Section: Research Paper

Satellite Image Using Image Processing and Machine Learning Techniques: applications to agriculture, environment and mining

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Abstract- This research investigates on satellite image categories classification using image processing and machine learning techniques. A satellite image is one of the important sources of the research-oriented platform which helps to monitor earth regularly. It provides information through multi-temporal images. It also ensures accurate data over a large geographical area in the world. The satellite image is independent of sunlight and atmospheric conditions so it is countered as the best source of an image detection device in remote sensing. The main objective of this research is to implement image analysis and classification techniques for extraction and finding the type of satellite images for clustering into groups. For this research 50, sample images were uses for the detection of satellite images. To characterize the type of satellite images, features collected as color-based, statistical features and texture features which achieved through wavelet transform technique and machine learning algorithms such as KNN classifier with 70%

training and 30% testing data using a confusion matrix. This technique will ensure the category of satellite images through classification techniques. It ensures that db7 works well with 95% accuracy using the KNN classifier for the characterization of satellite images compare with other measures.

Keywords- Satellite images, KNN classifier, Image processing, Machine learning

1. Introduction

The satellite represents essentially in the sky the presence of eyes. The captured data represents the behavioral condition of atmospheric nature [1]. All geographical changes made by the earth can be tracked and monitored through satellite images. There are following different kinds of satellites used to cover images like ENVISAT-ASAR, SCATSAT-1and INSAT-3DR.the images can be captured based on half-hourly, hourly, and depends on atmospheric changes [2]-[5]. Based on satellite image it is very easy to monitor changes detection happened due to geographical or man-made structure. Satellite image processed initially by selecting suitable frames, with that frames it analysis every framed data and extracts the possible signature through that frame which creates a synoptic map, then merge information on spatial frames density and distribute as per requirement [6]-[8]. For satellite imaginary LandSat works well for the acquisition of images. Landsat works in detection and monitoring agriculture, geology, cartography, forestry, surveillance, regional planning, and education of geological survey. The main goal of the satellite image is to achieve continuous, global, autonomous, high-quality data for investigation and research [9]-[10]. By providing timely, accurate, and easily accessible data will improve the management of the environment. It helps to mitigate and understand the facts and effects of climate changes, weather forecasting, and civil surveillance security [11]-[12]. Many researchers have been conducted based on satellite images for data observation and examination. In satellite image processing it is very important to extract features using image processing techniques which help to identify each region of the satellite images [13]. With the help of the latest technology, it becomes one of the best sources of development and prediction using the remote sensing process [14]-[15].

2. Methodology

These studies investigate stages, image preprocessing, and segmentation of the image, feature extraction, and classifications using image processing techniques. Data collected around 50 multiple satellite images that help in classifying images into three classes land, ocean, and forest**.** The main objective of this research is to implement image analysis and classification techniques for extraction and finding the type of satellite images for clustering into groups.

