

Introduction to Digital Image Processing

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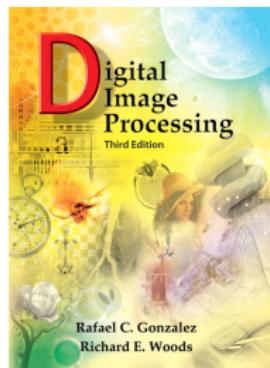
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India-751030

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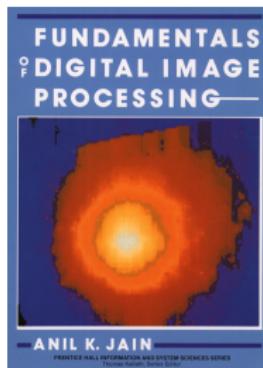
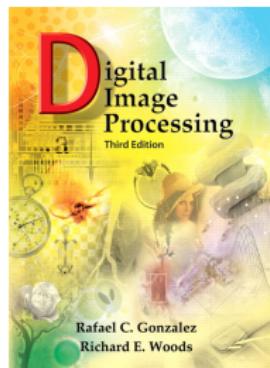
Course Syllabus and Format



Text Book:

- ▶ Digital Image Processing,
Gonzalez and Woods, 3rd
Edition

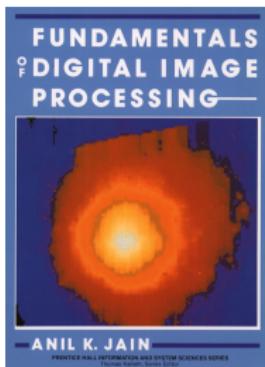
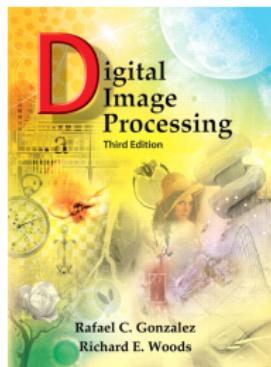
Course Syllabus and Format



Text Book:

- ▶ Digital Image Processing, Gonzalez and Woods, 3rd Edition
- ▶ Fundamentals of Digital Image Processing by A. K. Jain

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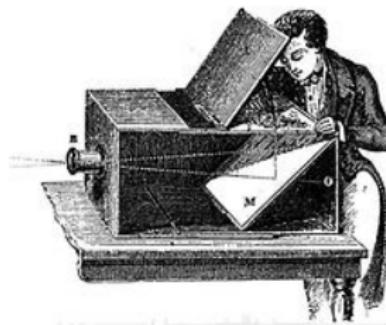
Syllabus

- ▶ Introduction and Digital Image Fundamentals, Digital Image Representation, Image Enhancement in the Spatial Domain, Image Enhancement in the Frequency Domain, Image Restoration, Image Compression, Image Segmentation.

Introduction to Digital Image Processing

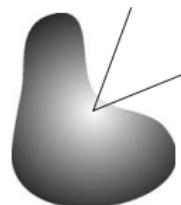
What is analog photograph?

- ▶ Analog photography uses a progressively changing recording medium, which may be either chemical process based (e.g., photographic film or plate) or electronic (e.g., vidicon or CCD sensor).
- ▶ Analog photography has come to mean anything that is “not digital”.
- ▶ made in approximately 1816.



What is digital Image?

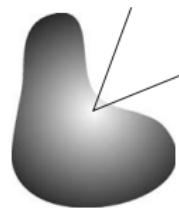
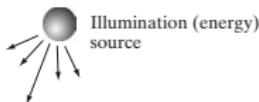
A *digital image* is a representation of a two dimensional image as a finite set of digital values, called picture elements or pixels.



Scene element

What is digital Image?

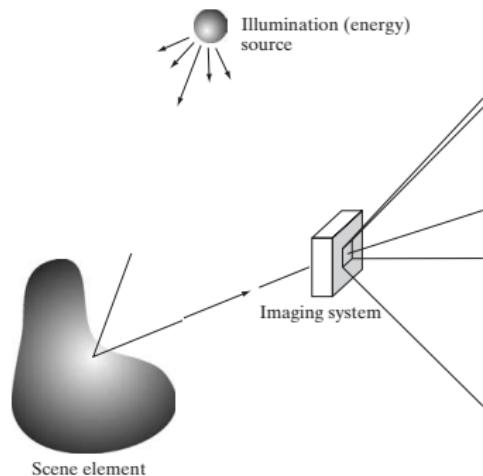
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Scene element

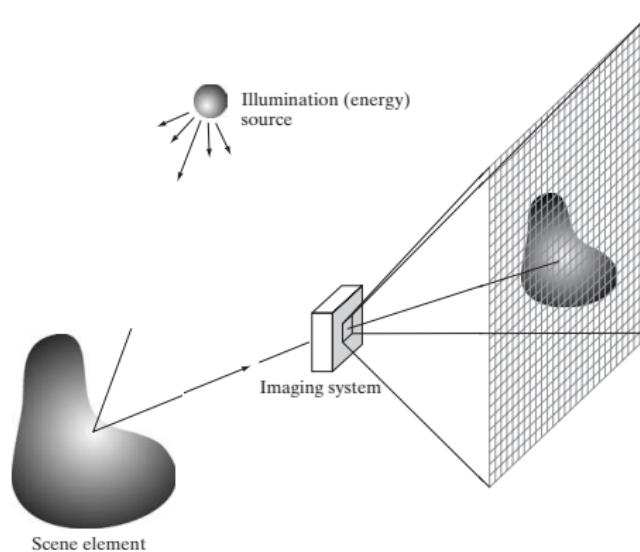
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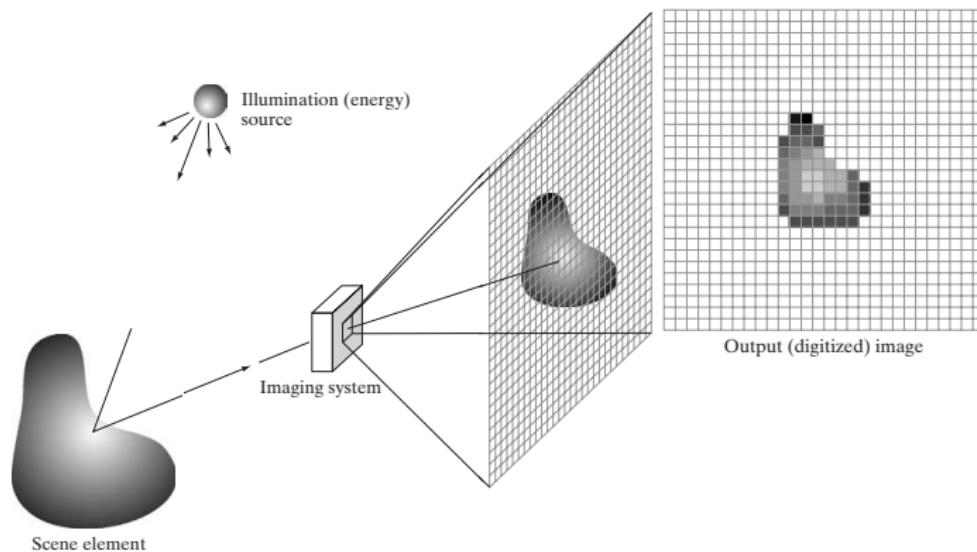
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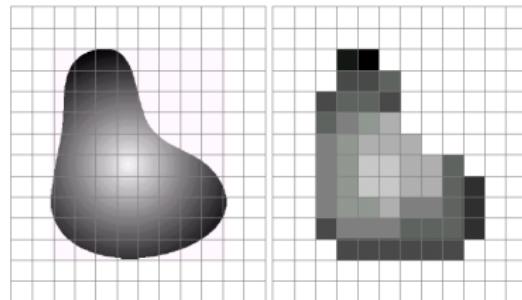
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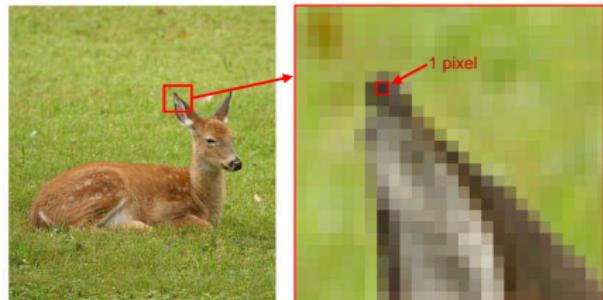
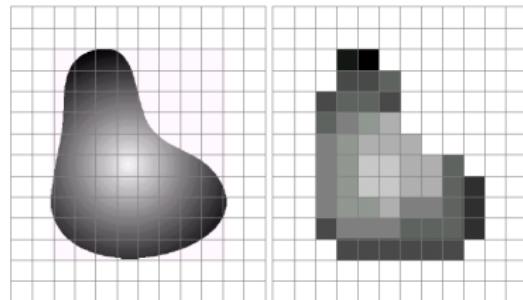
What is digital Image?

- ▶ *Pixel values* typically represent gray levels, colours, heights, opacities etc.
- ▶ Remember digitization implies that a digital image is an *approximation* of a real scene.



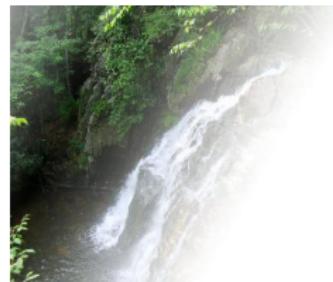
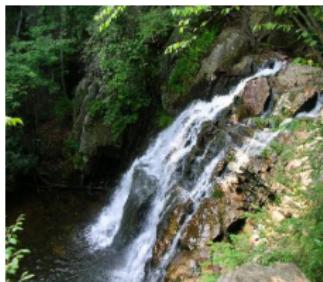
What is digital Image?

