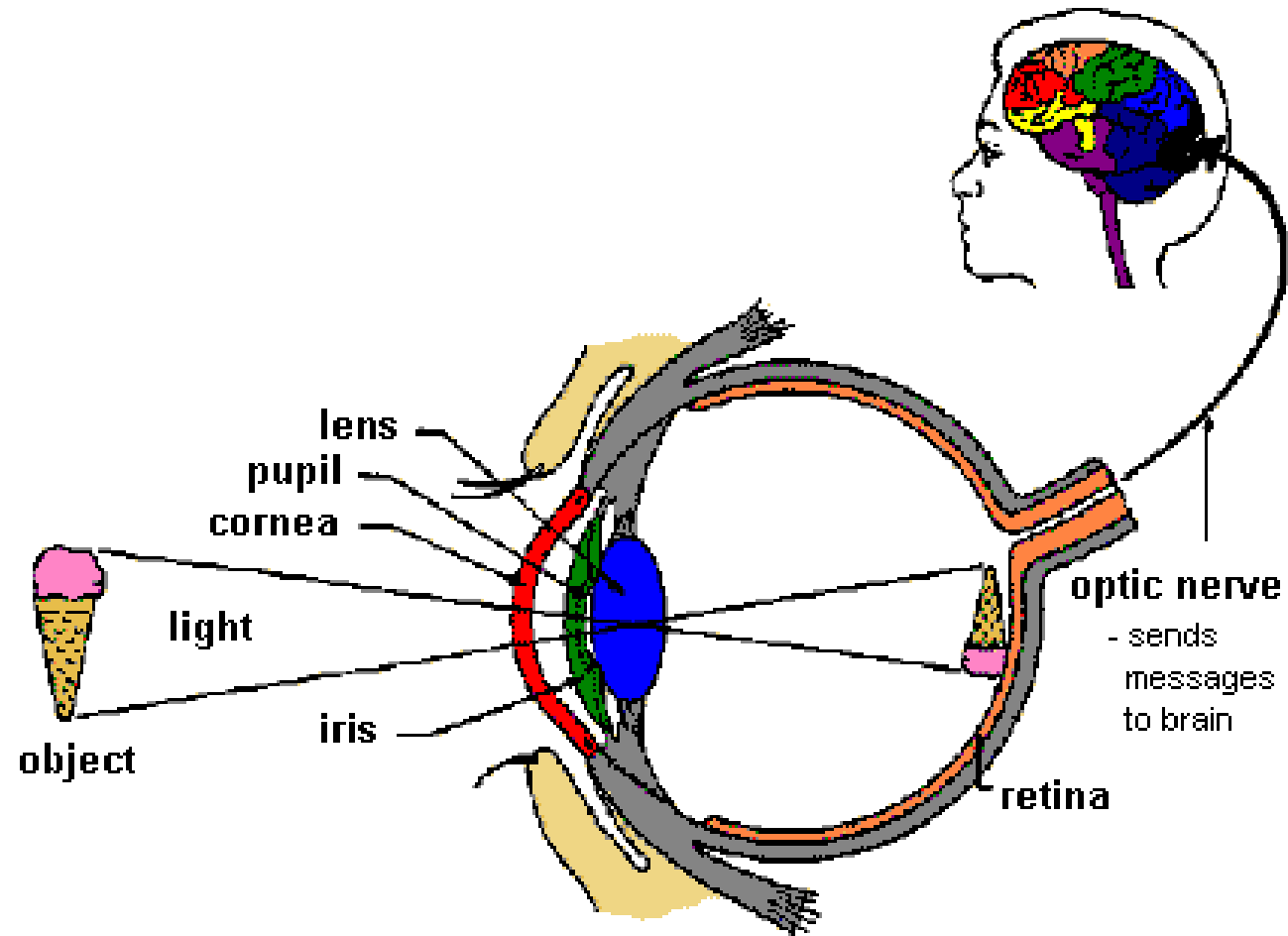


Introduction

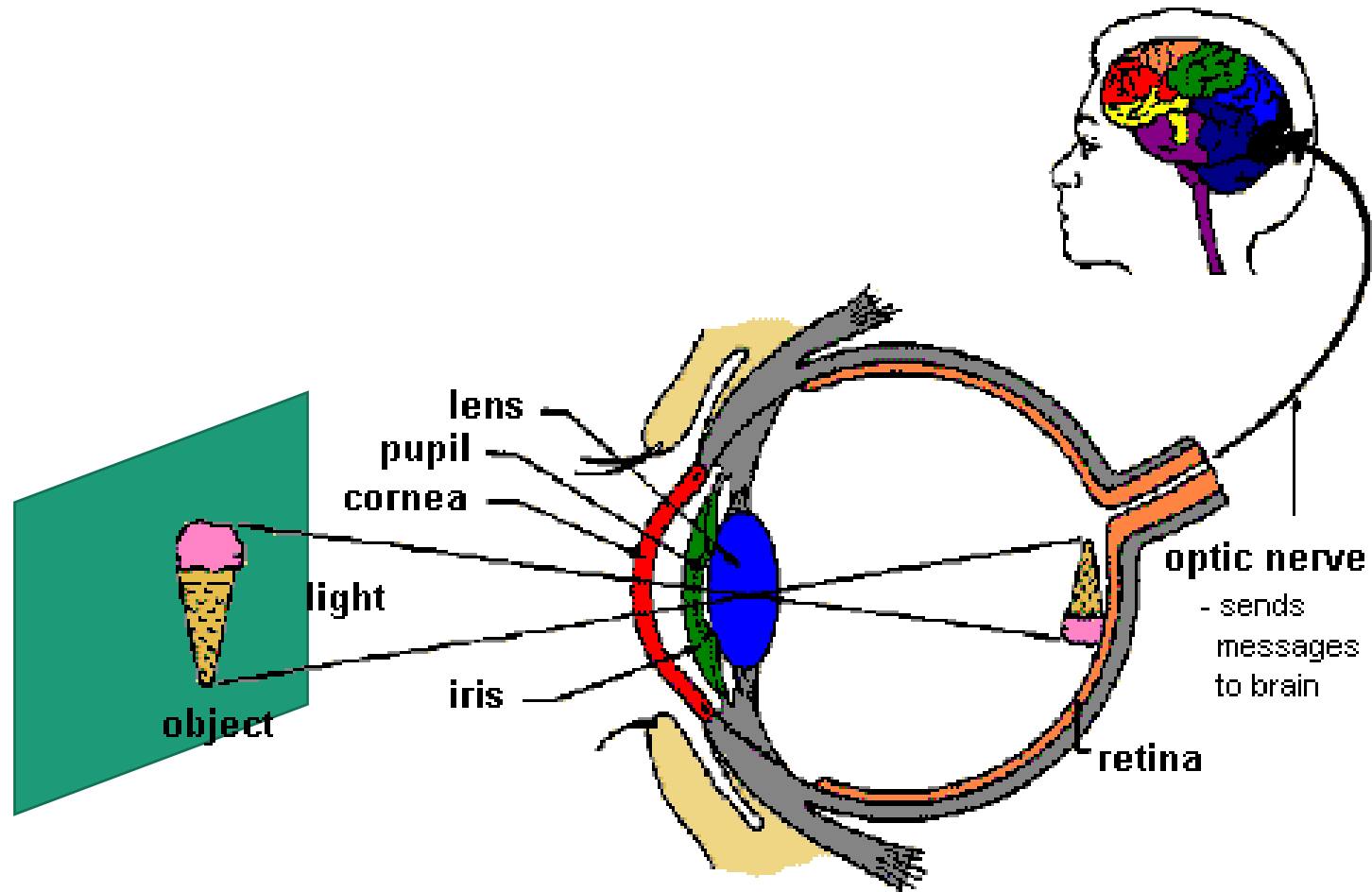
Digital Image Processing

Image

What is an “Image”?



What is an “Image”?



What is an “Image”?

- Snapshot of light
 - For a specific time
 - For specific directions
- Simulating real world
 - Producing similar visual stimuli
- In two dimensional form
 - Retina is 2D
 - Painting, photography...

What is an “Image”?

- Wikipedia
 - is an artifact that depicts [visual perception](#), such as a [photograph](#) or other [two-dimensional picture](#), that resembles a subject and thus provides a [depiction](#) of it
 - In the context of [signal processing](#), an image is a distributed amplitude of color(s).^[1]

What is an “Image”?

