Раздел IV. Анализ и распознавание образов

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LULC-АНАЛИЗ ЗЕМЛЕПОЛЬЗОВАНИЯ С ИСПОЛЬЗОВАНИЕМ НЕКОНТРОЛИРУЕМОЙ КЛАССИФИКАЦИИ

Землепользование и растительный покров являются естественным состоянием поверхности земли. Дистанционное зондирование - очень важный метод изучения землепользования (LULC). Для анализа земного покрова при дистанционном зондировании используются различные методы классификации. Данные методы не требуют предварительную информацию о земном покрове или типах землепользования. Наиболее часто для анализа изображений, полученных с помощью дистанционного зондирования, используют два метода классификации. К ним относятся контролируемая классификация и неконтролируемая классификация. Целями предлагаемой работы являются использование неконтролируемых методов классификации для поиска кластеров, по определению типов землепользования и сравнение данных методов с интерактивным анализом данных самоорганизации (ISODATA). Для анализа землепользования были использованы изображения датчика Hyperion. Датчик Hyperion имеет двести сорок две полосы, однако немногие полосы содержат полезную информации для спектрального анализа. Поэтому полосы, не содержащие полезную информацию выявляются и удаляются. После обработки входного изображения по данному алгоритму из двухсот сорока двух полос остаются только сто шестьдесят пять полос. При этом учитываются радиометрическая калибровка и немаловажная коррекция атмосферных факторов. Затем по результатам обработки с применением предложенных методов формируются кластеры для изучения землепользования с использованием гиперспектрального изображения. Для формирования кластеров осуществлялась группировка пикселей, на основе выбранных данных. Пиксели из одного кластера имеют больше сходства, в то время как пиксели из разных кластеров отличаются друг от друга. На основе результатов делается вывод о том, что метод кластеризации (k-means) позволяет лучше идентифицировать или прогнозировать тип землепользования на основе гиперспектрального изображения с высоким разрешением, чем метод интерактивного анализа данных самоорганизации (ISODATA). Выходное изображение, которое является результатом кластеризации, может быть использовано для идентификации различных типов объектов землепользования. Лучше всего были идентифицированы следующие объекты землепользования: водная среда, сельскохозяйственные угодья, растительность, застроенная территория или поселение, поля и скалистые регионы.

Земельный покров; землепользование; классификация земного ландшафта; LULC анализ; неконтролируемый процесс; платформа ENVI 5.5; методы кластеризации; метод K-means; интерактивный анализ самоорганизации (ISODATA).

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LULC-ANALYSIS OF LAND-USE WITH THE HELP OF UNSUPERVISED CLASSIFICATION

Land-use and vegetation cover are the natural state of the earth's surface. Remote sensing is a very important land use study (LULC) method. Various classification methods are used to analyze land cover in remote sensing. These methods do not require prior information on land cover or land use types. Two classification methods are most commonly used to analyze remote sensing images. These include controlled classification and uncontrolled classification. The objectives of the proposed work are to use unsupervised classification methods to find clusters, determine land use types, and compare these methods with interactive analysis of self-organization data (ISODATA). Hyperion sensor images were used for land use analysis. The Hyperion sensor has two hundred and forty-two bands, but few *bands provide useful information for spectral analysis. Therefore, bands that do not contain useful information are identified and removed. After processing the input image according to this algorithm, out of 242 bands, only one hundred and sixty-five bands remain. This takes into account radiometric calibration and an important correction of atmospheric factors. Then, based on the results of processing using the proposed methods, clusters are formed to study land use using a hyperspectral image. To form clusters, the pixels were grouped based on the selected data. Pixels from the same cluster have more similarity, while pixels from different clusters differ from each other. Based on the results, it is concluded that the clustering method (k-means) allows better identification or prediction of land use based on a high-resolution hyperspectral image than the Interactive Self-Organization Data Analysis (ISODATA) method. The output image, which is the result of clustering, can be used to identify different types of land use objects. The LULC classes predicted are Water Body, Agriculture Land, other Vegetation, Built Up or settlement, Bare Land and Rocky region.*

Land Cover; Land Use; Classification of the Terrestrial Landscape; LULC; Unsupervised; ENVI 5.5; K-means; ISODATA.

