Fpt Software | CAMPUS

DIGITAL IMAGE PROCESSING

Basics

May 21, 2019

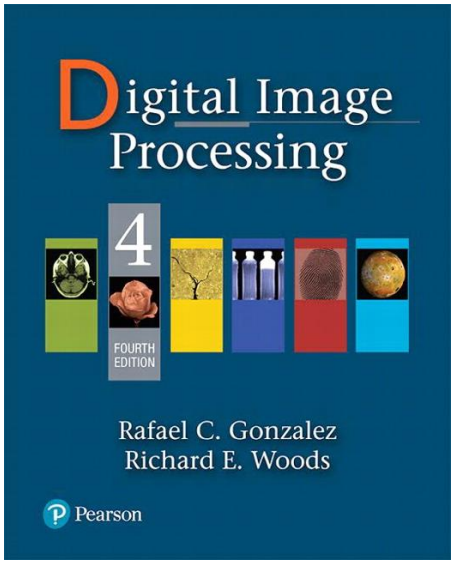
Contents

This lecture will cover:

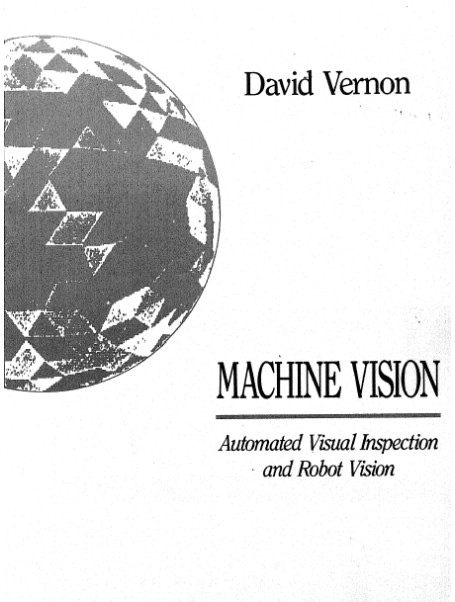
- What is digital image?
- What is digital image processing?
- History of digital image processing
- Some applications of digital image processing
- Key stages in digital image processing
- What are mathematics topics involved?

To see how it all works and more technical details, please refer to the reference books in the next slide.

References



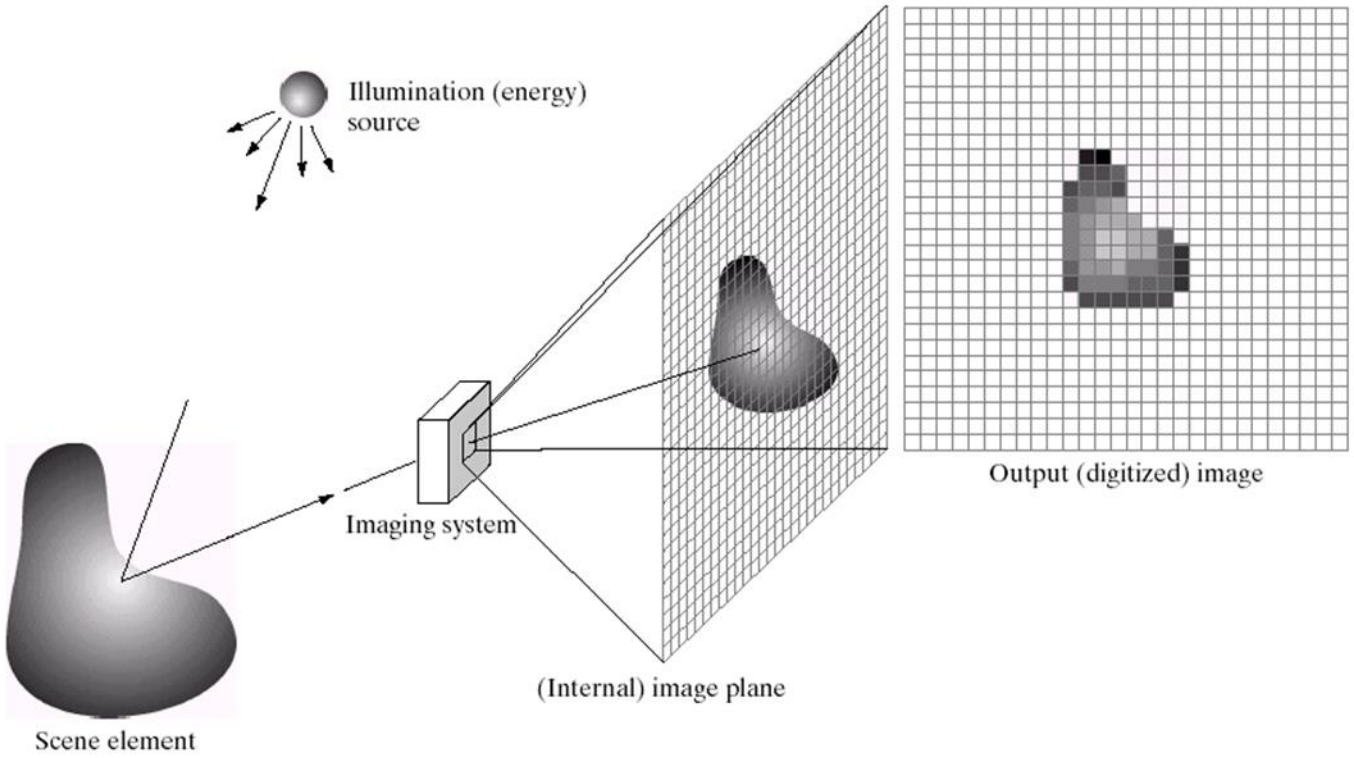
Digital Image Processing (4th Edition) by Rafael C. Gonzalez (Author), Richard E. Woods (Author), 2017.



