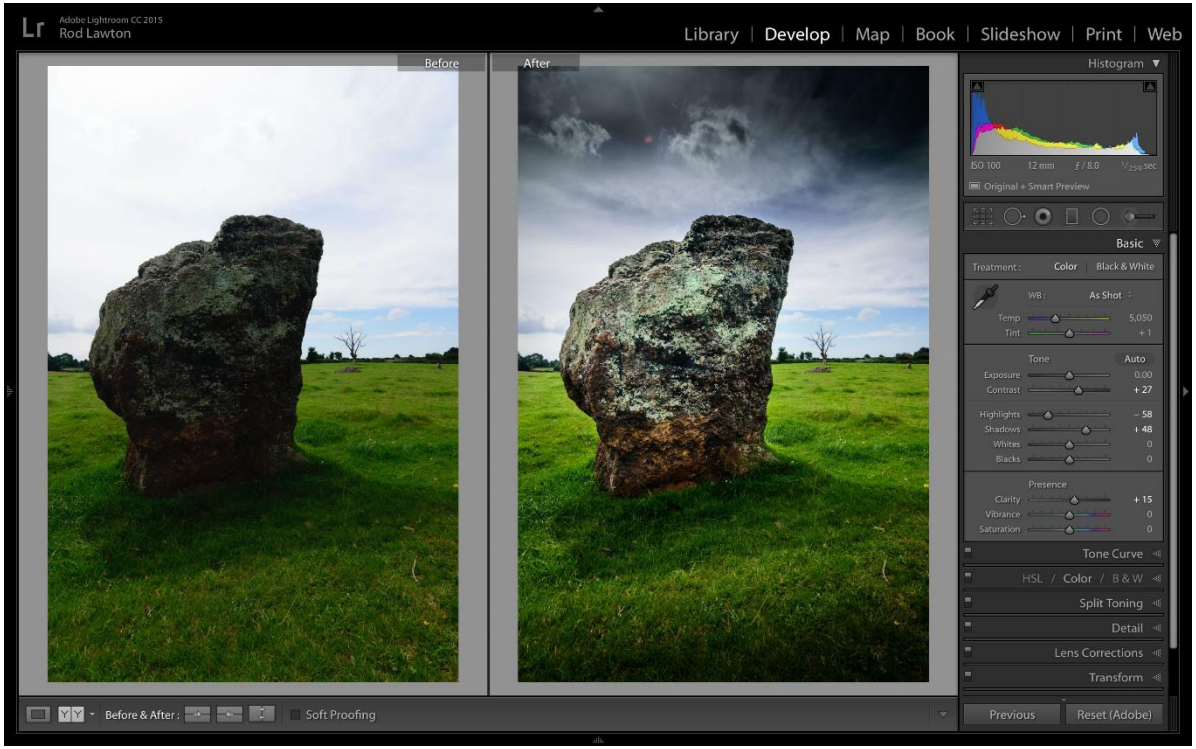
Chapter 6: "Introduction to Digital Image Processing"

Part 1 out of 2



Digital image processing involves the manipulation & analysis of digital images with the aid of a computer.

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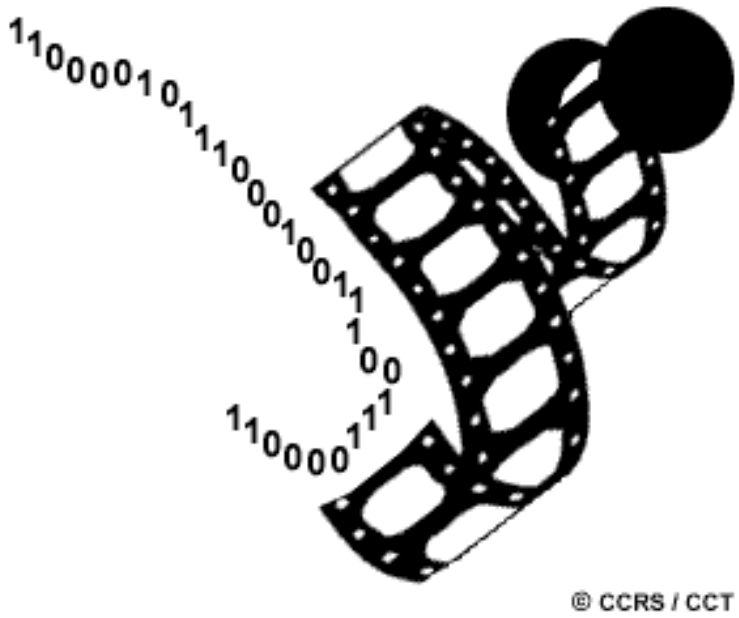
Why process image data digitally?