- 2D function
 - $f(x, y)$
 - Given 2D location (x, y)
 - There is some response (intensity) $f(x, y)$

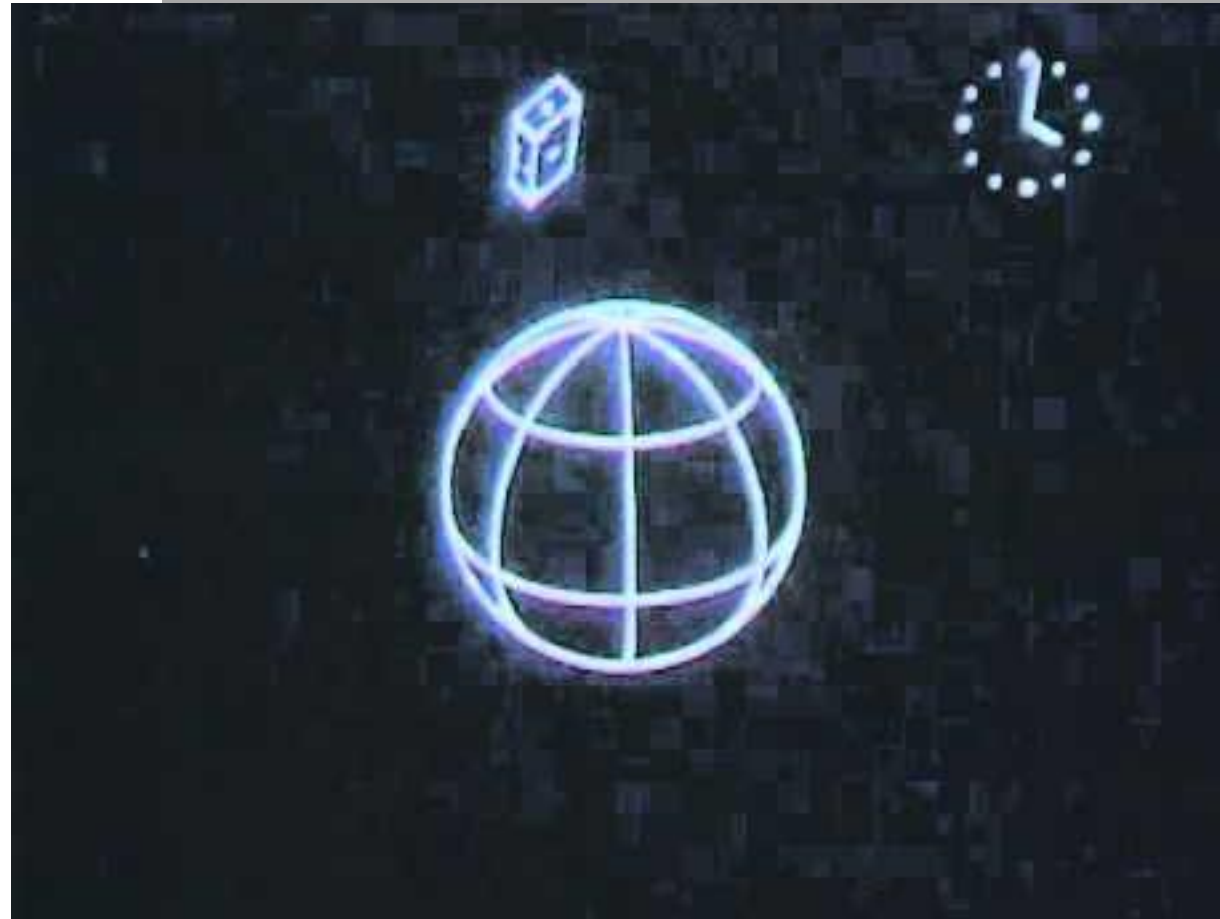
What is “Digital Image”?

- Image stored in a “digital form” (aka binary form)
 - Represented a sequence of numbers (finite)
- Common “digitization” method
 - Raster (aka Bitmapped) image
 - Vector image

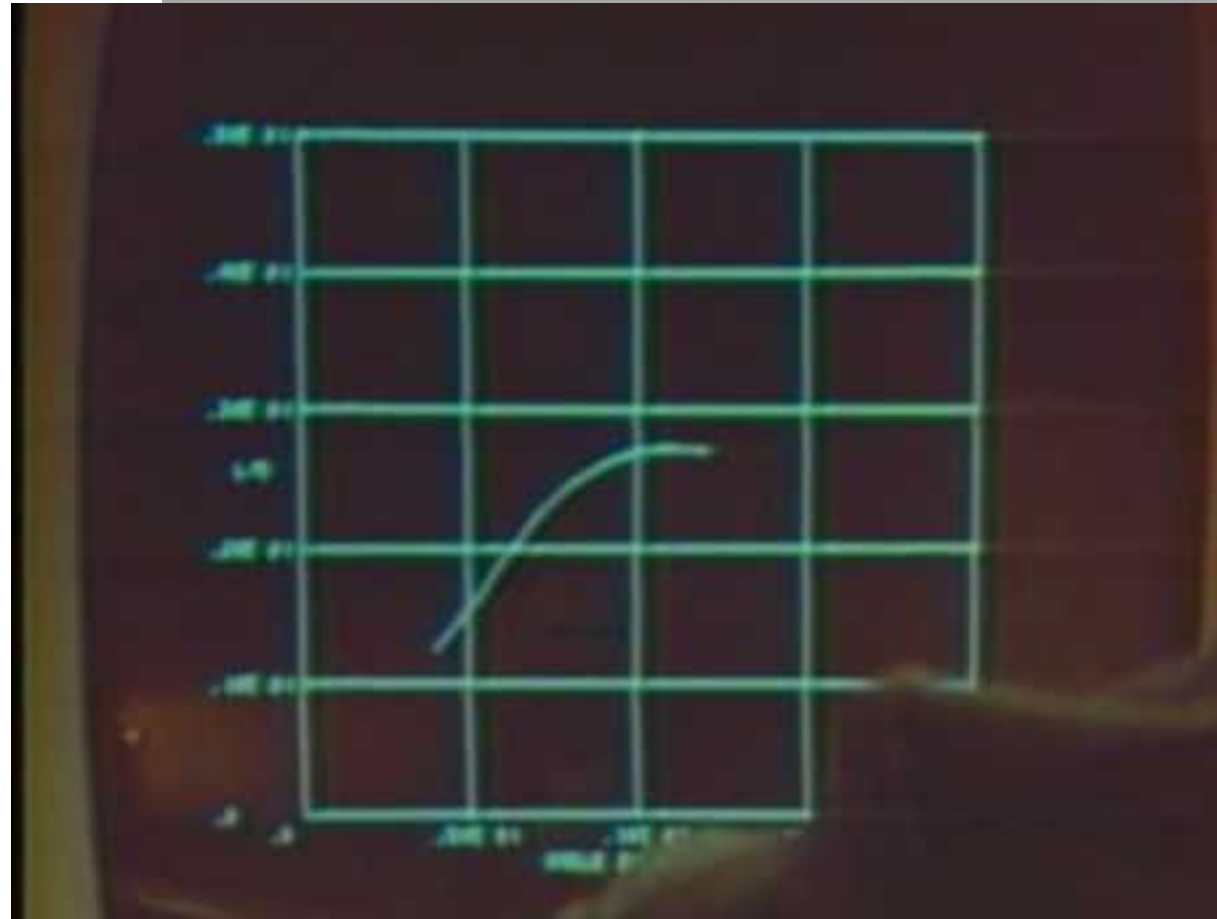
Raster Image

- Finite set of digital values
 - Picture elements (aka pixels)
 - Usually evenly distributed in vertical and horizontal direction
 - Pixels are squares in most cases
- Raster file formats
 - JPEG, PNG, GIF, DNG, and many

Vector Image



Vector Image



Vector Image

- Recent vector images
 - Storing how to draw thing on 2D image plane
 - Lines, polygons, circles, curves, ...
- Typical examples
 - Vector font
 - Data transferred to printer
 - SVG, AI, ...

Advantage & Disadvantage of Digital Image

- Easy reproduction
 - Fine detail
 - Natural image
 - Easy to access a part
 - Easy to modify globally
- Large data
 - Resolution dependent
 - Limited resolution
 - Bad for scaling
 - Hard to modify locally

Brief History of Digital Image



FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.[†])

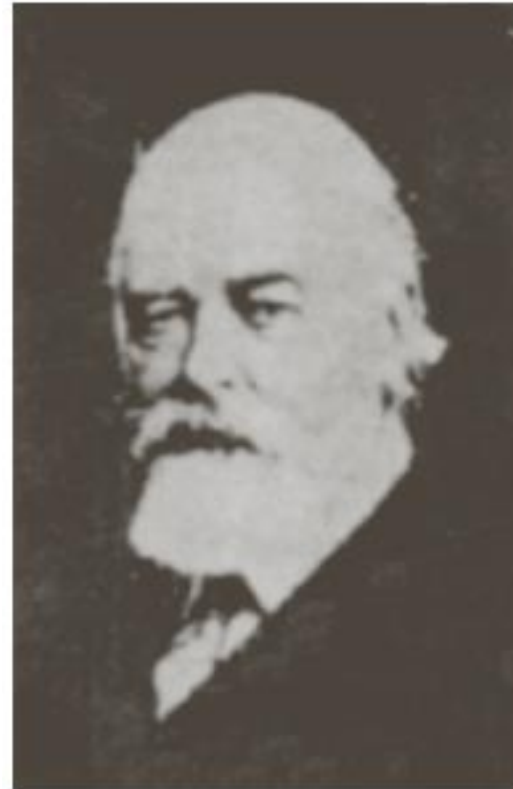


FIGURE 1.2 A digital picture made in 1922 from a tape punched after the signals had crossed the Atlantic twice. (McFarlane.)