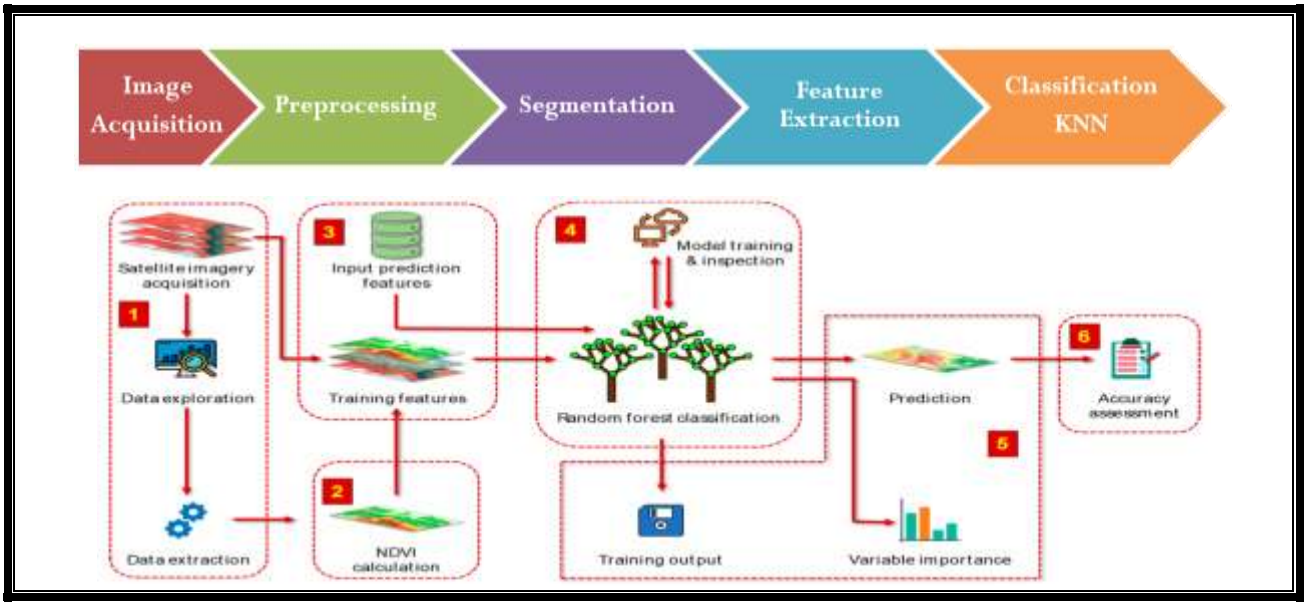

Figure 1- Methodology

3. Preprocessing using Median Filter

Preprocessing is a method for removing background noise from images. To remove noise from images median filter is used. Median filters play an important role in removing noise from images. The median filter is a non-linear statistical filter, which describes in spatial domain form. It smoothing images be utilizing the median value of the neighborhood pixels over the image. In the processed image median filter perform two tasks. Firstly all pixels in the neighborhood and the original image are sorted in ascending value orders. Secondly, the sorted median value computed and chosen as the pixel value for the processed image. Preprocessing helps in removing all un-required noise or background from the image.

Image enhancement using histogram equalization

Equalization is the process of evenly distributing gray levels across their range in the image. It helps in reassigns the pixel brightness value. In this research, the histogram equalization method used to achieve more visual results of images that are in a wide range. It contains the following four stages-

4	4	4	4	4
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Based on the input image initially calculate the maximum and minimum value among the given pixel. Maximum _Value is 5 and Minimum _Value is 3. Based on the max and min value there are possible gray value is eight countings from 0 – 7. The given tables show the histogram of input images.

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0

Step 1- Initially computes histogram values with running sum which is also known as cumulative frequency distribution. *(1)*

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25

Step2 – Divide the running sum value with the total number of pixels counted. In this input image, the total number of pixels is 25.
(2)

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25
Running _Sum/Total No. of Pixel	0	0	0	0.24	0.8	1	1	1

Step 3- Now multiply the max_ gray level value with obtaining the result in step 2
(3)

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25
Running _Sum/Total No. of Pixel	0	0	0	0.24	0.8	1	1	1
Multiplied result	0	0	0	2	6	7	7	7

Step 4- Now maps gray level value with one –to- one correspondence. *(4)*

Gray level original value	Histogram based calculated value
0	0
1	0
2	0
3	2
4	6
5	7
6	7
7	7

The below table shows resulted in the original image and histogram equalization image-

4	**4**	**4**	**4**	**4**
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Original image

6	**6**	**6**	**6**	**6**
2	6	7	6	2
2	7	7	7	2
2	6	5	6	2
6	6	6	6	6

Histogram equalization image

4. Segmentation

In the segmentation method, it helps to detect the region of interest area for the particular image which needs to be examined. The main objective of image segmentation is to find out region-based interest over the image. Segmentation steps involve split methods which help the image to split into the equal region or called as a unit. For iteration, it involves a split and merges process. Firstly, iteration split the region into different parts of the region then it followed by the merging process. In segmentation, the threshold value is set to 0.1.

5. K-mean cluster Algorithm

It is also called an unsupervised classification method. It does not consist of any training data. K means clustering algorithm is an iterative method in which algorithm clusters pixels value iteratively by computing intensity of mean value for the given classes and segment the pixel by classifying its closest mean from each pixel value.

