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Classification and Change Detection of Tirupati Urban Area using Erosion and Dilation Based PCA Transform

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Abstract*: In remote sensing, the identification of the land use and land cover (LULC) changes in the global and local region are developed by classification and detection algorithms. This classification system can be developed to meet the needs of state agencies, and Federal for an up-to-date analyze of LULC throughout the entire selected of region area. The multispectral images have multiple low-resolution bands due to lack of sensory acquisition problem, haze-covered on earth objects and atmospheric distributions. So difficult to analyze the full information, the user wrongly interprets the information. Image processing applications can be done for compress and enhance the details of land surface details. The Principal Component Analysis and Morphological operations are implemented for compressing and feature extract the color and earth object values with good accuracy level. Change Detection between the time difference of the proposed enhanced images for land objects classes was computed. The most extensive land cover change category identification of the Tirupati urban Agricultural and forest area for the last 14 years. The change analyzed by using the image differencemethod for obtaining the changing level of the forest and urban development areas between two-timeintervals.

Keywords : Multispectral images, Principal component analysis, Morphological operations, haze, enhancement, Land use.

I. INTRODUCTION

Satellite images are captured from a very long distance so; they contain too much noise and distortion because of atmospheric barriers. After capturing the image, some radiometric and geometric corrections are carried out on it. However, they are not sufficient for all the applications. It is very important to enhance the restored image before using it. Satellite image enhancement is the technique which is most widely required in the field of satellite image processing to improve the visualization of the features[14]. The digital image processing techniques help improve the quality of the objects for getting better feature extraction of the values of the object. The spatial and frequency domain methods are implemented for enhancing their details, but individual band processing techniques are complexity, avoid this complexity with dimensionality reduction technique instead of using each band compression of the total multispectral image. Object edges are very important for separating the one class from another class is that total global region of the image. Morphological operations are one of the most suitable technique to enhancing the edge or high sharpening details. So combinational of principal component analysis and morphological operations are one of the great methods for improving the object details from multispectral satellite images. The proposed method by using principal component analysis and morphological operations for enhanced the color, brightness and sharpening details of the local and global area of the low-resolution image. The Compression can be done by dimensional reduction with PCA and sharpening the edge details by morphological operations. The statistical redundancy between the components of high-dimensional vector data enables a lower-dimensional representation with less loss of information[9][10].

A.Study area

Tirupati 13°34'- 13°45' N, 79°15'- 79°29' E is the world famous pilgrim city of Lord Sri Venkateswara and it is the speediest developing city in the lower range of Seshachala hills in the Chittoor district of Andhra Pradesh. It covers an area about 499 Sq.km and consists of Tirupati urban and rural areas and its surroundings. The midyear temperature ranges from 35 to 48^{o} Celsius and the winter temperature ranges from 18 to 20^{o} Celsius.Classification There are two types of classification are mostly preferred for classification of the objects using the clustering process are unsupervised classification and supervised classification. Mostly the user knows the details of about training samples.

This method gives superior results compared with other classification methods. In unsupervised classification, the computer only can be formed as groups based on the intensity of each individual pixel. These pixels are considered as the same class. In this method supervised classification can be done by with clustering process.

B. Land use and Land cover classification

LULC changes are shown an important role in monitoring and managing the environmental changes

[4].Theagricultural, vegetation and water bodies are not constant level in various seasons, which are changes in seasonally.

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Urban expansion also one of the main reasons for losses and reducing these factors. These factors are based on decreased air quality, increased local temperature, and subsequent flooding etc.[5]. This growth of society also depends on its economic and social development[2][6].

C. Change detection

Many existing methods are available for identification of Land use and Land cover areas for a multispectral image concerning recent image and existing image. In this process the cross image difference method gives the results of changing the object levels of existing and new data set image[1][3][5]. In this method subtracting the two DN values of two time periods images which gives the results of the changed level of the object. Id(x,y)=I1(x,y)-I2(x,y)

WhereI1(x,y) : Existence imageI2(x,y) : Recent Real data image Both data are collected from the same area of interestwithout geometrical errors. The threshold values based on standard deviation from the mean are used to determine the difference of DN (digital number) of pixels. In this method, the difference of both images contains positive values, the class size is increased, it it is negative value indicates that the object size is decreased.

$$\text{Percentage} = \frac{\text{Final state - Intial State}}{\text{Intial state}} \times 100$$

II. LITERATURE REVIEW

Maria Gonzalez-Audícana et al. Explains new enhancement based on the same concept, Explains for improving the spatial and spectral details with a combination of HIS and PCA methods. Bin Zhang proposes SVM classifiers are applied to LULC classes are inferred to build supervised feature descriptors. These improve the spatial and spectral feature descriptors [8]. Ping Chen et al implementsLandsa-7 and Landsat-8 multispectral images are perform the change detection on the area of interest that covers the mangrove forest at different areas. S. M. Ali et al. The Principal Component Analysis has been used for image enhancement, compression, and temporal change detection. Two images LANDSAT and QUICKBIRD are used for this analysis [13].Praveen Kumar et al. Land use land cover change detection over temporal serial data on Urban city, Tirupati. This was studied using GIS(Geo graphical Information System) and Remote sensing. Remote sensing data LISS III and PAN data interpreted with Survey of India TOPO sheets 57 O/6 [14].

