INSTITUTE OF REMOTE SENSING

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LAB MANUAL

DIGITAL IMAGE PROCESSING LABORATORY

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Expt No. 1	IMAGE READING, WRITING AND CREATING FCC	Date of Expt:

AIM:

To read, write and create FCC for the given image.

SOFTWARE USED :

ERDAS IMAGINE 9.2

DATA USED:

eldoatm.img

PROCEDURE:

- Create a folder in C drive and name it as GEO5 and open a folder with roll number as the name inside GEO5. Open ERDAS IMAGINE 9.2 software
- Go to file and select open.
- From the drop-down menu, select raster layer and add the layer file (ie image) from the examples folder in the viewer.
- Click OK to add the image and to get information about the added data select i tool.
- Note down the statistical, layer, projection and map info of each layer for added image, eldoatm.img.
- Go to raster option and select band combinations.
- Change the combination of layers to visualize true colour composite, standard FCC and preferred FCC.
- To save the work select save as, choose view and input the file name and file location and click OK to save.

INFERENCE:

RESULT:

Thus, for the given image, image grading, writing and creating done and in my preferred features are more detailed.

Expt No. 2	STUDY OF IMAGE FILE FORMATS AND ORGANIZATION	Date of Expt:

AIM:`

To understand the various image file formats (raster data).

IMPORTANT FILE FORMATS:

- Band Interleaved by Pixels (BIP)
- Band Interleaved by lines (BIL)
- Band sequential File (BSQ)

Band Interleaved by Pixels (BIP)

BIP is one of the three primary methods of encoding image data for multiband raster images in the geospatial domain, such as images obtained from satellite imageries. BIP is not itself an image format, but it is a method for encoding the actual pixel values of an image in a file. Images stored in BIP format have the first pixel for all bands in sequential order, followed by the second pixel for all bands, followed by the third pixels for all band, etc, interleaved upto the number of pixels. The BIP data organization can handle any number of bands, and thus accommodates black and white, grayscale pseudocolour, true color and multi-spectral image data.

Advantages of BIP:

- Commonly used for storing colour images, with red, green, and blue values altering.
- Used in the early stages of Landsat data distribution.

Disadvantages of BIP:

- Array of pixels cannot be represented as discrete patches or regions.
- Manipulation of data is not possible and is therefore not used in present times to store satellite images.

Band Interleaved by Lines (BIL):

BIL is one of the three primary methods for encoding data for multispectral raster images in the geospatial domain. It is not in itself an image format, but it is a scheme for storing the actual pixel values of an image in a file band by band for each line, or row, of the image. For instance, given a threebanded image, all the three bands of data are written for one row, all three bands of data are written for band two, and so on. The BIL encoding is a compromise format, allowing fairly easy access to both spatial and spectral information. The BIL data organization can handle any number of bands and thus accommodates black and white, grayscale, pseudo color, true color, and multi-spectral image data.

Advantages of BIL:

- BIL is a popular format for storing multispectral images, and is supported by most remote sensing software such as ERDAS, etc,
- Well suited when multiband data analysis is required.
- Lot of data input and output is involved when access to a single band image is needed on sequential access systems.

Disadvantages of BIL:

- Moderate overhead on random access systems.
- If some bands are not of interest, this format is inefficient if the data are on tape, since it is necessary to read serially post all unwanted date.

Band Sequential Format (BSQ):

The BSQ format requires that all the data for a single band covering the entire scene to be written as one file. Thus if an analyst wanted to extract the area in the centre of a scene in four bands, it would be necessary to read into this location in four separate files to extract the desired information. Many researchers like this format because it is not necessary to read serially post unwanted information if certain bands are of no value, especially when the data are on a number of different tapes. Random-access optical disk technology obsolete.

Advantages of Band Sequential Format:

- Ideally suited when the multiband image is processed one band at a time, such as image enhancement, enhancement, neighborhood filtering, and so on.
- More overheads when all the band values are required at each pixel.

Disadvantages of BSQ:

- Requires additional information to interpret image data.

Other Image File Formats:

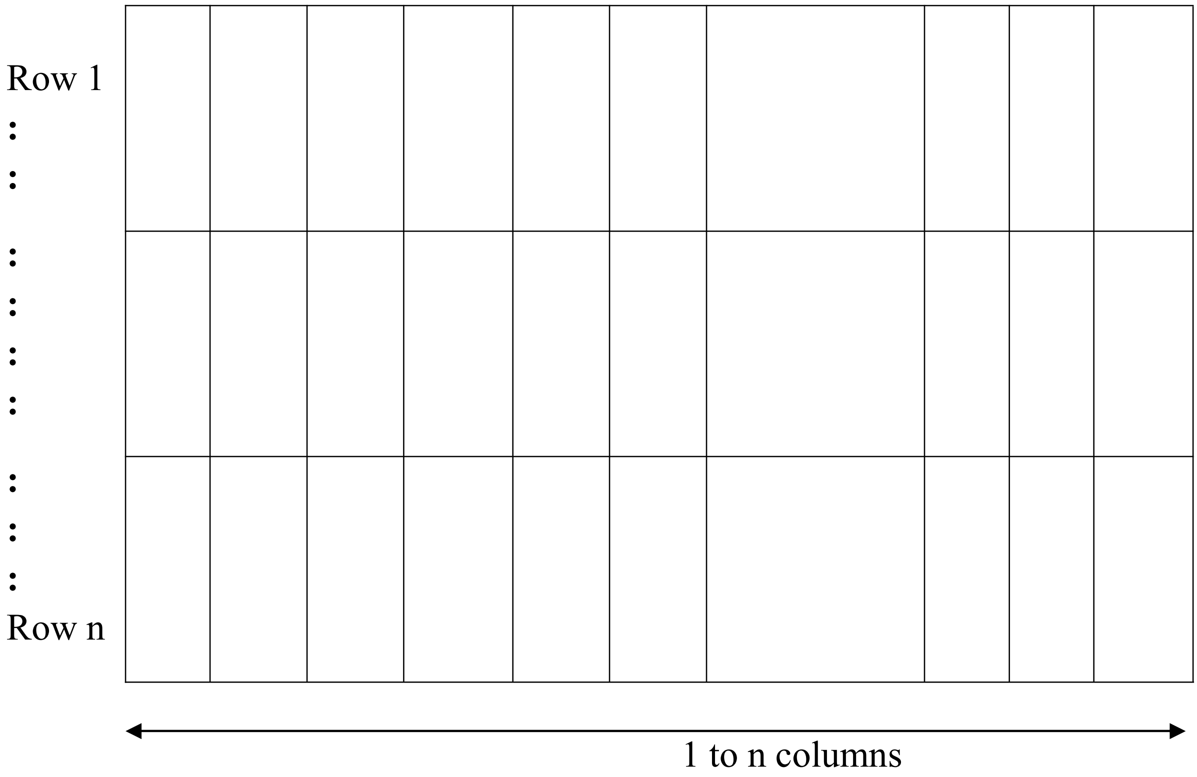
- **Tagged Image Format (.tif, .tiff)**
  - Broad format that handles bitmaps to compressed color palette images.
  - Supports several compression schemes.
  - Popular,simpleallowscolour.
- **Portable Network Graphics (.png)**
  - Provides lossless, well compressed storage of raster images.
  - Grayscale, colour palette, true colour images are supported.
  - Supports additional optional alpha channel, and depth 1 to 16 bits.
- **JPEG (.jpeg)**
  - Used for transmission of pictorial information.
  - Includes variable lossy encoding.
- **Graphics Interchange Format (.gif)**
  - Supports 8-bit colour palette.
  - Not popular among image processing researchers.
- **Postscript (.ps, .eps, .epsf)**
  - Used for introducing images on paper for printing.
  - Gray level images are represented by decimal or hex numerals encoding in ASCII.

