Resolution

Resolution refers to the ability of a remote sensing system to record and display fine details.

Remote sensing image systems, posses four major resolution charaacteristics -

1. Spatial resolution
2. Spectral resolution
3. Radiometric resolution
4. Temporal resolution.

1. Spatial resolution - Spatial resolution is by far the most important characteristic of a remote-sensing system. It determines the ability of a remote sensing system in recording spatial detail.

In analog photography, the spatial resolution of photograph refers to the sharpnees of the image.

Factors on which resolution depends are - the resolving power of film, and camera lens, image motion during exposure, atmospheric condition at the time of image exposure etc.

For digital images, spatial resolution is usually described as Instantaneous Field of View (CIFOV)

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2) Radiometric resolution -

It is the smallest difference in radiant energy that can be detected by a sensor and it is applicable to both photographs and digital images.

For digital images, radiometric resolution refers to the number of discrete levels into which a signal may be divided during the analog to digital conversion.

In photography, radiometric resolution is inversely proportional to the contrast of the film, so that a higher contrast film will be able to resolve small differences in exposure.

3) Temporal Resolution -

Temporal resolution is the capability to view the same target, under similar conditions at regular intervals. It can be daily, monthly, seasonly and yearly.

Eg. it can be used in vegetation and crops to see the health of crops at regular time basis.

4) Spectral Resolution -

Spectral Resolution refers to the electromagnetic radiation wavelengths to which a remote sensing system is sensitive.

There are two components -

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a)

→ the number of wavelength bands (or channels) used

→ and the width of each band.

A larger number of bands and a narrower bandwidth for each band will give rise to a higher spectral resolution.

The use of narrower bandwidths allows more unique spectral signatures of objects (such as crops and vegetation) to be recorded, thus helping to discriminate more subtle differences among these objects.

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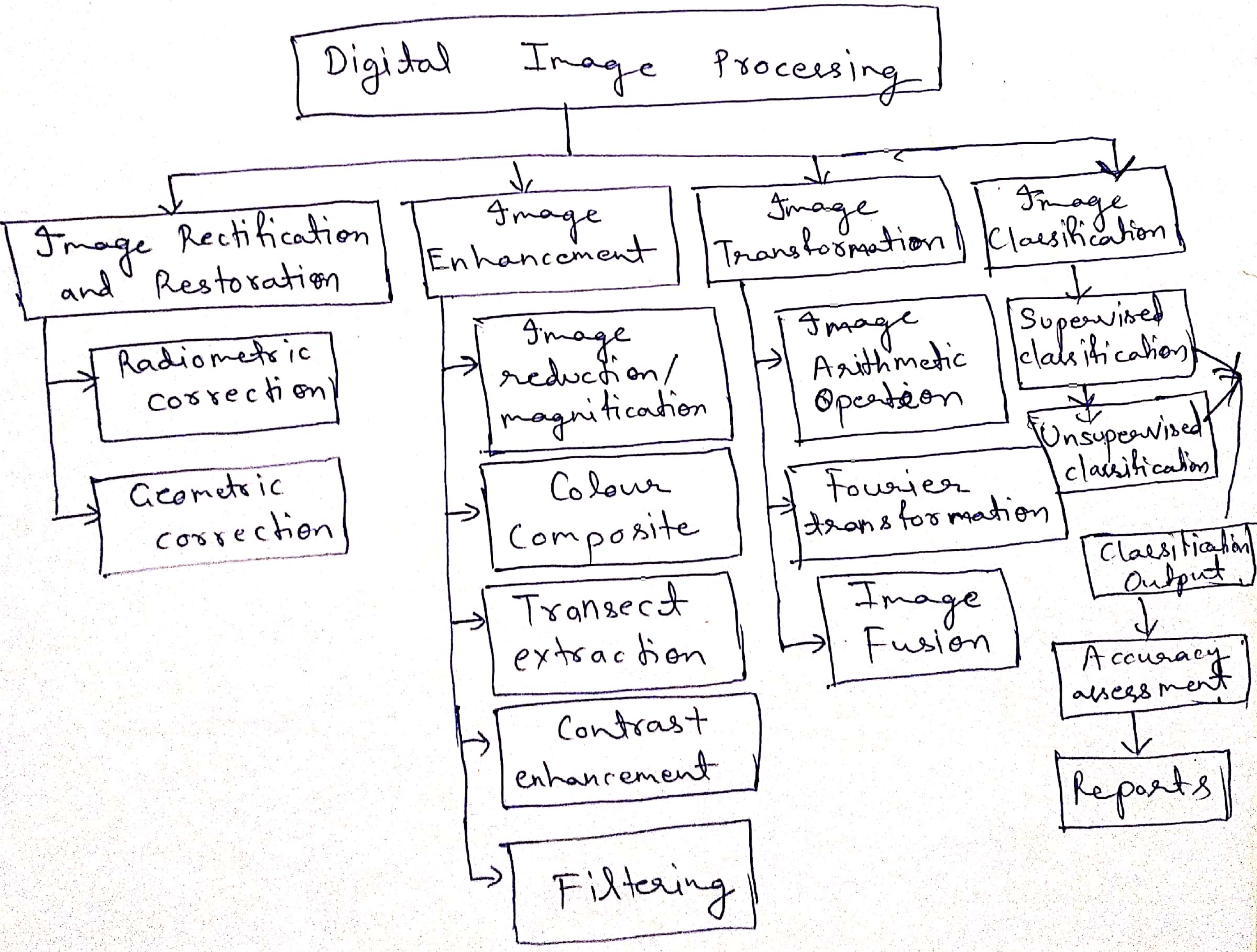
Digital Image Processing

