Moment(M2):

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(X1-\mu)^2}$$

Third Moment (M3):

$$Sk. = \frac{\sum_{i=1}^{n}(Xi-\mu)^3}{\sigma^3}$$

Fourth Moment (M4):

$$\upsilon = \frac{\sum_{i=1}^{n}(Xi-\mu)^4}{\sigma^4}$$

First moment (Mean) gives the average of pixel values, Second Moment (Standard Deviation) gives the dispersion, Third Moment (Skewness) gives the shape of the pixel values distribution curve and the Fourth Moment (Kurtosis) gives the sharpness of the curve. The feature vector consists of the values of these first four moments.
In the testing phase, an image is segmented using K-means clustering with K=3. The statistical features are computed for each cluster. Then minimum distance classifier and k-nn classifier are used for classification of clusters into vegetation, water body and land area based on the stored knowledge base

V. EXPERIMENTAL RESULTS AND DISCUSSION

Out of 121 images, 60 images are considered for training phase, while the remaining 61 images are used for testing phase of the proposed methodology. The k-nn classifier with k=5 is used for classification of clusters into vegetation, water body and land area segments. The band wise computation of confusion matrix and Kappa coefficient are given in the Tables 1-4.

Kappa Coefficient is given by[1]:

$$K=\frac{\sum_{i=1}^{r} Xii - \sum_{i=1}^{r}(Xi*X+i)}{N2-\sum_{i=1}^{r}(Xi+*X+i)}$$

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TABLE 1: CONFUSION MATRIX CORRESPONDING TO BAND2

	Water	Vegetation	Land	Total	User's accuracy
Water	12	8	0	20	60%
Vegetation	4	15	1	20	75%
Land	5	0	15	20	75%
Total	21	23	16	60	
Producers accuracy	52%	65%	57%		

Total Accuracy=42/60=70%, Kappa Coefficient K=0.3

TABLE 2: CONFUSION MATRIX CORRESPONDING TO BAND3

	water	Vegetation	Land	Total	User's accuracy
Water	15	04	01	20	75%
Vegetation	8	12	00	20	60%
Land	08	00	12	20	60%
Total	31	16	13	60	
Producers accuracy	48%	75%	92%		

Total Accuracy=39/60=65%, Kappa Coefficient K=0.283.

TABLE 3: CONFUSION MATRIX CORRESPONDING TO BAND4

	Water	Vegetation	Land	Total	User's Accuracy
Water	17	03	00	20	85%
Vegetation	00	20	00	20	100%
Land	00	00	20	20	75%
Total	23	23	26	57	
Producers Accuracy	74%	87%	57%	76%	

Total Accuracy=57/60=95%, Kappa Coefficient K=0.923.

TABLE 4: CONFUSION MATRIX CORRESPONDING TO BAND5

	water	Vegetation	Land	Total	User's accuracy
Water	17	03	00	20	85%
Vegetation	00	20	00	20	100%
Land	00	00	20	20	75%
Total	17	23	26	57	
Producers accuracy	100%	87%	77%		

Total Accuracy=57/60=95%, Kappa Coefficient K=0.923.

It is observed that the band4 and band5 contain stronger discriminatory information about vegetation, water body and land area leading to good classification results, where as band2 and band3 yield poor classification results. For band4 and band5, the classification accuracy is 95% and Kappa coefficient is 0.923, which is a good agreement with the ground truth used for comparing the classification test results.

The analysis of the results imply that the reflection of water body and vegetation overlap in Green (band2) and Red (band4) bands, and therefore classification results are poor in the respective bands. Vegetation and Barren land reflects maximum invisible light, and hence band4 and band5 yield classification fairly well.

The comparison of the proposed method with other methods in the literature is given in the Table 5. It is observed that the proposed method yields a comparable performance at reduced computational cost.