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- ▶ Remember digitization implies that a digital image is an *approximation* of a real scene.



What is digital Image?

- ▶ Common image formats include:
 - ▶ 1 sample per point (B& W or Grayscale)
 - ▶ 3 samples per point (Red, Green, and Blue)
 - ▶ 4 samples per point (Red, Green, Blue, and "Alpha"(Opacity))



- ▶ 4 bit, 8-bit, 16-bit, 24-bit Images

What is digital Image Processing?

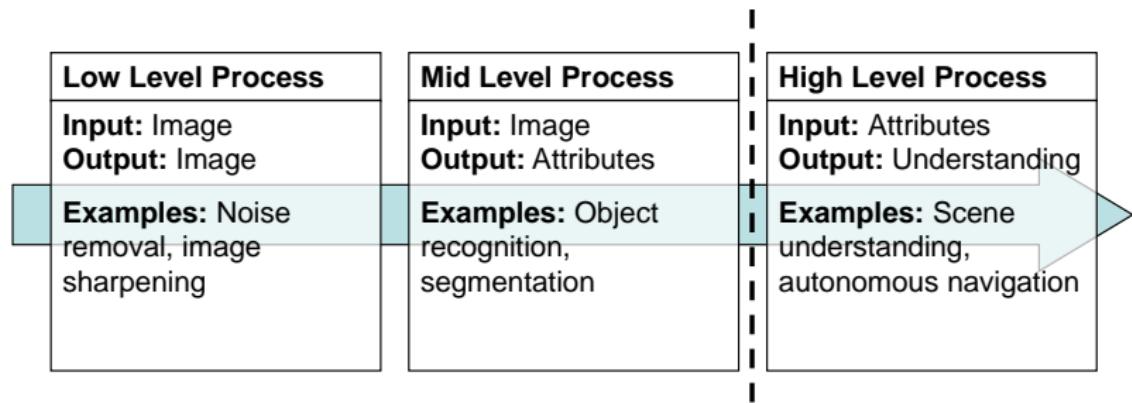
- ▶ Digital image processing focuses on two major tasks
 - ▶ Improvement of pictorial information for human interpretation
 - for example, deblurring, noise removal, image sharpening
 - ▶ Processing of image data for storage, transmission and representation for autonomous machine perception
 - for example, data compression, segmentation

What is digital Image Processing?

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 - ▶ Processing of image data for storage, transmission and representation for autonomous machine perception
 - for example, data compression, segmentation
- ▶ Some argument about where image processing ends and fields such as image analysis and computer vision start.

What is digital Image Processing?

- ▶ The continuum from image processing to computer vision can be broken up into low-, mid- and high-level processes



In this course we will
stop here

Origins of Digital Image Processing

Early 1920: One of the first application of digital imaging was in the news paper industry

- ▶ The Bartlane cable picture transmission service
- ▶ Images were transferred by submarine cable between *London* and *New York*
- ▶ Pictures were coded for cable transfer and reconstructed at the receiving end on a telegraph printer



Figure: Digital picture produced in 1921

Origins of Digital Image Processing

Mid to late 1920s:

Improvement to the Bartlane system resulted in higher quality images

- ▶ New reproduction processes based photographic techniques
- ▶ Increased number of tones in reproduced images



Figure: (a) A digital picture made in 1922,
(b) Transmitted in 1929 from London to New York by 15-tone equipment.

Origins of Digital Image Processing

- ▶ **1960s:** Improvement in computing technology and the onset of the space race led to a surge of work in digital image processing.

- ▶ **1964:** Computers used to improve the quality of images the quality of images of the moon taken by the *Ranger 7 probe*.
- ▶ Such techniques were used in other space missions including the Apollo landings.

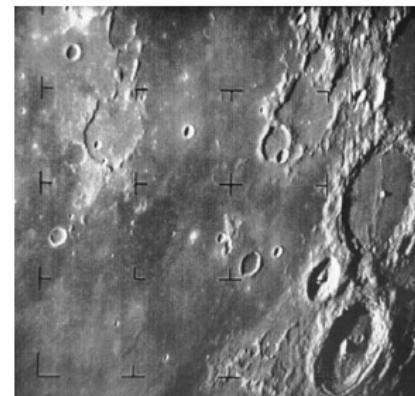
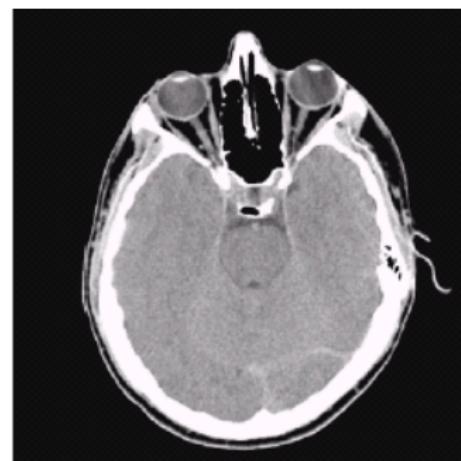


Figure: The first picture of the moon by a U.S. spacecraft

Origins of Digital Image Processing

1970s: Digital image processing begins to be used in medical applications

- ▶ **1979:** Sir Godfrey N. Hounsfield & Prof. Allan M. Cormack share the Nobel Prize in medicine for the invention of *tomography*, the technology behind Computerized Axial Tomography (CAT) scans



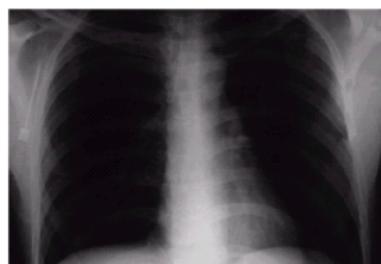
Origins of Digital Image Processing

1980s - Today: The use of digital image processing techniques has exploded and they are now used for all kinds of tasks in all kinds of areas

- ▶ Image enhancement/restoration
- ▶ Artistic effects
- ▶ Medical visualization
- ▶ Industrial inspection
- ▶ Law enforcement
- ▶ Human computer interfaces

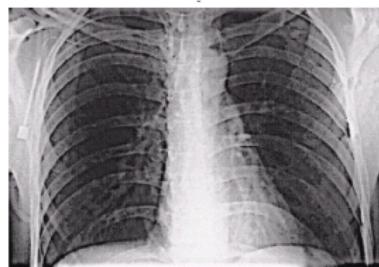
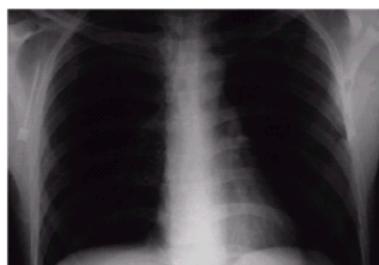
Application: Image Enhancement

- ▶ One of the most common uses of DIP techniques: improve quality, remove noise, etc.



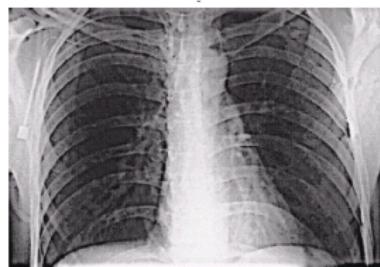
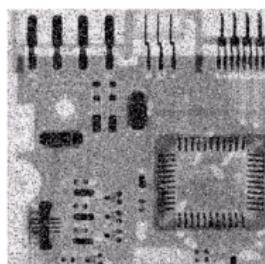
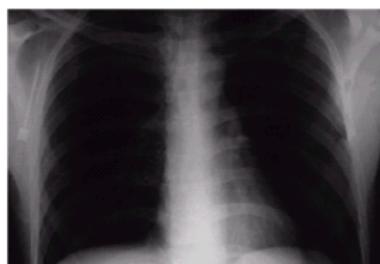
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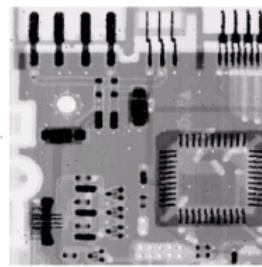
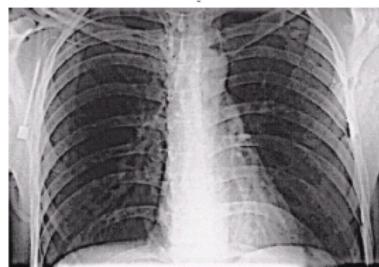
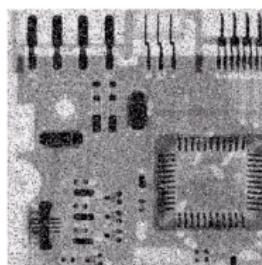
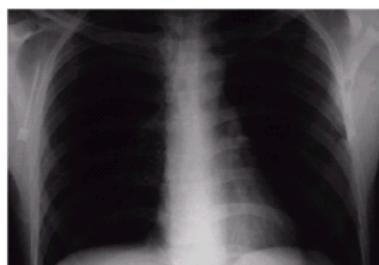
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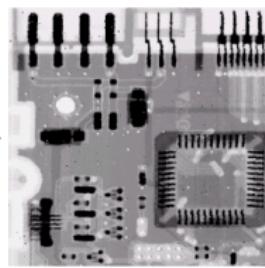
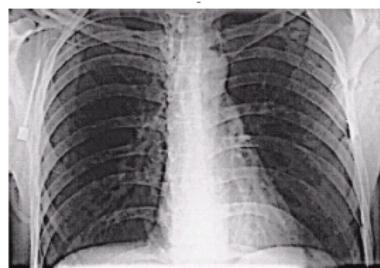
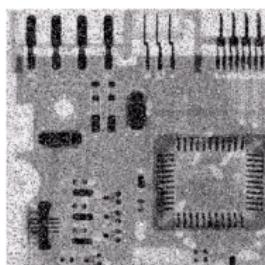
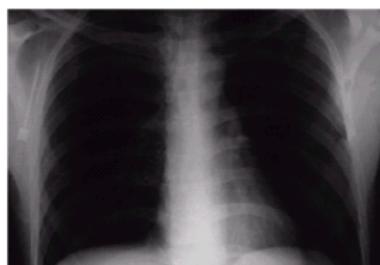
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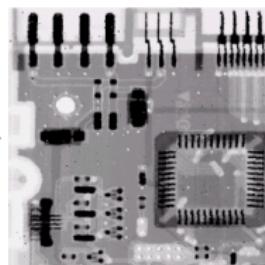
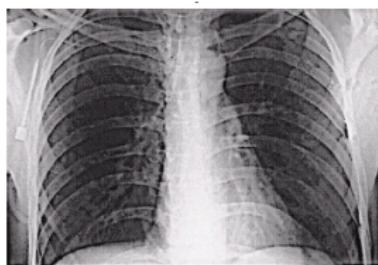
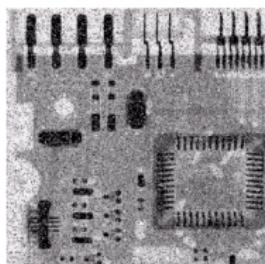
Application: Image Enhancement