- *To keep up with the advancement in the satellite imaging, we have to process image data digitally because we need to process images with speed & accuracy using the computer.*
- *The problem is that the computers can only deal with data on digital format.*



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So why do we need the computer in image processing?

Despite the fact that humans are faster in recognizing images, computers are needed because:

1. *Computers are much more adept at storing & manipulating huge amount of data with speed & accuracy.*
2. *There are certain thresholds beyond which the human interpreter cannot detect.*
3. *results obtained by a computer are always repeatable, even when they are wrong!*

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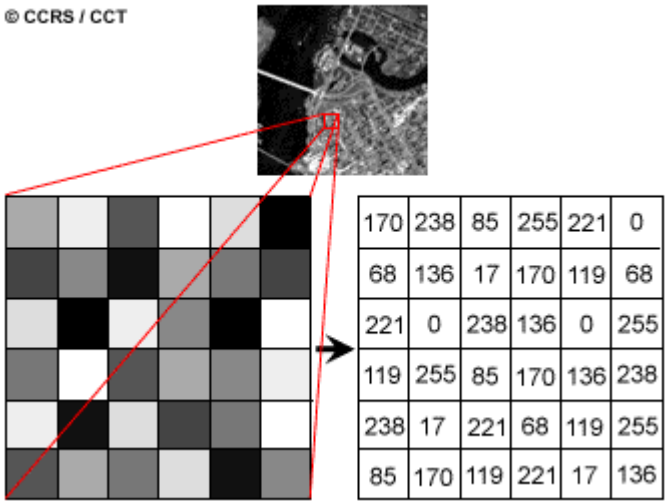
The question now is what is a digital image?

-A digital image is a computer compatible pictorial rendition in which the image is divided into a fine grid of pixels, when viewed, the appearance is that of continuous tone picture.

-Digital images are produced through a process referred to as discrete sampling. In which, a small image area, called pixel, is "sensed" to determine the amount of electromagnetic energy given of surface on the object.



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The question now is what is a digital image? (continue)

- Discrete sampling of an image has two fundamental characteristics; (1) geometric resolution, & (2) radiometric resolution.

- Geometric resolution refers to the physical size of an individual pixel, with smaller pixel sizes corresponding to higher geometric resolution.

10-meter resolution.

30-meter resolution.

80-meter resolution.

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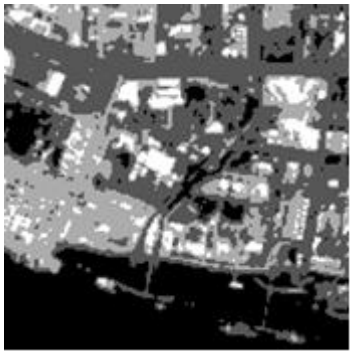
The question now is what is a digital image? (continue)

- Radiometric resolution, on the other hand, can be broken down into level of quantization & spectral resolution.

- Quantization level refers to the conversion of the amplitude of the original electromagnetic energy. Grater levels of quantization result in more accurate digital representation of the analog signals.

1-bit quantization Level.

2-bit quantization Level.



8-bit quantization Level.

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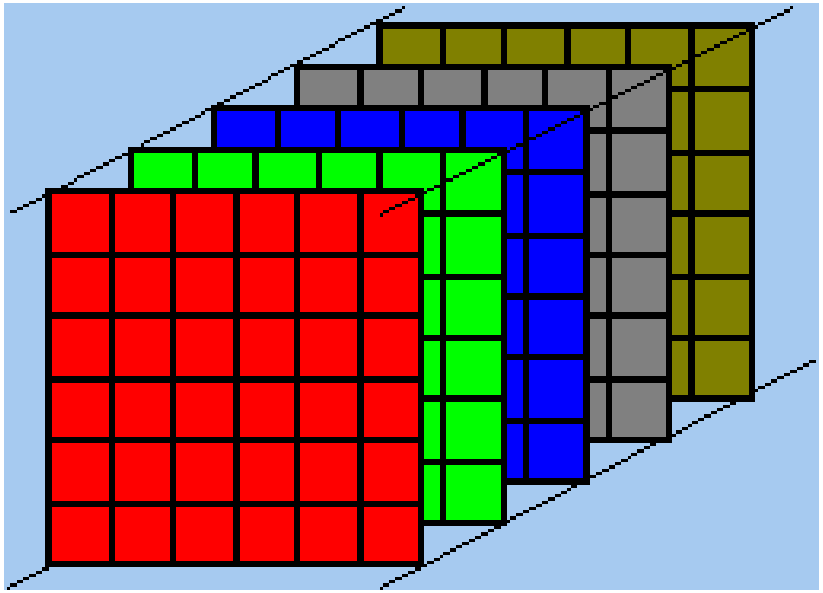
The question now is what is a digital image? (continue)