III. METHODOLOGY

i) Principal Component Analysis

The principal component analysis is a family of technique which takes high dimensional data and converts lower dimension without loss of original information. In statistics visualizing or interpreting the more than two variables is very difficult to overcome this simplifying the group of variables to a single new variable.this is possible with principal component analysis is a general technique uses sophisticated mathematical principals to transform the number of possible correlated variables to a smaller number of uncorrelated variables called principal components. It is simple and robust method and also called KL (Karhunen-Loeve) Transform and also Hotelling Transform. PCA is used for dimension reduction, compression, enhancement, and also removing the noise.PCA transforms the correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component gives much more variation and succeeding components having remaining variability as possible. It is a statistical procedure with elucidating the covariance structure of a set of variables.

(ii) Morphological operations

Set theory morphological is based on dilation and erosion operations to remove the interference in an image and enhance the edge details of objects. The low resolution of multispectral images, different objects overlap one another. The objects are separated without the loss of edge details by using this proposed technique. It can be used to extract useful information regarding objects, such as the shape, skeletons, boundaries, and convex hull. [11][12][15].

(iii) Proposed method

In this proposed method Landsat-7, Landsat-8 data are used for classification of the object with less number of bands and identification of the change object details with good accuracy results[4]. Fig.1 represents the enhancement of the Landsat-8, in this image the high-resolution image is used to enhance the brightness details of the total global area. The high-resolution panchromatic image is replaced by the first principal component image, due to this reason the full detail of information has appeared in the first band of principal component analysis. This proposed output gives good classification results compare with the direct method of classification.The supervised classification is preferred for classification of the object. The sample training is collected with the help of Google earth and Topo sheets of Tirupati (Land use) and Chittoor district (Land cover) area, which are located in Andhra Pradesh, India. Fig.2 represents the original multispectral image, this image contains 11 band information, difficult to process all these data. The proposed image contains three band information (PC1, PC2,and PC3). This image contains the maximum color and brightness details, these qualitiesare measured with the below parameters RMSE, RASE, ERGAS, and Entropy. The first three parameter values are less for the qualitative image, the entropy values are almost equal compared with the original image.

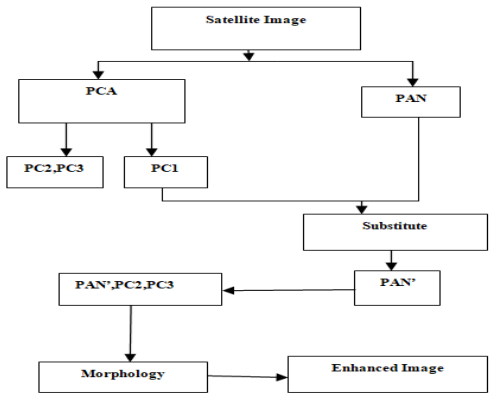

Fig. 1: Compression and enhancement of the Satellite image

From the table 1: the proposed method gives higher brightness and color details compare with Intensity, Hue and Saturation transformation[13], principal component analysis and Brovey methods.

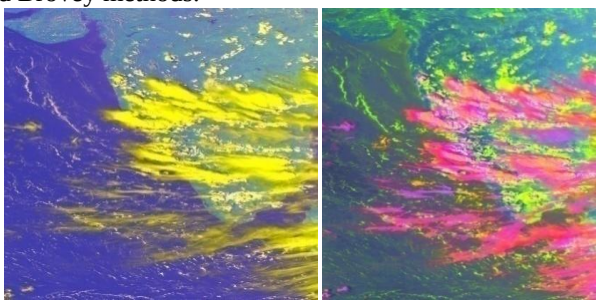

Fig.2: Input mage and PCA image

There is lower ERGAS, RASE and RMSE values and good entropy values compare with other previous methods.

Table 1: Comparison of Results with different methods with the proposed method

Img 1	RMSE	RASE	ERGAS	ENTROPY
IHST	70.35	59.31	14.94	6.71
BROVEY	85.77	72.30	18.23	7.51
RM	103.9	82.40	20.56	6.97
ICAT	70.19	58.24	14.58	7.47
PCA+B	109.1	86.29	21.59	6.99
PCA+IHS	71.94	64.22	16.19	5.16
B+IHS	69.0	60.82	15.36	5.55
PM	57.39	47.64	11.79	7.57

(iv) Classification and accuracy assessment

In the clustering process, the data divided a group of objects, which are helpful for analyzing the total information of the global area of the satellite image. The Vector quantization is applied in the clustering process to reduce or compression of each cluster. These objects are similar to another with some loss of information and a substantial reduction in the data size is desired. The forming of classes is based on the centroid and the minimum distance method. This classifier, the same intensity pixels is formed as a single class, similarly the same thickness objects are separated by using the minimum distance classifier algorithm in clustering process[8]. In this process, clustering can be started from each point as a singleton cluster from this using merging process of same density similar clusters are formed as single, all-encompassing clusters remain.