Image File Formats (Raster)

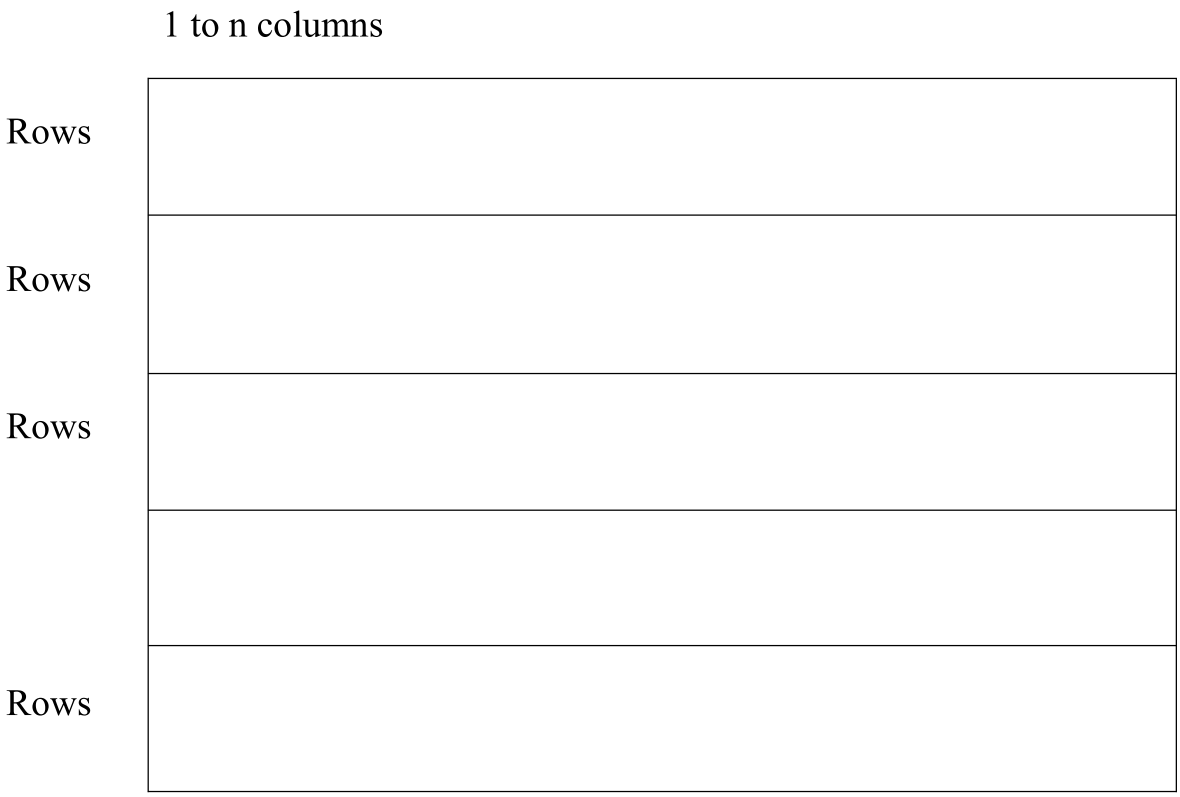
(a) Band Interleaved by Line (BIL):

	1 to n columns	1 to n columns	1 to n columns
Row 1			
Row 2			
: : : :			
Row n			

(b) Band Interleaved by Pixel (BIP):



(c) Band Sequential Format (BSQ):



RESULT :

The functionality behind various image file formats has been understood.

Expt No. 3	PREPROCESSING TECHNIQUES: RADIOMETRIC CORRECTION	Date of Expt:

AIM:

To rectify and pre-process the raw imagery by using geometric correction.

SOFTWARE USED:

ERDAS imagine 9.2

DATA USED:

- 56k7.img
- Liss3.img

PROCEDURE:

To resample 56 K-7 and LISS 3 imagery:

- ➢ Open ERDAS imagine 9.2 software and input the 56k-7 image and select Geometric correction tool from Raster option.
- ➢ Set Geometric model as Polynomial with an order of I which requires at-least minimum the 3 input points.
- ➢ Change the projection to Geographic- WGS & lat/Long' from the Add/change projection tool. Set the unit in Degrees.
- ➢ Input the co-ordinate values of a) grid in decimal by Keyboard entry from set projection from GCP tools.
- ➢ Else GCP tool to create GCP's and input the X-Ref and Y-Ref value manually
- ➢ Note down the Residuals, contribution and RMS errors.
- ➢ Select Resampling from Geo correction tool. Now the image is resampled and output file saved in folder
- ➢ The same steps are followed for 'LISS 3' image and a minimum of 4 GCP's are selected and to reduce RMS error, multiple points and corrected. are selected
- ➢ To check overlay select char display from Raster option while importing on the viewer and use surpe option to check the accuracy.