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Application: Image Enhancement

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Application: Artistic effects



Application: Artistic effects

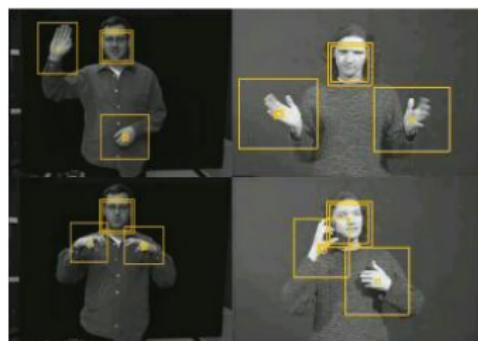


Application: Artistic effects

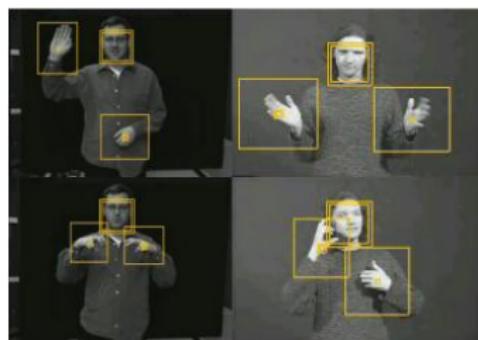
- ▶ Artistic effects are used to make images more visually appealing, to add special effects and to make composite images.



Application: Human Computer Interface



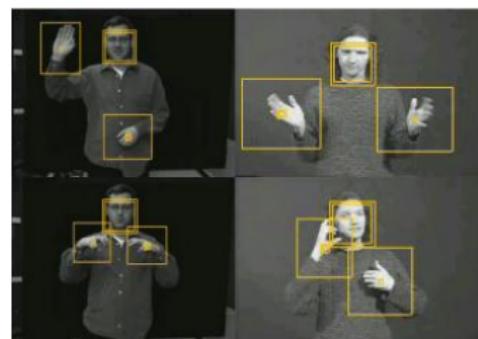
Application: Human Computer Interface



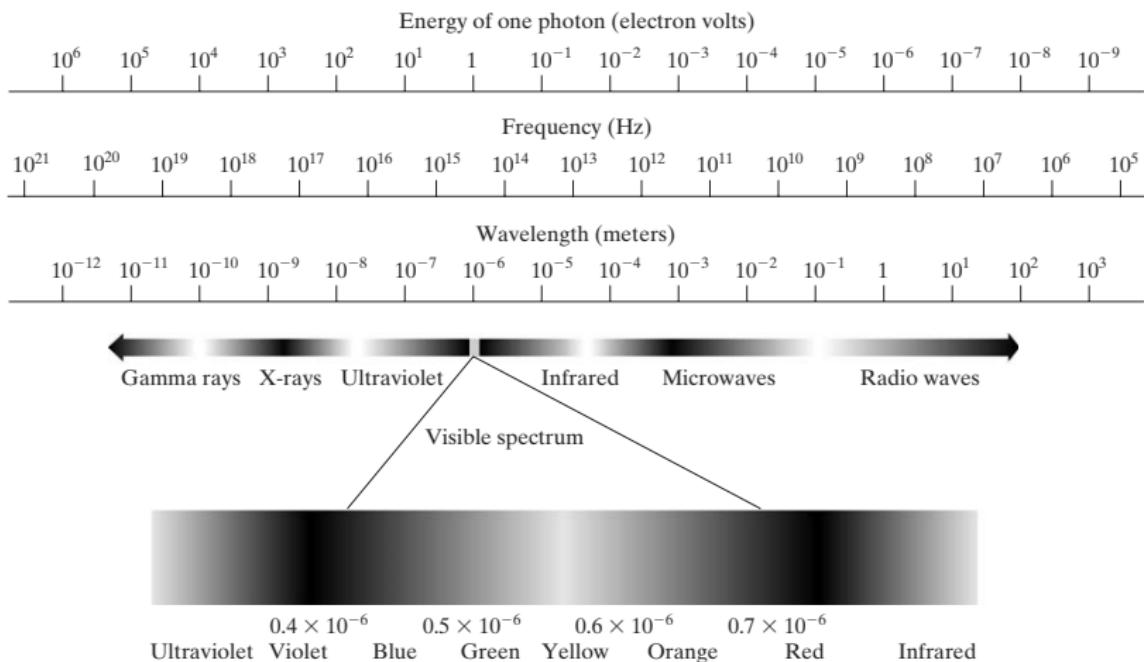
Application: Human Computer Interface

- ▶ Try to make human computer interfaces more natural
 - ▶ Face recognition
 - ▶ Gesture recognition

These tasks can be extremely difficult

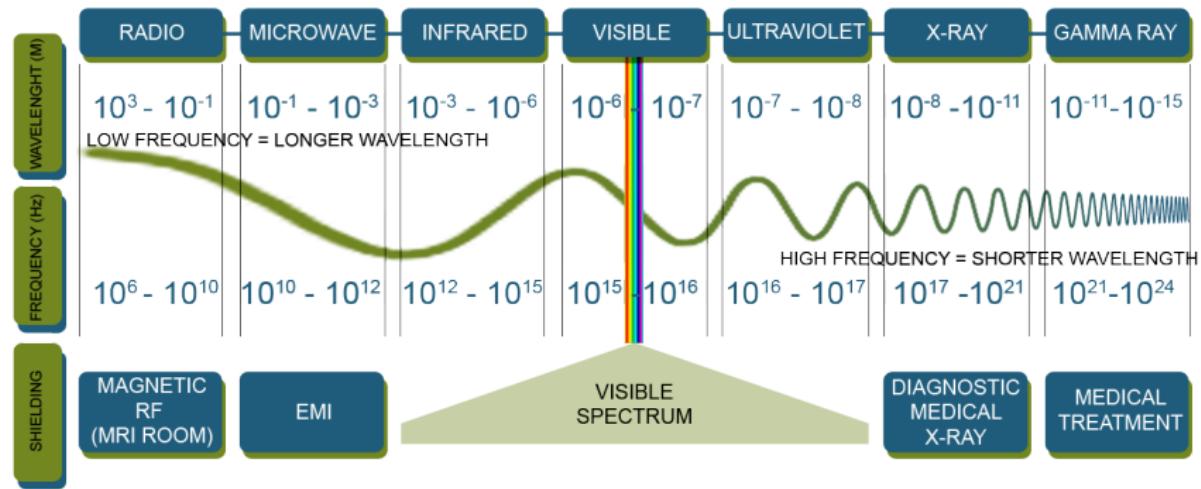


Electromagnetic Spectrum



Electromagnetic Spectrum

ELECTROMAGNETIC SPECTRUM



Gamma-Ray Imaging

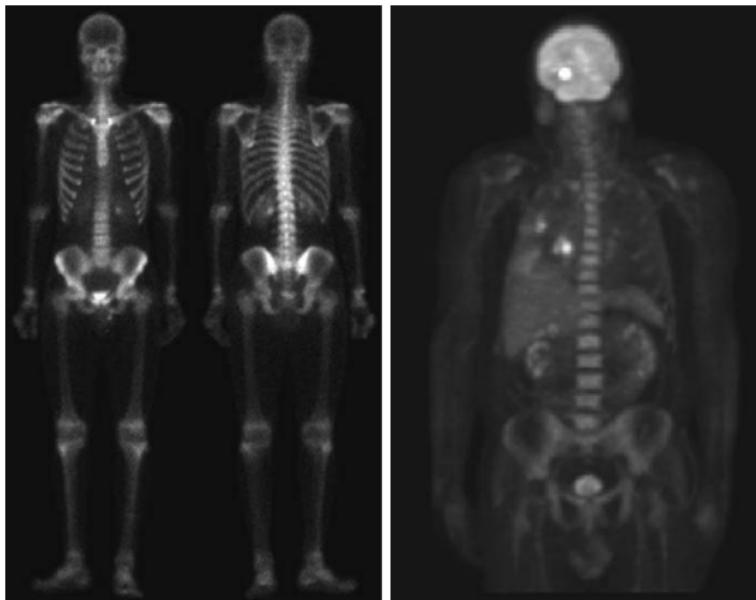


Figure: Example of gamma-ray imaging. (a) Bone scan, (b) Positron emission tomography (PET) image.