Brief History of Digital Image

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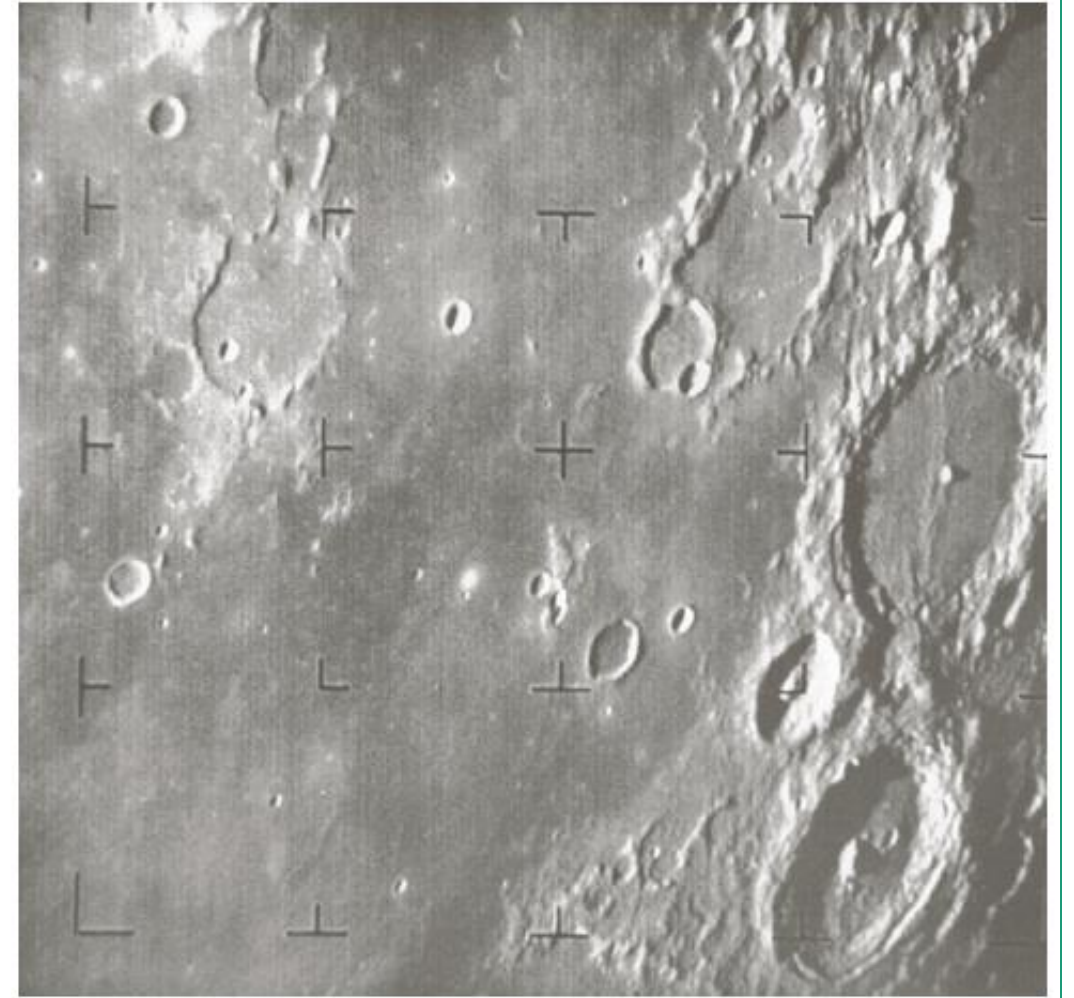
Brief History of Digital Image

- 5 distinct brightness levels
 - Improved in 1929 to 15 levels
 - Developing a film plate
 - Coded picture tape



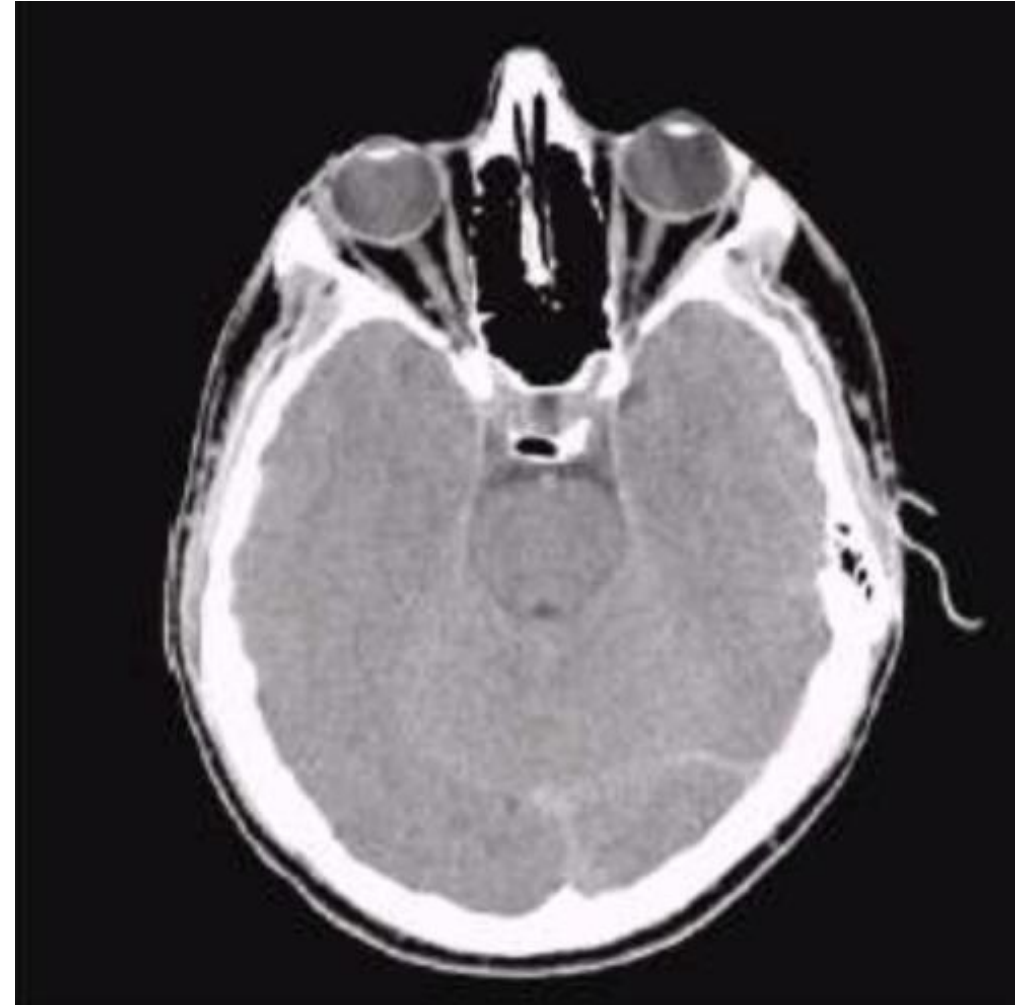
Brief History of Digital Image

- First picture of the moon (1960)
 - Took by spacecraft Ranger
 - Computers used to improve the quality of image



Brief History of Digital Image

- Medical applications (1970)
 - Tomography
 - Processed to Computerized tomography (aka CT)