INFERENCE:

RESULT:

Thus, the rectification and preprocessing geometric correction of the raw imagery are done and studied.

Expt No. 4	PREPROCESSING TECHNIQUES: GROUND CONTROL AND GEOMETRIC RECTIFICATION	Date of Expt:

AIM:

To apply preprocessing techniques such as ground control and geometric rectification to digital images for removing geometric distortions and aligning the images with a reference coordinate system.

SOFTWARE USED:

ERDAS imagine 9.2

PRINCIPLE

Preprocessing techniques are essential in digital image processing to correct distortions and prepare the images for further analysis.

1. **Ground Control Points (GCPs)**:
   - GCPs are reference points on the Earth's surface with known geographical coordinates. These points link the image's pixel coordinates to real-world geographic coordinates.
2. **Geometric Rectification**:
   - This process corrects geometric distortions in the image caused by sensor errors, terrain relief, or other factors.
   - A mathematical transformation (e.g., affine, polynomial, or rubber-sheet) is applied to map the distorted image to a standard coordinate system.

The result is an image that is spatially accurate and aligned with a reference map or coordinate system.

PROCEDURE:

1. **Import the Image**:
   - Load the raw satellite or aerial image into the digital image processing software.

2. **Identify Ground Control Points (GCPs)**:
    - ○ Use GPS devices or existing reference maps to identify GCPs in the image.
    - ○ Select at least 4-5 well-distributed GCPs for accurate rectification.
3. **Assign Coordinates to GCPs**:
    - ○ Mark the GCPs in the image and input their corresponding geographic coordinates (latitude, longitude).
4. **Choose a Rectification Model**:
    - ○ Select a suitable geometric rectification model based on the image and distortion type (e.g., affine transformation for simple distortions, polynomial for complex distortions).
5. **Apply Transformation**:
    - ○ Use the software to compute the transformation matrix based on GCPs and apply it to the image.
    - ○ Resample the image using methods such as nearest neighbor, bilinear interpolation, or cubic convolution.
6. **Verify Accuracy**:
    - ○ Overlay the rectified image on a reference map or check alignment with additional control points to validate accuracy.
7. **Save the Rectified Image**:
    - ○ Save the rectified image in the desired format for further analysis.

OBSERVATION TABLE

GCP ID	Image Coordinates (Row, Column)	Geographic Coordinates (Latitude, Longitude)	Residual Error (m)
1			
2			
3			
4			
5			

RESULT:

The distorted image was successfully rectified using ground control points and geometric rectification techniques. The residual errors were minimized, and the final rectified image is spatially aligned with the reference coordinate system

Expt No. 5	ENHANCEMENTS-HISTOGRAM, CONVOLUTION FILTERS	Date of Expt:

AIM:

To learn about image enhancement techniques such as linear stretching, level slicing and thresholding using ERDAS IMAGINE 9.2

SOFTWARE USED:

ERDAS IMAGINE 9.2

ENHANCEMENT:

Image enhancement is the process of making an image more interpretable for a particular application.

It is often used instead of classification technique for feature extraction. Studying and locating areas and objects on the ground and deriving useful information from images.

ENHANCEMENT FUNCTIONS:

- Radiometric – based on individual pixels
- Contrast, Default, Linear, Histogram Equalization and special stretch, etc
- Spatial - based on values of individual and neighboring pixels.
- Convolution filtering and resolution merge
- Spectral – transforms the values of each pixel and a multiband basis (MSS)
- Spectral rationing and indices – performs band ratios (Vegetation and mineral studies)
- Principle components – compresses redundant data values into fewer bands
- Tosselled cup – rotates the data structure axes to optimize data viewing (Vegetation studies)

1) Linear Stretching :

The input values of a map are re-scaled to output values in the output map. It improves the contrast of the image by linearly stretching the range of intensity values it contains to span a desired range of values, that is the full range of pixel values that the image type concerned allows.

Procedure:

i. Go to raster → Contrast→ General contrast → linear → break points

ii. Look at min max values of histogram

iii. Method : Linear, here we can change the slope and shift to stretch the image.

iv. Histogram source: whole image

v. Apply to lookup table

2) Level slicing

It is used to enhance an image by dividing the range of brightness in a single band intervals say 5,10,15 then assigning each interval to a color. Therefore density slicing is a digital data interpretation method that is used in enhancing the information gathered from an individual brightness band

Procedure:

i. Go to raster → contrast → General contrast

ii. Method : Level slice

iii. Histogram source: whole image

iv. Apply to lookup table

v. Leavels = 5 (0, 63, 127, 191, 255)

3) Thresholding

Image thresholding is a simple form of image segmentation. It is a way to create a binaryImage from a grey scale / full color / pseudo-color image. This is typically in order to separate object or foreground pixels from background pixels to aid an information.

Types:

1. Simple or Global thresholding
   Where one provides the threshold value as an input constant. This threshold is applied for all pixels of the image.
2. Adaptive thresholding
   Where threshold is not a constant scalar rather a distribution that is applied over a small window of pixels.

Procedure:

i. Go to Raster → Contrast → General Contrast stretching

ii. Histogram source : whole image

iii. Method : linear

iv. Apply to lookup table and give the threshold values.

1) **Linear Stretching**

Image :

Red Band	Green Band	Blue Band

Output file :

2) **Level slicing**

Image -
Method -
Number of levels -
Starting value -
Ending value -

Break points for RGB

X	Y

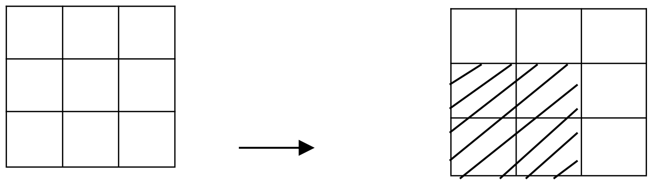
Output File :

3) Thresholding

Image:

Break points for grey scale or full color lookup table

X	Y



Input Output

Output File :

RESULT:

Thus,the application of histogram-based enhancement techniques (equalization and contrasting) improved the visual quality of the image.

