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Research Article

Optimized Performance and Utilization Analysis of Real-Time Multi Spectral Data/Image Categorization Algorithms for Computer Vision Applications

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Abstract: In the field of computer vision , the process of acquiring, processing, analyzing and understanding multispectral data images is a major requisite. The major tool for digital data analysis and object recognition is data categorization. The basic and main stages involved in data categorization are the identification of an appropriate categorization system, an assortment of training and testing samples and the categorization method. Data categorization (or) classification is to recognize and depict the features of any data that can be later used for knowledge discovery. This work aims to compare supervised data classification techniques. This paper illustrates utilization of various techniques viz., Minimum distance (MD), Maximum likelihood (ML) and Mahalanob is distance (Mad). All the procedures are compared and analyzed for finest results and maximum accuracy.

Keywords: Data Categorization, Remote sensing, Supervised Classification, Algorithms.

1. Introduction

Undeniably a very high demand for land use or land cover maps for monitoring and management of natural resources, expansion approaches and global change studies is observed. Therefore, image classification serves as a noteworthy tool for image analysis. The procedure of satellite image classification involves an alliance of pixel values into major categories and estimating areas by including each category of pixels. The classification of Satellite images involves the understanding of images or spatial data mining that study a variety of vegetation types like agriculture, barren land, forestry, etc., and to analyze various land use land cover data (Minu Nair S,2016; S. Varadarajan 2018). This paper mainly deals with remote sensing images and their classification.

Some of the common researches on various supervised classification approaches for remote sensing images are being discussed and compared in this survey and relative analysis is done. There are different approaches to Satellite image classification. Classification algorithms of supervised classification involve Minimum distance (MD), Maximum likelihood, and Mahalanobis distance (D.Liu, Q. Weng,,2017 ; D. Pollard,1980). All these methods possess their limitations, strengths and results. The researches demonstrate that the Minimum distance (MD) classifier is very much suggested in all image classification applications , as it has the lowest calculation instance as it depends mostly on the training information, and it works finest in applications (Barandela, R. Juarez ,2002; D. B. Tushara,2016). The outcomes of supervised classification mainly rely on the eminence of training data.

2. Remote Sensing Images and Their Classification

Image classification is the most significant part of image analysis, remote sensing and pattern identification applications. It generates a variety of raster or vector maps like land use maps in remote sensing. In most of the cases, image categorization possibly serves as the eventual product whereas in additional cases it serves only as an intermediate step. The major tool for digital image analysis and object recognition is image categorization. The basic and main stages involved in image categorization are the identification of an appropriate categorization system, an assortment of training and testing samples and the categorization method. Moreover, the assortment of the suitable categorization method is having a significant outcome on the consequences, of whether the categorization can be used as a final product or as one of the numerous investigative procedures applied for obtaining data from an image for further analyses. Figure 1 illustrates the blocks involved in classification. The methodology that is involved in the classification procedure can be shown in figure 2.