-In spectral resolution, however, samples of electromagnetic energy are normal sensed only within narrow band of the spectrum.

-With a higher level of spectral resolution, more channels, a more accurate representation of an objects spectral response pattern can be made.



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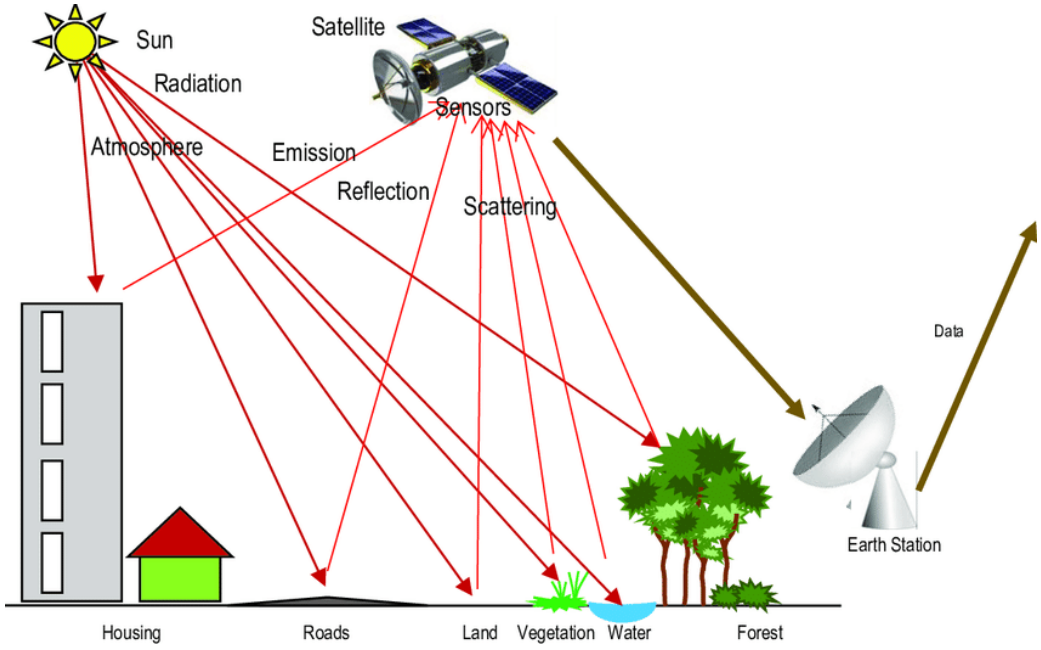
Data Acquisition in Digital Format:

Two fundamentals mechanisms to acquire images on a digital format:

1. *Acquire images on a photographic format, then digitize them, or*
2. *Acquire images on a digital format from the beginning.*



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Data Acquisition in Digital Format: *(continue)*

A photograph is a 2-D reflectance, or transmittance that varies as a function of x, & y position.

The density of the (x, y) position is a measure of the light-absorbing capability of the silver at that location on the image.

The gray shades, or brightness values, in such image may be converted into discrete values that are proportional to the integrated output of a small pixel.

This process is called analog-to-digital (A-to-D) conversion & creates a matrix of brightness values corresponding to the average radiance measured from individual pixels that have been scanned.

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Data Acquisition in Digital Format: (continue)

Three methods, to be covered hear, for converting hard-copy photography into a format suitable for digital image processing; (1) optical-mechanical scanning, (2) video digitization, & (3) linear photodiode, or charged-coupled-device (CCD) digitization.