1. Introduction. Remote sensing is the technique where information about the objects can be captured without directly touching that object or phenomenon i.e. the information can be obtained remotely by using the sensors or satellites [1]. There are two types of sensors viz. pushbroom scanner and whiskbroom scanner. The pushbroom scanner or across track scanner uses a line of detectors to capture the image one line at a time. Whiskbroom scanner or the along track scanner uses mirror, which moves back and forth to reflect the light onto one detector only [2].

The EO-1 satellite was launched by introducing hyperspectral remote sensing in Nov 2000. The EO-1 Hyperion is pushbroom imager having spectral range 400 nm to 2500 nm. The spatial resolution of EO-1 Hyperion sensor is 30m and spectral resolution of 10 nm. The total number of bands of Hyperion sensor is 242 [3]. The image acquired by Hyperion is with swath width of 7.5 km and covering 20km area as shown in fig. 1.

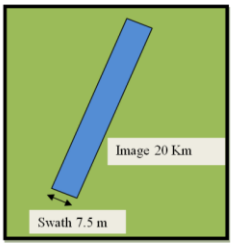


Fig. 1. Study Image Coverage with Swath

Land can be analyzed through remote sensing and its related techniques for variety of applications such as Land Use/Land Cover (LULC) Mapping [4, 5], hydrological impacts of LULC changes [6], changes in the water reservoirs or watershed [7], change detection with respect to the turban areas, Forest cover, and agriculture spread or decline and waterbody detecting the dynamics of LULCC [8] and change detection for river basins [9]. There are two types of classification techniques available for analyzing the images obtained through remote sensing viz. supervised classification and unsupervised classification. K-means and ISODATA (Interactive Self Organization Data Analysis) these are the two unsupervised techniques provided in ENVI [10]. In clustering the image pixels are grouped into clusters based on the similarity among those pixels.

Once the clusters formed, each cluster has to be identified and predicted for LULC type which is supportive for the land use and land cover studies. Most of the researchers have used k-means algorithm for remote sensing applications. In the field of remote sensing different classification techniques were used for land cover analysis. The unsupervised technique does not require any prior information about the land cover or types of land cover. A class is assigned to each cluster by interpreter leading to identification of land cover type [11].

The first method for land cover classification using LANDSAT image was pixel-based classification [12]. The other technique for image classification is Parallel piped technique which is based on finding the parallel piped-shaped boxes for the predefined classes. The parallel piped boundaries assist in assigning the test pixel to a particular matching class.

In mid 1970's it was recognized that as the land cover changes it modifies surface of albedo that's the reason the surface atmosphere energy exchanges which have effects on regional climate [13]. LULC primarily impacts on the biotic diversity worldwide. Like change on ecosystem, goods and services were further identified [14].

Aykut A. et al applied many classification methods on the satellite images. The maximum likelihood method was found reliable and applicable for satellite image classification [15]. According to the study of Bardsley J. M. et al. the image classification based on pixels does not depends on its neighbors and spatially based techniques which includes the methodologies like spectral based classification, quadratic discriminant analysis [16]. Lonesome M. M. developed an alternative procedure for an object based image classification. They used region based approach for classification of satellite images (17). Afroz S.M. et al. used high resolution satellite imagery to achieve meaningful area wide special information for the development and management of the city [18].

Harish K. E. et al. they worked on cadastral features like buildings and roads. They used Particle Swarm Optimization technique for extracting cadastral features and land cover mapping using swarm computing techniques [19]. Two k-means clustering algorithms with Laplacian of Gaussian (LoG) were coupled with Prewitt filter. These methods were used by Balasubramanian S. et al. for processing the satellite images [20]. Ashwini T. et al. used K-means clustering and back propagation algorithms of artificial neural network for segmentation and classification of satellite images [21].

The proposed work aimed at using the unsupervised classification methods K-means and ISODATA in order to do analysis of land use and land cover using high resolution image of Hyperion sensor.

2. Methodology. The hyperspectral imagery is having very high resolution and can be used for analyzing or identifying the different types of land use and land cover. The fig. 2 is the Methodology for proposed work.