X-Ray Imaging

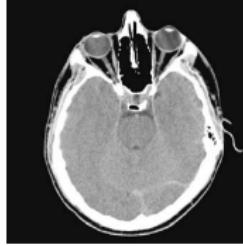
Chest X-ray



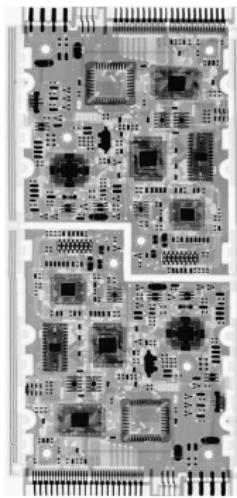
Angiography



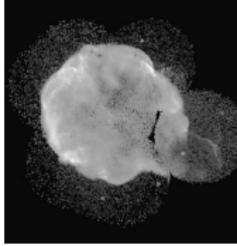
CT



Circuit Board

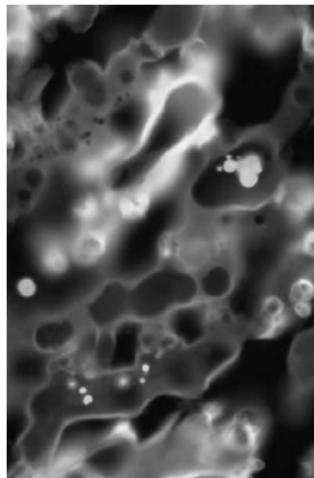


Cygnus Loop

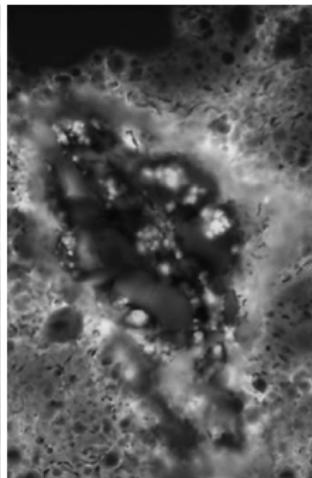


Imaging in the Ultraviolet Band

Normal Corn



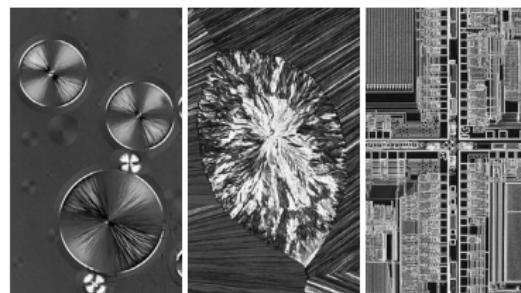
Smut Corn



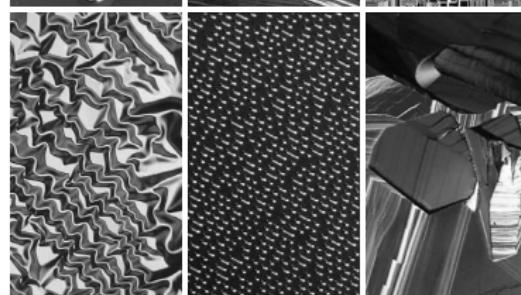
Imaging in the Visible and Infrared Bands

Cholesterol

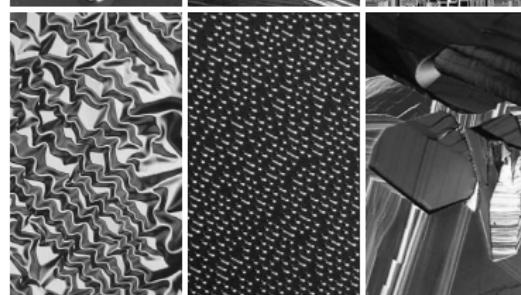
Taxol (Anti cancer)



Microprocessor



Nickel Oxide Thin Film



Superconductor

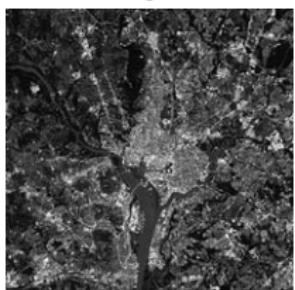
CD Surface

Multi Channel imaging: Satellite Imaging

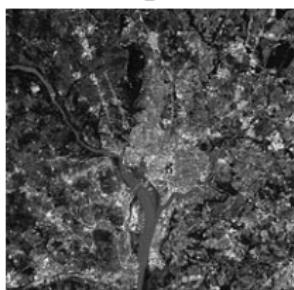
Band No.	Name	Wavelength (μm)	Characteristics and Uses
1	Visible blue	0.45–0.52	Maximum water penetration
2	Visible green	0.52–0.60	Good for measuring plant vigor
3	Visible red	0.63–0.69	Vegetation discrimination
4	Near infrared	0.76–0.90	Biomass and shoreline mapping
5	Middle infrared	1.55–1.75	Moisture content of soil and vegetation
6	Thermal infrared	10.4–12.5	Soil moisture; thermal mapping
7	Middle infrared	2.08–2.35	Mineral mapping

Multi Channel imaging: Satellite Imaging

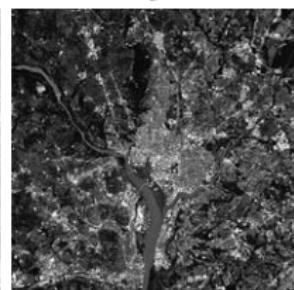
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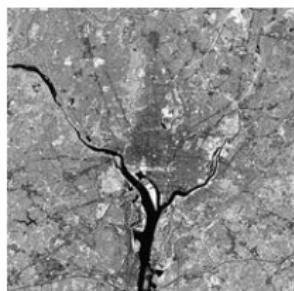
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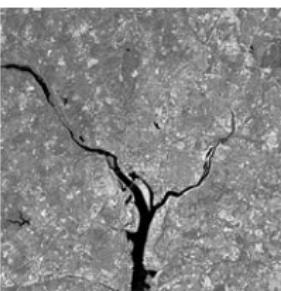
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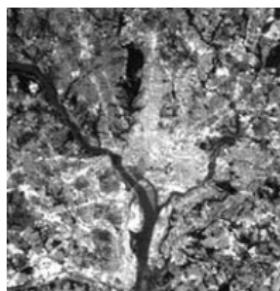
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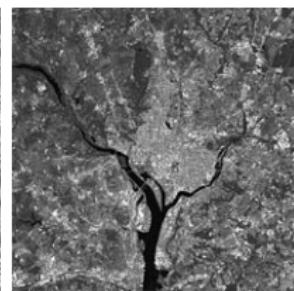
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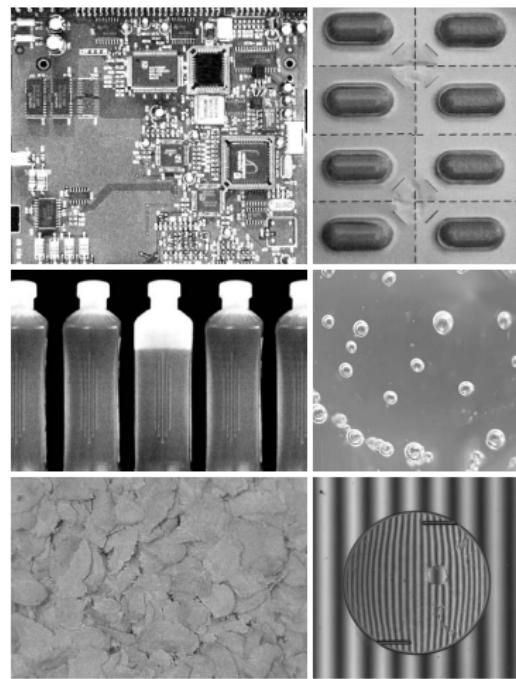


7



Visual Spectrum

- ▶ Human operators are expensive, slow and unreliable
- ▶ Make machines do the job instead
- ▶ Industrial vision systems are used in all kind of industries