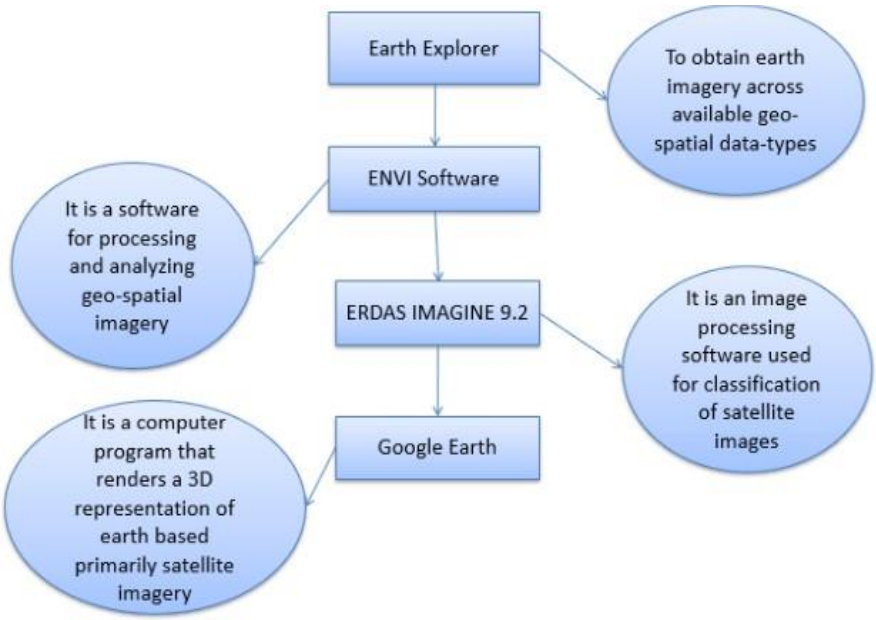

Figure 1. Blocks involved in Real-Time Satellite Image Classification

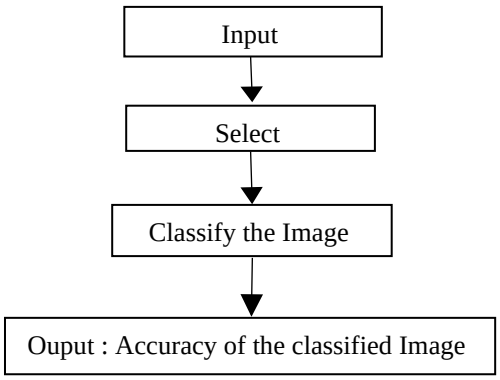

Figure 2. Methodology involved in the classification procedure

3. Classification procedure

3.1 Earth Explorer

The Earth Explorer (EE) is an online explore, detection, and order tool. It is developed by the United-States Geological-Survey. Earth Explorer supports the penetrating of an aircraft, satellite and several remote sensing inventories with interactive, user-friendly and text-based query capabilities. Enrolled users have more access to more features of Earth Explorer compared to guest users. Earth Explorer is remote sensing software that helps users to discover, foretaste, and download published digital information or order it by the USGS.

STEP 1: Locate Area of Interest in the "search criteria" tab.

Users can form regions of interest (ROI) by double-clicking the browser. The ROI is the geographic border that confines the search to obtain data.

STEP 2: Choose the required satellite image and its models to be downloaded in the “Data sets” tab. The data sets tab displays different remote sensing data sets such as Aerial imagery, Commercial imagery, LiDAR, RADAR, Landsat, MODIS and more.

STEP 3: Filter the images in the “Additional Criteria “tab.

Additional criteria tab is having a feature to filter out the scenes with extra cloud cover. Cloud cover can be set to less than 10%.

STEP 4: Download any kind of free satellite imagery in the” Results” tab.

The footprint for exactly where the scene is located can be checked and the data can be previewed. Download it by clicking the download option in whatever format needed. Figure 3 illustrates the downloaded satellite imagery.

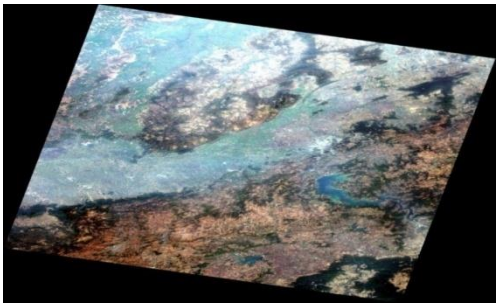

Figure 3. C1 LEVEL-1 Landsat 8 OLI/TIRS Satellite Imagery of Madhya Pradesh

3.2 ENVI Software

ENVI (Environment for Visualizing Images) is an application that is used to visualize, develop and examine geospatial imagery. Remote sensing executives and image analysts commonly use ENVI software. Complete image processing package of ENVI includes superior, yet simple to use, geometric correction, spectral tools, RADAR analysis, terrain analysis, Raster and Vector GIS capabilities, an extensive stake for images for a broad assortment of sources, and much more.

Step 1: Open ENVI 4.8 Software.

Step 2: Open the downloaded image which has different bands.

Step 3: Band combinations (RGB) should be selected based on the downloaded dataset.

Step 4: Assign the bands to the images based on the data set and click on "Load RGB."

Step 5: A processed RGB image appears and the image can be saved in any format required.

3.3 ERDAS Software

ERDAS IMAGINE software is specially intended for Raster file formats. It allows the user to bring in a broad diversity of remotely sensed images from the satellite and Aerial platform and produce useful information from the data.

Step 1:Open the merged RGB image in the viewer and crop it.

Step 2: To crop an image, in the viewer toolbar select AOI > Tools > Shape > Drag the cursor

and select the area to crop > Click on OK.