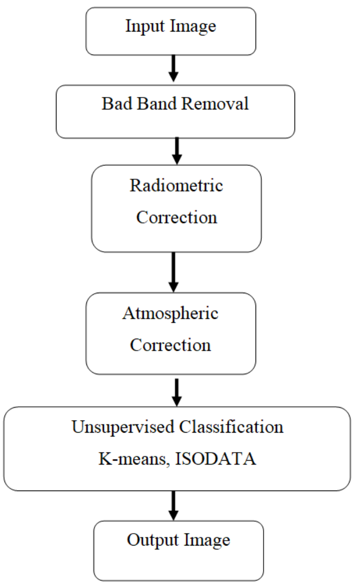


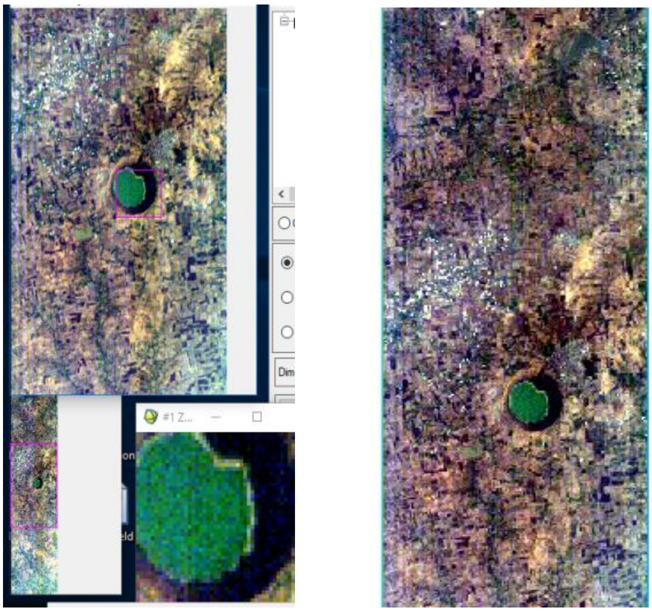
Fig.2. Methodology of Proposed Work

The proposed methodology used Hyperion sensor image with 242 bands. Few bands contain no useful information for spectral analysis. So there is need to identify and remove those bad bands which does not contain useful information. Out of 242 bands, only 165 bands remained after handling the input image for bad bands. The radiometric calibration and atmospheric correction are also very important preprocessing techniques for handling calibration problems and problems due to atmospheric factors.

Then K-means and ISODATA both techniques have to be applied in order to form the clusters and analyze the different types of LULC using hyperspectral image.

The output image which is the result of clustering can be used for indentifying the different types of LULC which utilizes the information from clusters or classes obtained through k-means.

3. Results and Discussions. The dataset for the proposed work was downloaded from Glovis Portal [22]. The Hyperion image was preprocessed for the removal of bad bands and 165 bands were left as informative band which were used for further analysis. Fig. 3,a is the input image after bad band removal. The image was also preprocessed for radiometric calibration and the result is shown in fig. 3,b.

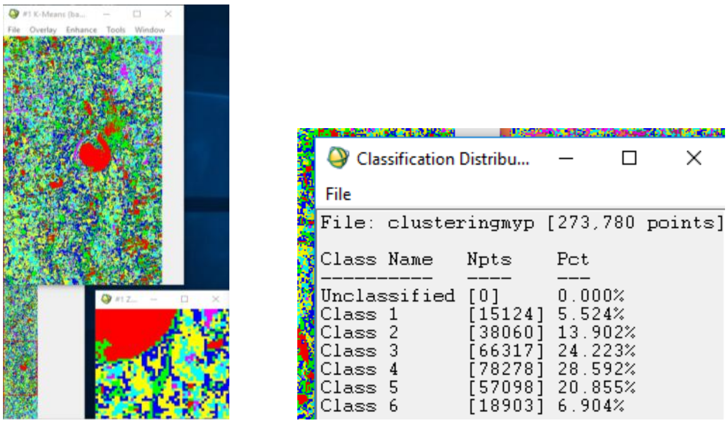


a b

Fig. 3. Image Handled For (a) Bad Bands (b) Radiometric Calibration

The atmospheric correction was performed using FLAASH algorithm. The noise removal with dimensionality reduction was done using MNF (Minimum Noise Fraction) Technique. ENVI 5.5 was used for the proposed work. The k-means technique was applied with the parameters change threshold of 5.00, number of classes 6 with three iterations.