Visual Spectrum

Finger print

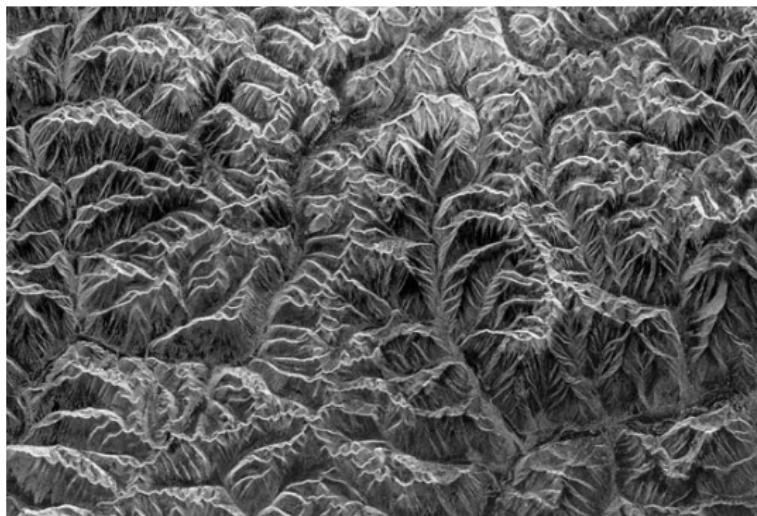


Currency



Number plate

Imaging in the Microwave Band



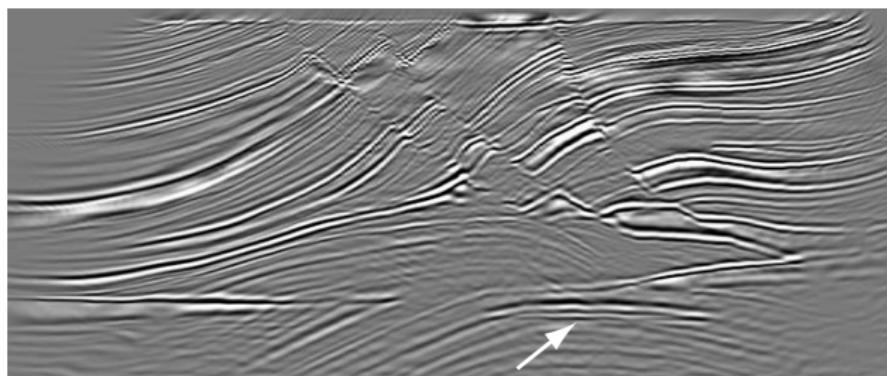
Radar Image of Mountain

Imaging in the Radio Band



Magnetic Resonance Imaging - MRI

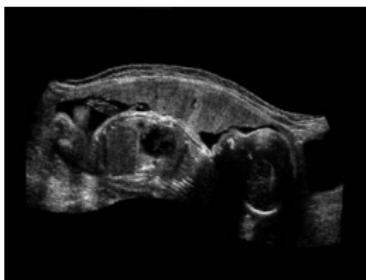
Imaging in the Ultrasonic Images



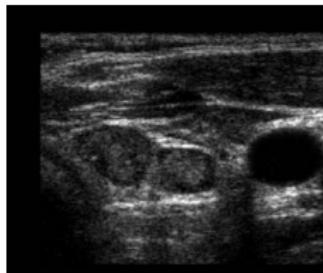
Oil/Gas/Water trap

Imaging in the Ultrasonic Images

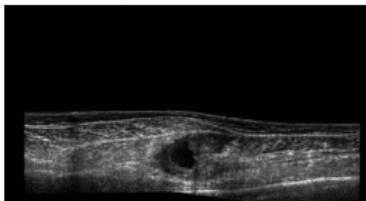
Infant



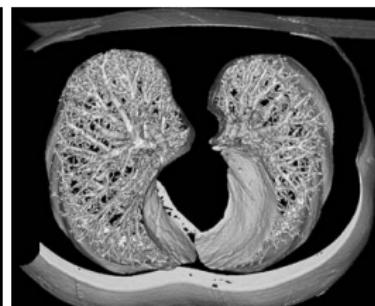
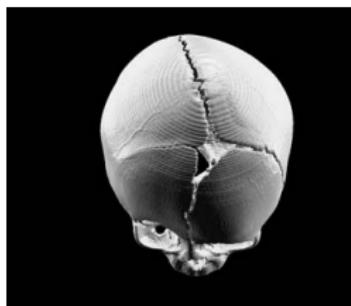
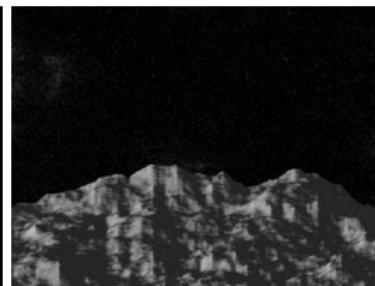
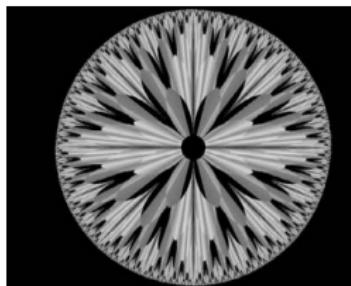
Thyroid