Expt No. 6	BAND RATIOING AND NORMALIZATION-NDVI, SAVI & NDWI	Date of Expt:

AIM:

To perform band ratioing and normalization techniques such as NDVI, SAVI, and NDWI on multispectral satellite images to extract vegetation and water information.

SOFTWARE USED:

ERDAS imagine 9.2

PRINCIPLE:

Band ratioing is a preprocessing technique used to enhance specific features in multispectral images by combining spectral bands mathematically. Normalization techniques like NDVI, SAVI, and NDWI are used to highlight vegetation and water bodies based on their reflectance characteristics.

1. **Normalized Difference Vegetation Index (NDVI)**:
   - NDVI = (NIR - Red) / (NIR + Red)
   - Measures vegetation health, where higher NDVI values indicate healthier vegetation.
2. **Soil Adjusted Vegetation Index (SAVI)**:
   - SAVI = (NIR - Red) (1 + L) / (NIR + Red + L)
   - Similar to NDVI but includes a soil adjustment factor (L) to reduce soil noise.
3. **Normalized Difference Water Index (NDWI)**:
   - NDWI = (Green - NIR) / (Green + NIR)
   - Highlights water bodies, where higher values indicate the presence of water.

PROCEDURE:

1. **Load the Image**:
   - Open the multispectral satellite image in the digital image processing software.

2. **Identify Bands**:
   - Identify the relevant spectral bands for the calculations:
     - **Red Band** (e.g., Band 4 in Landsat 8 or Band 4 in Sentinel-2).
     - **NIR Band** (e.g., Band 5 in Landsat 8 or Band 8 in Sentinel-2).
     - **Green Band** (e.g., Band 3 in Landsat 8 or Band 3 in Sentinel-2).

3. **Calculate NDVI**:
   - Use the formula **NDVI = (NIR - Red) / (NIR + Red)**.
   - Apply the formula using the software's raster calculator or band math tool.

4. **Calculate SAVI**:
   - Choose an appropriate soil adjustment factor **L** (commonly 0.5 for intermediate vegetation cover).
   - Use the formula **SAVI = (NIR - Red) (1 + L) / (NIR + Red + L)** in the raster calculator.

5. **Calculate NDWI**:
   - Use the formula **NDWI = (Green - NIR) / (Green + NIR)**.
   - Perform the computation using the same method.

6. **Visualization**:
   - Generate thematic maps for NDVI, SAVI, and NDWI.
   - Assign a color scale to represent the index values (e.g., green for high NDVI, blue for high NDWI).

7. **Save Results**:
   - Save the output maps and indices for interpretation and analysis.

OBSERVATION TABLE:

Index	Formula	Maximum Value	Minimum Value	Remarks
NDVI	(NIR - Red) / (NIR + Red)			High NDVI indicates healthy vegetation.
SAVI	(NIR - Red) (1+L) / (NIR + Red + L)			Reduce soil interference.
NDWI	(Green - NIR) / (Green + NIR)			Highlights water bodies.

RESULT:

The NDVI, SAVI, and NDWI indices were successfully calculated and mapped. The NDVI map highlights healthy vegetation, the SAVI map improves vegetation detection in areas with significant soil noise, and the NDWI map effectively identifies water bodies.

Expt No. 7	PCA AND FOURIER TRANSFORM	Date of Expt:

AIM:

To study about the pattern of image enhancement as well as compression using principal component analysis technique and fourier transform.

SOFTWARE USED:

ERDAS IMAGINE 9.2

IMAGE USED:

PROCEDURE:

PCA:

- Open ERDAS IMAGINE 9.2 and select 'Principal component' from the spectral enhancement in the interpreter tool.
- Give the input and location of output file and select the option 'write to file for both Eigen matrix and Eigen values and save it in the required location
- Change the datatype to 'Float' and when required the other datatypes are chosen.
- Select the number to components initially 3 and then follow the same procedure for 7 bauds
- Save the image and open it.

FOURIER TRANSFORM:

- Open ERDAS IMAGINE 9.2 and select 'Fourier Analysis from the Interpreter.
- Go to Fourier transform and input the image and select the no. of layers.
- Since the Fourier transformed. image can't be viewed in the Viewer, Fourier transform Editor is opened and the various mask tools are used to remove the anomalies and the low frequency values file. This file is saved as

- The inverse Fourier transform us selected and the transformed file is inputted.

OBSERVATION:

INTERPRETATION:

RESULT:

Thus the PCA and FOURIER TRANSFORM was performed.

Expt No. 8	IMAGE FUSION	Date of Expt:

AIM:

To merge the 2 different subsetted images to get the detailed information of the particular area.

IMAGE USED:

PROCEDURE -

- Open ERDAS IMAGINE and input both the LISS-IV and CARTOSAT 3 data in two different viewers.
- Go to 'Interpreter and select subset from utilities' option. Select the desired co-ordinates from both the images and subset it.
- Go to interpreter and select the Spatial Enhancement tool. Select Resolution merge and input the Cartosat subset image in sight resolution input and the LISS IV subset image in Multispectral input.
- Choose the various methods and resampling techniques
- Analyse and study the features and note down the Image info from 'i' tool
- Save the output for further interpretation.

OBSERVATION:

INTERPRETATION:

RESULT:

Thus, the different images and fused to get it are subsetted detailed information of the desired area and the interpretation is done visually.

Expt No. 9	CLASSIFICATION-SUPERVISED & UNSUPERVISED	Date of Expt:

AIM:

To apply the techniques of unsupervised and supervised classification and infer how the clusters are grouped accordingly.

SOFTWARE USED:

ERDAS IMAGINE 9.2

PROCEDURE:

- Go to classifier → unsupervised classification

  Input Raster file: your desired image

  Output Layer: Give some specified location

  Output Layer: Save it in your folder

  Clustering options

  Number of classes: (Number of classes increases accuracy increases.)