Result of k-means clustering is as shown in fig. 4,a. The different types of LULC identified from the output of K-means are Class 1 (Red) Water, Class 2 (Green) BuiltUp, Class 3 (Violet) Vegetation, Class 4 (Yellow) Agriculture Land, Class 5 (Blue) Rock, and Class 6 (Pink) Bare Land. The percentage for each class being classified is as shown in fig. 4,b.



a b

Fig. 4. a – Result of K-means Clustering b – Classification Distribution

The table 1 contain the classes identified with K-means technique with their corresponding LULC types and the result of percentage classified and the graph for different LULC types obtained by K-means is shown in fig. 5.

Table 1

LULC Types and Class-wise Percentage using K-means

Class Name	Color	LULC Types	Percent classified
Class 1	Red	Water Body	5%
Class 2	Green	BuiltUp	14%
Class 3	Violet	Vegetation	24%
Class 4	Yellow	Agriculture Land	28%
Class 5	Blue	Rock	21%
Class 6	Pink	Bare Land	7%

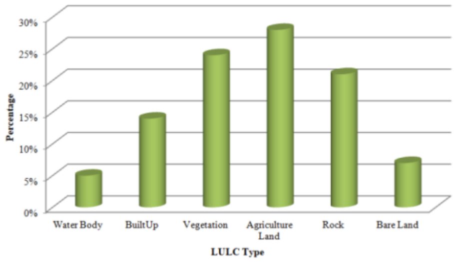


Fig. 5. LULC Types With Their Percentage of Classification

The class distribution in meters^2 for each class is as shown in fig. 6.

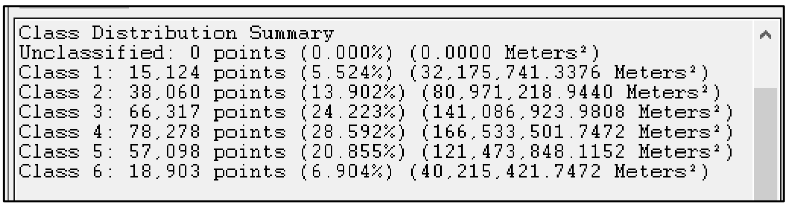
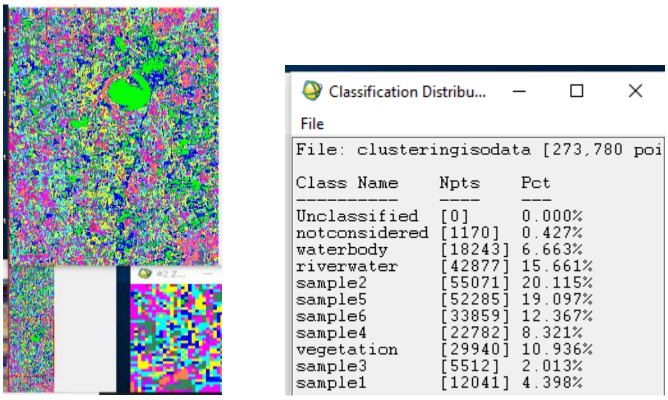


Fig. 6. Class-wise Area Covered in Meters^2

From the values of class 3 and class 4 with 141km^2 and 166 km^2 respectively, indicates more vegetation in the selected area of study while class 5 and class 6 covers total area of 162 km^2 and 32km^2 for class waterbody.

Another technique for classifying the LULC types is ISODATA. It is also an unsupervised classification technique available in ENVI 5.5. This technique was applied on the preprocessed input image of Hyperion sensor. The parameter number of classes set in between 7 and 10 and the change threshold was set to 5. The output image of technique ISODATA is displayed in fig. 7,a and the resultant class distribution is as shown in fig. 7,b.



a b

Fig. 7. a – Output Image of ISODATA Technique, b – Class Distribution

The table 2 shows LULC types identified and the corresponding percentage of classification.