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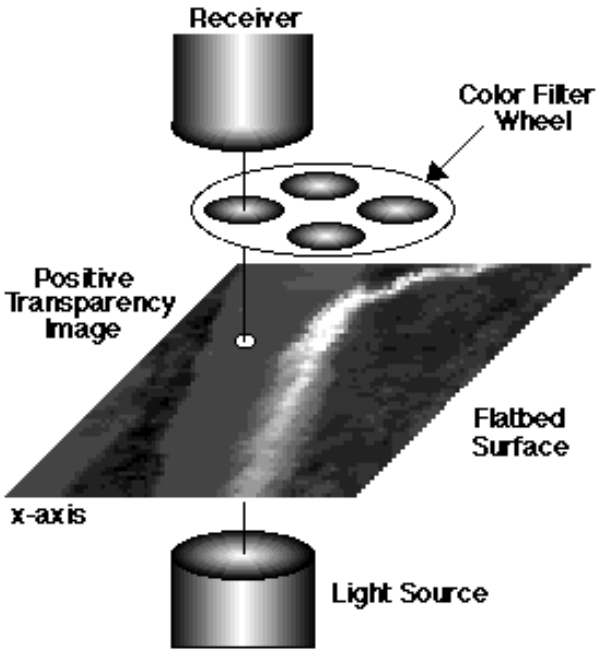
1. Optical-Mechanical Scanning:

- Flat-Bed & Rotating-Drum Scanners are two types of optical-mechanical scanning systems that are used to convert hard-copy photographic images into digital values.

- Both these systems measure image density with an instrument called a densitometer.

- A densitometer is a device that measures the average density of a small area of specified size on a photographic transparency or print.



Flat-Bed scanners.

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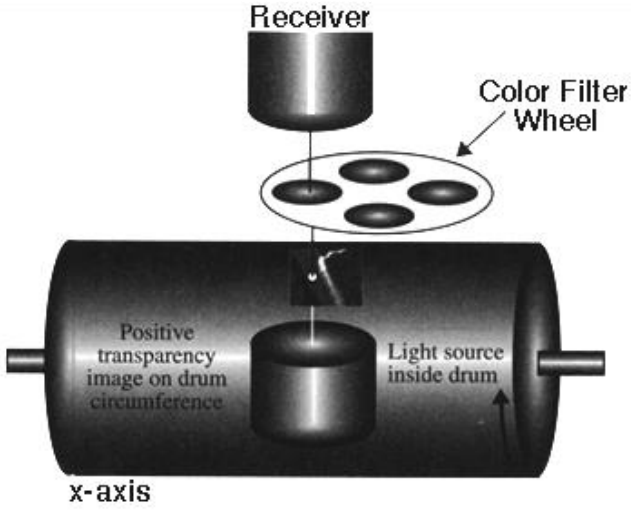
1. Optical-Mechanical Scanning: *(continue)*

- *This process operates on a pixel-by-pixel basis & results in a matrix of values that are usually recorded in 8 bit quantization level ranging from 0 to 255.*

- *Flat-Bed & Rotating-Drum microdensitometers are relatively slow, expensive, & difficult to maintain.*

- *But offer repeatable spatial & radiometric accuracy.*



Rotating-Drum scanners.

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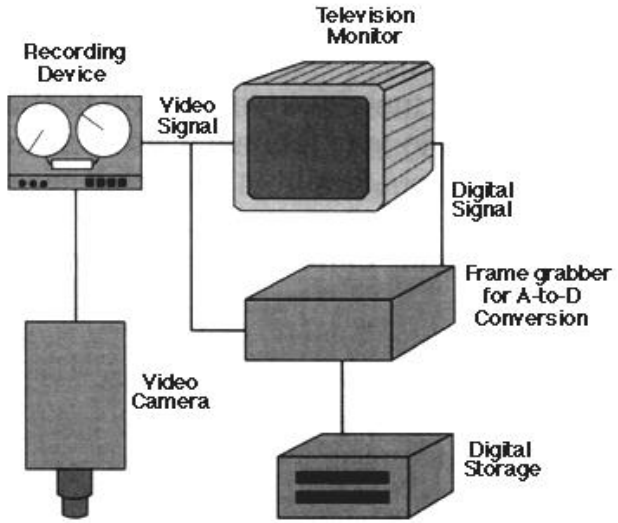
2. Video Digitization:

- Another approach to digitizing hard-copy imagery can be through the use of a video camera.
- Video digitizing involves "freezing" & then digitization of individual video frames.
- Video digitizing represents a low-cost alternative which is convenient.
- But exhibits generally poor spatial resolution & often unrepeatable radiometric or gray-scale resolution.