UNSUPERVISED CLASSIFICATION

- Unsupervised classification will give clusters to the unknown pixels.
- Example: In Odisha, there are people illegally doing paddy cultivation by destroying the forest. By means of this classification, it can give a cluster to the unknown pixels.
- The outcomes are based on the software analysis of an image without the user providing sample classes.
- The computer uses techniques to determine which pixels are related and groups them into classes.
- The user can specify which algorithm the software will use and the desired number of output classes but otherwise does not aid in the classification process.

METHODS:

- Principle Component
- Cluster Analysis

Common Algorithms

- **Clustering**
    a) Hierarchical clustering
    b) K-means
    c) Mixture Models
    d) DBSCAN
    e) OPTICS Algorithm
- **Anomaly detection** – Local outlier filter
    - **Neural Networks**
    a) Autoeucoders
    b) Deep Belief Nets
    c) Hebbian Learning
    d) Generative adversarial Networks
    e) Self-organizing maps

ISODATA Algorithm

ISODATA - Iterative Self Organizing Data Analysis Technique.

A method of unsupervised classification. Don't need to know the number of clusters. Algorithm splits and merges clusters. User defined threshold values for parameters, Computer runs algorithm through many iterations until the threshold is reached.

How ISODATA works:

1) Cluster centers are randomly placed and pixels are assigned based on the shortest distance to center method.
2) The standard deviation within each cluster and the distance between cluster centers is calculated.
   Case (i):
   Clusters are split if one or more standard deviation is greater than the user-defined threshold.
   Case (ii):
   Clusters are merged if the distance between them is less than the user-defined threshold.
3) A second iteration is performed with the new cluster centers

4) Further iterations are performed until

   (a) The average inter-center distance falls below the user-defined threshold
   (b) The average change in the inter center distance between iterations is less than a threshold, or
   (c) The maximum number of iterations is reached.

Drawbacks:

- May be time consuming if data is unstructured.
- Algorithm can spiral out of central leaving only one class.

Advantages:

- Don’t need to know much about the data before hand.
- Little user effort required.
- ISODATA is very effective at identifying spectral clusters in data.

Skip Factor:

For faster (although less accurate) processing, we can enter an X and Y skip factor.

X, Y : Enter the X and Y skip factors to use when processing.

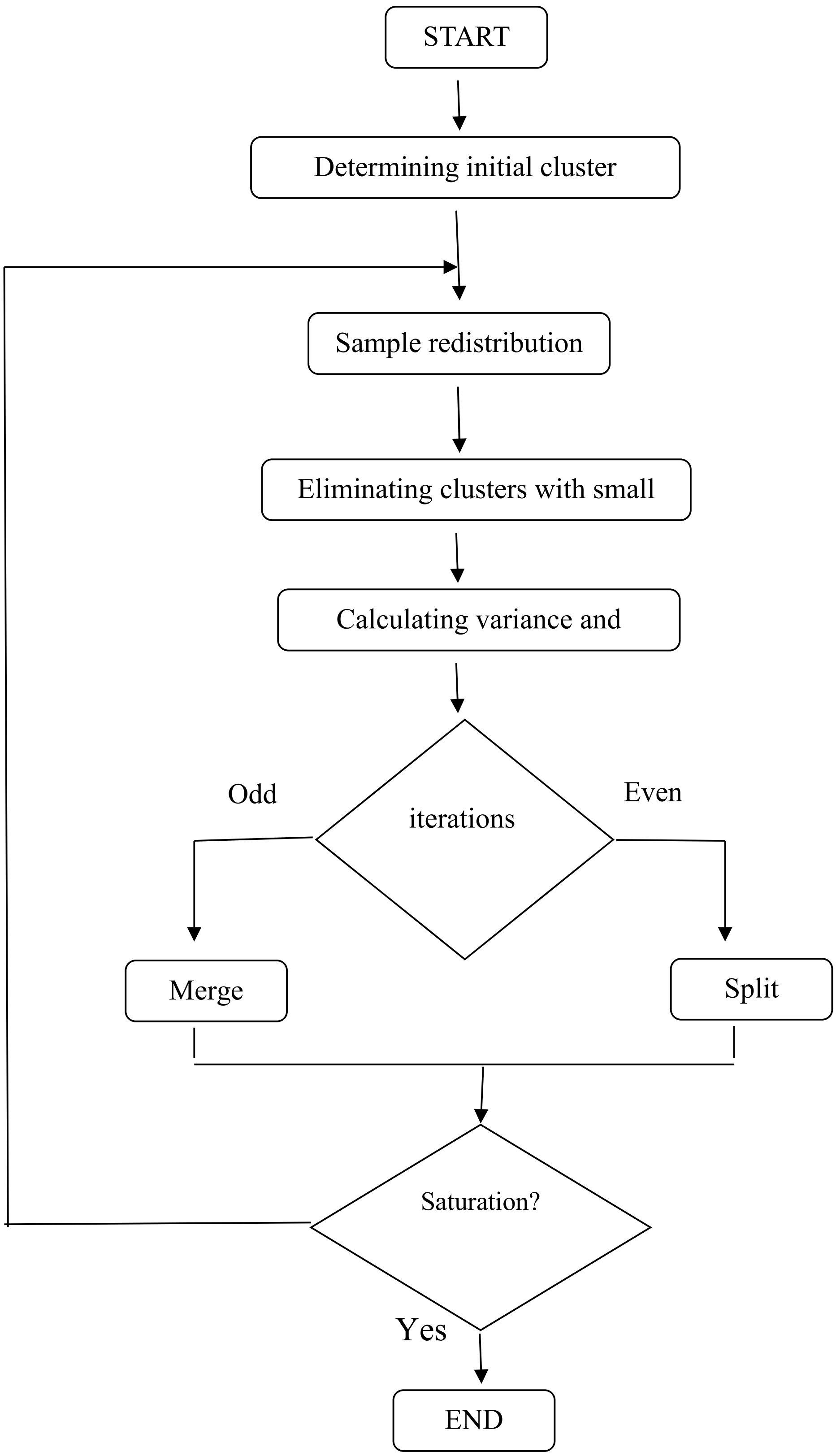
Entering a 1 – Processes all pixels

2 - Processes every other pixel.