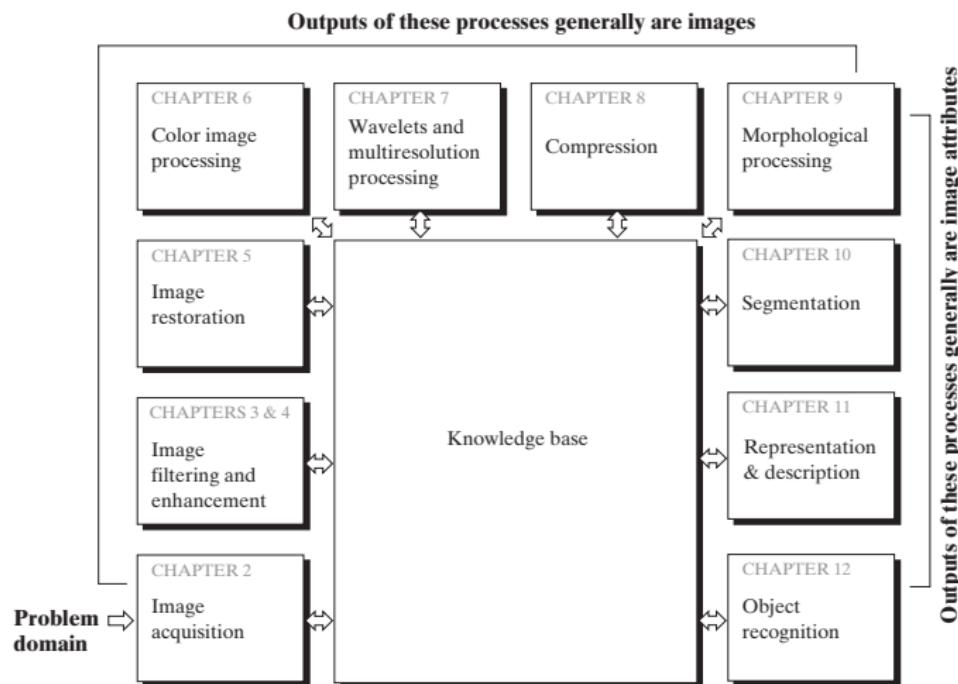
Muscle



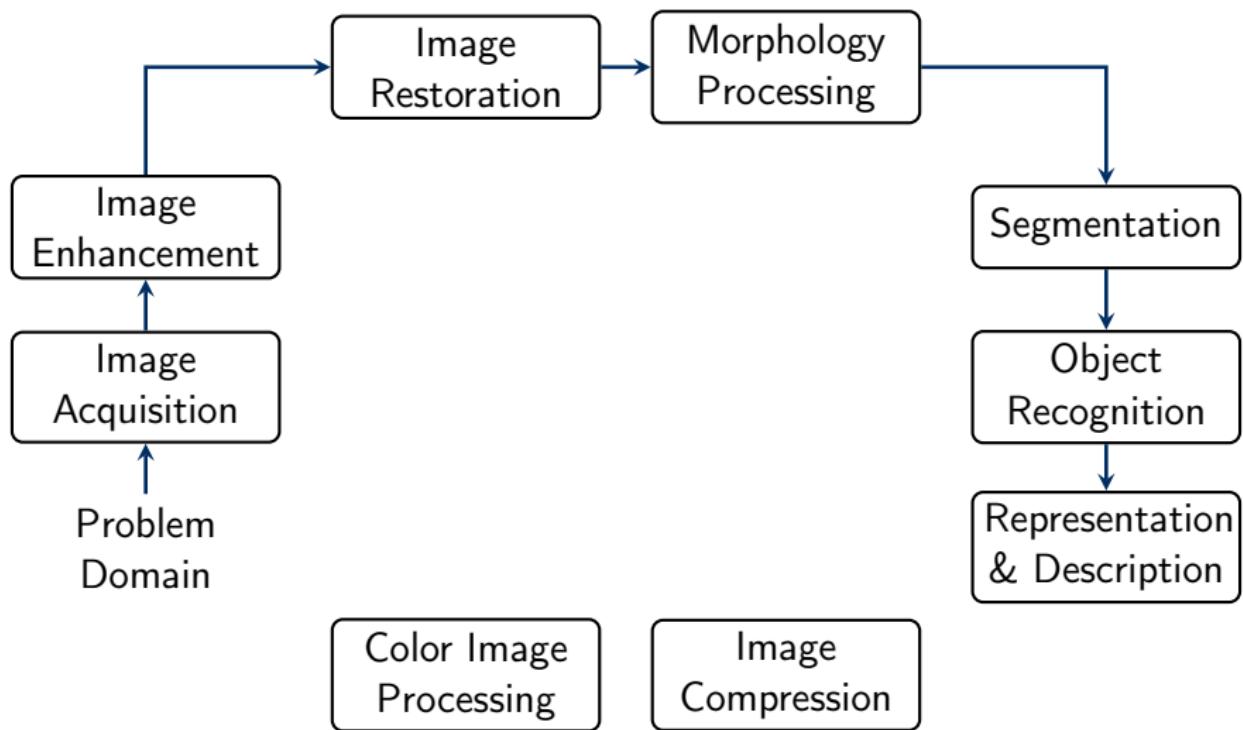
Synthetic Images



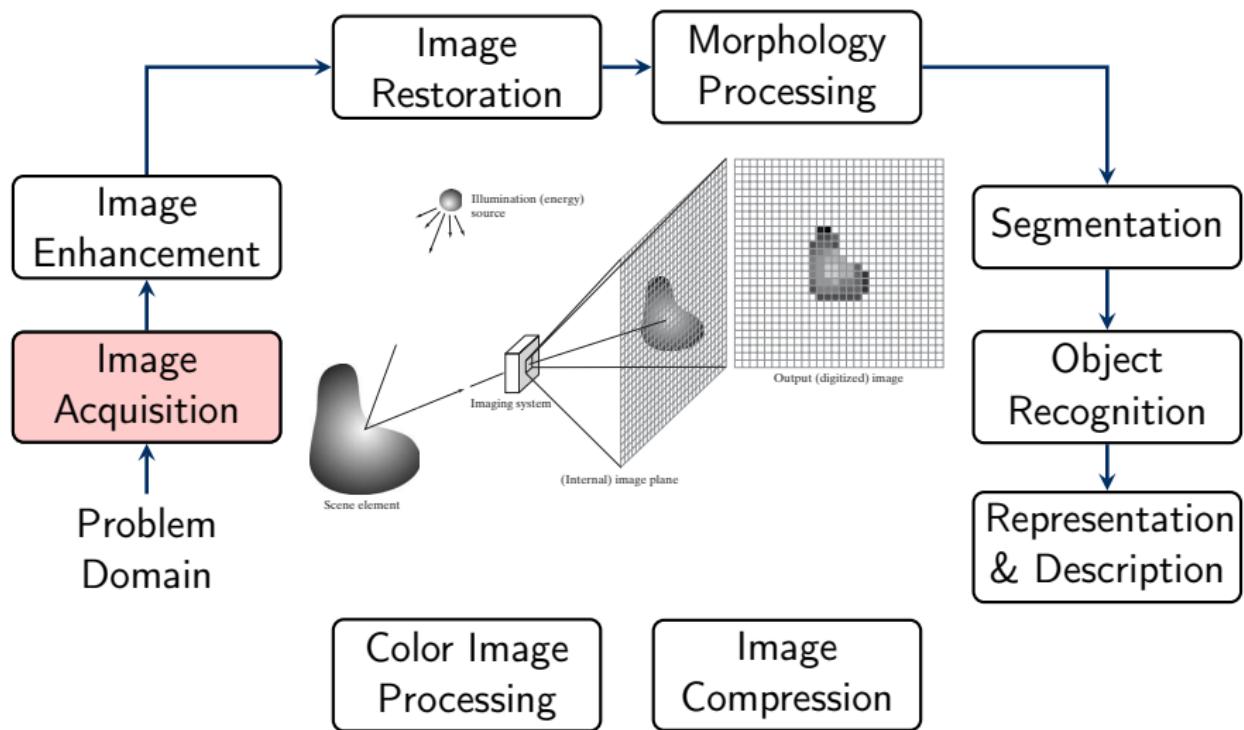
Fundamental steps in digital image processing



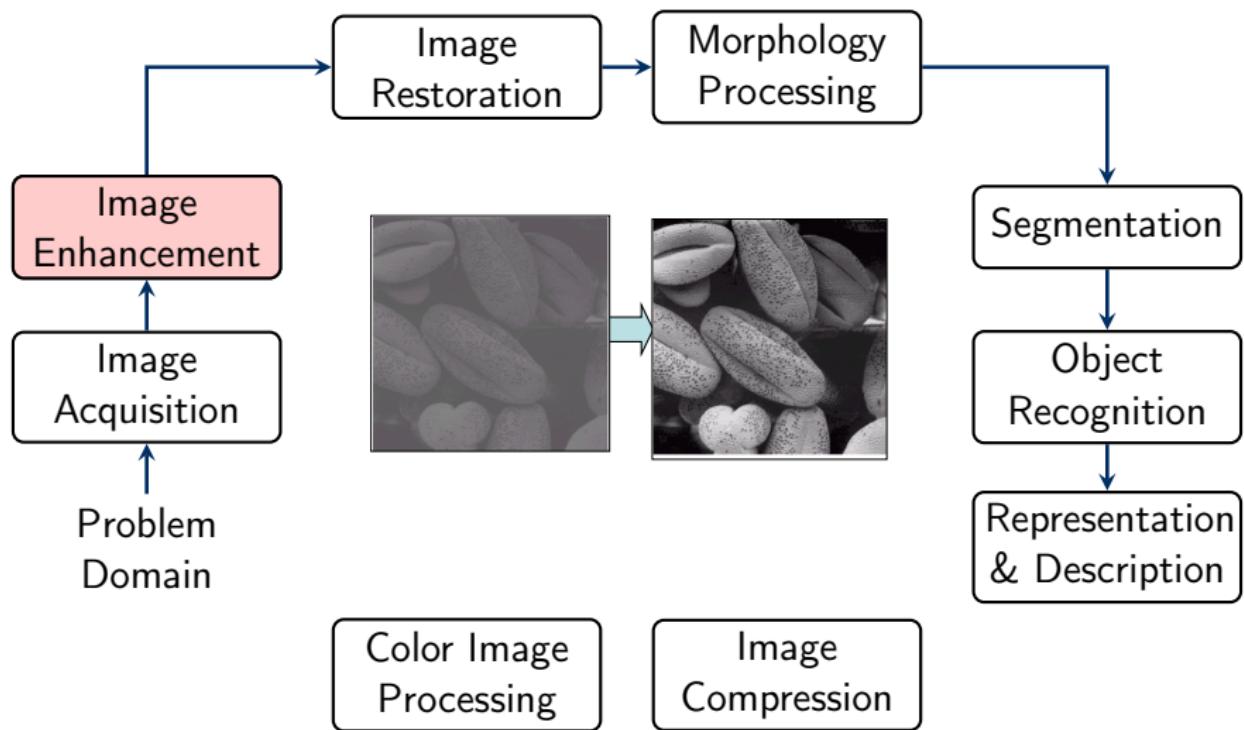
Fundamental steps in digital image processing



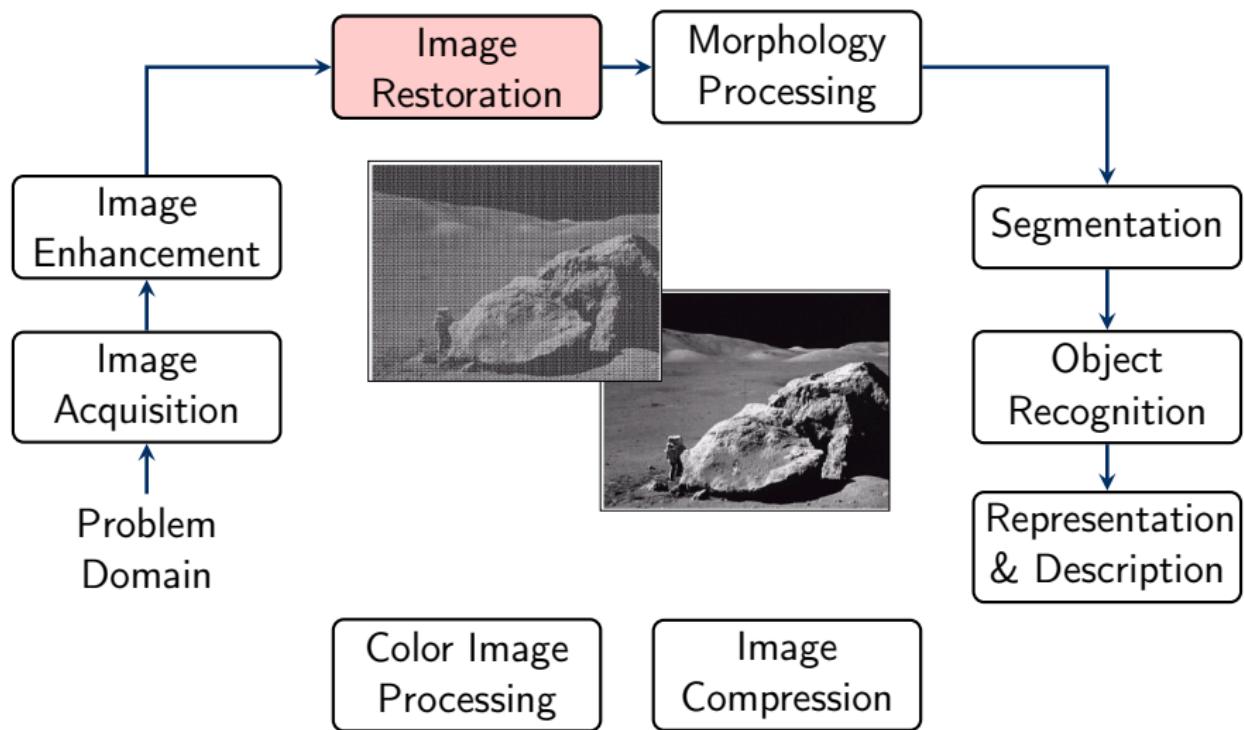
Fundamental steps in digital image processing