Initially select K as Clusters $m_1(1), m_2(1), \ldots\ldots\ldots\ldots M_n(l)$ (1)

In k^{th} iterative step, based on relation distribute pixel x on ‘K’ clusters, it is represented as

$p \in C_j(k) \quad \text{if} \; \| p - m_j(k) \| < \| p - m_i(k) \|$ (2)

For $i \neq j$, $i = 1,2,\ldots\ldots K$, where $C_j(k)$ represent cluster center with set of pixel is $m_j(k)$

Compute cluster with new centers $m_j(k + 1)$, $j=1, 2,\ldots\ldots K$, so that sum of the square distance from each pixel in $C_j(k)$ is minimized to a new cluster. The measure taken to minimize pixel value is the sample mean value of $C_j(k)$. Based on this new cluster center is represented as

$C_j(k + 1) = \frac{1}{Q_j} \sum_{x \in Cj(k)} R, \; j = 1, 2, \ldots\ldots K$ (3)

Where Q_j denote sample number in $C_j(k)$

If the condition $C_j(k + 1)$, $j = 1, 2,\ldots\ldots K$, the steps terminated and algorithm converge or else repeat step 2. (4)

6. Classification

Machine learning is a computer-based study algorithm that automatically improves through experience. It is also seen with an artificial intelligence subset. It built a mathematical model according to sample data called training data to make proper decisions and predictions for programmed to implement. It related to statistical and computational work which helps in calculating and perdition of using computers.

Table 1: Daubechies analysis with KNN classifier for satellite image classification

Sl. No.	Feature Extraction	Wavelet Analysis	Classification	Classes
1.	R _Color	**DAUBECHIES** (db) 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 analyses	K-Nearest neighbor (KNN) Classifier	Land. Ocean and Forest
2.	G _Color			
3.	B _Color			
4.	Mean_ Value			
5.	SD_Value			
6.	Entropy			
7.	Ellipticity			
8.	Intensity			
9.	Coefficient with Correlation			

In this research, the KNN classifier is used for classifications. In the K-Nearest Neighbors classifier algorithm (KNN) it consists of closest training k in feature space. The output value depends on regression or classifications. In KNN classification a class membership is an output, an object is classified using neighbors vote system with most common among k nearest neighbors. If the value of k =1 then the object is assigned to a single nearest neighbor. For satellite image detection, the collections of feature extracted are color-based features RGB, mean standard deviation, entropy, ellipticity, intensity, coefficient with Correlation. These are the feature considered for the detection of satellite images using wavelet analysis DAUBECHIES analysis family. In these work, 70% of training data and 30% testing data are used with k=3. Around 50 sample images have been considered for satellite image detection. The land is considered as one of the classes in the KNN classifier. The second class is the ocean in KNN classification. The third class is the forest, which is used in KNN Classifier. In these work, 70% of training data and 30% testing data are used with k=3. Around 50 sample images have been considered for satellite images. The main objective of this research is to implement image analysis and classification techniques for extraction and finding the type of satellite images for clustering into groups. In the KNN classifier, we need some reference data. It computes data files with all data records based on data records it looks for k closest data. In this investigation, we have assign k=3, so it will look 3 references from the closest data point. In the KNN classifier, the prediction is most important. For this prediction firstly convert discrete data into numeric form. For this investigation, a distance equation is needed to find out the distance from each point to the reference data. The distance equation used is Euclidean distance with a 2-dimensional dataset.

7. Result and Discussion

The result display satellite image detection using image processing techniques. Four stages were examined image preprocessing using the median filter, segmentation with fuzzy clustering algorithm with detection of satellite images, and classification of the type of satellite image. Data collected for testing around 50 satellite images. For this research, three classes investigated they are land, ocean, and forest.