Step 3: In ERDAS IMAGINE toolbar, select DataPrep> Subset image >Assign Input and

Output file names > Click on save option

Step 4: In ERDAS IMAGINE toolbar, select viewer and open the cropped image and right. Click on the image and fit the image to the window.

Step 5: In the viewer, toolbar select AOI > Tools > Shape > Drag the cursor and select different classes.

Step 6: Select classifier option> signature editor> assign class values and colors for different classes that are selected and then the signature editor can be saved in a folder.

Step 7: In classifier tool bar>select supervised classification > Enter the input file name,

Signature editor file name and output file name and select the technique (either Maximum likelihood (ML) (or) Minimum distance (MD) (or) Mahalanobis distance (Mad) > Click on OK.

Step 8: Select a new viewer and open the classified image.

Step 9: Go to a classifier and select an accuracy assessment for the classified image and then Select edit option >create random points> Click on OK.

Step 10: A tabular column appears with X (LATITUDE) and Y (Longitude values) > Edit> show class values > Click on OK.

Step 11: Then with the help of Google Earth i.e., latitude and longitude values we assign the reference values in comparison with the class values.

Step 12: Then select the report > Accuracy report and click on OK. The confusion matrix and the Kappa coefficient are calculated.

Figure 4. C1 Level-1 cropped image of Landsat 8 OLI/TIRS of Madhya Pradesh

3.4 Google Earth

Google earth provides a 3D illustration of earth-based mostly on satellite imagery. This program is used to map the earth by superimposing aerial photography, satellite images aerial photography, and GIS (Global Information System) information onto a 3Dimension globe, and allows users to view urban areas and prospects from diverse angles. Figure 5 shows a sample of Google Earth Imagery of an area.

Figure 5. Google Earth Imagery of Madhya Pradesh

4. Supervised Classification Algorithms and Their Results

In general image, categorization is merged into parametric and non-parametric, or supervised or unsupervised, or hard and soft (fuzzy) classification, or pixel, sub-pixel and per field. The two phases/levels of the supervised categorization process are (a) Training level and (b) Classification level. In the training level, the classification model is generally given with detailed information to differentiate different classes. This process is generally performed by allocating a number of digital pixels to the respective classes that they belong to. The file which provides this information is called the training data file. Coming to the classification phase, the algorithm which uses the information provided in the training data file by looking at each pixel for the most similar trained class and assign classes to each pixel. Table 1 indicates various land use land cover types and colors assigned to the classes

Table 1. Vegitation types and colors assigned to the classes

Classes	Colour	Vegetation
C1 (Class 1)	Aquamarine	Green Fields
C2 (Class 2)	Brown	Buildings
C3 (Class 3)	Blue	Water
C4 (Class 4)	Dark Green	Forest
C5 (Class 5)	Maroon	Mountains
C6 (Class 6)	Tan	Barren Land

4.1 Minimum Distance (MD) Classifier

This classifier uses the midpoint to signify a class in the training set. This method makes use of the distance standard, where the Euclidean distance will be measured among the pixel standards and the midpoint value of the trial class. The pixel which is having the least distance with the class is allocated to that class. The classifier is quick in implementation, calculation time is very less as it depends mostly on the training dataset and it classifies all the pixels, but the algorithm may be susceptible to errors and results in misclassification of pixels as it will classify a pixel even if the least distance is far away. The spectral distance can be determined for all values of a class mean; the unclassified pixel is assigned to the class with the least spectral distance which ultimately results in the classification of all pixels. The minimum distance (MD) algorithm depends on the distance (minimum) from the mean value Mt of each class of the training data to the digital value 'Dv' of each pixel in the given image. This distance is calibrated by using a simple distance model like a Euclidean distance measurement

$$\text{Sqrt } (Dv - Mt)^2$$

The minimum distance (MD) pixel value will be allocated as the class of the pixel in this method. Figure 6 shows a sample image of minimum distance (MD) classification. Table 2 shows the class and reference values assignment. Table 3 indicates the error matrix of the Minimum Distance (MD) Classifier. Table 4 shows the accuracy assessment of the Minimum Distance (MD) classifier. Table 5 illustrates the Kappa co-efficient for different classes of Minimum Distance (MD) Classifier

