Chapter 1

DIGITAL IMAGE PROCESSING INTRODUCTION

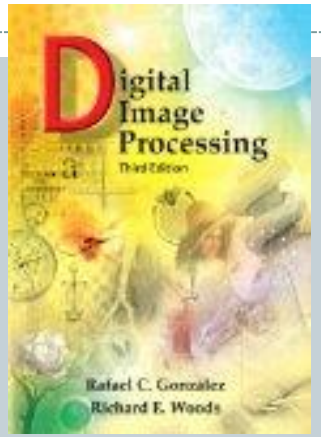
Introduction

"One picture is worth more than ten thousand words"

Anonymous

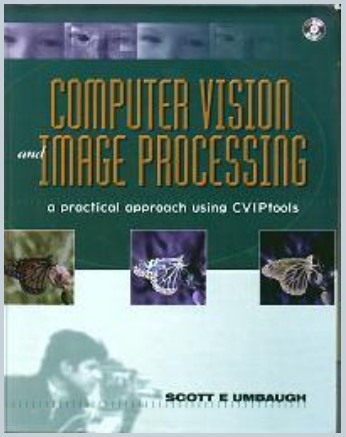
References

"Digital Image Processing",
Rafael C. Gonzalez & Richard E. Woods,
Addison-Wesley, 2008

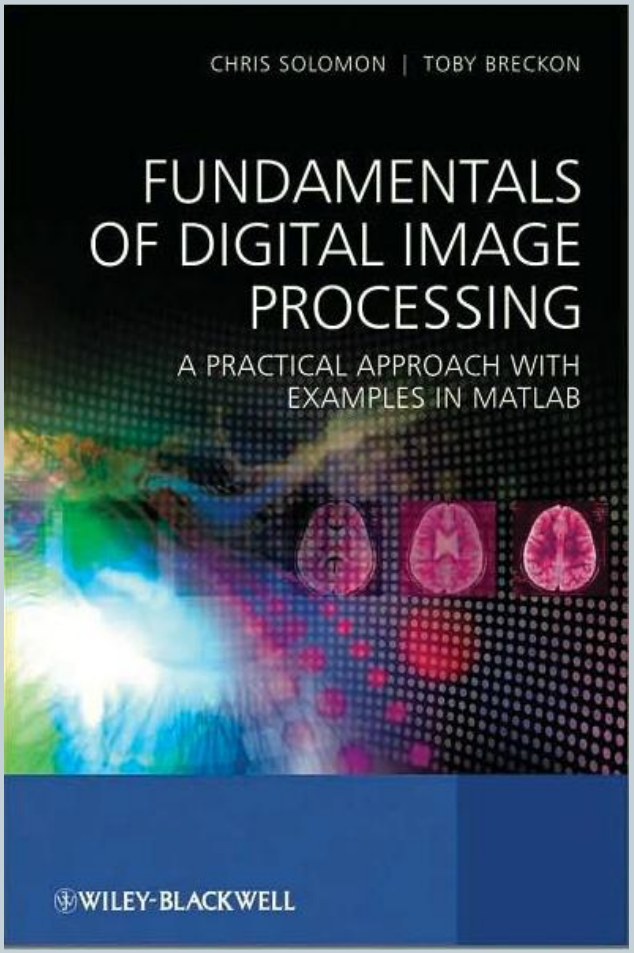


And

"Computer Vision and image processing :
A practical approach using cvip tools
Scott E umbaugh, Prentice hall 1998



http://www.mathworks.com/help/images/index.html



Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab

- Chris Solomon
- 2011 by John Wiley & Sons, Ltd

- Course Instructor : Assoc. Prof. : Mazen Selim
- Course Demonstrator : Eng. Yasmin
- Course marks : 100 marks
- Distributed as 65 : final exam
  35 : class work
- 4 quizzes will be hold
- 1 midterm exam
- 8 experiments using Matlab
- Beside the course chapter problems.

Course Outlines

- Ch1 : Introduction
- Ch2 : Digital Image Fundamentals
- Ch3 : Intensity Transformation and Spatial Filtering
- Ch4 : Filtering in The Frequency Domain
- Ch5 : Image Restoration and Reconstruction
- Ch8 : Image Compression
- Ch9 : Morphological Image Processing
- Ch10: Image Segmentation

Contents

This lecture will cover:

- What is a digital image?
- What is digital image processing?
- History of digital image processing
- State of the art examples of digital image processing
- Key stages in digital image processing

Computer imaging

- It's defined as the acquisition and processing of visual information by computer.
- The ultimate receiver of information is:
  - Computer
  - Human visual system
- So we have two categories:-
  - Computer vision
  - Image processing

Computer vision and image processing

- In computer vision:
  - The processed output images are for use by computer.
- In Image processing:
  - The output images are for human consumption

Computer vision

- One of the computer vision fields is image analysis.
- It involves the examination of image data to facilitate solving a vision problem.
- Image analysis has 2 topics:
  - Feature extraction: acquiring higher level image information
  - Pattern classification taking these higher level of information and identifying objects within the image

- Image Processing

  image in → image out

- Image Analysis

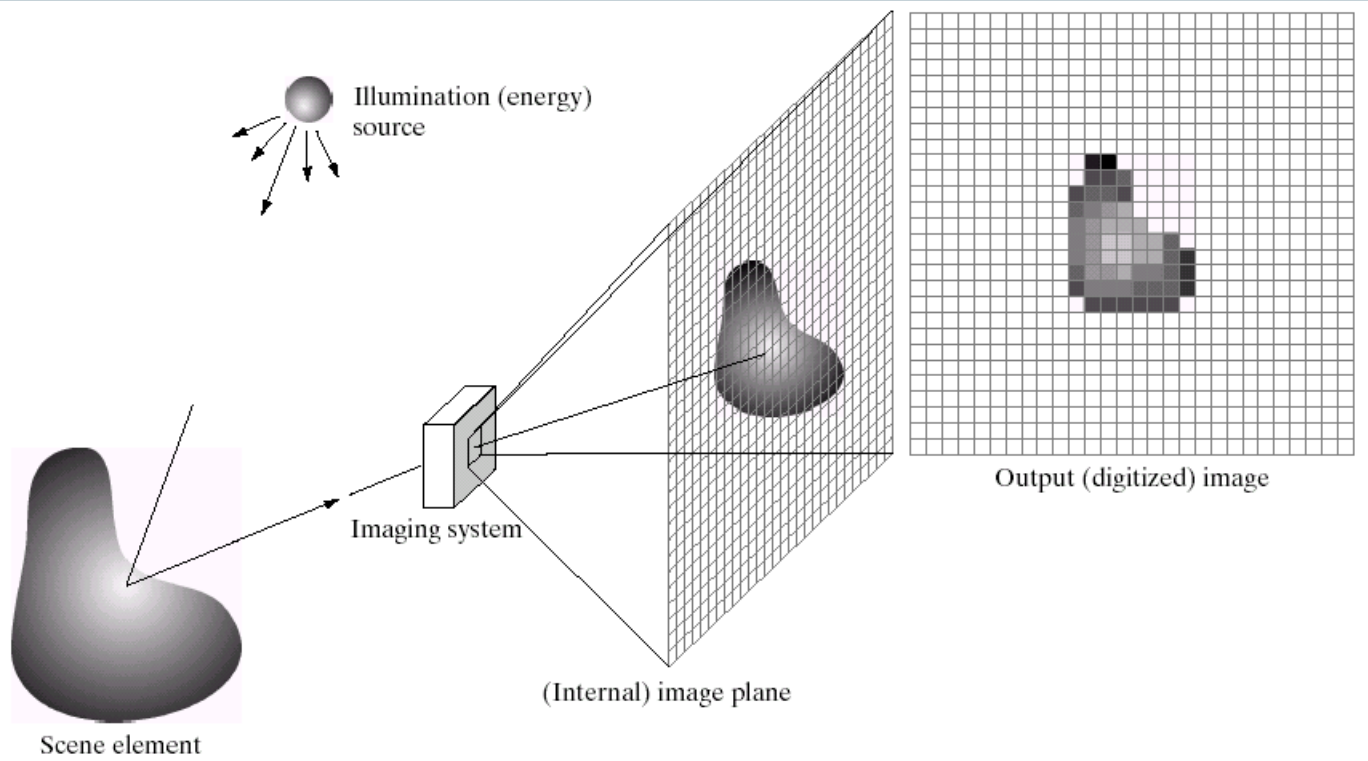
  image in → measurements out

- Image Understanding

  image in → high-level description out

What is a Digital Image?