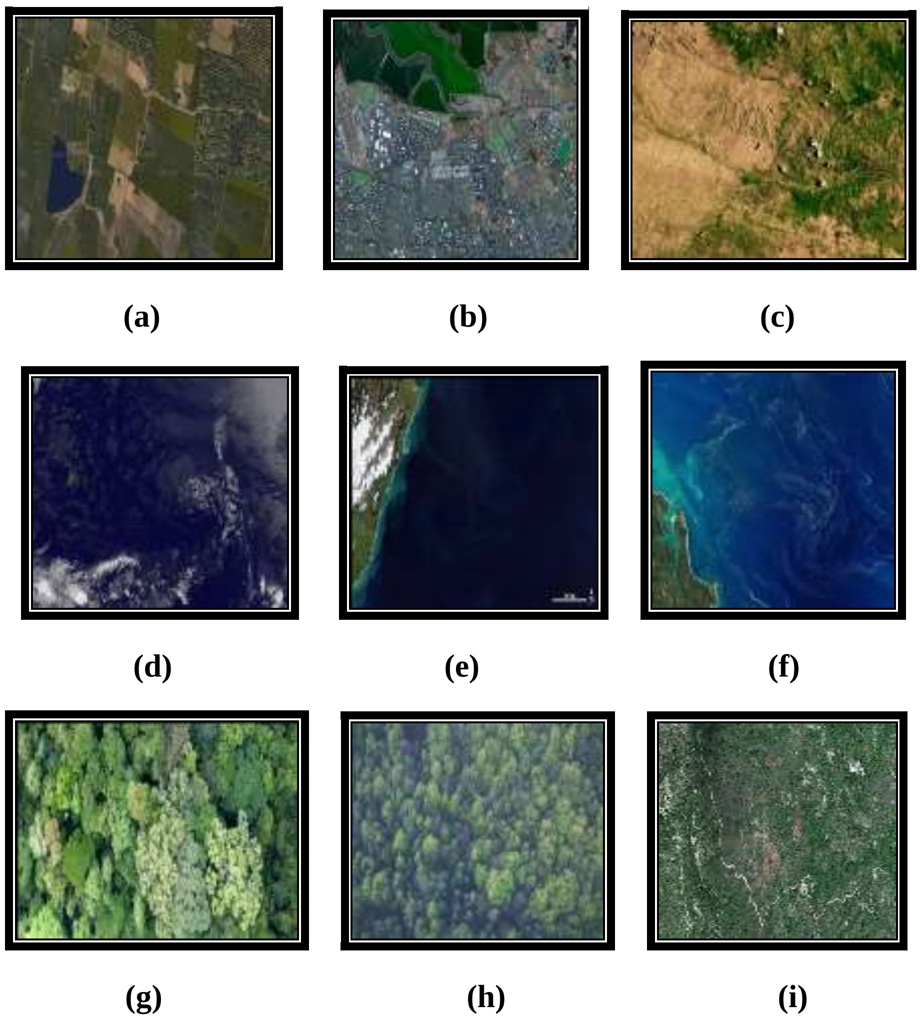

Figure 2- Satellite Dataset

The wavelet used is db analysis. It is symmetrical; it contains db1, db2, db3, db4, db5, db6, db7, db8, and db9 and db10 analysis. It has properties of near- biorthogonal, symmetrical, and orthogonal. In this research work, a confusion matrix model is used which helps to describe the performance of a classification model on a set of test data for which the true values are known. These work classification of satellite images which is calculated through finding total accuracy of satellite types between three sets of classes such as land, ocean, and forest using the k-nearest neighbor classification of the machine learning algorithm.

The total number of test samples used is 50 satellite images. For db analysis, the test sample classified as land, ocean, and forest where k =3 because the data point is more attracted to each other compare to other k values. The object assigned to the class of a single nearest neighbor. In these work, 70% of training data and 30% testing data are used with k=3. Around 50 sample images have been considered for satellite image detection. The given table represents db analysis with three classes' land, ocean, and forest using the confusion matrix. It implements image analysis and classification techniques for extraction and finding the type of satellite images for clustering into groups.

KNN algorithm is a classification algorithm; it is used to predict future groups that are in which group the data belongs to it which is called reference data. For KNN calculation we need reference data. Now the data records need to classify it compute the distance between the data record and all reference data records then it looks at the k closest data records in the reference data for this research k = 3 chosen then it will look the 3 nearest records in the reference data. Whatever in the majority class in this group of k data records it is the predicted class of algorithm.