Video Digitization.

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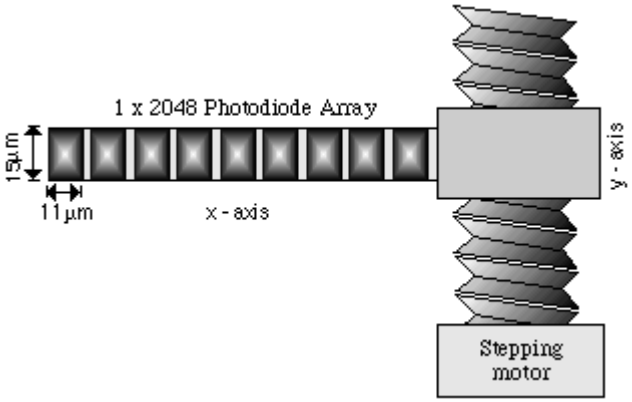
3. Linear photodiode, or (CCD) digitization:

- CCDs are very small detectors designed to rapidly encode images in a numeric format for subsequent computer analysis.

- Typical output from such systems is a matrix with 1 to 12 bits per pixel & results in high spatial resolution, good radiometric accuracy, & fast digitization.

- The only drawback is that it has a relatively high initial coast.



A linear photodiode.

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Data Already in a Digital Format:

Ideally, data are provided to the user in a digital format. This is the case with much of the remotely sensed data & digital cameras.

In order to properly process remotely sensed data, it is better to know how the data is organized & stored on digital formats, & how the data is processed by computers & software. Understanding existing digital data formats is the key for successful data processing.

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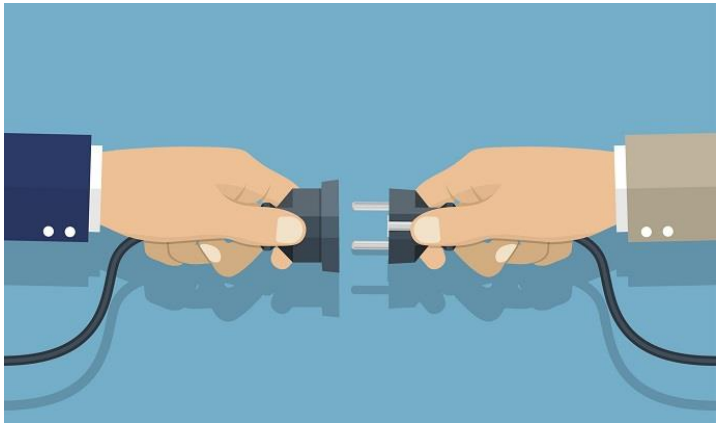

Data Exchange Standards:

The data exchange process are users import data purchased from data providers.

These are usually government agencies or commercial data sources.

For data export, each internal data model must be converted to a specific file structure on disk or other media.The process is reversed for data import.

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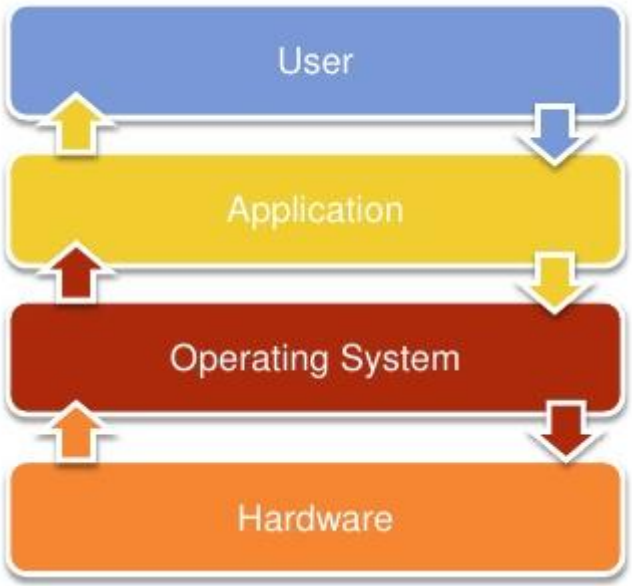
Image Processing System Considerations:

Once the data are in a digital format, it is possible to analyze them using a digital image processing system to extract information from the imagery.