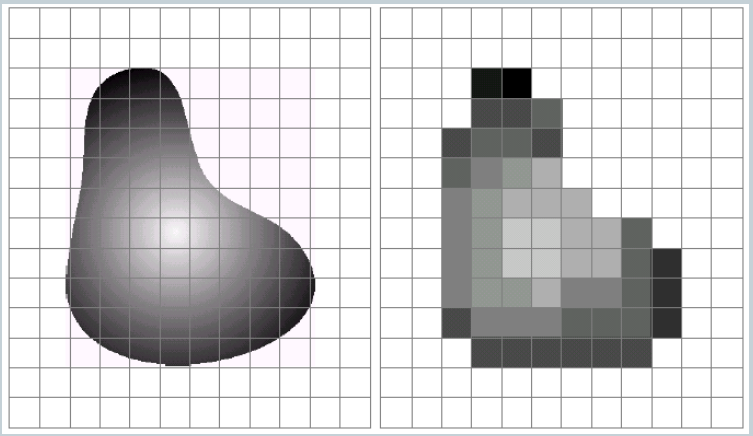
A **digital image** is a representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels

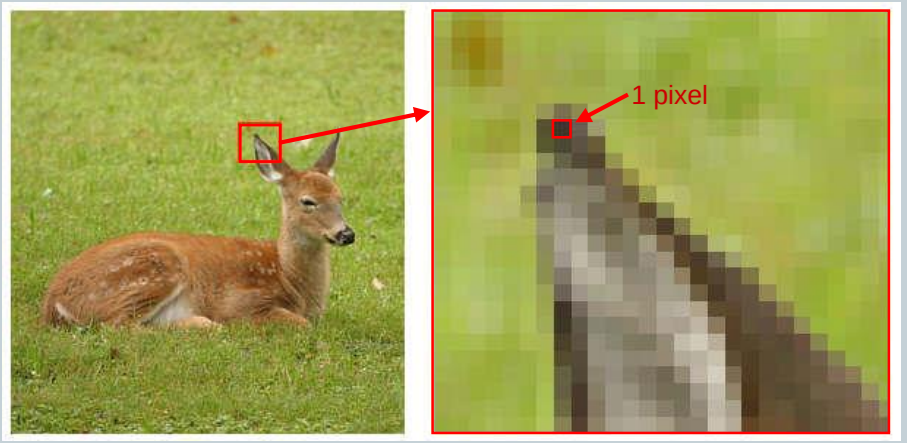


What is a Digital Image? (cont…)

- It is an approximation of a real scene.
- It is a representation of a two-dimensional image.
- It composed of a finite number of elements called pixels or picture elements.
- Pixel values represent gray levels (intensity).

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





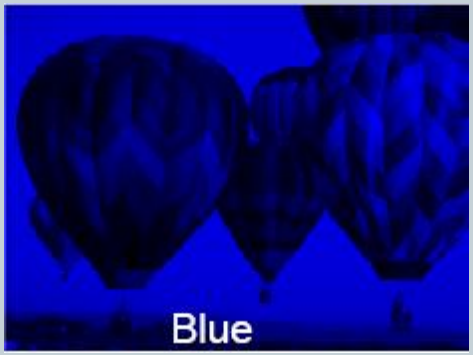
What is a Digital Image? (cont…)

Common image formats include:

- 1 sample per point (B&W or Grayscale)
- 3 samples per point (Red, Green, and Blue)

Fo urs n grey-scale images

RGB Coloring System



What is Digital Image Processing?

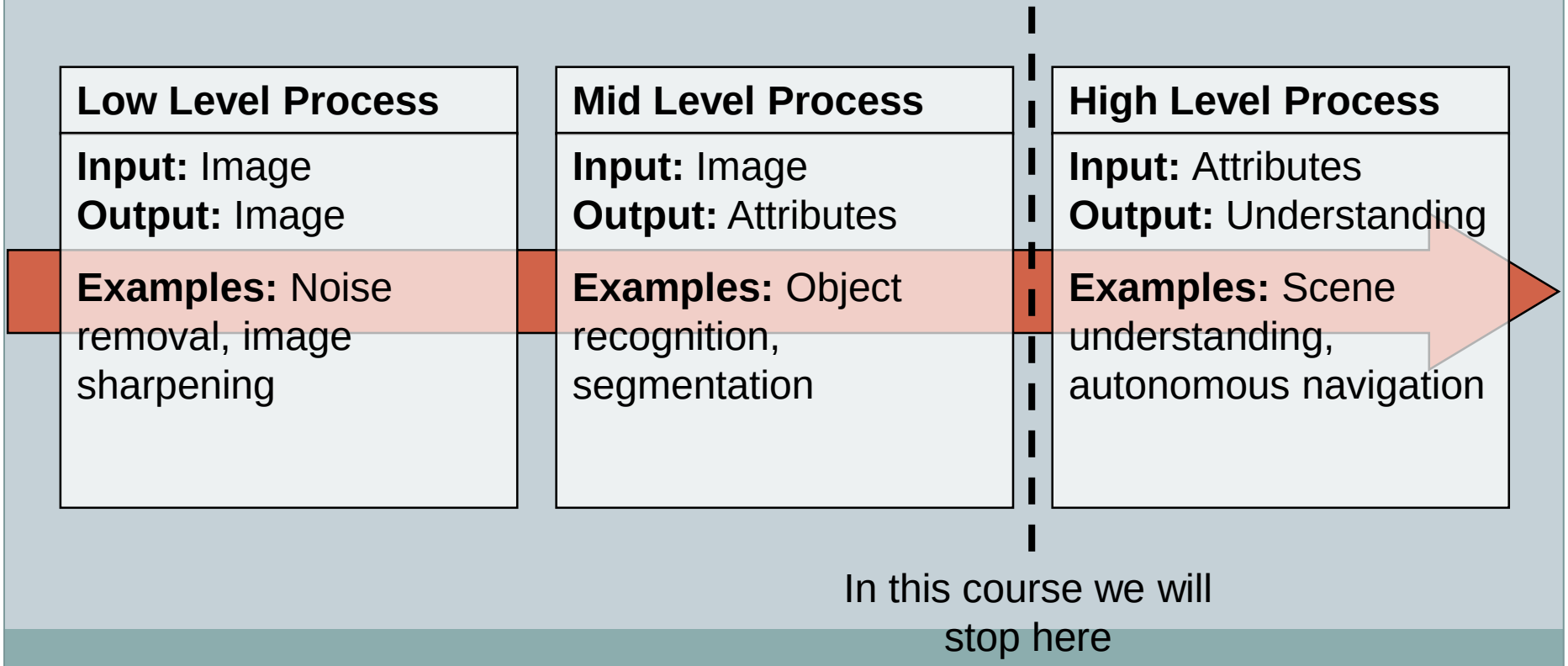
Digital image processing focuses on two major tasks

- Improvement of pictorial information for human interpretation
- Processing of image data for storage, transmission and representation for autonomous machine perception- فهم إدراك

Some argument about where image processing ends and fields such as image analysis and computer vision start

What is DIP? (cont…)

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



History of Digital Image Processing

Early 1920s: One of the first applications of digital imaging was in the news-paper industry (5 levels)

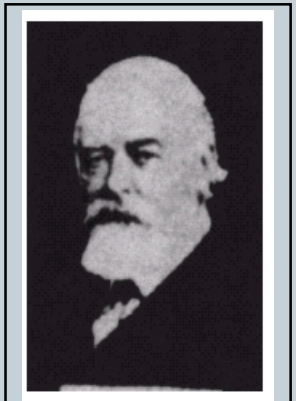
Early digital image

- 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

History of DIP (cont…)

Mid to late 1920s: Improvements to the Bartlane system resulted in higher quality images

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



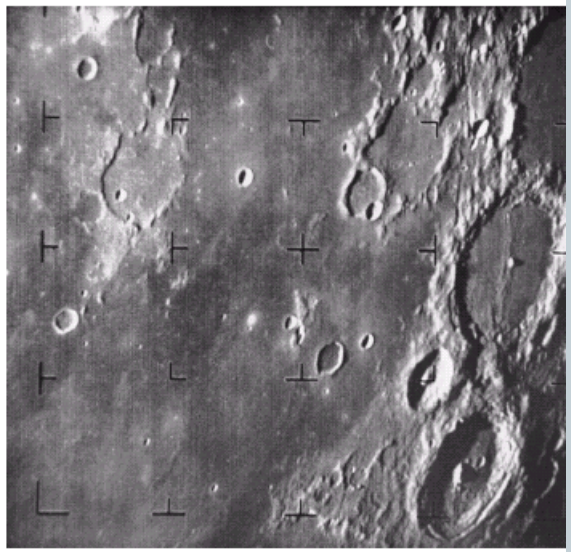
Improved digital image

Early 15 tone digital image

History of DIP (cont…)

1960s: Improvements 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 of the moon taken by the *Ranger 7* probe
- Such techniques were used in other space missions including the Apollo landings



A picture of the moon taken by the Ranger 7 probe minutes before landing

History of DIP (cont…)

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 رسم سطحی, the technology behind Computerised Axial Tomography (CAT) scans

Typical head slice CAT image

- A computerized axial tomography scan is an x-ray procedure that combines many x-ray images with the aid of a computer to generate cross-sectional views and, if needed, three-dimensional images of the internal organs and structures of the body.