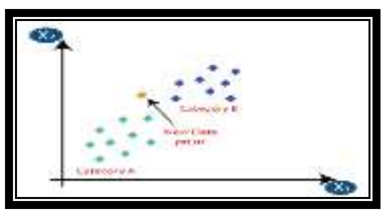

Figure 3- KNN New data point

Figure 3 represents 2-dimensional image representation with x-axis and y-axis with categories A and B with a new data point.

Table 2: db1 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db1** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	82	81	71
	G _Color	72	70	81
	B _Color	78	66	70
	Mean_ Value	82	71	60

	SD_Value	50	77	66
	Entropy	60	45	70
	Ellipticity	78	50	58
	Intensity	55	70	35
	Coefficient with Correlation	85	80	61

Table 2 represents db1 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 3: db2 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db2** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	62	84	64
	G _Color	80	73	43
	B _Color	63	81	81
	Mean_ Value	86	90	66
	SD_Value	84	70	80
	Entropy	76	82	90
	Ellipticity	45	70	83
	Intensity	77	85	81
	Coefficient with Correlation	83	74	53

Table 3 represents db2 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 4: db3 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db3** Analysis

		Accuracy Satellite _Land Image (%)	Accuracy Satellite _Ocean Image (%)	Accuracy Satellite _Forest Image (%)
KNN Classification	**R _Color**	67	76	76
	G _Color	64	82	72
	B _Color	77	80	77
	Mean_ Value	77	69	57
	SD_Value	66	66	84
	Entropy	82	73	54
	Ellipticity	76	75	66
	Intensity	72	73	41
	Coefficient with Correlation	77	78	70

Table 4 represents db3 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 5: db4 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db4** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	85	65	71
	G _Color	64	71	77
	B _Color	86	62	72
	Mean_ Value	76	73	78
	SD_Value	46	56	75
	Entropy	81	73	75
	Ellipticity	64	45	65
	Intensity	82	67	78
	Coefficient with Correlation	81	78	82

Table 5 represents db4 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 6: db5 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db5** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	68	81	76
	G _Color	45	54	44
	B _Color	81	73	77
	Mean_ Value	65	76	54
	SD_Value	58	72	66
	Entropy	69	49	76
	Ellipticity	78	62	64
	Intensity	65	74	36
	Coefficient with Correlation	73	63	72

Table 6 represents db5 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 7: db6 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db6** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	85	81	66
	G _Color	72	79	37
	B _Color	78	64	75
	Mean_ Value	88	78	67

	SD_Value	40	77	60
	Entropy	42	88	61
	Ellipticity	84	72	82
	Intensity	81	76	64
	Coefficient with Correlation	55	83	83

Table 7 represents db6 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 8: db7 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db7** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	45	44	68
	G _Color	44	62	78
	B _Color	73	84	66
	Mean_ Value	65	59	76
	SD_Value	72	95	82
	Entropy	73	82	54
	Ellipticity	45	60	80
	Intensity	81	80	61
	Coefficient with Correlation	82	60	73

Table 8 represents db7 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 9: db8 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db8** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	43	44	68
	G _Color	54	62	58
	B _Color	73	74	66
	Mean_ Value	35	59	76
	SD_Value	93	86	83
	Entropy	63	82	54
	Ellipticity	45	50	80
	Intensity	41	80	57
	Coefficient with Correlation	82	60	73

Table 9 represents db8 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 10: db9 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db9** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	47	54	68
	G _Color	44	62	78
	B _Color	73	84	66
	Mean_ Value	85	74	88
	SD_Value	64	72	82
	Entropy	89	54	76

	Ellipticity	65	82	66
	Intensity	71	80	61
	Coefficient with Correlation	42	50	73

Table 10 represents db9 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 11: db10 analysis with KNN classifier for satellite image classification

Algorithm	Feature Extraction	Wavelet-based **db10** Analysis		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**R _Color**	81	50	81
	G _Color	67	40	53
	B _Color	83	76	70
	Mean_ Value	81	67	84
	SD_Value	75	81	63
	Entropy	63	59	76
	Ellipticity	58	63	64
	Intensity	45	75	76
	Coefficient with Correlation	68	80	89

Table 11 represents db10 analysis with feature extraction using KNN classifier for satellite image characterization where the value of K=3 for classification of three classes land, ocean, and forest.