The analyst should know that there is a positive relationship between the accuracy of a function is performed, the speed at which the image processing is performed, & the cost.



OPERATING SYSTEM OVERVIEW

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Image Processing System Considerations: *(continue)*

When designing a digital image processing system, the following factors should be considered in the following sequence:

- *1. The maximum number of access to the system at one time.*
- *2. Softwares necessary for the digital image processing system.*
- *3. Hardware considerations, such as the CPU, the RAM, operating systems & compilers, the amount & types of mass storage required, the spatial & color resolutions of the monitor.*

In addition to the above requirements, one should consider other necessary supporting equipments such as printers, plotters, digitizers, scanners, etc.

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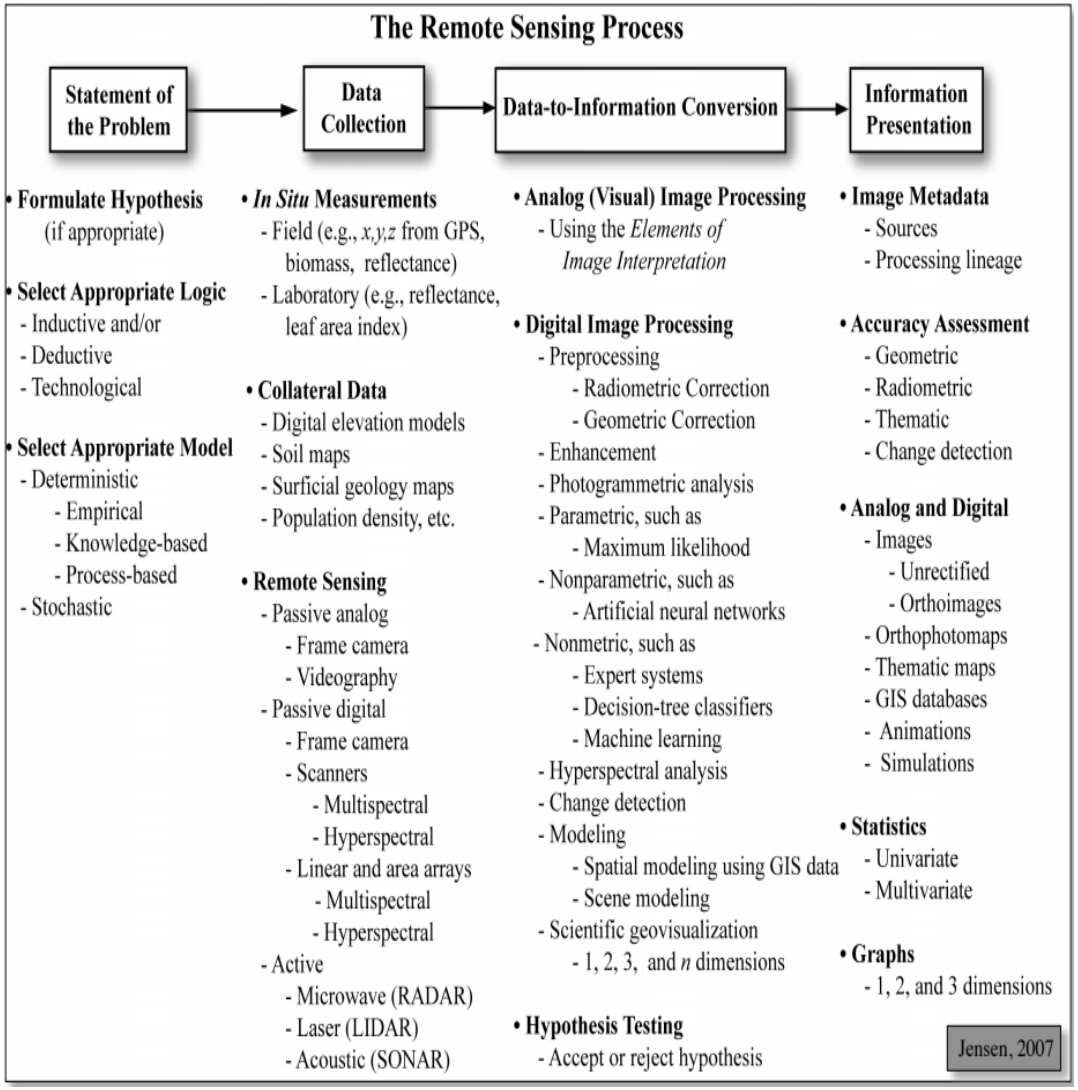
Digital Image processing operations:

Digital image processing is an extremely broad subject that often involves procedures that can be mathematically complex.