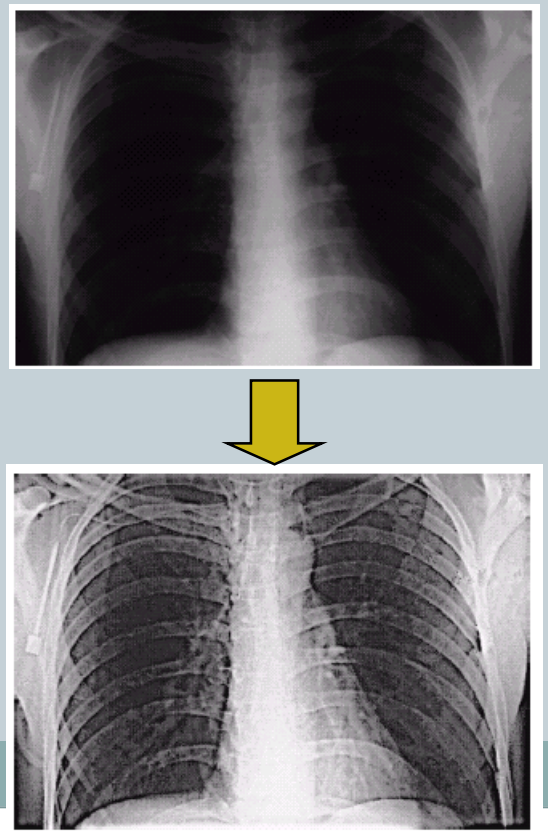
History of DIP (cont…)

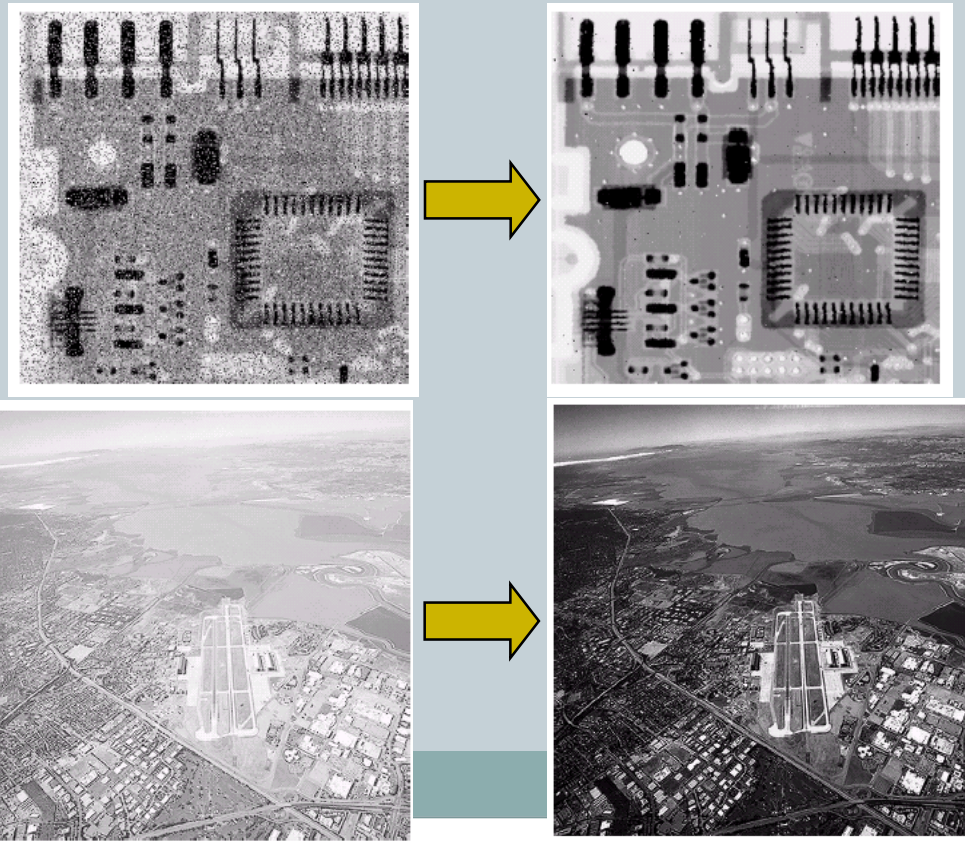
1980s - Today: The use of digital image processing techniques has exploded and they are now used for all kinds of tasks in all kinds of areas

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

Examples: Image Enhancement

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



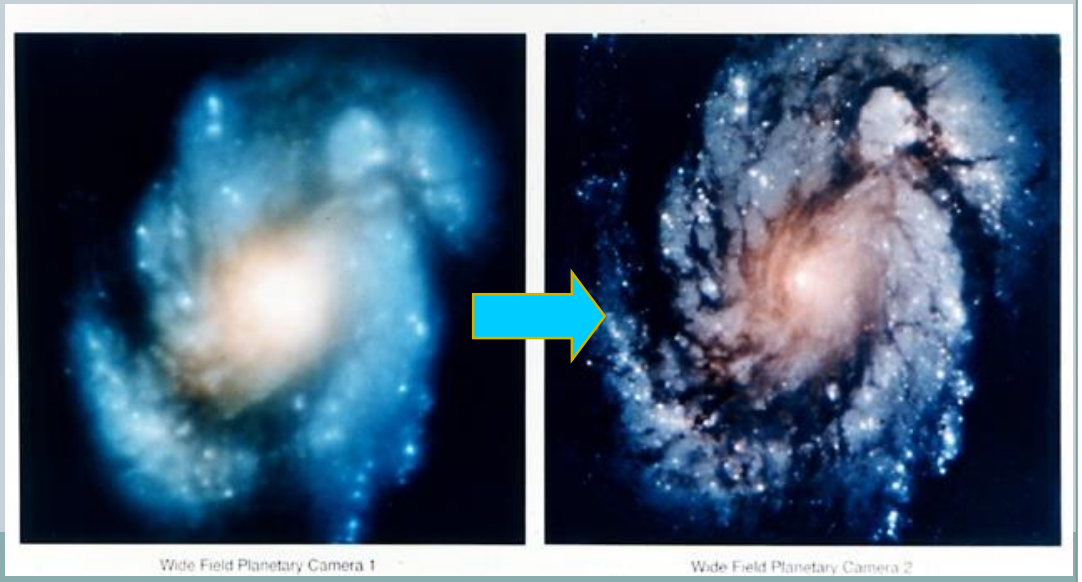


Examples: The Hubble Telescope

Launched in 1990 the Hubble telescope can take images of very distant objects

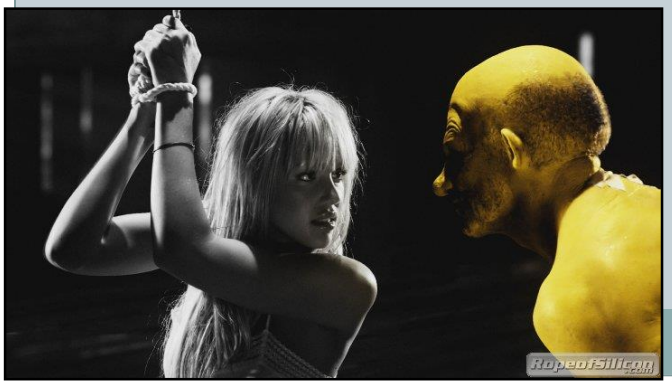
However, an incorrect mirror made many of Hubble's images useless

Image processing techniques were used to fix this



Examples: Artistic Effects

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

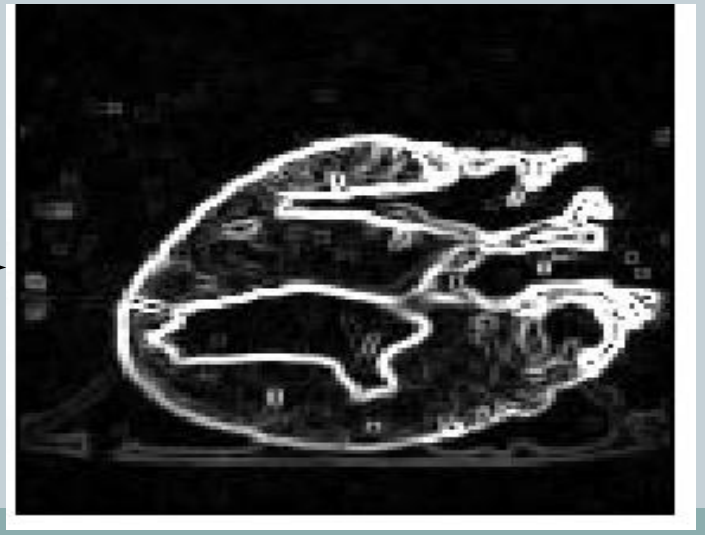


Examples: Medicine

Take slice from MRI scan of canine heart, and find boundaries between types of tissue