The data processing in remote sensing is referred as digital image processing (DIP).

The DIP consists in the application of interest by manipulation and interpretation of the images.

The ultimate ~~image~~ aim of DIP is to extract information from a digital image that is not readily apparent or available in its original form.



Steps Involved in Digital Image Processing

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Principal of Digital Image Processing

1) Improvement of pictorial information for human interpretation.
2) Processing of image data for storage, transmission, and representation & for autonomous machine.

Advantages of Digital Image Processing

→ Since Humans are limited to the visual band of the electromagnetic (EM) spectrum.

→ But imaging machines cover almost the entire EM spectrum, ranging from gamma to radio waves.

→ It thus operate on images generated by sources that humans are not capable to sense.

→ These include ultrasound, electron microscopy, and computer - generated images.

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1. Image Rectification and Restoration

This operation is often termed as preprocessing. The process ~~image~~ of image rectification and restoration is to correct the image data and is accomplished by offsetting problems with the band data by recalculating the DN values.

The preprocessing operation attempts to correct radiometric errors- removal of sensor or atmospheric noise and geometric distortions- converting data to ground coordinates

a) Radiometric Corrections -

i) Noise correction - Any unwanted disturbance in image data that is due to limitations in the sesing, signal digitisation, or data recording process is image noise.

ii) De-stripping - When a detector goes out of adjustment, de-stripping, also known as line striping or banking occurs.

b) Geometric Corrections -

It is the process of rectification of geometric errors introduced in the image during the process of aquisition.

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2) Image enhancement

This process consists in converting the image quality to a better understable level for feature extraction or subsequent visual image interpretation; increasing the visual distinctions between the features in a scene is known as image enhancement.

The main object of image enhancement is to make the satellite images more informative & suitable for specific information.

i) Image Reduction -

Since the display monitor generally consists of 1024 X 768 ~~cases~~ screen resolution only, the computer display systems are unable to feature a full image at the normal image pixel scale (e.g. higher than 2500 rows & 2500 columns).

In such case the original image data set is reduced to smaller data set, and the analyst can view the image AOI at one time on the screen by deleting systematically selected rows & colums.

42	52	75	81	60	52
30	54	72	32	44	76
41	64	71	45	85	63
44	85	72	55	81	78
91	62	86	72	54	46
72	60	23	42	81	73

Raw Image

42	75	60
41	71	85
91	86	59

Reduced image

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b) Image Magnification

This process is also known as zooming. It is used to modify the scale of the image to improve the visual interpretation and to match the scale of another image. To accomplish this, an image is magnified by replications of rows and columns.