Invisible Light Imaging

- Electromagnetic energy spectrum

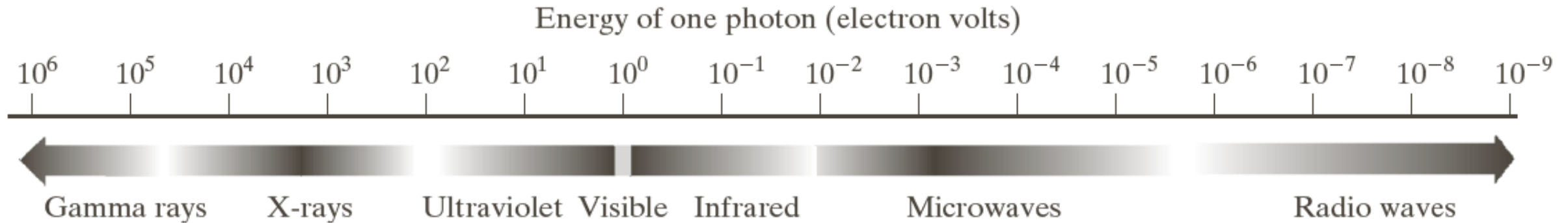
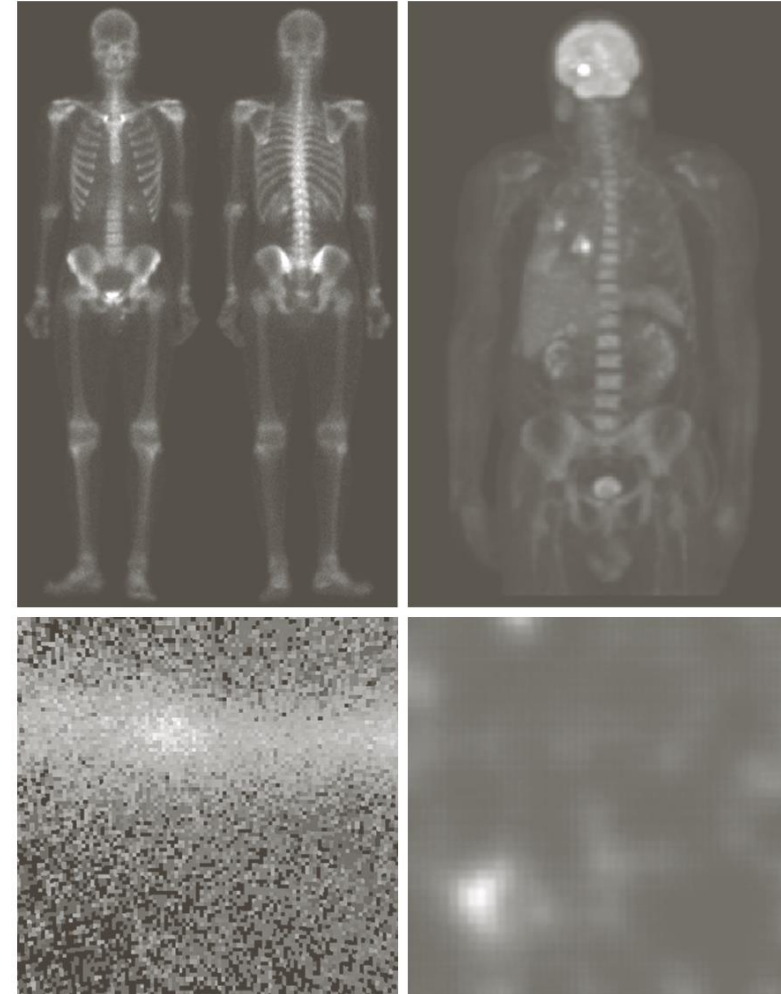