- Image with gray levels representing tissue density
- Use a suitable filter to highlight edges

Original MRI Image of a Dog Heart

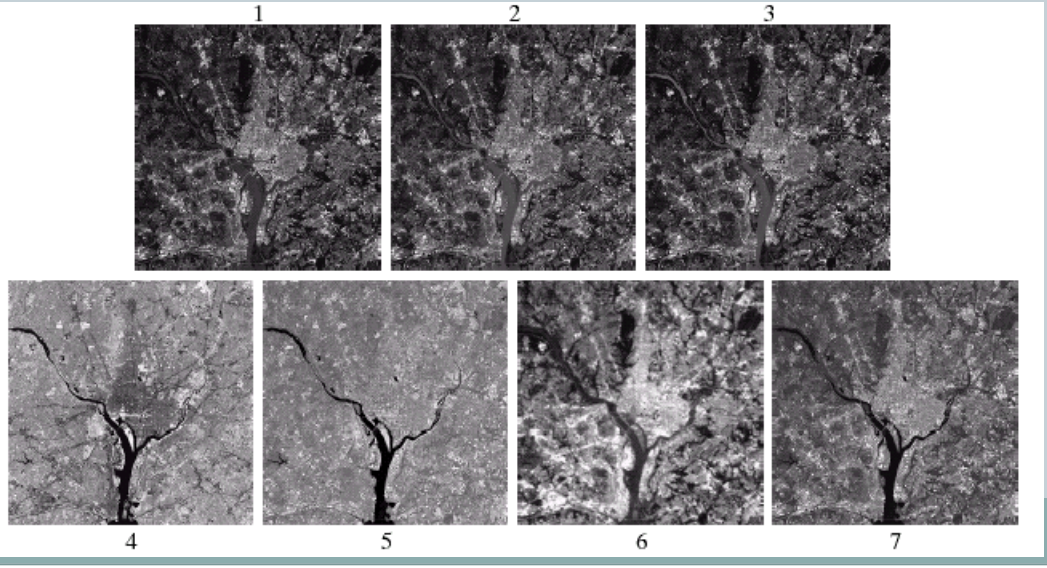


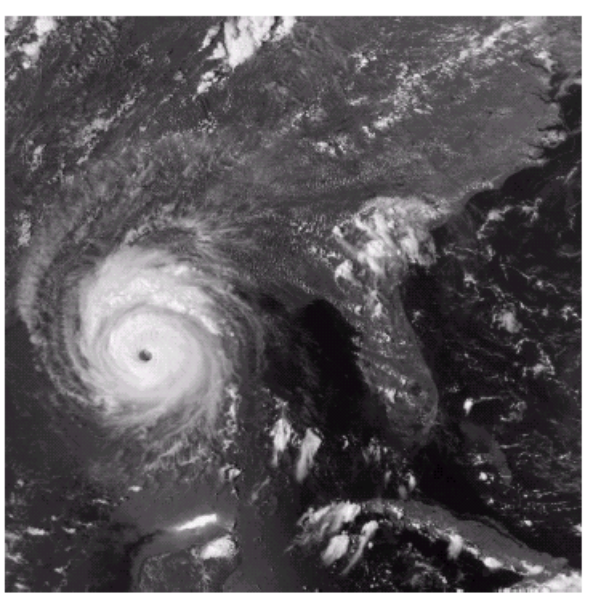
Edge Detection Image

Examples: GIS

Geographic Information Systems

- Digital image processing techniques are used extensively to manipulate satellite imagery
- Terrain تضاريس classification
- Meteorology الأرصاد الجوية





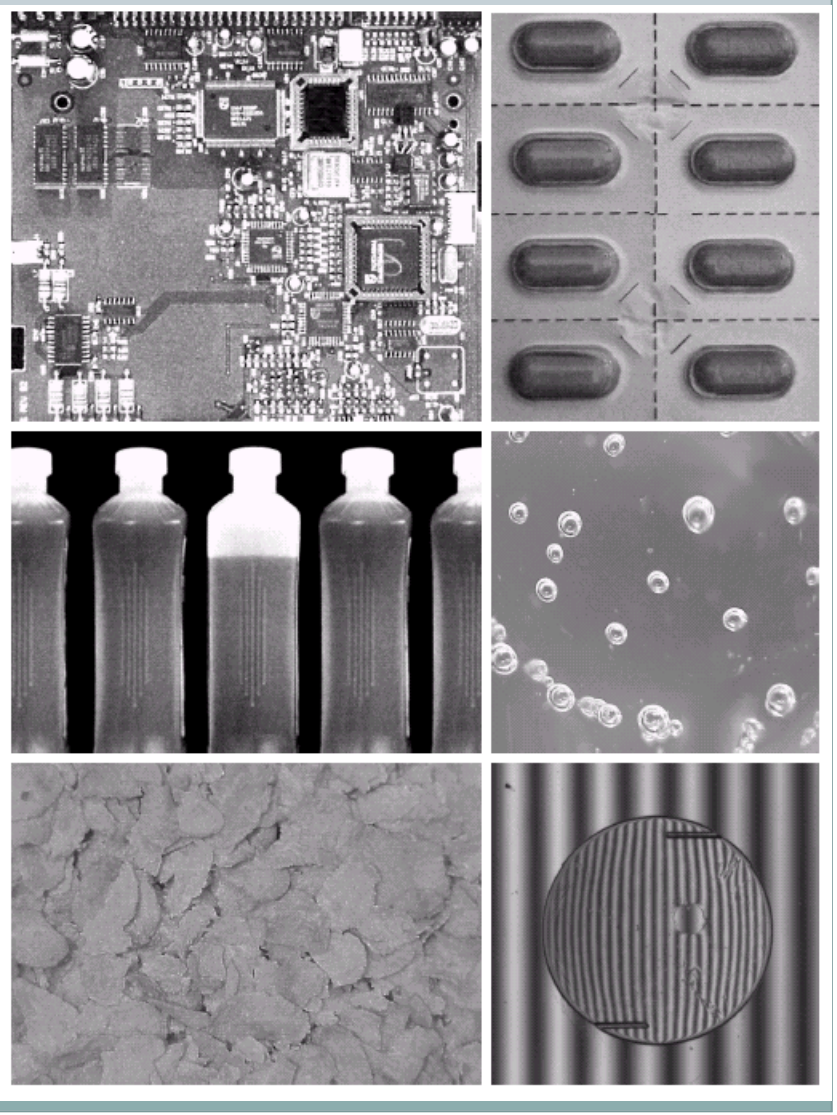
Examples: GIS (cont…)

Night-Time Lights of the World data set

- Global inventory of human settlement
- Not hard to imagine the kind of analysis that might be done using this data

Examples: Industrial Inspection

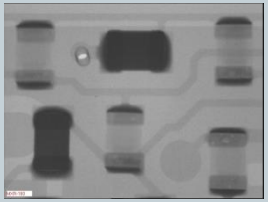
- Human operators are expensive, slow and unreliable
- Make machines do the job instead
- Industrial vision systems are used in all kinds of industries
- Can we trust them?

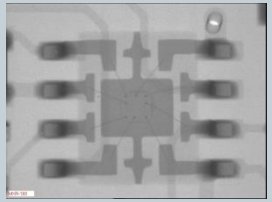


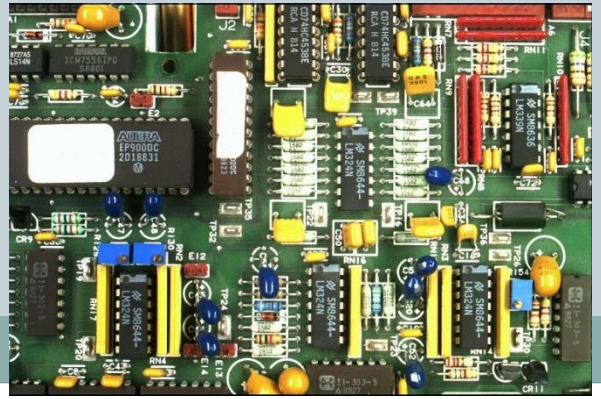
Examples: PCB Inspection

Printed Circuit Board (PCB) inspection

- Machine inspection is used to determine that all components are present and that all solder joints are acceptable
- Both conventional imaging and x-ray imaging are used