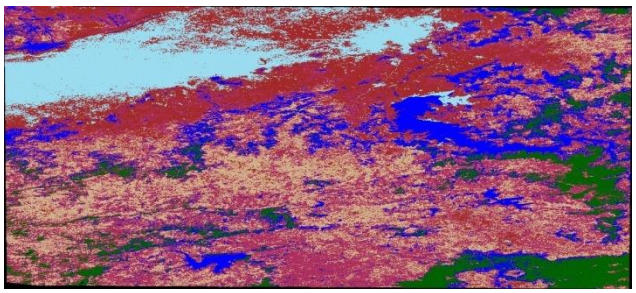

Figure 6. Minimum distance (MD) Classification of Madhya Pradesh

Table 2. Class and Reference Values Assignment

S.NO	TITLE	X	Y	CLASS	REFERENCE
1	ID#1	416550	2494410	5	5
2	ID#2	41630	2520150	4	3
3	ID#3	413310	2513070	4	4
4	ID#4	355680	2519820	4	4
5	ID#5	351300	2549250	1	1
6	ID#6	397350	2491560	4	3
7	ID#7	382920	2510310	5	4
8	ID#8	410820	2480520	4	4
9	ID#9	325470	2481330	6	6
10	ID#10	370710	2466270	4	4
11	ID#11	348480	2534010	2	1
12	ID#12	367830	2499300	4	4
13	ID#13	403830	2498130	4	4
14	ID#14	324450	2568540	2	2
15	ID#15	358080	2526000	4	4
16	ID#16	393750	2468910	5	5
17	ID#17	329700	2503440	6	6

18	ID#18	419550	2536440	6	6
19	ID#19	389940	2498310	5	5
20	ID#20	418740	2571180	4	4
21	ID#21	371580	2535390	4	4
22	ID#22	372060	2486220	3	3
23	ID#23	393000	2514180	4	4
24	ID#24	374610	2562930	1	1
25	ID#25	354270	2568540	2	2
26	ID#26	3235800	2504460	3	3
27	ID#27	330600	2493930	5	5
28	ID#28	380040	2497230	5	5
29	ID#29	324510	2562690	4	4
30	ID#30	341760	2528850	2	2
31	ID#31	410670	2546970	5	5
32	ID#32	353550	2556120	1	1
33	ID#33	328770	2547180	1	1
34	ID#34	348690	2564070	1	0
35	ID#35	429720	2470770	0	0
36	ID#36	332640	2512530	4	4
37	ID#37	360630	2501700	4	4
38	ID#38	423780	2573970	0	0
39	ID#39	323310	2475000	6	6
40	ID#40	351180	2521290	4	4
41	ID#41	421050	2540370	4	4
42	ID#42	384750	2529090	5	5
43	ID#43	422850	2506770	4	4
44	ID#44	337050	2567220	4	4
45	ID#45	340350	2472450	4	3
46	ID#46	354810	2557950	1	1
47	ID#47	323280	2502540	5	5
48	ID#48	420090	2469330	6	6
49	ID#49	381450	2533860	4	4
50	ID#50	347700	2542080	2	2

4.2 Error Matrix

Table 3. Error Matrix of Minimum Distance (MD) Classifier

CD	Un classified	C1 (Class 1)	C2 (Class 2)	C3 (Class 3)	C4 (Class 4)	C5 (Class 5)	C6 (Class 6)	RT
Unclassified	0	1	0	0	0	1	2	4

C1 (Class 1)	0	3	0	0	0	0	3	6
C2 (Class 2)	0	0	7	0	0	0	7	14
C3 (Class 3)	0	0	0	7	0	0	7	14
C4 (Class 4)	15	0	0	0	4	0	19	38
C5 (Class 5)	0	0	0	0	7	0	7	14
C6 (Class 6)	0	0	0	0	0	5	5	10
CT	15	4	7	7	11	6	50	100

Where CD: Classified Data, CT: Column Total, RT: Row Total Accuracy Total

Table 4. Accuracy Assessment of Minimum Distance (MD) Classifier

CN	RFT	CT	NC	PA	UA
Unclassified	0	2	0	---	---
C1 (Class 1)	4	3	3	75.00%	100.00%
C2 (Class 2)	7	7	7	100.00%	100.00%
C3 (Class 3)	7	7	7	100.00%	100.00%
C4 (Class 4)	15	19	15	100.00%	78.95%
C5 (Class 5)	11	7	7	63.64%	100.00%
C6 (Class 6)	6	5	5	83.33%	100.00%
Totals	50	50	44		