3 - every third pixel and so on.

Inferences:

Comparing the original image (lanier.img) to the classified image(unsup.img), it can be observed that the three features are perfectly classified except in some places where the shadow of vegetation is wrongly classified as water. When the number of classes are increased (unsup4.img), it could be seen that both the water body and built-up area was reduced and the vegetation was split based on dusked red pixels and brighter red pixels.


START
Determining initial cluster
Sample redistribution
Eliminating clusters with small
Calculating variance and
iterations
Odd
Even
Merge
Split
Saturation?
Yes
END

1) **I/P** → lanier.img
O/P →

Number of classes:

◉ Initialize from statistics

Histogram	Colour	R	G	B	Class Names	Area (ha)

2) **I/P** → lanier.img
O/P →

Number of classes:

◉ Initialize from statistics

Histogram	Colour	R	G	B	Class Names	Area (ha)

3) **I/ P** → **lanier.im**
O/P →

I/P → **unsup_sig.sig**
O/P →

Number of classes:

◉ By signature means

Histogram	Colour	R	G	B	Class Names	Area (ha)

SUPERVISED CLASSIFICATION:

Supervised classification is the technique most often used for the quantitative analysis of remote sensing image data. At core is the concept of segmenting the spectral domain into regions that can be associated with the ground cover classes of interest to a particular application. Supervised machine learning is a type of machine learning algorithm that uses a known dataset which is recognized as the training dataset to make predictions. The training dataset includes input (x) and response variables (y).

In ENVI there are 4 different classification algorithms that you can choose from in the supervised classification procedure. They are as follows:

1) Maximum likelihood
2) Minimum Distance
3) Mahalanobis Distance

Maximum Likelihood:

Assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. Each put it assigned to the class that has the highest probability (that is maximum likelihood). This is the default.

Mahalanobis Distance:

A direction – sensitive distance classifier that uses statistics for each class. It is similar to maximum likelihood classification, but it assumes all class covariance are equal and therefore is a faster method. All pixels are classified to the closest training data.

Minimum Distance:

Use the mean vectors for each class and calculates the Euclidean distance from each unknown pixel to the mean vector for each class. The pixels are classified to the nearest class.

Advantages of supervised classification:

1) You can train the classifier in a way which has a perfect decision boundary to distinguish different classes in the most accurate manner.
2) You can specifically determine how many classes you want to have.

3) After training, you don't necessarily need to keep the training examples in memory. You can keep the decision boundary as a mathematical formula and that would be enough for classifying future inputs.

Disadvantages of supervised classification:

1) Your decision boundary might be over trained. Training set is not including some examples you want to have in a class.
2) When this input which is not a class in reality, then it might get a wrong class label after classification.
3) You have to select a lot of good examples from each class while you are training the classifier. If you consider classification of big data that can be a real challenge.
4) Training needs a lot of computation time, so does the classification.
5) You might need to use a cloud and leave the training algorithm work over a night before obtaining a good decision boundary model.

PROCEDURE:

- Go to Classifier → signature editor
- AOI tools → Polygon editor → adds to signature editor

  Rename the classes

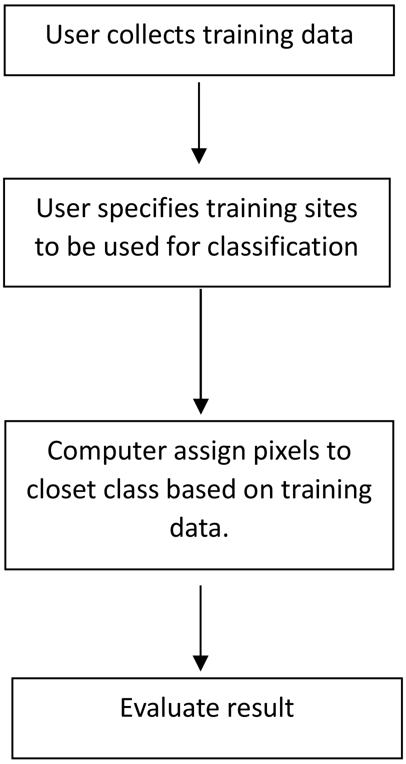
  1. Vegetation
  2. Water body
  3. Builtup, etc.,
- Select same classes and merge at a single class
- Now save the signature.
- Save the file in viewer.

  File → save → AOI layer as
- Now go to classifier → Supervised classification

  I/P:lanier.img **I/P:** Signature created

  O/P: with nine different combinations.
- Also use the signature from previous experiment for this classification.

Supervised Classification



BEST AVERAGE SEPARABILITY

Layer per combination:

From the above table, it can be seen that the maximum separability is always between the class 1 and 2

		AVE	MIN	1:2	1:3	1:4	2:3	2:4	3:4
1	**Euclidean Distance**								
2	**Divergence**								
3	**Transformed Divergence**								
4	**Jefferies Matusita**								

1 → water
2 → Built-up
3 → Soil
4 → vegetation

The least separability is between the class 3 and 4. It can be observed that the maximum separability is achieved with the divergence method but the minimum separability is achieved with the Euclidean distance method.

- **Using old signature:**

  Comparing previous experiment using unsupervised classification and the supervised classification, it can be observed that the classification done is almost similar. The built-up area is slightly increased in the unsup_sup.img

None

Method

Maximum Likelihood

RESULT:

Thus, the unsupervised and supervised classification was done for the respective images using ERDAS IMAGINE software.

Expt No. 10	ACCURACY ASSESSMENT-CORRELATION, RMSE & KAPPA	Date of Expt:

AIM:

To perform accuracy assessment for the classified image (p_mind.img) and get the overall accuracy and kappa statistics.

SOFTARE USED:

ERDAS IMAGINE 9.2

ERROR MATRIX:

It consists of an n*n array where n is the number of classes in the data. The columns always represent the reference data or the data that is known to be true. The rows are mapped classes from remote sensed data.