Table 12: Comparing Results of db 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 analyses with KNN classifier for satellite image classification

Algorithm	Wavelet Analysis	Classes k=3		
		Accuracy Satellite _Land Image (%)	**Accuracy Satellite _Ocean Image (%)**	**Accuracy Satellite _Forest Image (%)**
KNN Classification	**db1**	85	80	61
	db2	86	90	66
	db3	66	66	84
	db4	86	62	72
	db5	86	64	44
	db6	88	78	67
	db7	72	95	82
	db8	93	86	83
	db9	89	54	76
	db10	68	80	89

Table 12 represents characterization using db7 analysis, it also illustrates that db with 95% provide higher accuracy in detection using the KNN classification technique. For db analysis, the test sample classified as land, ocean, and forest where k =3 because the data point is more attracted to each other k values comparatively. The object assigned to the class of a single nearest neighbor. The given table represents db analysis with three classes land, ocean, and forest using the confusion matrix.

Table 13: Comparing Results of db 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 analyses with KNN classifier for satellite image classification

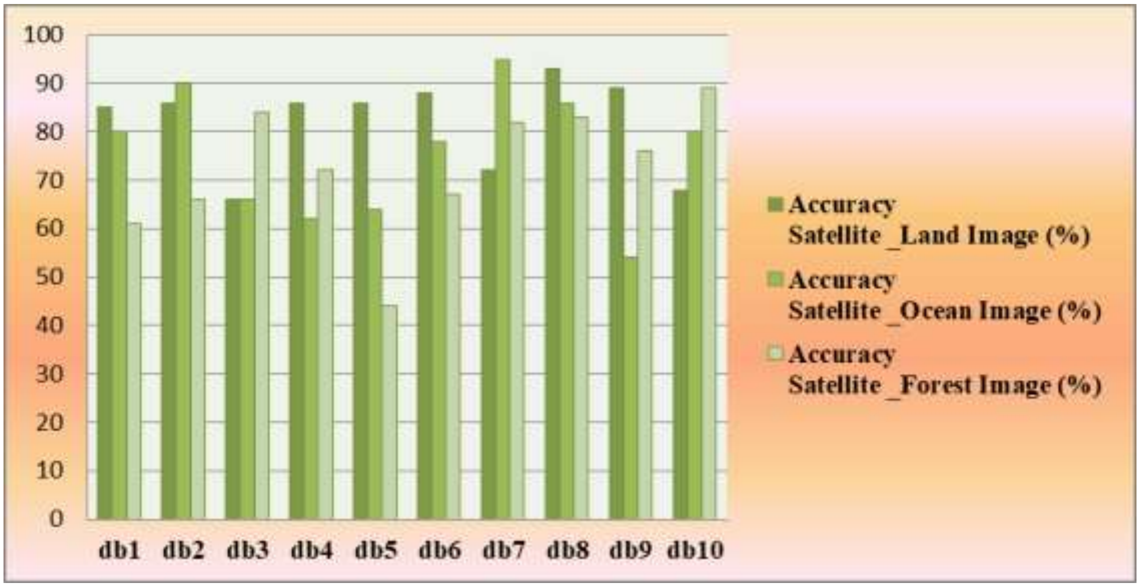

Table 13 represents comparing results with KNN classifier for satellite image classification using db analysis, it also illustrates that db7 with 95% provide higher accuracy of ocean compared to other measures.

Conclusion

This research investigates on satellite image categories classification using image processing and machine learning techniques. The main objective of this research is to implement image analysis and classification techniques for extraction and finding the type of satellite images for clustering into groups. For this research 50, sample images were uses for the detection of satellite images. To characterize the type of satellite images, features collected as color-based, statistical features and texture features which achieved through wavelet transform technique and machine learning algorithms such as KNN classifier with 70% training and 30% testing data using a confusion matrix. This technique will ensure the category of satellite images through classification techniques. It ensures that db7 works well with 95% accuracy using the KNN classifier for the characterization of satellite images compare with other measures.

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