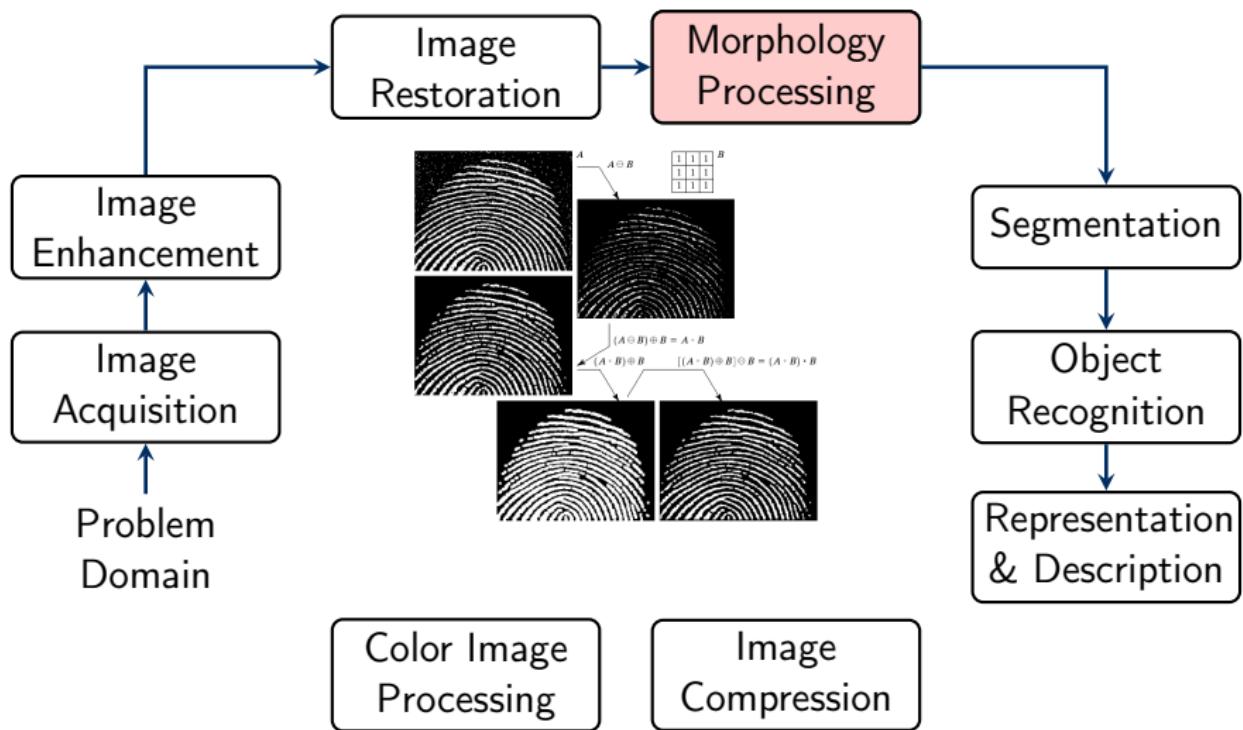
Fundamental steps in digital image processing