The error matrix allows you to calculate the following

i) Overall accuracy and error
ii) Errors of omission
iii) Errors of commission
iv) User's accuracy
v) Producer's accuracy
vi) Accuracy statistics (kappa)

Overall Accuracy:

It tells us all about the reference sites what proportion were mapped correctly. It is usually expressed as a percent.

$$\text{Overall Accuracy} = \frac{\text{Number of correctly classified site}}{\text{Total number of reference sites}}$$

Errors of Omission:

Error of omission refers to the reference sites that were left out from the correct class in the classified map.

$$\text{Error of Omission} = \frac{\text{Incorrectly classified reference sites}}{\text{Total number of reference sites}}$$

Errors of commission:

Errors of commission refer sites that are classified as to reference sites that were left out from the correct class in the classified map.

$$\text{Error of commission} = \frac{\text{Incorrectly classified sites}}{\text{Total number of classified sites}}$$

Producer's accuracy:

It is the map accuracy from the view of the map maker.

Producer's accuracy = 100% - Omission error

User's accuracy:

It is the accuracy from the view of the map user.

User's accuracy = 100% - commission error

Kappa Coefficient:

It is a statistical test to evaluate the accuracy of classification. A value of 0 represents random classification, negative value represents worse than random classification. A value close to 1 represents that it is significantly better than random classification.

$$K = \frac{\Pr(a) - \Pr(e)}{1 - \Pr(e)}$$

PROCEDURE:

- Classifier ⟶ Accuracy Assessment ⟶ Open image from viewer
  Edit ⟶ Create / add random points (random, satisfied, equalized)
- View ⟶ Show all (25 points), New viewer ⟶ original image.
- View ⟶ Link images ⟶ Geographical (now all points are displayed)
- Edit ⟶ Show class values ⟶ View ⟶ Change colours

ID#	Class	Reference
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

I/P : .img

1 – waterbody - blue

2 – vegetation – green

3 – vegetation - brown

4 – builtup - yellow

Overall classification Accuracy = %

Overall kappa statistics =

ID#	Class	Reference
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

I/P : .img

1 – water–Dark blue

2 – builtup – cyan

3 – soil - green

4 – vegetation–Reddish brown

Overall classification Accuracy = %

Overall kappa statistics =

REFERENCE DATA						
		Water	**Vegetation**	**Vegetation**	**Builtup**	**Total**
Classified Data	**Water**					
	Vegetation					
	Vegetation					
	Builtup					
	Total					

Omission error:

Producer's accuracy:

Commission error:

User's accuracy:

RESULT:

The accuracy assessment for the classified images was done and the overall accuracy and kappa statistics were calculated.

Expt No. 11	KNOWLEDGE BASED CLASSIFICATION	Date of Expt:

AIM:

To classify a satellite image into different land cover classes using knowledge-based classification techniques in a digital image processing environment.

SOFTWARE USED:

- ERDAS Imagine or ENVI
- QGIS (if open-source software is preferred)

MATERIALS USED:

- High-resolution satellite image (e.g., Landsat, Sentinel, or other multispectral imagery).
- Predefined rules or ancillary data (e.g., elevation data, NDVI thresholds).
- Computer system with image processing software installed.

PROCEDURE:

- Load the Image:
- Open the satellite image in the image processing software.
- Perform radiometric and geometric corrections if necessary.
- Define Knowledge Rules
- Analyze the image using spectral values, indices, or ancillary data.
- Define rules for different land cover classes (e.g., vegetation, water, urban, barren land).

Example of Rules:

- Vegetation: NDVI > 0.3
- Water: Reflectance in NIR band < Reflectance in Blue band
- Urban: High reflectance in visible bands
- Barren Land: Low reflectance across all bands

Apply Rules:

- Use the rule-based classification tool in the software.
- Input the defined rules for classification.

Perform Classification:

- Run the knowledge-based classifier.
- Generate the classified image showing different land cover types.

Accuracy Assessment (Optional):

- Validate the results using ground truth data or existing classified maps.
- Generate a confusion matrix to calculate the classification accuracy.

OBSERVATION:

RESULT:

The given satellite image was successfully classified into various land cover types using a knowledge-based classification approach.

Expt No. 12	CLASSIFICATION USING ARTIFICIAL NEURAL NETWORK	Date of Expt:

AIM:

To classify a digital satellite image into different land cover types using an Artificial Neural Network (ANN) algorithm in a digital image processing software.

SOFTWARE USED:

ERDAS Imagine or ENVI

PRINCIPLE:

Artificial Neural Networks (ANN) are machine learning algorithms inspired by the structure of biological neural networks. ANNs are effective in image classification tasks because they can model complex relationships between input features (spectral bands) and land cover classes.

Key Concepts:

1. **Input Layer**: Represents input data, such as pixel values from spectral bands.
2. **Hidden Layers**: Perform computations using weights and activation functions to detect patterns.
3. **Output Layer**: Produces the classification result, assigning a pixel to a specific land cover class.
4. **Training and Testing**: The ANN is trained using a labeled dataset (training data) and evaluated on unseen data (testing data).

The ANN learns to classify each pixel by iteratively adjusting weights to minimize classification error.

PROCEDURE:

1. **Load the Image**:
    - Open the multispectral satellite image in the software.

2. **Prepare Training Data**:
    - Identify distinct land cover classes (e.g., water, vegetation, urban, bare soil).
    - Select representative training samples for each class using a region-of-interest (ROI) tool.
3. **Normalize Input Data**:
    - Normalize spectral band values to ensure they are within a similar range (e.g., 0 to 1) for better ANN performance.
4. **Design the ANN**:
    - Configure the ANN model with the following parameters:
        - Input layer: Number of nodes equal to the number of spectral bands.
        - Hidden layers: Choose 1 or more layers with appropriate nodes.
        - Output layer: Number of nodes equal to the number of classes.
        - Activation function: Use functions like ReLU for hidden layers and Softmax for the output layer.
5. **Train the ANN**:
    - Split the dataset into training (e.g., 70%) and testing (e.g., 30%) subsets.
    - Train the ANN using the training dataset and monitor performance using metrics like accuracy or loss.
6. **Classify the Image**:
    - Apply the trained ANN model to classify the entire image into land cover classes.
7. **Evaluate the Classification**:
    - Compare the ANN classification result with ground truth or reference data.
    - Calculate accuracy metrics such as overall accuracy, producer's accuracy, and user's accuracy.
8. **Save and Visualize Results**:
    - Generate a classified map with distinct colors for each land cover class.
    - Save the map and model for future analysis.