Where CN: Class Name, RFT: Reference Total, CT: Classified Total, NC: Number Correct PA: Producers Accuracy, UA: Users Accuracy
Overall Classification Accuracy = 88.00% KAPPA (K^) STATISTICS
Overall Kappa Statistics = 0.8498

Table 5. Kappa co-efficient for different classes of Minimum Distance (MD) Classifier

CN	Kappa
Unclassified	0.0000
C1 (Class 1)	1.0000
C2 (Class 2)	1.0000
C3 (Class 3)	1.0000
C4 (Class 4)	0.6992
C5 (Class 5)	1.0000
C6 (Class 6)	1.0000

4.3 Maximum Likelihood (ML) Classifier

This method of classification is used to calculate the probability for a given pixel in every class and then the pixel will be allocated to a particular class that has the highest probability. It also calculates the covariance matrix and mean for the training samples and imagines that the pixel values are commonly scattered. A class may be characterized by the mean value and the covariance matrix. A PDF (Probability Density Function) will be defined and the input pixels are mapped depending on the likelihood that the pixel belongs to that particular class.
Figure 7 shows the sample image of the Maximum Likelihood (ML)classification. Table 6 shows Class and Reference Values Assignment Table 7 indicates the error matrix of Maximum Likelihood (ML) Classifier., Table 8 shows the accuracy assessment of the Maximum Likelihood (ML) classifier. Table 9 shows the Kappa co-efficient for different classes of Maximum Likelihood (ML) Classifier.

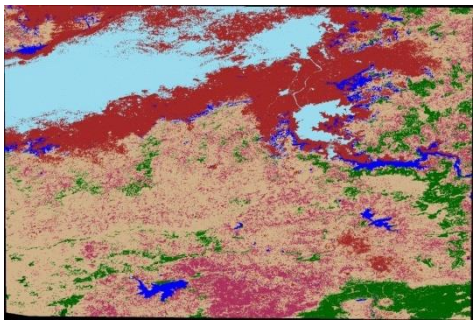

Figure 7. Maximum Likelihood (ML) Classification of Madhya Pradesh

Table 6. Class and Reference Values Assignment

S.No	Title	X	Y	Class	Reference
1	ID#1	336510	2465610	5	5
2	ID#2	379860	2515080	5	5
3	ID#3	382140	2556090	1	1
4	ID#4	425790	2518980	5	5
5	ID#5	428590	2548560	6	6
6	ID#6	392250	2569440	1	2
7	ID#7	376260	2565810	2	2
8	ID#8	375120	2512800	5	5
9	ID#9	396540	2461710	0	0
10	ID#10	341550	2505750	5	5
11	ID#11	406410	2571210	2	2
12	ID#12	362160	2469030	5	5
13	ID#13	418800	2557920	5	5
14	ID#14	418800	255930	2	2
15	ID#15	356010	2477730	3	3
16	ID#16	360900	2513670	5	5
17	ID#17	385530	2508330	5	5
18	ID#18	405530	2767100	5	5
19	ID#19	398340	2477700	5	5
20	ID#20	395190	2479470	5	5
21	ID#21	415320	2529410	6	6
22	ID#22	390540	2510640	5	5
23	ID#23	429210	2570190	5	4
24	ID#24	392010	2472650	5	4
25	ID#25	410310	2557380	2	2
26	ID#26	380280	2487000	5	4
27	ID#27	393600	256840	1	1

28	ID#28	371000	2469240	4	4
29	ID#29	429750	2544450	5	5
30	ID#30	363150	2514690	5	4
31	ID#31	372630	2567340	2	2
32	ID#32	416910	2713790	5	2
33	ID#33	361560	2530620	5	5
34	ID#34	362580	2510190	5	4
35	ID#35	339600	2535870	1	1
36	ID#36	386340	2563860	2	2
37	ID#37	411480	2462740	5	5
38	ID#38	337590	2505630	5	5
39	ID#39	326070	2533590	2	2
40	ID#40	369750	2530560	5	5
41	ID#41	408030	2544630	5	5
42	ID#42	399810	2535630	5	4
43	ID#43	349020	2535630	1	1
44	ID#44	424330	2506260	6	6
45	ID#45	426780	2486550	5	5
46	ID#46	383100	2477100	4	4
47	ID#47	396150	253260	2	2
48	ID#48	385890	2569860	1	1
49	ID#49	358950	2522760	5	5
50	ID#50	379800	2548980	2	2