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

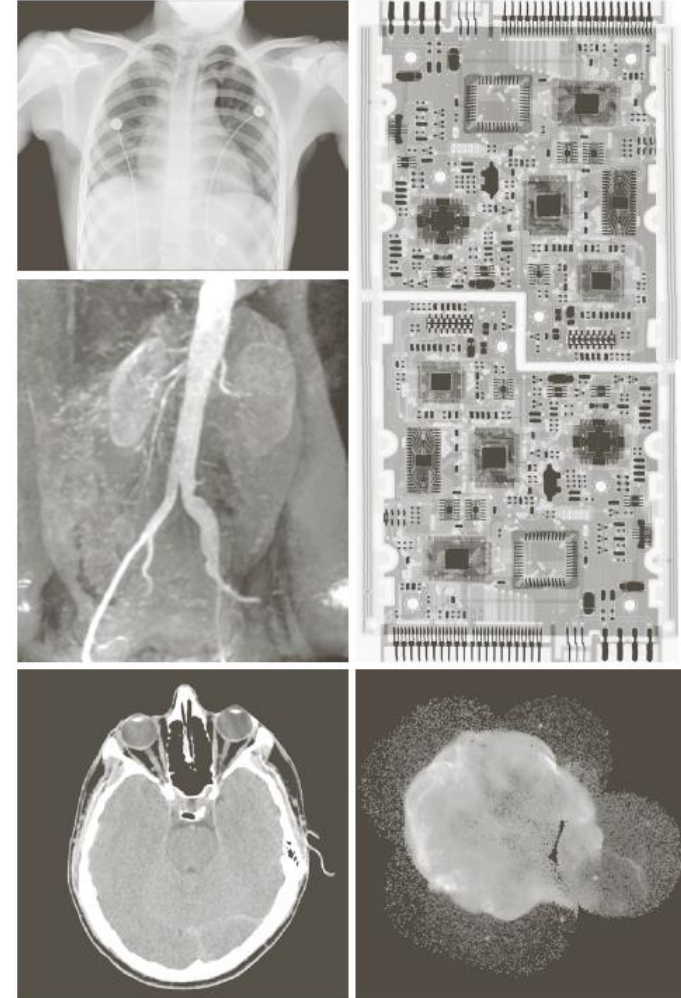
Invisible Light Imaging

- Gamma-Ray Imaging



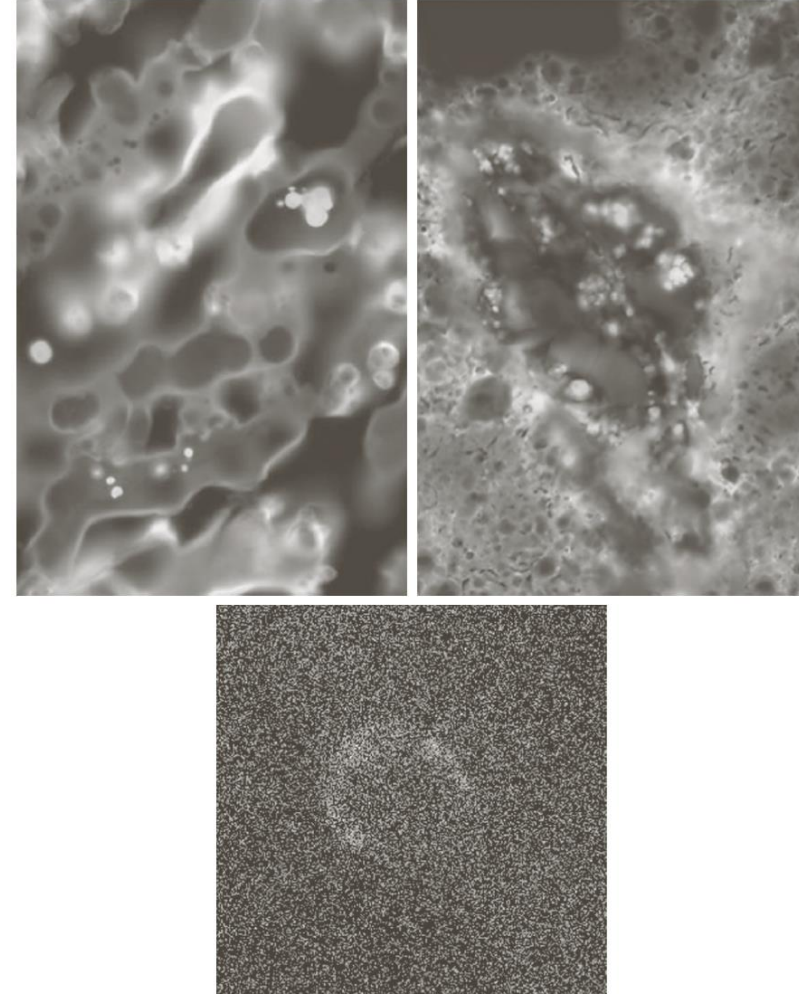
Invisible Light Imaging

- X-Ray imaging



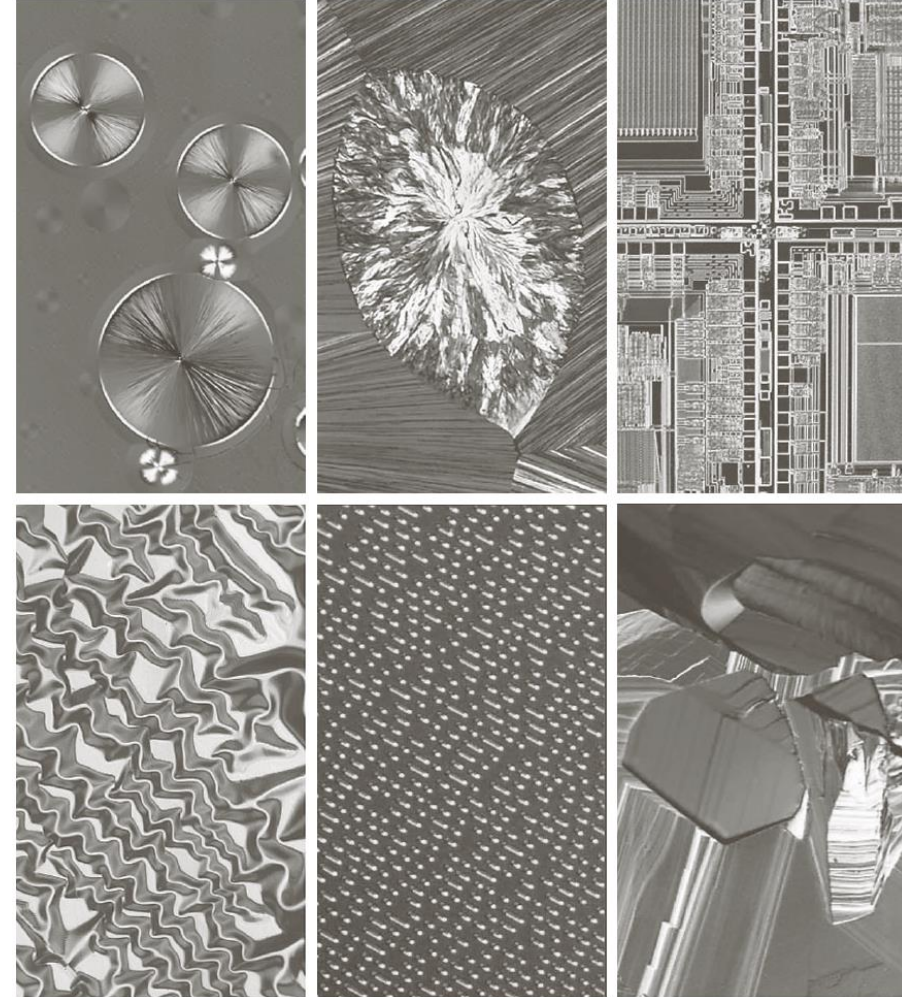
Invisible Light Imaging

- Ultra-violet band

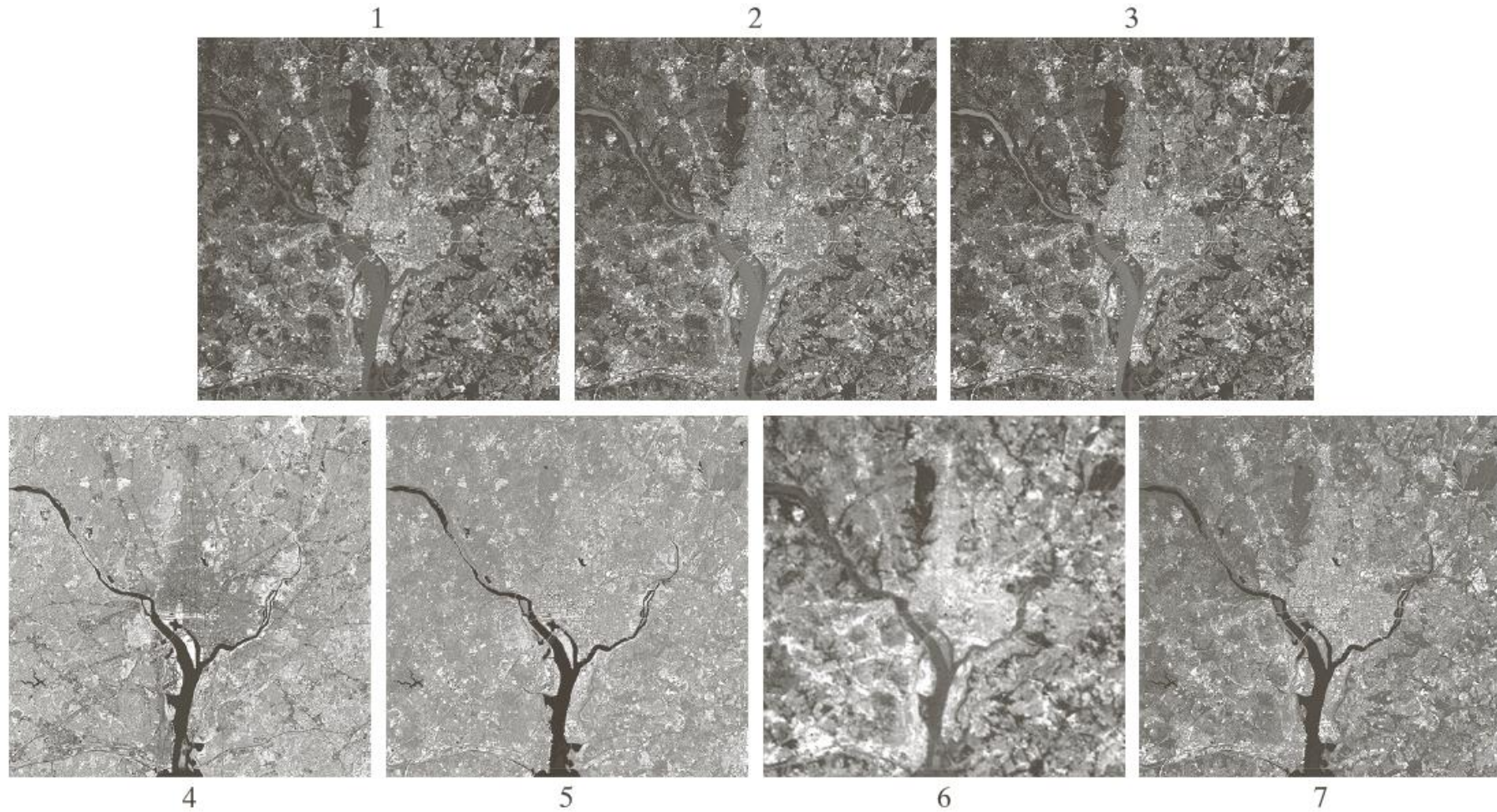


Invisible Light Imaging

- Visible + Infrared band image
 - Microscopic images



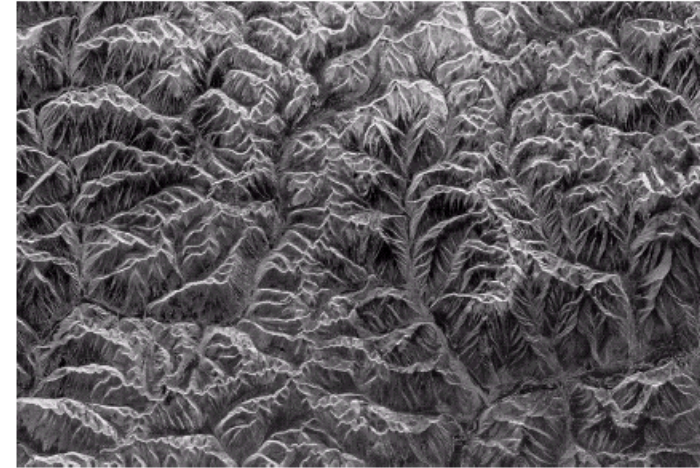
Invisible Light Imaging



Invisible Light Imaging

- Microwave band imaging

FIGURE 1.16
Spaceborne radar
image of
mountains in
southeast Tibet.
(Courtesy of
NASA.)



Invisible Light Imaging

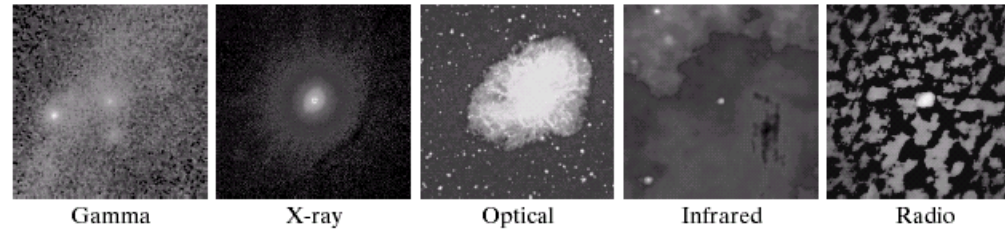
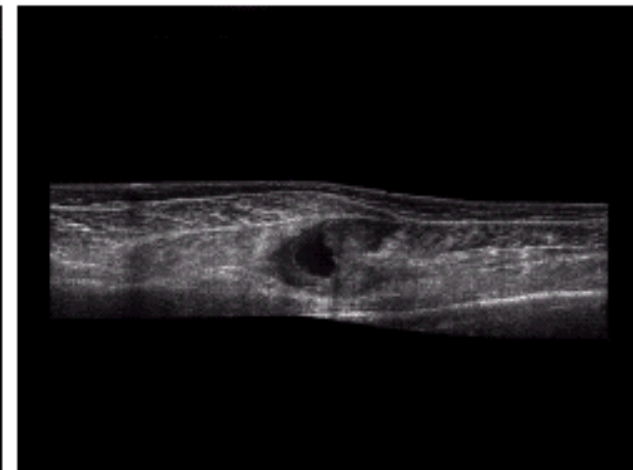
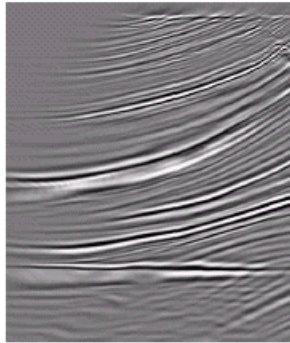


FIGURE 1.18 Images of the Crab Pulsar (in the center of images) covering the electromagnetic spectrum. (Courtesy of NASA.)