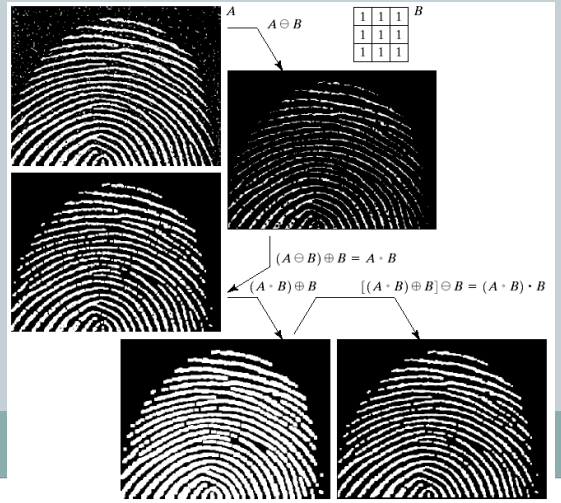




Examples: Law Enforcement

Image processing techniques are used extensively by law enforcers

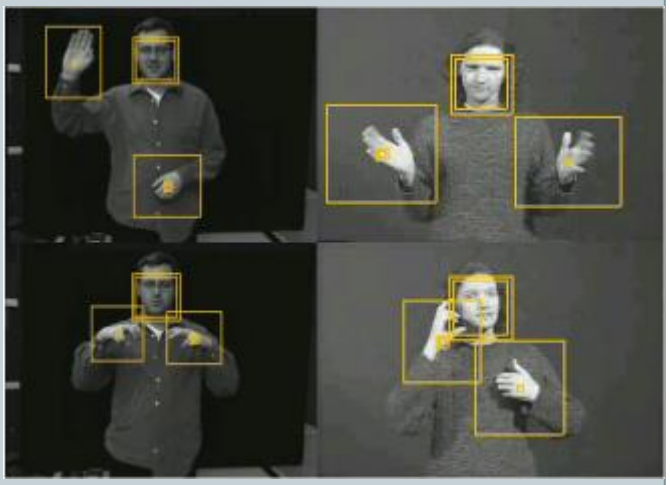
- Number plate recognition for speed cameras/automated toll systems
- Fingerprint recognition
- Enhancement of CCTV images



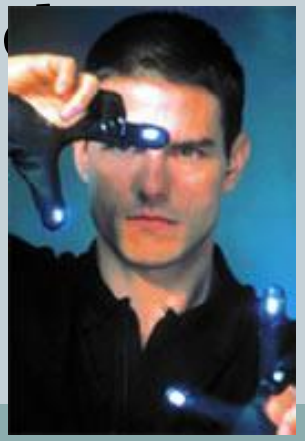
Examples: HCI

Try to make human computer interfaces more natural

- Face recognition
- Gesture ايماءةrecognition

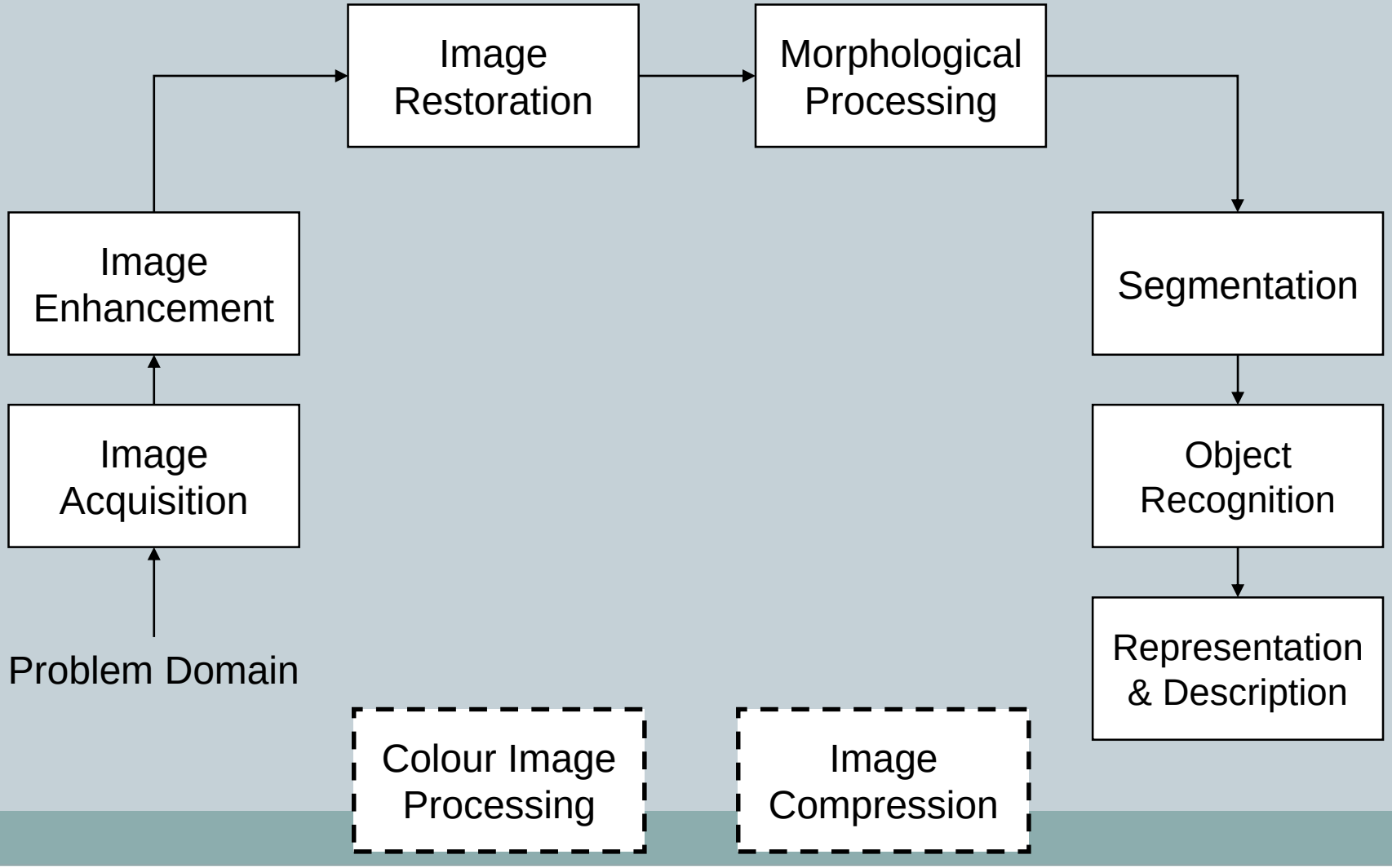


Does anyone remember the user interface from “Minority Report”?