4.4 **Error Matrix**

Table 7. Error Matrix of Maximum Likelihood (ML) Classifier

CD	Unclassified	C1 (Class 1)	C2 (Class 2)	C3 (Class 3)	C4 (Class 4)	C5 (Class 5)	C6 (Class 6)	RT
Unclassified	0	0	1	0	0	0	1	2
C1 (Class 1)	1	0	0	0	0	0	8	9
C2 (Class 2)	0	6	0	1	0	0	6	13
C3 (Class 3)	0	0	6	0	0	0	0	6
C4 (Class 4)	4	0	0	0	0	0	4	8
C5 (Class 5)	0	0	3	2	22	0	27	54
C6 (Class 6)	0	0	0	0	0	4	4	8
CT	5	6	10	3	22	4	50	100

Accuracy Tools

Table 8. Accuracy Assessment of Maximum Likelihood (ML) Classifier

CN	RFT	CT	NC	PA	UA
Unclassified	1	1	1	---	---
C1 (Class 1)	6	8	6	100.00%	75.00%
C2 (Class 2)	9	6	6	66.67%	100.00%
C3 (Class 3)	3	0	0	---	---
C4 (Class 4)	5	4	4	80.00%	100.00%
C5 (Class 5)	22	27	22	100.00%	81.48%
C6 (Class 6)	4	4	4	100.00%	100.00%
Totals	50	50	43		

Overall Classification Accuracy =86.00% KAPPA (K^) STATISTICS
Overall Kappa Statistics = 0.8019

Table 9. Kappa co-efficient for different classes of Maximum Likelihood (ML) Classifier

CN	Kappa
Unclassified	1.0000
C1 (Class 1)	0.7159
C2 (Class 2)	1.0000
C3 (Class 3)	0.0000
C4 (Class 4)	1.0000
C5 (Class 5)	0.6693
C6 (Class 6)	1.000

4.5 MAhalanobis Distance (MAD) classifier

A sample image of Mahalanobis Distance (Mad) classification is shown in figure 8. Table 10 shows Class and Reference Values Assignment. Table 11 indicates the error matrix of Mahalanobis distance (Mad) Classifier. Table 12 shows the accuracy assessment of the Mahalanobis distance (Mad) classifier. Table 13 shows the Kappa co-efficient for different classes of Mahalanobis distance (Mad)

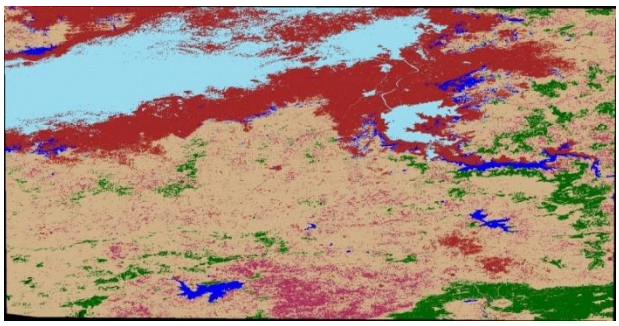

Figure 8. Mahalanobis Distance (Mad) Classification of Madhya Pradesh

Table 10. Class and Reference Values Assignment

S.NO	TITLE	X	Y	CLASS	REFERENCE
1	ID#1	319500	2559150	5	5
2	ID#2	344490	2550720	1	1
3	ID#3	328170	2555580	1	1
4	ID#4	322020	2548410	1	1
5	ID#5	340110	2505510	5	5