Sound & Ultrasonic Wave Imaging

FIGURE 1.19
Cross-sectional
image of a seismic
model. The arrow
points to a
hydrocarbon (oil
and/or gas) trap.
(Courtesy of
Dr. Curtis Ober,
Sandia National
Laboratories.)



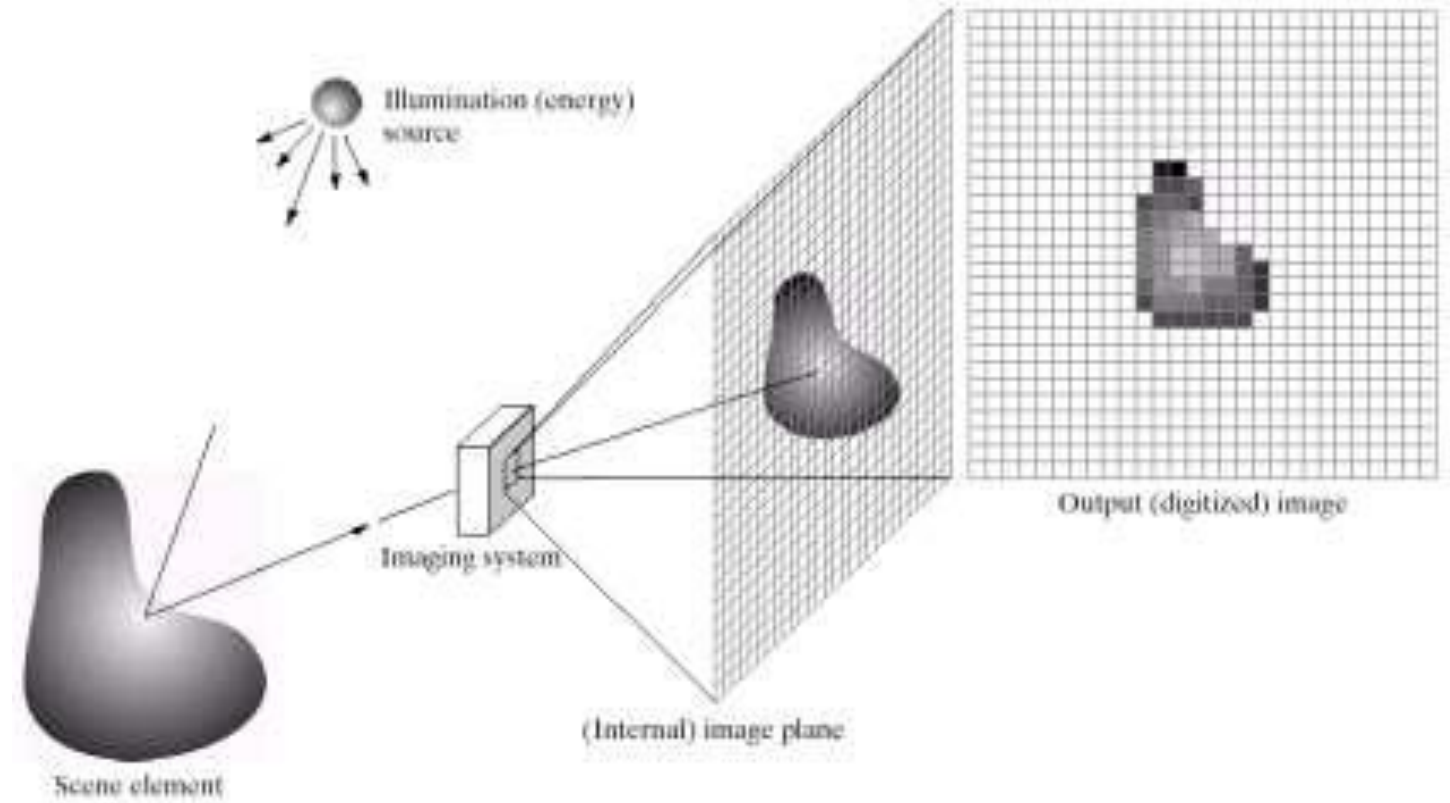
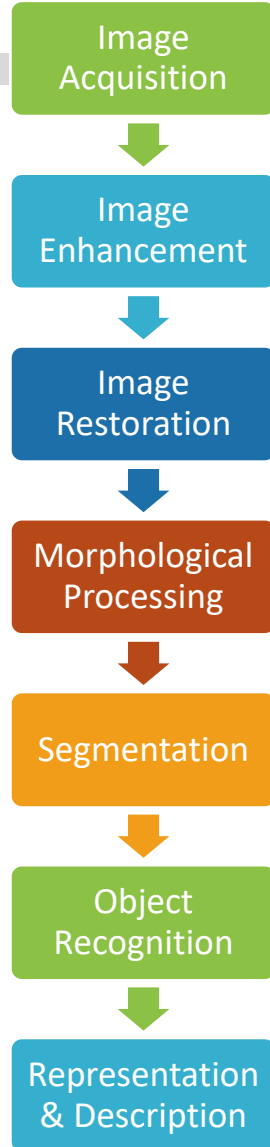
What is Digital Image Processing

- Digital image processing focuses on two major tasks
 - Improvement of pictorial information for human interpretation
 - Processing of image data for storage, transmission and representation for autonomous machine perception
- Some argument about where image processing ends and fields such as image analysis and computer vision start

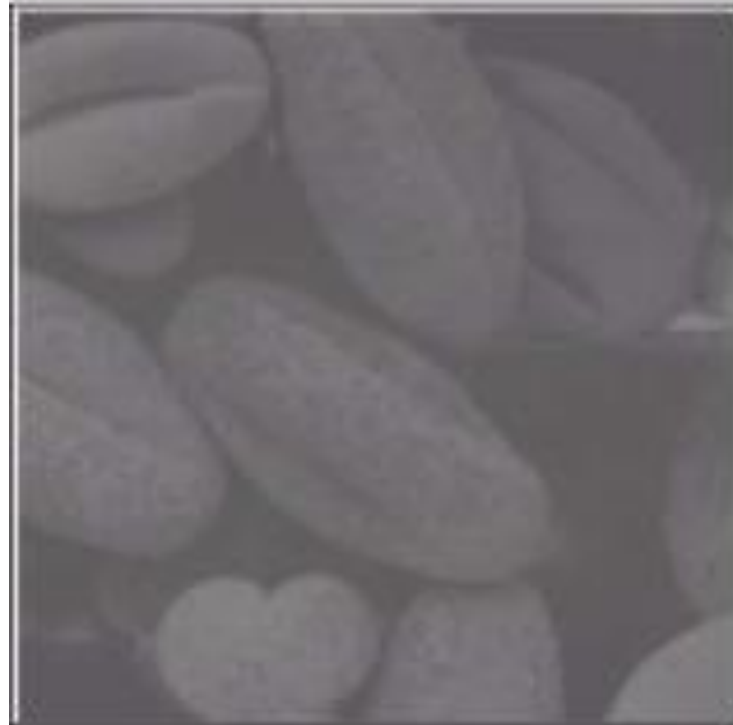
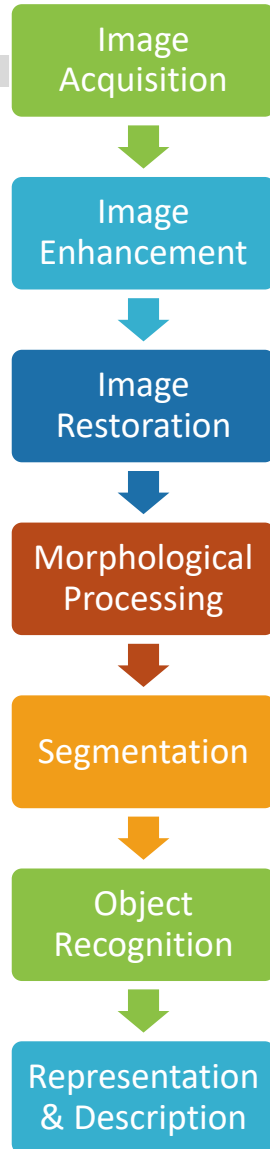
Fundamental Levels in DIP