IV. RESULTS AND DISCUSSIONS

The PCA is applied to Landsat images, which contain total 11 bands information. There is more redundant information is available between bands. The removing of redundancy can be done by using principal component analysis. The total information appeared into orthogonal components, which is called principal components analysis. The local image objects are enriched with morphological operations using dilation and erosion operations.

The comparison of Tirupati urban area from 2000 to 2017 is shown in table 2 and figure 3. The forest area is decreased and the urban development area is increased due to the development of population in Tirupathi city from last 17 years. The water levels also decreased, which is observed from above table. Figure 4 shows the change in areas of geographical area with a percentage. The identification of the objects with NDVI(Normalized difference vegetation index), NDWI (Normalized difference water index), parameters.

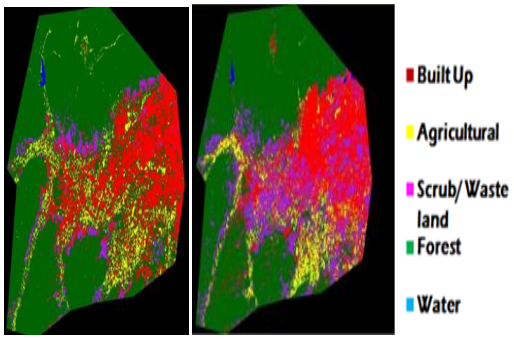

Fig 3: Land use Classification of Tirupati Area in the year 2000 and 2017

The classification can be done by using the clustering algorithm; the details of objects have appeared in table 2.

Table 2: Land use statistics of Tirupati 2000-2017

S.No.	Land Use Class	2000		2017	
		Area (Sq. Kms.)	Area in (%)	Area (Sq. Kms.)	Area (%)
1	Built-up Land	29.94	6	81.16	16
2	Agricultural	99.8	20	68.2	14
3	Barren Land	90.77	18	105.48	21
4	Forest Land	277.13	56	243.33	49
5	Water Bodies	1.36	0.27	0.83	0.16

The NDVI values are very high for high vegetated areas andfor water levels NDWI values are more[7]. The same procedure is repeated for Landsat-2017 image for classifying the objects. The change of objects is observed using a method of change detection, Which is very helpful for the prediction of the future object changes.

From the above table 3, the corresponding accuracy levels are given; these objects values are identified by Topo sheets and Google earth images. The classification results are verified by producer, user accuracy and Kappa coefficient values.

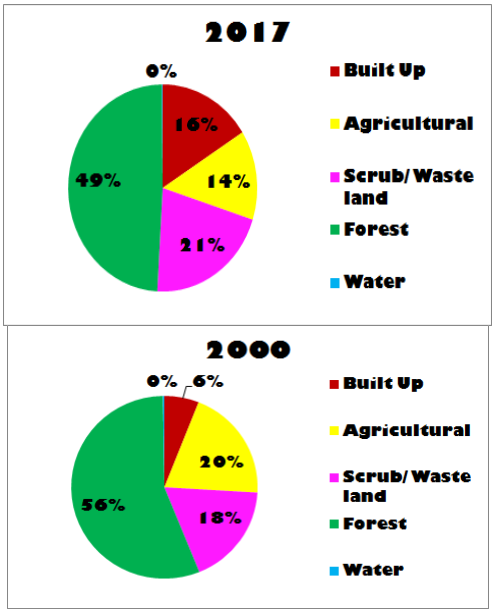

Fig. 4: Land use classes of Tirupati area in the year 2000 & 2107

The index values represent the classification can be done concerning the reference image

Table 3 : Classification Accuracy assessment report

S.No.	Land Use Class	Accuracy for 2000		Accuracy for 2017	
		Producer's Accuracy	User's Accuracy	Producer's Accuracy	User's Accuracy
1	Urban development	73.33	61.11	78.84	82.54
2	Agricultural Land	72.45	82.14	80.00	66.66
3	Barren/Waste Land	78.68	72.35	75.00	94.74
4	Forest Land	91.38	98.15	100	96.88
5	Water Bodies	100	100	100	100
6	Overall Accuracy	87.00		93.33	
7	Kappa Statistic	0.7854		0.9075	

V. CONCLUSION AND FUTURE SCOPE

Tirupati urban area one of the development area in these days, this area is famous for seshachalam forest, this forest area is decreased from the last fifteen years due to drastically increasing of population. In analyzing these changes from 2000 to 2017, very difficult for large data multispectral image data set. Avoiding this problem using compressing and enhancing the clustering objects and spatial, spectral values. In this work, removing the redundant information can be done by using principal component analysis and local object details are enriched by using morphological operations. This region classification can be done for identification of water, forest, scrub/wasteland, agriculture, and built-up areas. The urban area is increased and forest areas are decreased with increasing population. The digital image processing technique is helpful for avoiding the complexity of large data, etc. This technique also useful in medical and hyperspectral satellite images also.

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