42	75	60
41	71	85
91	86	54

42	42	75	75	60	60
42	42	75	75	60	60
41	41	71	71	85	85
41	41	71	71	85	85
91	91	86	86	54	54
91	91	86	86	54	54

c) Colour Composting

Colour images can be interpreted better than the black and white images. Colour composting is avery useful techinque to enhance visual interpretation. Combinations other than true colour combination produce false colour combinations resulting in identification of the features that were not visible in true colour composites.

d) Contrast Enhancement

This is also referred as contrast manipulation or radiometric enhancement.

Contrast enhancement is a process that makes the image features more clearly by making optimal use of the colours available on the display or output device. It involves changing the range of values in an image in order to increase the contrast.

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c) Histogram

Histogram is a graphical representation of brightness values that comprises an image. It can also be defined as a statistical graphic representation of an image of tones from dark to light and associated number of pixels for each tone of an image.

4) # Filtering

Spatial filtering can be described as selectively highlighting or suppressing specific features in an image based on their spatial frequency.

The term spatial frequency is related to the image texture and refers to the frequency of the roughness of the tonal variations occuring in an image.

3) # Image transformation

This involves manipulation of multiple bands of data from images of the same area acquired at different times (multitemporal image data), or from images of the same area acquired at different spatial resolution (multiresolution).

The aim is to generate new images from two or more sources so as to highlight particular features or properties of interest better than the original input images.

Various methods of image transformation are -

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image arithmetic operations, Fourier transformation, image fusion etc.

$$\begin{bmatrix} 32 & 27 & 24 & 26 \\ 23 & 26 & 27 & 30 \\ 26 & 33 & 29 & 25 \\ 28 & 30 & 26 & 28 \end{bmatrix} - \begin{bmatrix} 27 & 26 & 23 & 22 \\ 23 & 25 & 28 & 29 \\ 26 & 30 & 29 & 23 \\ 28 & 26 & 22 & 27 \end{bmatrix} = \begin{bmatrix} 5 & 1 & 1 & 4 \\ 0 & 1 & -1 & -1 \\ 0 & 3 & 0 & 2 \\ 0 & 4 & 4 & 1 \end{bmatrix}$$

Image subtraction

It can be addition or multiplication also which comes under image arithmatic operations.

4) Image Classification

Image classification may be defined as the process of assigning the pixels in an image into a finite number of individual classes based on the DN values.

The classification is usually based on the patterns of their DN, spatial relationship with neighbouring pixels, and the relationships between data acquired on different dates.

The objectives of image classification are to detect different kinds of features in an image, discriminate the distinctive shapes and patterns and to identify temporal changes in the image.

Classification transforms the image into information.

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There are two types of classification -

1. Unsupervised classification (calculated by software)
2. Supervised classification (human - guided)

1. <u>Unsupervised classification</u> -

Unsupervised classification is where the outcomes (grouping of pixels with common characteristics) 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.

2. <u>Supervised classification</u> -

Supervised classification is based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all other pixels in the image.
Training sites (also known as testing sets or input classes) are selected based on the knowledge of user.

In <u>supervised classification</u>, the analyst identifies the classes by image interpretation techniques and collects signatures for making feature classes.
In <u>unsupervised classification</u>, the software tool itself classifies the image into specified number of classes by grouping nearly matching pixel values for making feature classes.

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Applications of Remote Sensing

1. Metrology - Profiling of atmospheric temperatures, pressure, water vapour and wind velocity.
2. Oceanography - Measuring sea surface temperatures, mapping ocean currents and wave energy spectra.
3. Glaciology - Measuring ice cap volumes, ice stream velocity and sea ice distribution.
4. Geology - Geomorphology, identification of rock type, mapping faults and structure.
5. Geodesy - Measuring the figure of the earth and its gravity field.
6. Topography and Cartography - Improving digital elevation models.
7. Agriculture, Forestry and Botany - Monitoring the biomass of land vegetation, the health of the crops, mapping soil moisture, forecasting crop yields.
8. Hydrology - Assessing water resources from snow, rainfall and underground aquifers.
9. Disaster Warning and Assessment - Monitoring of floods and landslides, volcanic activity, assessing damage zones from natural disasters.
10. Planning Applications - Mapping ecological zones, monitoring deforestation, monitoring urban land use.

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11) Oil and Mineral Exploration - Locating natural oil seeps and slicks, mapping geological structures monitoring oil field subsidence.

12) Military - Developing precise maps for planning, monitoring military infrastructure, monitoring ship and troop movements.

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