- Low level
 - Image \Rightarrow image
 - Example: Noise removal, image sharpening
- Mid level
 - Image \Rightarrow Attributes
 - Example: Object recognition & segmentation
- High level
 - Attribute (image) \Rightarrow Understanding
 - Example: Scene understanding, autonomous navigation

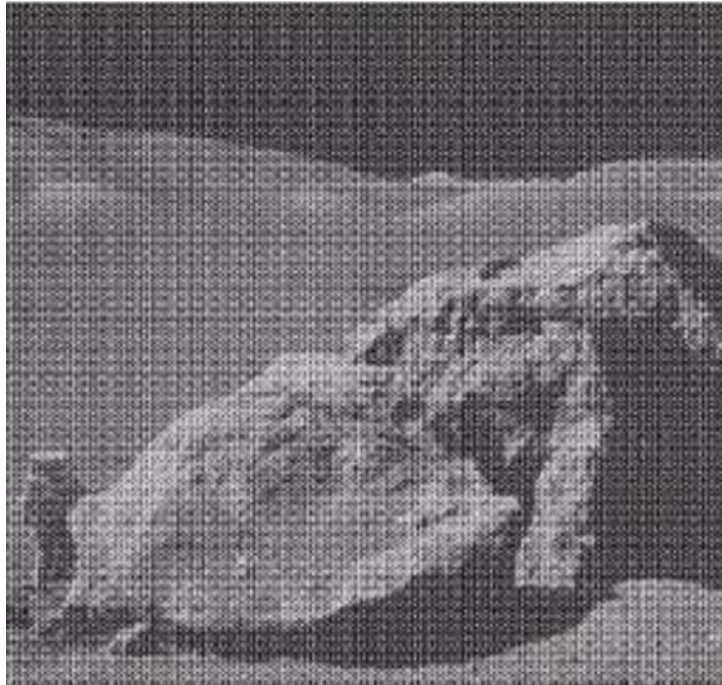
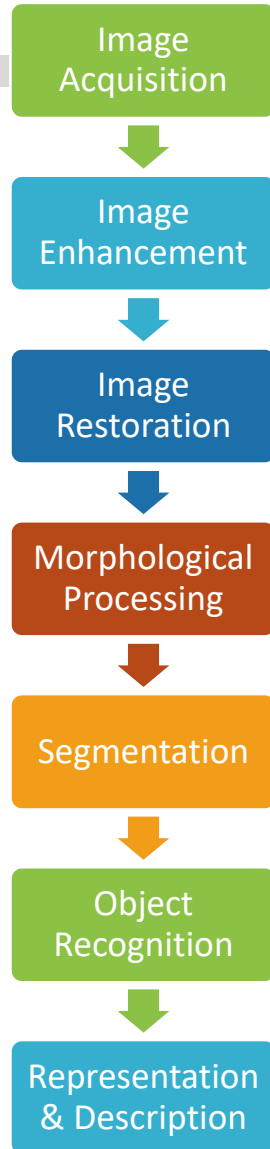
Key Stages in DIP



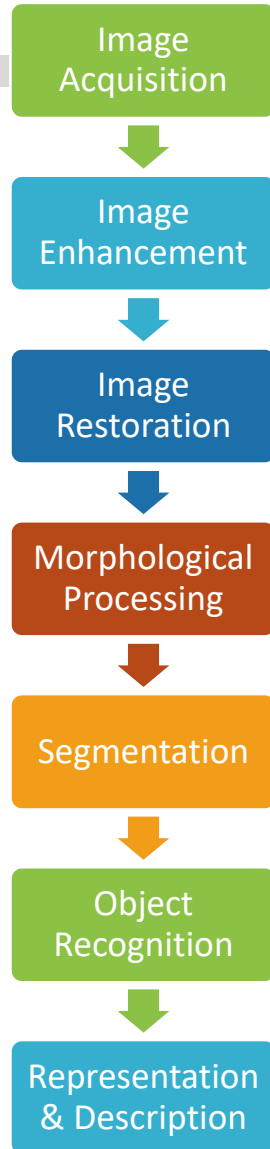
Key Stages in DIP



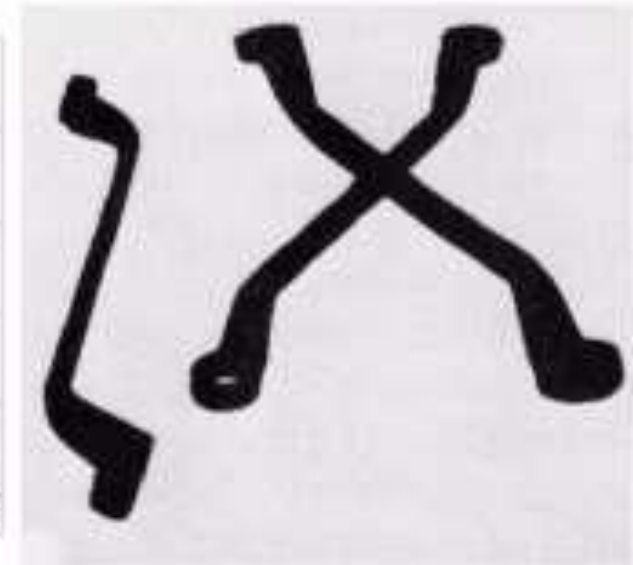
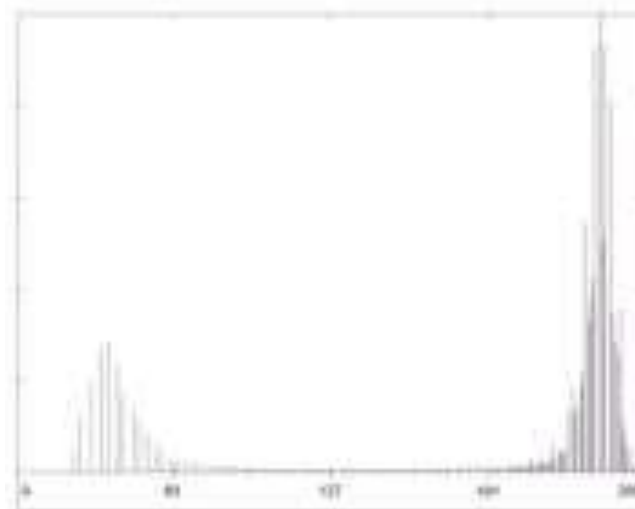
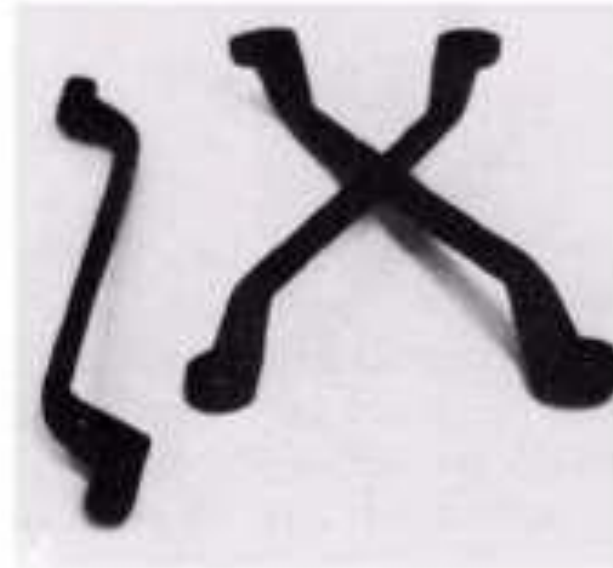
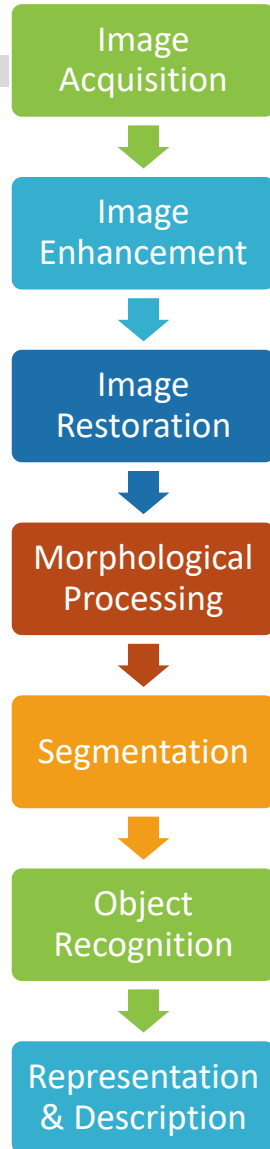
Key Stages in DIP