6	ID#6	320850	2512800	5	5
7	ID#7	364140	2567580	1	1
8	ID#8	366300	2501700	5	5
9	ID#9	426990	2484990	6	6
10	ID#10	345930	2527800	2	2
11	ID#11	379350	2471940	4	4
12	ID#12	339390	2540100	1	1
13	ID#13	366150	2477160	4	4
14	ID#14	369000	2483730	5	4
15	ID#15	327600	2486610	5	3
16	ID#16	352530	2717270	5	3
17	ID#17	376620	2529870	5	5
18	ID#18	381600	2512290	4	4
19	ID#19	397860	2494500	5	5
20	ID#20	364140	2540550	2	1
21	ID#21	323040	2565120	5	3
22	ID#22	343200	2505660	5	5
23	ID#23	340680	2506080	5	5
24	ID#24	374280	2523150	5	4
25	ID#25	377190	2551410	2	1
26	ID#26	419880	2538570	5	5
28	ID#28	362670	2561100	1	1
29	ID#29	327840	2486250	5	4
30	ID#30	347310	2468100	1	1
31	ID#31	370380	2556750	1	1
32	ID#32	414360	2502150	5	4
33	ID#33	321960	2502330	5	4
34	ID#34	429930	2548530	0	0
35	ID#35	327990	2522580	3	2
36	ID#36	402240	2529630	5	5
37	ID#37	401070	2496600	5	5
38	ID#38	366690	2542820	2	1
39	ID#39	346320	2524020	2	2
40	ID#40	395220	2568450	1	1
41	ID#41	412620	2526030	6	5
42	ID#42	429570	2472660	0	0
43	ID#43	384270	2559630	1	1
44	ID#44	346530	2540520	2	2

45	ID#45	330420	2555910	1	1
46	ID#46	326670	2544480	1	1
47	ID#47	412830	2539440	4	4
48	ID#48	375810	2471910	5	5
49	ID#49	429270	2466090	5	5
50	ID#50	330570	2551980	1	1

Error Matrix

Table 11. Error Matrix of Mahalanobis distance (Mad) classifier

CD	Unclassified	C1 (Class 1)	C2 (Class 2)	C3 (Class 3)	C4 (Class 4)	C5 (Class 5)	C6 (Class 6)	RT
Unclassified	0	0	0	0	0	1	2	3
C1 (Class 1)	0	7	0	0	0	0	3	10
C2 (Class 2)	0	0	8	0	0	0	7	15
C3 (Class 3)	0	0	0	2	0	0	7	9
C4 (Class 4)	15	0	0	0	4	0	19	38
C5 (Class 5)	0	0	4	1	7	0	7	19
C6 (Class 6)	0	0	0	0	0	5	5	10
CT	15	7	12	3	11	6	50	104

Accuracy Tools

Table 12. Accuracy Assessment of Mahalanobis Distance (Mad) Classifier

CN	RFT	CT	NC	PA	UA
Unclassified	1	1	1	---	----
C1 (Class 1)	7	8	7	100.00%	66.67%
C2 (Class 2)	12	8	8	66.67%	100.00%
C3 (Class 3)	3	2	2	66.67%	100.00%
C4 (Class 4)	9	0	0	----	----
C5 (Class 5)	16	29	16	100.00%	55.17%
C6 (Class 6)	2	2	2	100.00%	100.00%
Totals	50	50	36		

Overall Classification Accuracy = 72.00%

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.6263

Table 13. Kappa co-efficient for different classes of Mahalanobis Distance (Mad) Classifier

CN	Kappa
Unclassified	1.0000
C1 (Class 1)	0.8547
C2 (Class 2)	1.0000

C3 (Class 3)	1.0000
C4 (Class 4)	0.0000
C5 (Class 5)	0.3408
C6 (Class 6)	1.0000

5. Unsupervised Classification

Unsupervised classification of the image is the process in which each image that is present in a dataset will be recognized to be one of the members of the inherent categories that are present in the image compilation without the usage of labeled training samples.

The ISODATA clustering method forms clusters by using the minimum spectral distance formula. It begins with either a casual cluster means or means of an existing signature set, and each time this process clustering repeats, and then the means of these clusters are shifted. The next iteration always uses the new cluster means.

Figure 9 shows the Unsupervised Classification of Madhya Pradesh. Table 14 shows Class and Reference Values Assignment. TABLE 15 shows the error matrix of unsupervised classification. TABLE 16 shows the Accuracy Assessment of Unsupervised Classifier using ISODATA Clustering and TABLE 17 shows Kappa co-efficient for different classes of Unsupervised Classifier using ISODATA Clustering.