OBSERVATION TABLE:

Class Name	**Training Pixels**	**Testing Pixels**	**Accuracy (%)**	**Remarks**
Water				
Vegetation				
Urban				
Bare Soil				

RESULT:

The image was successfully classified using an Artificial Neural Network. The classified map effectively distinguishes between the identified land cover types, with an overall accuracy of **___%**.

Expt No. 13	SUB PIXEL CLASSIFICATION	Date of Expt:

AIM:

To perform sub-pixel classification of satellite imagery to estimate the proportion of different land cover types within a single pixel using advanced digital image processing techniques.

SOFTWARE USED:

ERDAS Imagine or ENVI

PRINCIPLE:

Sub-pixel classification is an advanced image analysis technique used when a single pixel contains multiple land cover types (mixed pixels). Instead of assigning a single class to the pixel, this method estimates the proportions of different land cover classes within the pixel.

1. **Spectral Unmixing**:
    - Each pixel's reflectance is considered a linear combination of the reflectance values of the land cover types (called "end members").
    - The goal is to estimate the fractional abundance of each end member within the pixel.
2. **Endmember Selection**:
    - End members are pure spectral signatures of distinct land cover types (e.g., vegetation, water, soil).
    - They can be derived from the image itself or from external spectral libraries.
3. **Algorithms Used**:
    - Linear Spectral Unmixing (LSU)
    - Minimum Distance Method
    - Matched Filtering

PROCEDURE:

1. **Load the Satellite Image**:
    - Import the multispectral or hyperspectral image into the digital image processing software.

2. **Preprocessing**:
   - Perform radiometric and geometric corrections to ensure the image is free of distortions.
   - Normalize the spectral bands for better unmixing accuracy.

3. **Select Endmembers**:
   - Use the software's tools to identify pure pixels representing distinct land cover types.
   - Alternatively, import spectral signatures from external libraries.

4. **Apply the Sub-Pixel Classification Algorithm**:
   - Choose an appropriate algorithm (e.g., Linear Spectral Unmixing).
   - Configure the parameters for the unmixing process.

5. **Generate Fractional Abundance Maps**:
   - Compute the fractional abundance of each endmember for all pixels in the image.
   - Display the results as separate grayscale or color-coded abundance maps.

6. **Validation**:
   - Validate the results using reference data or ground truth information to ensure accuracy.

7. **Save the Results**:
   - Save the fractional abundance maps and classified output for further analysis.

OBSERVATION TABLE:

Pixel ID	**Fraction of Vegetation (%)**	**Fraction of Soil (%)**	**Fraction of Water (%)**	**Remarks**
1				
2				
...				

RESULT:

The sub-pixel classification was successfully performed, and fractional abundance maps were generated for the selected land cover types. The results effectively highlight mixed pixels and provide a detailed understanding of land cover proportions.

Expt No. 14	NOISE REMOVAL, VECTORISATION & MAP COMPILATION	Date of Expt:

AIM:

To perform noise removal, vectorisation, and map compilation on a satellite image to enhance its quality, extract meaningful vector data, and compile a final map for analysis and interpretation.

SOFTWARE USED:

ERDAS Imagine or ENVI

PRINCIPLE:

1. **Noise Removal**:
   - Satellite images often contain noise caused by sensor errors, atmospheric conditions, or environmental interference.
   - Noise is removed using filtering techniques such as median filtering, low-pass filtering, or Fourier transformation.
2. **Vectorization**:
   - Vectorization involves converting raster data (pixel-based images) into vector data (points, lines, and polygons).
   - It simplifies image interpretation, making it suitable for GIS-based spatial analysis.
3. **Map Compilation**:
   - Map compilation is the process of integrating spatial data (raster and vector layers) into a coherent and visually appealing map.
   - Layers are symbolized, labeled, and aligned to convey spatial information effectively.

PROCEDURE:

1. **Noise Removal**:
   - Import the satellite image into the software.
   - Identify noise patterns in the image.
   - Apply an appropriate filtering technique:
     - **Median Filter**: Removes speckle noise while preserving edges.

        - **Low-Pass Filter**: Reduces high-frequency noise.
        - **Fourier Transform**: Removes periodic noise.
    - Save the denoised image for further processing.
2. **Vectorization**:
    - Load the denoised raster image into the software.
    - Select the vectorization tool and define parameters (e.g., edge detection thresholds).
    - Extract features such as roads, boundaries, or water bodies into vector layers.
    - Edit the vector data to remove errors and ensure topological correctness.
3. **Map Compilation**:
    - Import the vectorized layers into a GIS platform.
    - Overlay the vector layers on the raster base map.
    - Customize the map with:
        - Symbology for vector layers (e.g., different colors for roads, water bodies, and vegetation).
        - Labels for important features.
        - North arrow, scale bar, and legend.
    - Export the compiled map in the desired format (e.g., PDF or image).

OBSERVATION TABLE:

NOISE REMOVAL RESULTS:

Filter Type	**Before Noise Removal (MSE)**	**After Noise Removal (MSE)**	**Remarks**
Median Filter			Effective for speckles
Low-Pass Filter			Reduces high-frequency noise

VECTORIZATION ACCURACY:

Feature Name	Number of Pixels (Raster)	Vector Data (Length/Area)	Errors Removed	Remarks
Road				
Water Body				

MAP COMPILATION:

Layer Name	Data Source	Visualization Type	Remarks
Base Map	Raster Image	Background	
Roads	Vectorized Data	Lines	
Water Bodies	Vectorized Data	Polygons	

RESULT:

Noise in the satellite image was successfully removed, improving image clarity.The raster image was vectorized into accurate vector layers representing roads, water bodies, and other features.A final map was compiled, integrating raster and vector data with appropriate symbology, labels, and legends.