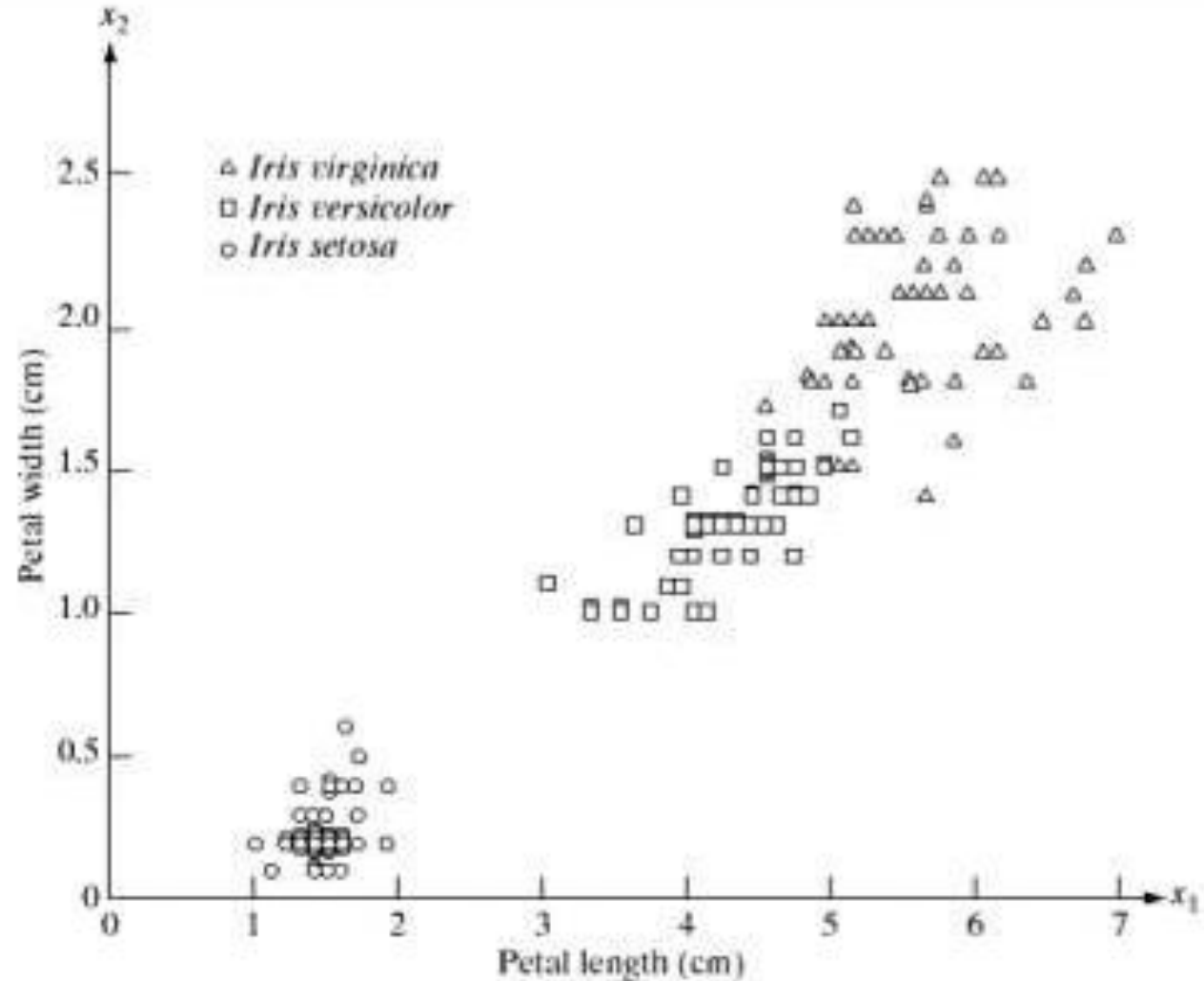
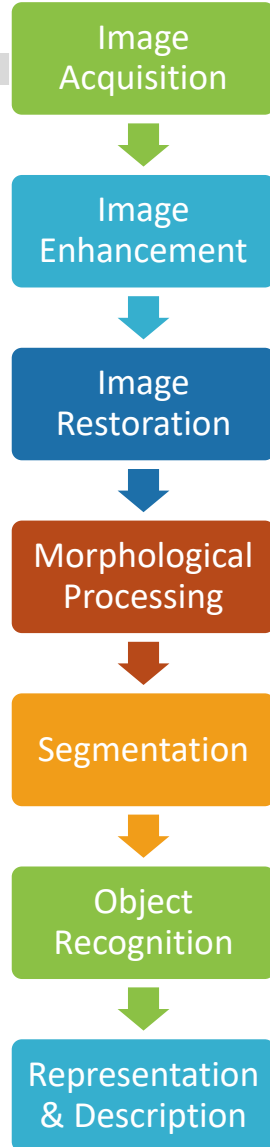
Key Stages in DIP



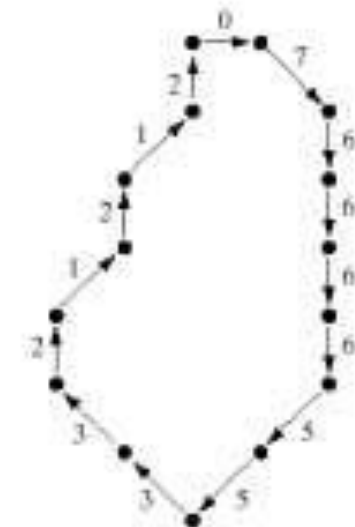
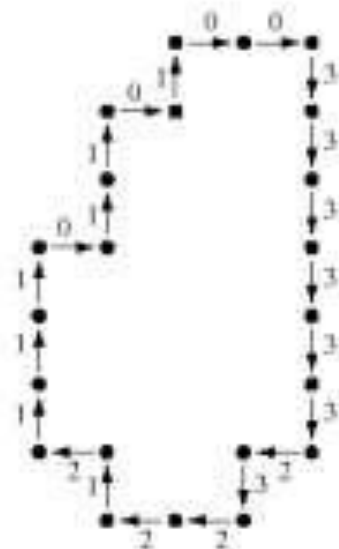
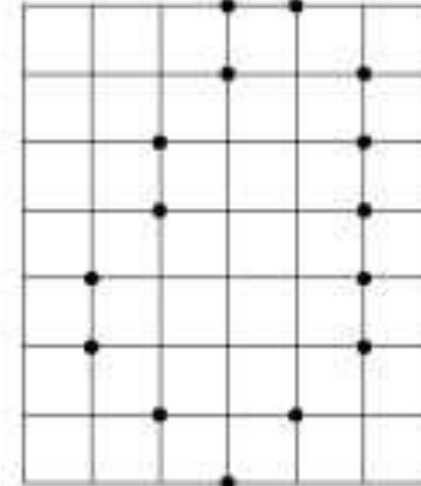
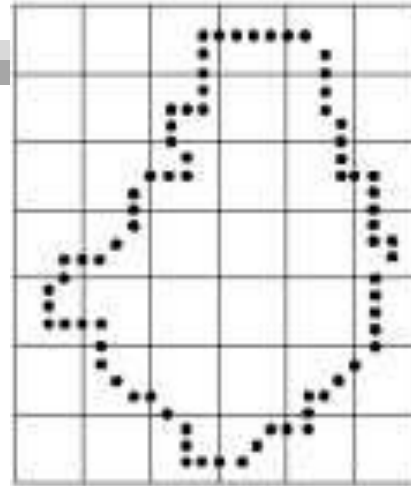
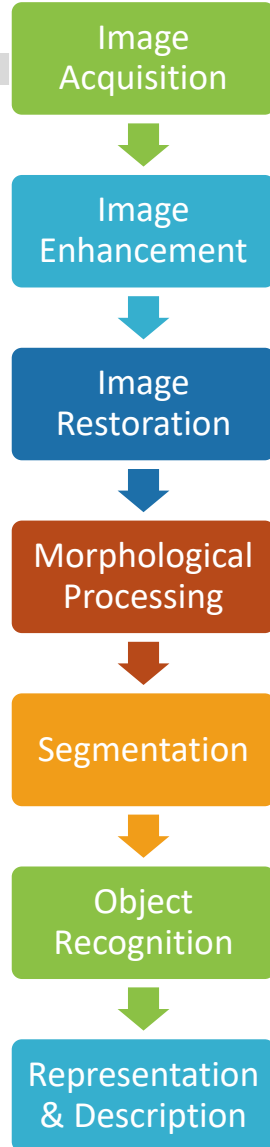
Key Stages in DIP



Key Stages in DIP



Key Stages in DIP



Extra Issues

- Image compression
- Color image processing

Questions?