These tasks can be extrem difficult

Key Stages in Digital Image Processing

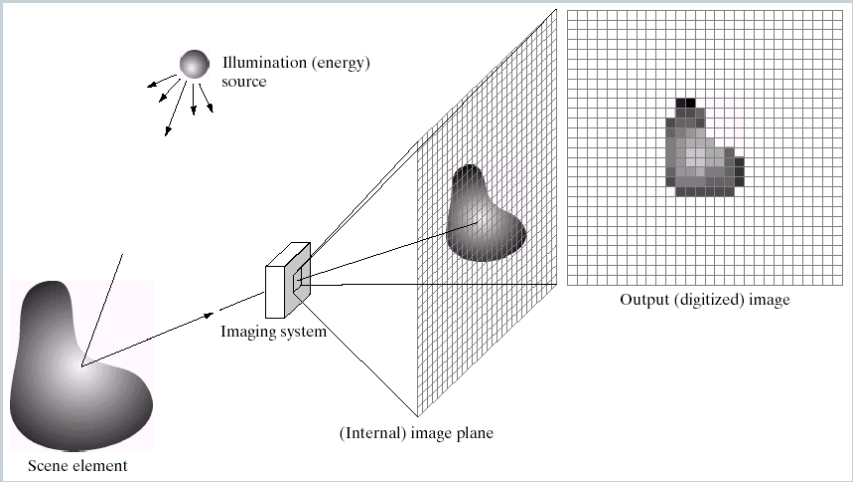


Key Stages in Digital Image Processing: Image Aquisition

Image Restoration

Morphological Processing

Image Enhancement



Segmentation

Image Acquisition

Object Recognition

Problem Domain

Representation & Description

Colour Image Processing

Image Compression

Image Enhancement: taking an image and improving it visually

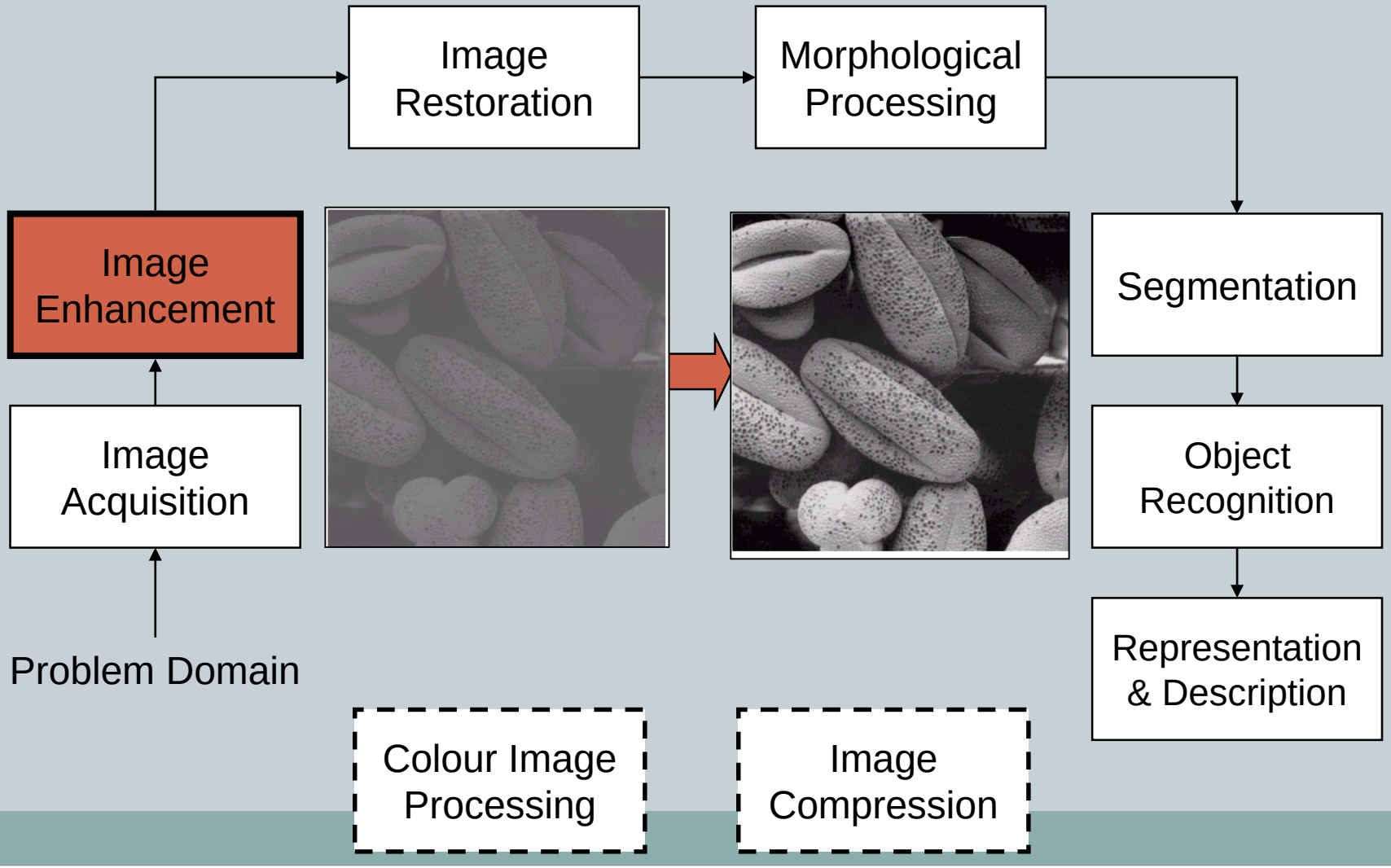
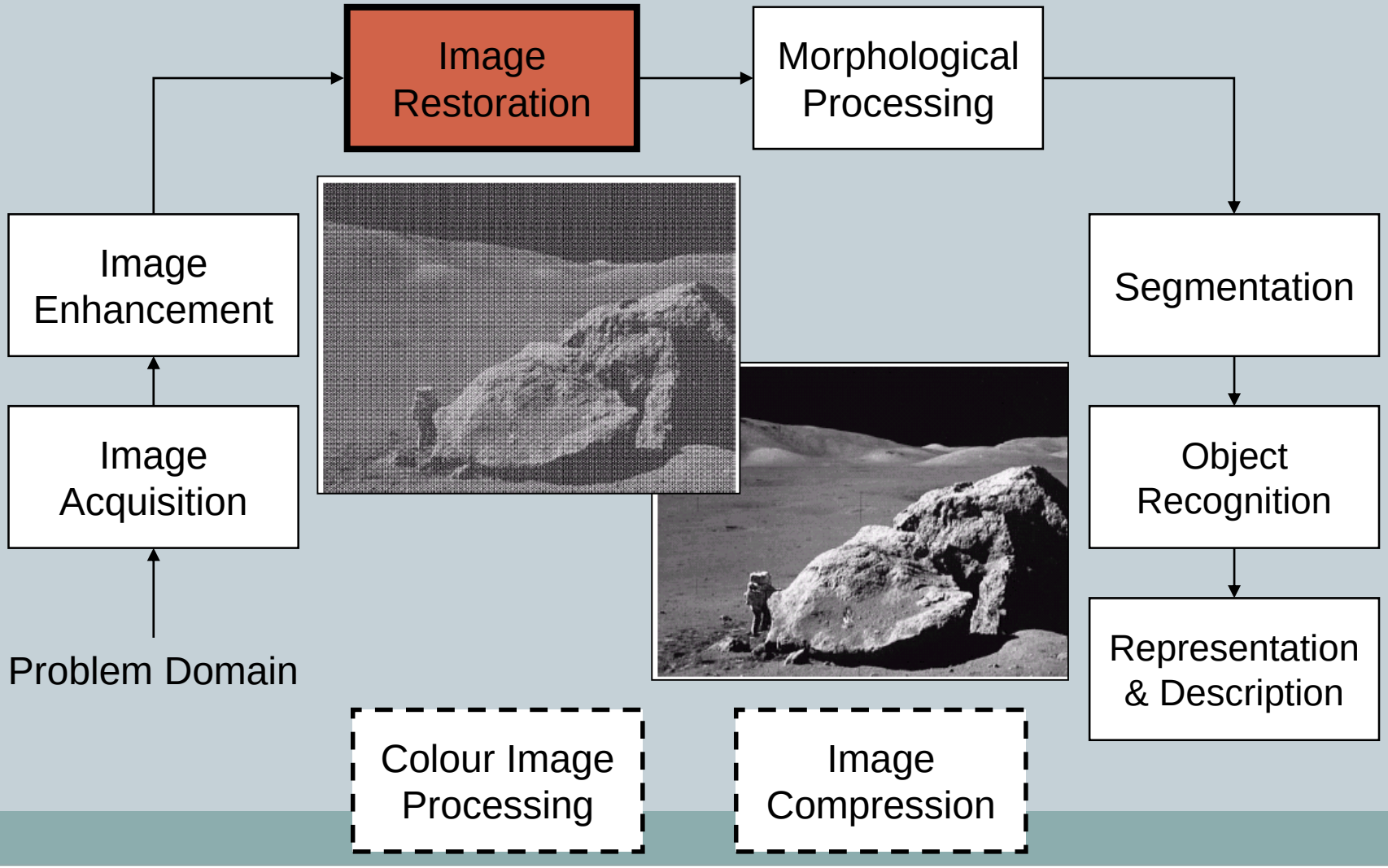


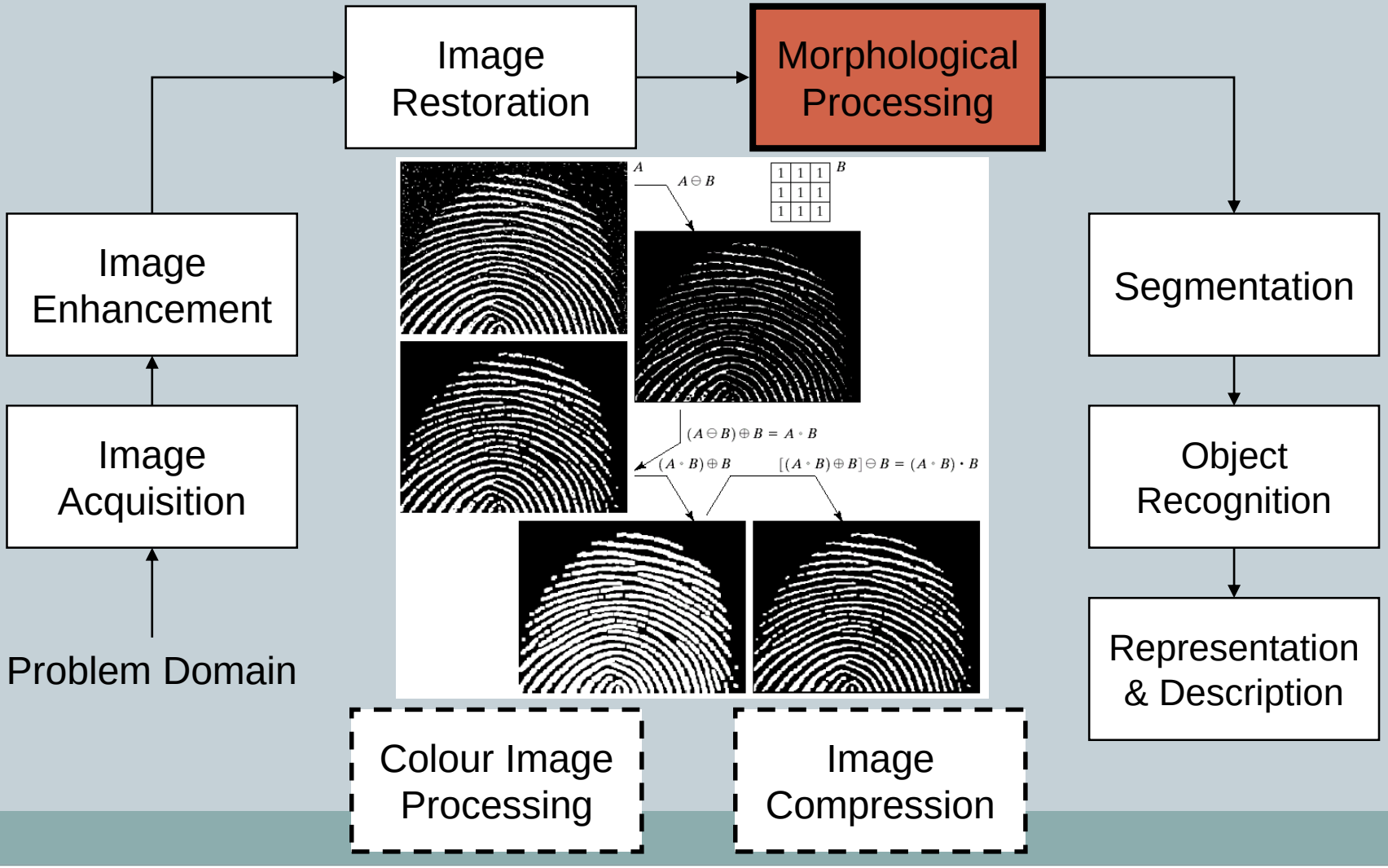
Image Restoration :