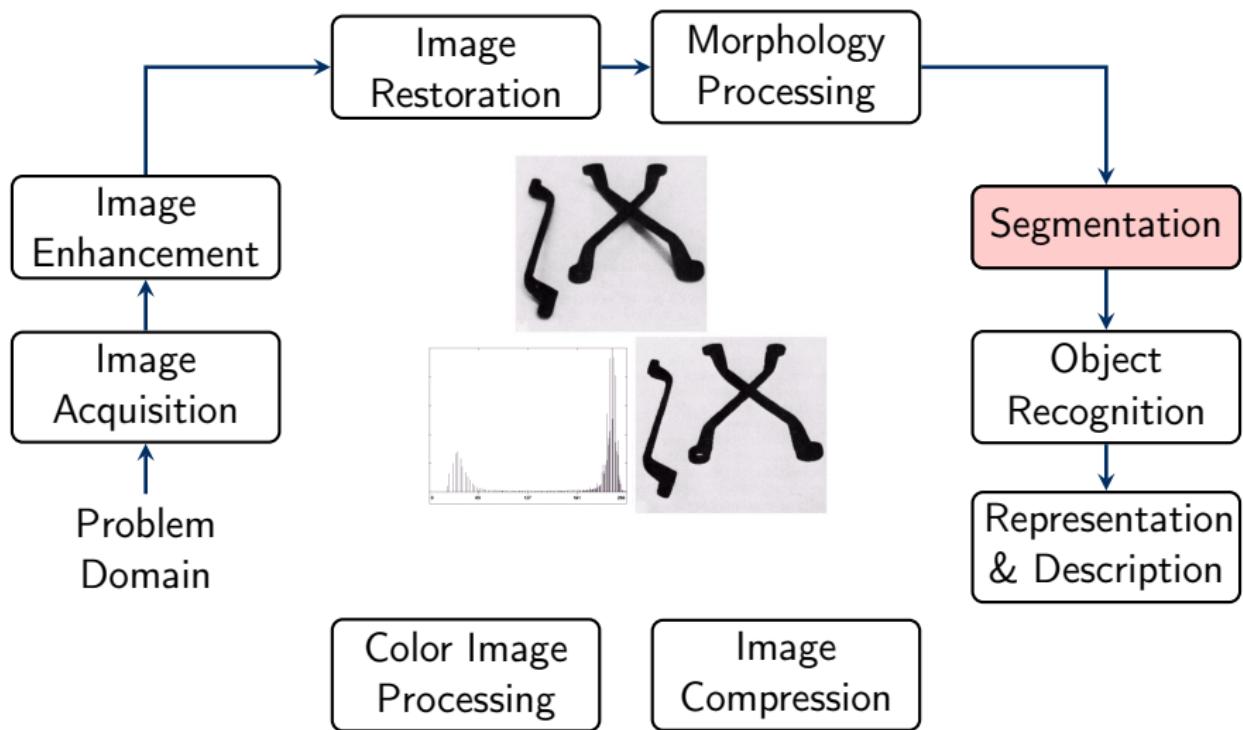
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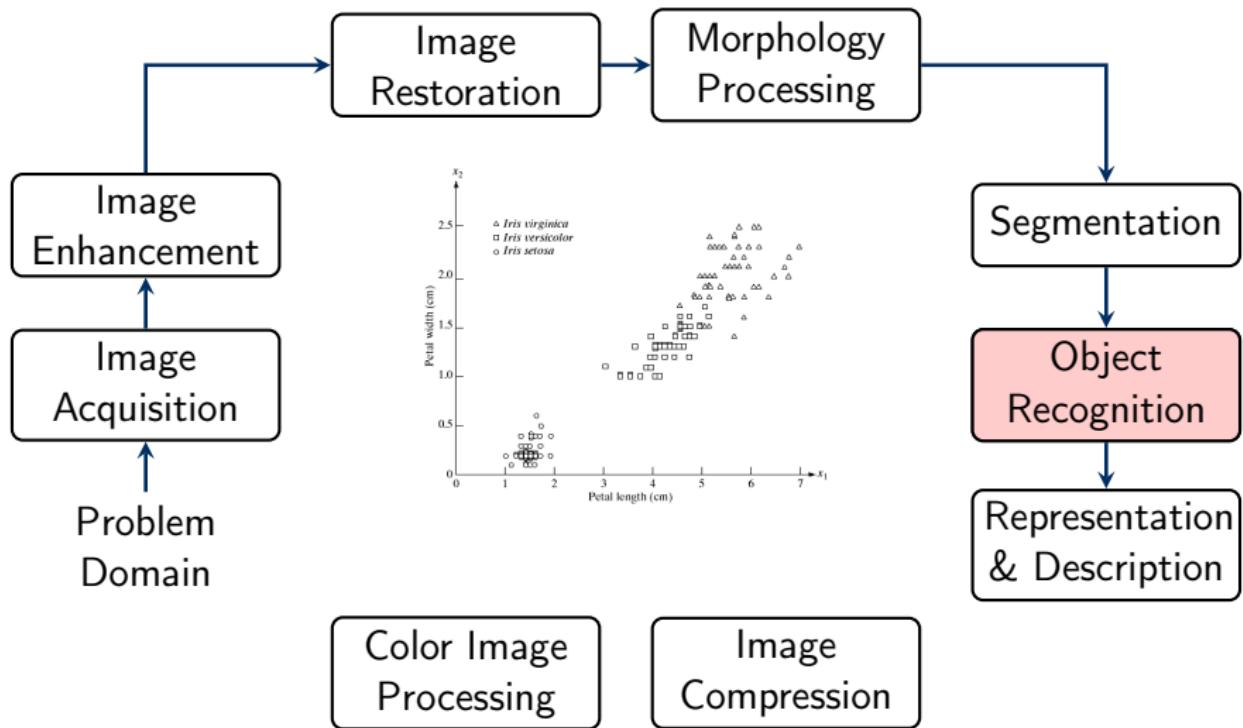
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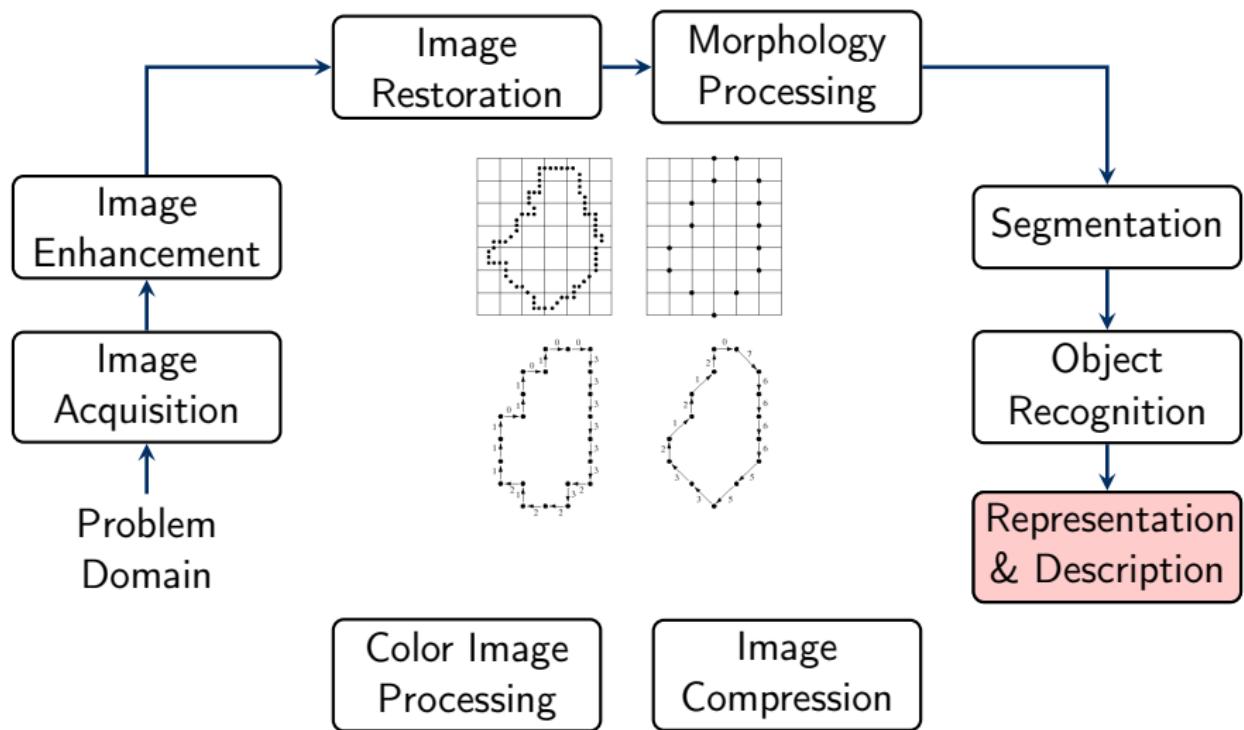
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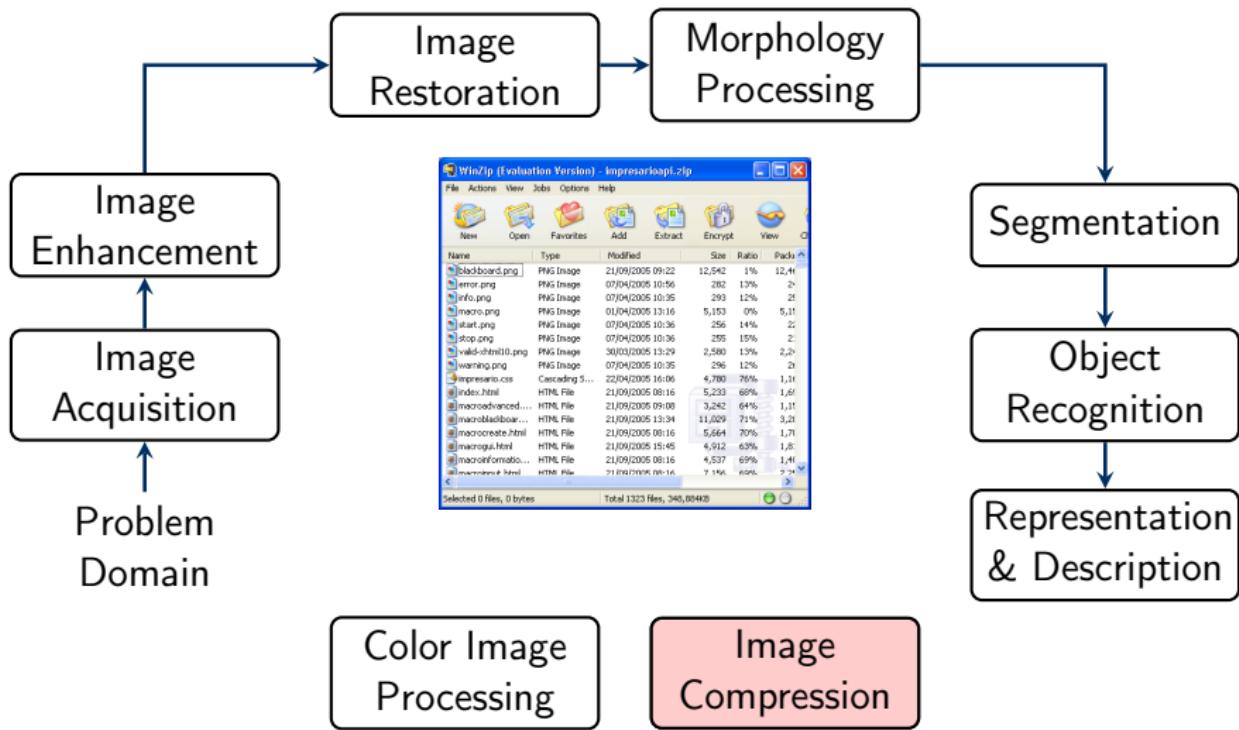
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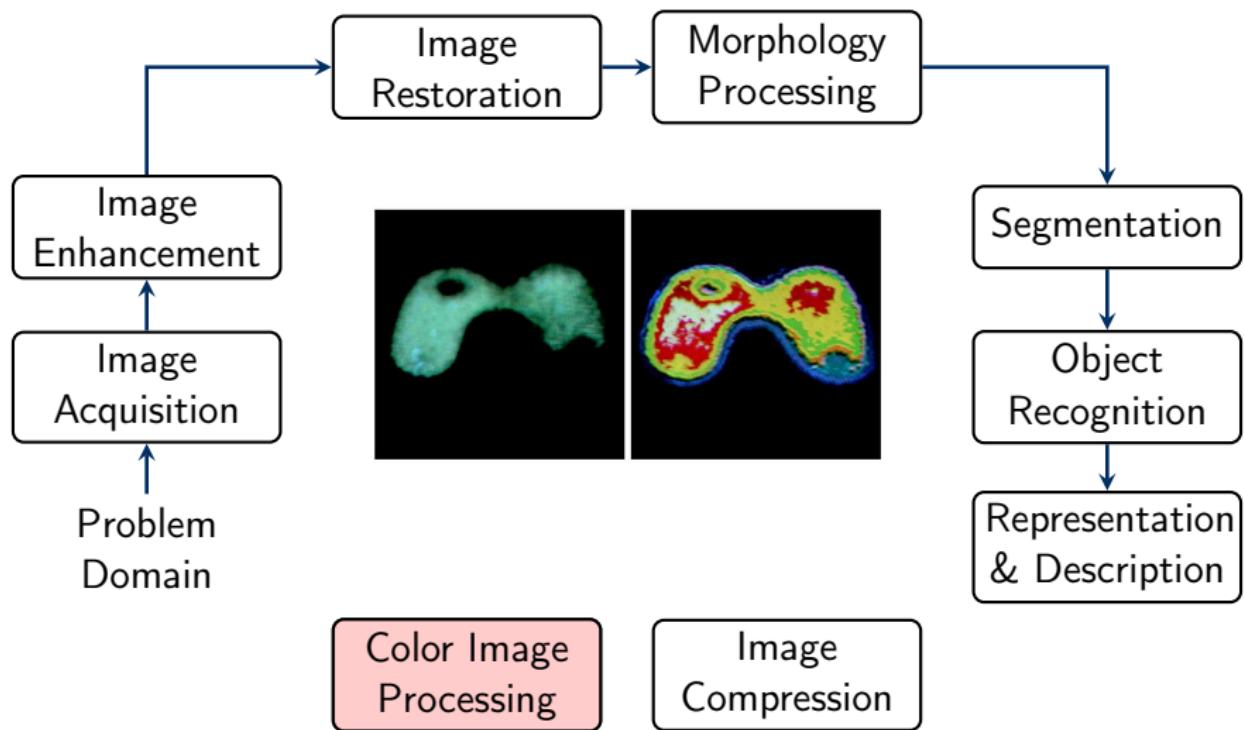
Fundamental steps in digital image processing



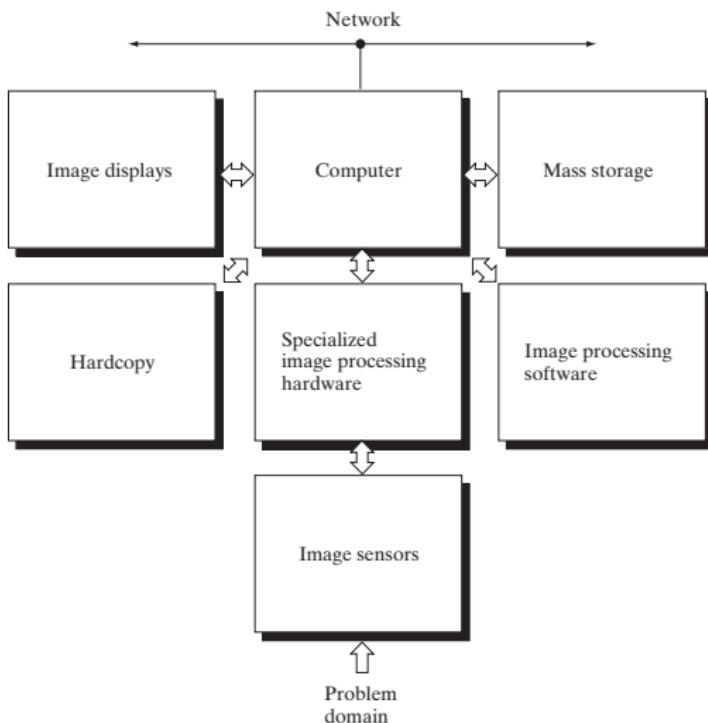
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Components of a general purpose image processing system



Thank You
Queries?