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Digital Image processing operations: *(continue)*

All of the procedures involved in digital image processing operations may be categorized into one or more of the following five broad types of computer assisted operations:

- *1. Image Rectification & Restoration, or "pre-processing".*

  The aim of these operations is to correct distorted or degraded image data to create a more faithful representation of the original scene.

- *2. Image Enhancement.*

  These procedures are applied to image data in order to more effectively display the data for subsequent visual interpretation.

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Digital Image processing operations: *(continue)*

- *3. Image Classification.*

  The objective of these operations is to replace visual analysis of the image data with quantitative techniques for automating the identification of features in a scene.

- *4. Data Merging.*

  Data merging are used to combine image data for a given geographic area with other geographically referenced data sets for the same area.

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Digital Image processing operations: *(continue)*

- *5. Biophysical Modeling.*

  The objective of these procedures is to relate quantitatively the digital data recorded by a R.S. system to biophysical features & phenomena measured on the ground, such as water depth & pollution considerations.

Nonetheless, we should always remember that the bounders between these various operations are not well defined in practice.

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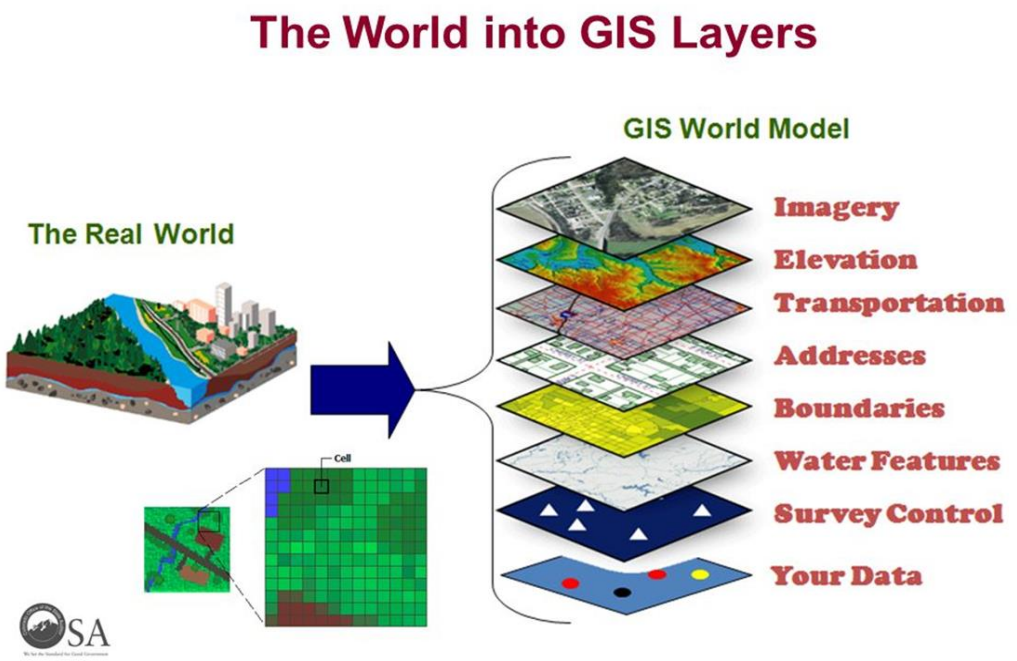

GIS & Remote Sensing:

Geospatial information system (GIS) is a computer-based tool for mapping & examining the changes on earth.

GIS is designed to capture, store & manage all types of geospatial data.

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GIS & Remote Sensing: *(continue)*

GIS technology integrates common database operations, such as query & statistical analysis, with maps.

GIS manages location-based information & provides tools for display & analysis of various statistics, including population characteristics, economic development opportunities, & vegetation types.

GIS allows you to link databases & maps to create dynamic displays.

Whereas Remote Sensing is the art & science of making measurements of the earth using sensors on aircrafts or satellites.

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GIS & Remote Sensing: *(continue)*

These sensors collect data in the form of images & provide specialized capabilities for manipulating, analyzing, & visualizing those images.

Remote Sensing is the accession of information about the object without any physical contact.

Remote sensed imagery is integrated within a GIS.

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That's the end of Chapter 6

Thank You.