taking an image with some known or estimated degradation and restoring it to its original appearing



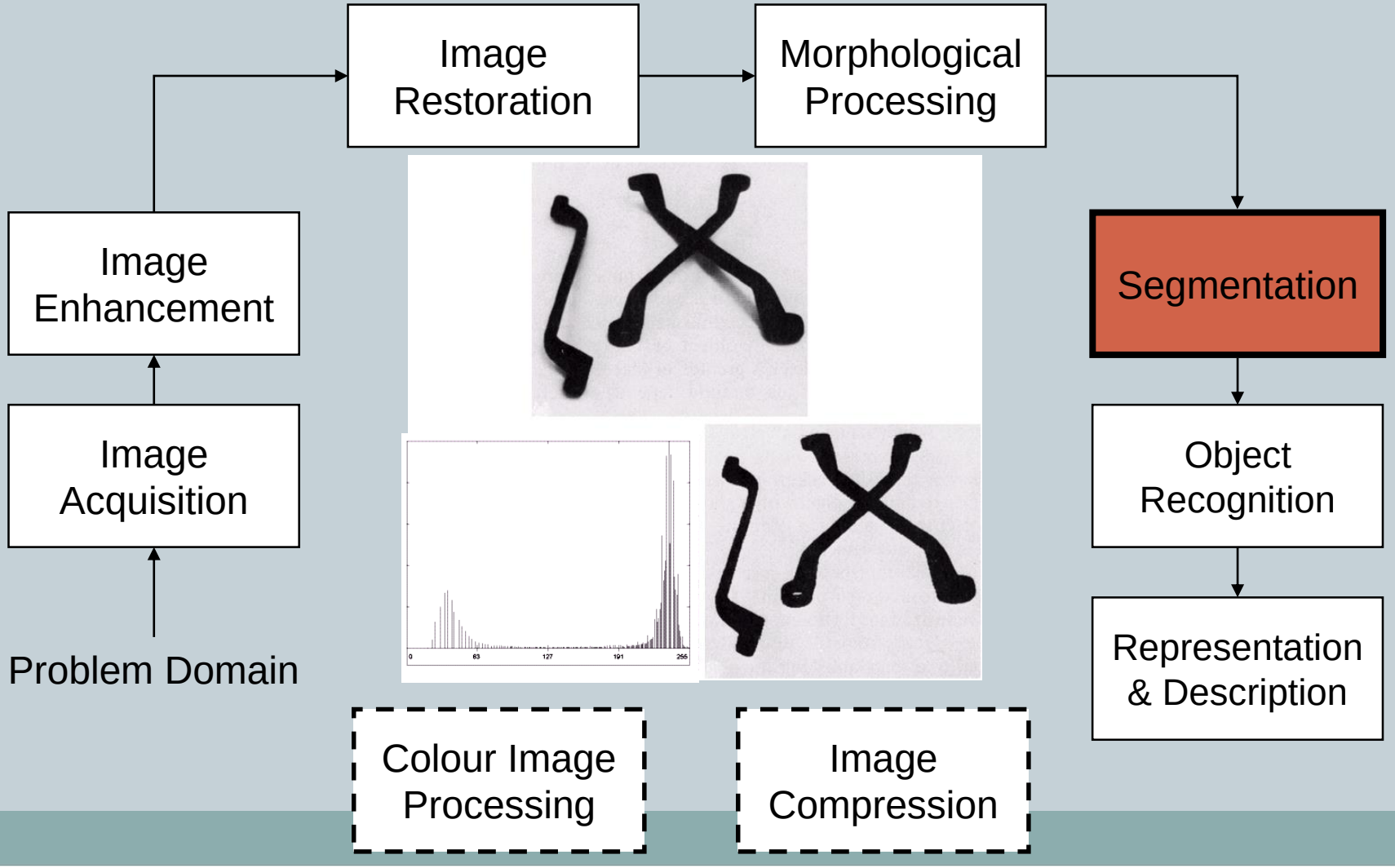
Key Stages in Digital Image Processing: Morphological Processing

extracting image component that are useful in the representation and description of region shape, such as boundaries, skeletons, and the convex hull