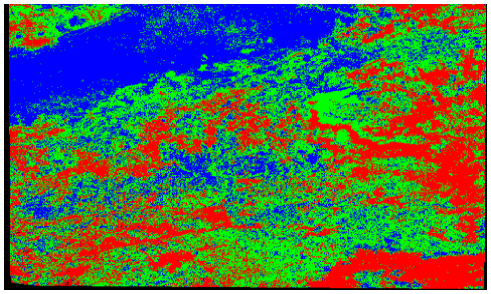

Figure 9. Unsupervised Classification of Madhya Pradesh

Error Matrix

Table 14. Class and Reference Values Assignment

S.no	Title	X	Y	Class	Reference
1	ID#1	341670	2509150	1	2
2	ID#2	371370	2606010	1	2
3	ID#3	300030	2522100	2	2
4	ID#4	386760	2559630	2	2
5	ID#5	359580	2545650	2	1
6	ID#6	397650	2521830	1	2
7	ID#7	381780	2582490	3	2
8	ID#8	398648	2551140	2	2
9	ID#9	366570	2582580	2	2
10	ID#10	314010	2545530	3	3
11	ID#11	360120	2564280	2	2
12	ID#12	302550	2558580	2	2
13	ID#13	403020	2551290	2	2
14	ID#14	324150	2497410	2	2
15	ID#15	355020	2544570	2	2
16	ID#16	306600	2551680	2	2
17	ID#17	318630	2496620	2	2

18	ID#18	310530	2575260	1	1
19	ID#19	393900	2508090	1	1
20	ID#20	335100	2585640	2	1
21	ID#21	398520	2503470	1	1
22	ID#22	298590	2497320	1	1
23	ID#23	339960	2595270	2	2
24	ID#24	302760	2502750	1	2
25	ID#25	307620	2599170	2	2
26	ID#26	316110	2527650	2	2
27	ID#27	373740	2539230	1	1
28	ID#28	339060	2587780	0	0
29	ID#29	324600	2539230	3	3
30	ID#30	296340	2615070	1	1
31	ID#31	321330	2510370	2	2
32	ID#32	303450	2577840	1	1
33	ID#33	395220	2490660	3	3
34	ID#34	320120	2612010	0	0
35	ID#35	343740	2615110	1	1
36	ID#36	360060	2588210	2	2
37	ID#37	304710	2589300	2	2
38	ID#38	325410	2687930	0	0
39	ID#39	318180	2571180	1	1
40	ID#40	299130	2540790	3	1
41	ID#41	399390	2536470	2	1
42	ID#42	364650	2579250	2	1
43	ID#43	317700	2509500	1	1
44	ID#44	384750	2491170	2	1
45	ID#45	362670	2596656	2	1
46	ID#46	340410	2515320	2	2
47	ID#47	349780	2614320	3	1
48	ID#48	360240	2505180	2	2
49	ID#49	319470	2614080	3	1
50	ID#50	319480	2614020	3	1

Table 15. Error Matrix of unsupervised Classification

CD	Unclassified	C1 (Class 1)	C2 (Class 2)	C3 (Class 3)	RT
Unclassified	0	0	0	0	0
C1 (Class 1)	0	18	0	0	18
C2 (Class 2)	0	11	10	0	21

C3 (Class 3)	0	0	5	6	11
CT	0	29	15	6	50

Accuracy Totals

Table 16. Accuracy Assessment of Unsupervised Classifier

CN	RFT	CT	NC	PA	UA
Unclassified	0	0	0	---	----
C1(Class 1)	29	18	18	62.07%	100.00%
C2Class 2)	15	21	10	66.67%	47.62%
C3 (Class 3)	6	11	6	100.00%	54.55%
Totals	50	50	34		

Overall Classification Accuracy = 68.00% KAPPA (K^) STATISTICS
Overall Kappa Statistics = 0.4991

Table 17. Kappa co-efficient for different classes of Unsupervised Classifier

CN	Kappa
Unclassified	0.0000
C1 (Class 1)	1.0000
C2 (Class 2)	0.2517
C3 (Class 3)	0.4835

6. Conclusion

This paper analyses different supervised classification approaches and methods such as minimum distance which provides an accuracy of 88.00%, maximum likelihood which provides an accuracy of 86.00% and mahalanobis distance which provides an accuracy of 72.00% and concludes that minimum distance technique is best compared with other techniques. The minimum distance classifier classifies unidentified image data to classes which minimizes the distance between the image data and the class in multi-featured space. The advantage of the minimum distance algorithm is that every pixel is assigned to a class and it is very quick to compute.

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