TABLE5. PERFORMANCE COMPARISON OF THE PROPOSED METHOD WITH OTHER METHODS

Method	Accuracy %	Kappa Co eff K	Method
Proposed method	95	0.923	K-means clustering, Statistical features, KNN Classifier
Upadyay[1]	94.76	0.933	Pixel based, LVQ-ANN
Upadyay[2]	97	0.9652	Statistical features, LVQ-ANN

VI. 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 statistical texture features are extracted for image objects. The KNN classifier is used for classification. The validation of the experimental results is done by using ground truth. It is found that the reflection of water body and vegetation overlap in Green (band2) and Red (band4) bands and, hence, yield poor classification results in the respective bands. However, Vegetation and Barren land reflect maximum invisible light and, hence, band4 and band5 yield better classification. It is observed that the proposed method yields a comparable performance at reduced computational cost

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REFERENCES

[1]. Anand Upadhyay Santosh Kumar Singh, Rajesh Gupta,. Dayashankar Gupta,'Classification of LISS-III images using LVQ', International Journal of Engineering Research & Technology (IJERT) IJERT,ISSN: 2278-0181,Vol. 3 Issue 5, May - 2014,pp.781-785.

[2]. Anand Upadhyay, Santosh Kumar Singh, Vipin.G.Shukla, 'Impact of features on classification accuracy of IRS LISS-III images using artificial neural network', International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 3, Issue 10, October 2014, ISSN 2319 - 4847,pp.311-317.

[3] Suman Sinha, Laxmi Kant Sharma, Mahendra Singh Nathawat,'Improved Land-use/Land-cover classification of semi-arid deciduous forest landscape using thermal remote sensing', The Egyptian Journal of Remote Sensing and Space Sciences (2015)18, pp.217–233.

[4] Qingting Li, Cuizhen Wang, Bing Zhang and Linlin Lu, 'Object-Based Crop Classification with Landsat-MODIS Enhanced Time-Series Data', Remote Sens. 2015, 7, pp.16091–16107

[5] PraveenKumar Mallupattu and Jayarama Reddy, Sreenivasulu Reddy, 'Analysis of Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati, India', Hindawi Publishing Corporation, The Scientific World Journal Volume 2013, Article ID 268623,6 pages

[6] P.S.Roy, R.S. Dwivedi, D. Vijayan, 'Remote Sensing Applications', National Remote Sensing Centre, Hyderabad

[7] Karwariya.Sateesh, Goyal Sandip,'Land use and Land Cover mapping using digital classification technique in Tikamgarh district, Madhya Pradesh, India using Remote Sensing', INTERNATIONAL JOURNAL OF GEOMATICS AND GEOSCIENCES Volume 2, No 2, 2011, ISSN 0976 – 4380,pp.519-529

[8]. Madhubala M, S.K Mohan Rao, G. RAvindra Babu 'Classification of IRS LISS-III Images by using Artificial Neural Networks', IJCA Special Issue on "Recent Trends in Image Processing and Pattern Recognition" ,RTIPPR, 2010,pp 152-157.

[9]. José M. Peñ ,Pedro A. Gutié rrez, Cé sar Hervá s-Martí nez , Johan Six ,Richard E. Plant,and Francisca Ló pez-Granados,' Object-Based Image Classification of Summer Crops with Machine Learning Methods' , Remote Sens. 2014, 6, pp.5019-5041.

[10]. Vincent Simonneaux, Benot, Duchemin, D. Helson, S. Er Raki, A. Olioso,Abdelghani Chehbouni,' The use of high-resolution image time series for crop classification and evapo transpiration estimate over an irrigated area in central Morocco', International Journal of Remote Sensing, Taylor & Francis,2008, 29 (1), pp.95-116.

[11]. T. Blaschke, 'Object based image analysis for remote sensing', ISPRS Journal of Photogrammetry and Remote Sensing 65 (2010) pp.2-16.

[12]. P. Aplina, G.M. Smith,' ADVANCES INOBJECT-BASED IMAGE CLASSIFICATION', The International Archiveso f the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B7.Beijing 2008.

[13]. H.R. Matinfar,F. Sarmadian,S.K. Alav Panah and R.J. Heck,' Comparisons of Object-Oriented and Pixel-Based Classification of Land Use/Land Cover Types Based on Lansadsat7, Etm Spectral Bands (Case Study: Arid Region of Iran)', American-Eurasian J. Agric. & Environ. Sci., 2 (4):, 2007,ISSN 1818-6769,pp. 448-456.

[14]. Amit K. Bhattacharya, P.K Srivastava and Anil Bhagat, 'A Modified Texture Filtering Technique for Satellite Images', Asian Conference on Remote Sensing, 5-9 Nov 2001.

[15.] Myoungkeun Choi and Bert Sweetman, 'Efficient Calculation of Statistical Moments for Structural Health Monitoring', Journal of Structural Health Monitoring, Jan1, 2010,Vol 9,No.1 , pp19-24