Key Stages in Digital Image Processing: Segmentation

subdivides an image into its constituent



Key Stages in Digital Image Processing: Object Recognition

Problem Domain

Image Acquisition

Image Enhancement

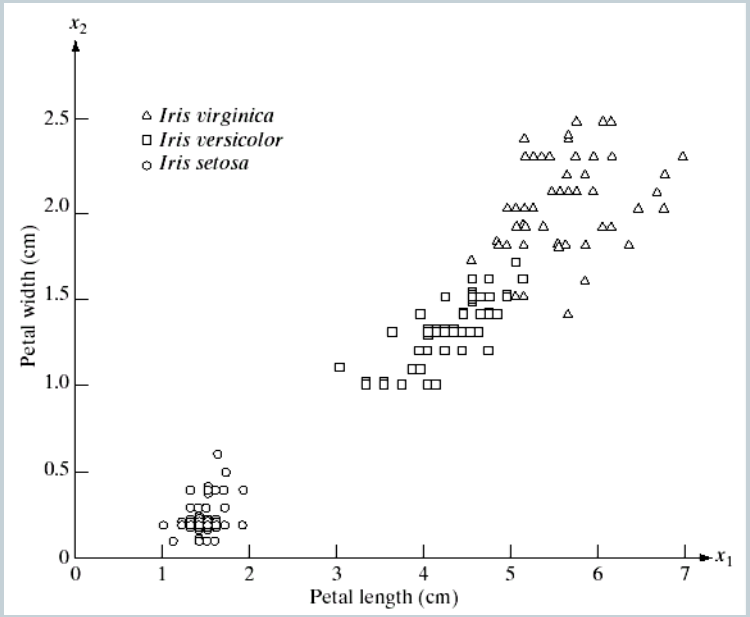
Image Restoration

Morphological Processing

Segmentation

Object Recognition

Representation & Description



Colour Image Processing

Image Compression

Key Stages in Digital Image Processing: Representation & Description

Problem Domain

Image Acquisition

Image Enhancement

Image Restoration

Morphological Processing

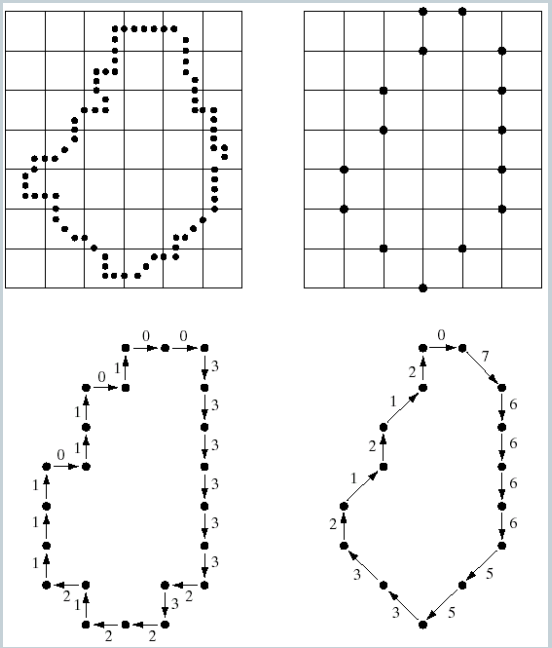
Segmentation

Object Recognition

Representation & Description

Colour Image Processing

Image Compression



- **Types of neighborhoods**

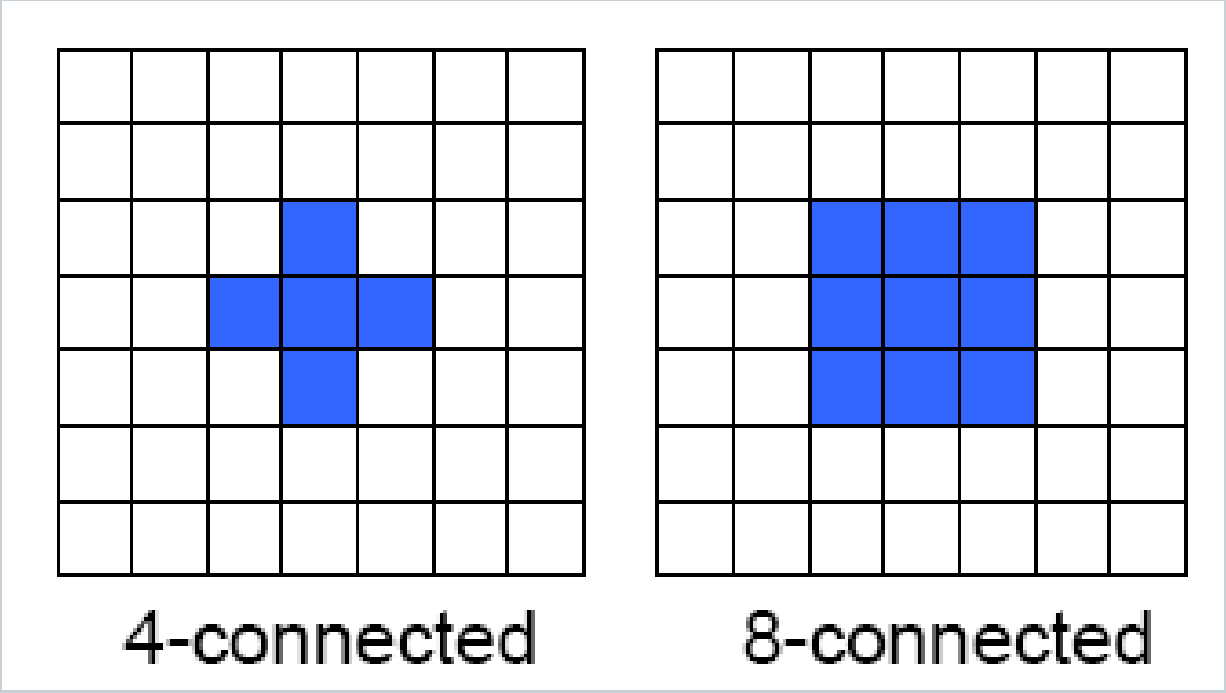


Image compression:

reducing the massive amount of data needed to represent an image

Problem Domain

Image Acquisition

Image Enhancement

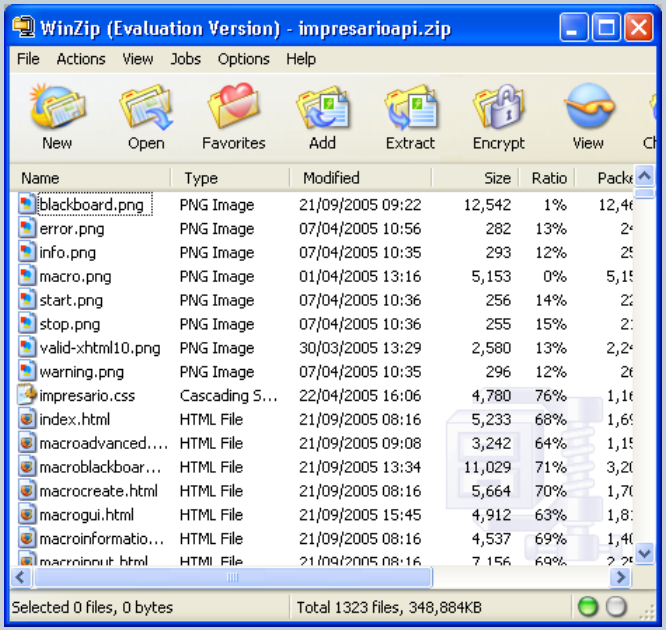
Image Restoration

Morphological Processing

Segmentation

Object Recognition

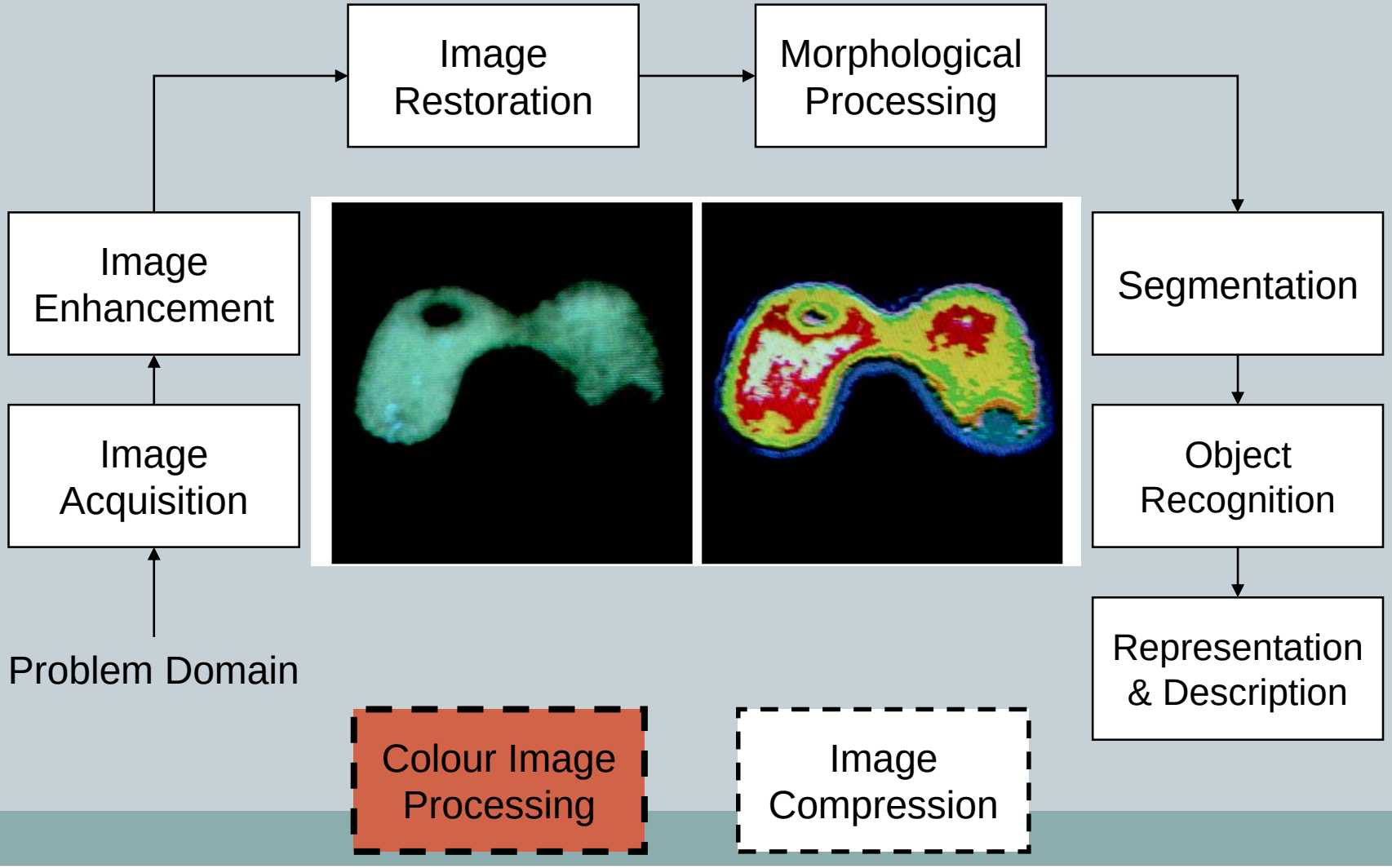
Representation & Description



Colour Image Processing

Image Compression

Key Stages in Digital Image Processing: Colour Image Processing



Summary

We have looked at:

- What is a digital image?
- What is digital image processing?
- History of digital image processing
- State of the art examples of digital image processing
- Key stages in digital image processing

Next week we start to see how it all works…