Table 2

LULC Types and Class-wise Percentage using ISODATA

Class	Color	LULC Type	Percent Classified
Class 1	Green	Waterbody	6.66%
Class 2	Violet	Buildup	15.66 %
Class 3	Yellow	Agriculture Land	20.11%
Class 4, Class 7	Blue, Sea Green	Vegetation	29%
Class 5	Pink	Rock	12%
Class 9	Orange	Bare Land	4.39%

The fig. 8 mentions the LULC types predicted using ISODATA techniques with the corresponding percentage of classification.

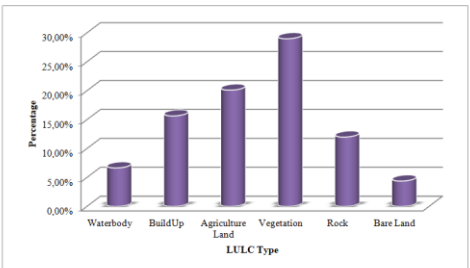


Fig. 8. LULC Types Identified with Percentage Classified using ISODATA

The comparison between the results of K-means and ISODATA technique is as displayed in fig. 9.

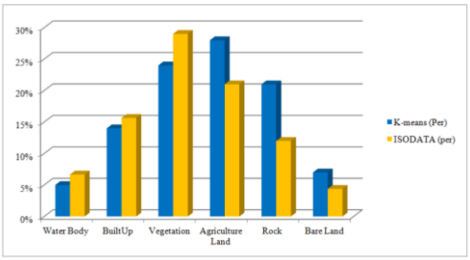


Fig. 9. Comparison of K-means and ISODATA Results

Thus the different types of LULC identified with both the techniques are Vegetation, Agriculture land, Water Body, Built up or settlement, bare land and Rock. The K-means method is better in LULC analysis than the ISODATA method.

Conclusion. The land can be analyzed accurately for its use and cover using remote sensing techniques. The unsupervised classification techniques K-means and ISODATA were used for the proposed work. In the K-means technique the Euclidean distance measure is used for forming the clusters. The minimum threshold for this technique was set to 5 based upon which the clusters were formed. The ISODATA used the Self Organization to form the clusters. From the comparison of both the techniques, k-means formed the clusters efficiently than ISODATA. Using ISODATA it was difficult to predict the LULC type for small clusters. Thus K-means is better in identifying or predicting LULC type using Hyperspectral image with high resolution than ISODATA. The LULC types identified in the proposed work are Water Body, Agriculture Land, other Vegetation, Built Up or settlement, Bare Land and Rocky region.

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СОПОСТАВЛЕНИЕ ИЗОБРАЖЕНИЙ ПО ОСОБЫМ ТОЧКАМ РАЗЛИЧНЫХ КАТЕГОРИЙ[*]

Работа посвящена экспериментам с различными методами выделения особых точек на изображениях с последующим их описанием бинарным дескриптором и сопоставлением методом полного перебора. В работе активно используется метод описания окрестностей особых точек, основанный на построении бинарной строки, характеризующей изменения яркостей пикселей в описываемой окрестности. Результирующая строка получается путем сравнения яркостей пикселей по определенному шаблону. Сегодня использование особых точек при работе с изображениями позволяет разрабатывать прикладные методы в различных сферах компьютерного зрения с повышенными требованиями ко времени работы и устойчивости к резким изменениям сцен. В работе приведены результаты экспериментов с особыми точками различных классов, классификация приводится в разделе 1. При проведении экспериментов использовались методы, реализованные в библиотеке OpenCV. В работе даны краткие описания используемых в экспериментах методов. В разделе 1 работы предлагается классификация современных типов особых точек изображений и дается краткое описание популярных методов детектирования описываемых типов особых точек. В разделе 2 авторы дают общее описание методов работы с особыми точками изображений. В разделе 3 приводится описание проводимых экспериментов с сопоставлением особых точек различных типов, описанных одним дескриптором, и раскрываются их результаты. Проведенные эксперименты позволяют выявить сильные и слабые стороны связок различных типов особых точек при их сопоставлении.

Особые точки изображения; сопоставление особых точек; дескрипторы особых точек; классификация особых точек изображений.

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