Machine Vision: Automated Visual Inspection and Robot Vision, David Vernon, Prentice Hall, 1991.
Available Online at:
homepages.inf.ed.ac.uk/rbf/BOOKS/VERNON

What is a Digital Image?

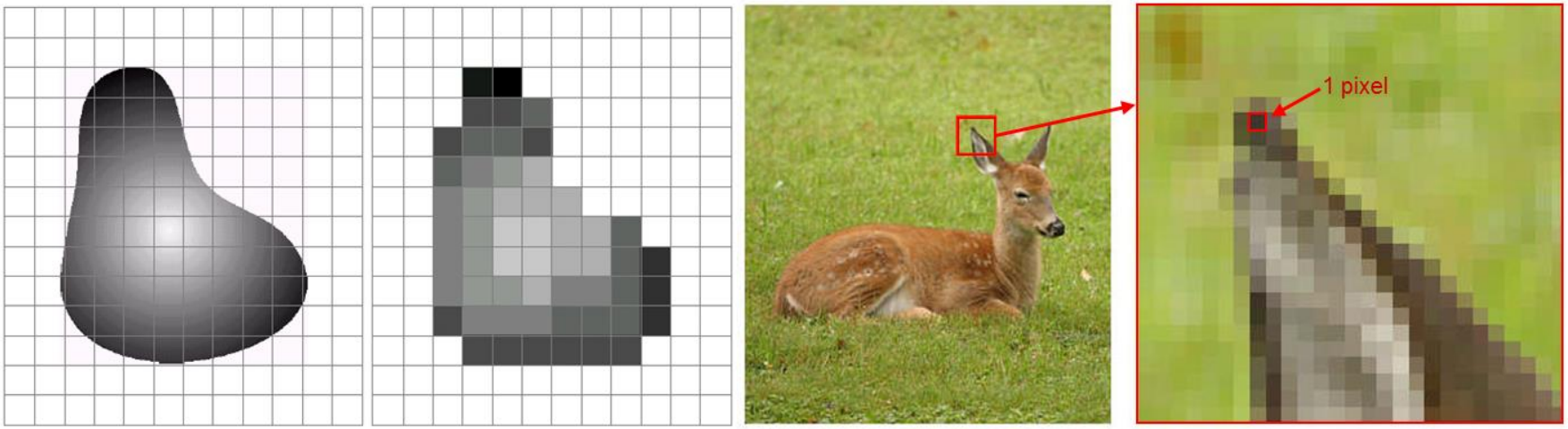
A **digital image** is a representation of a two dimensional image as a finite set of digital value, called picture elements or pixels.



What is a Digital Image?

Pixel values typically represents gray levels, colors, heights, opacities, etc…

Digitalization implies that a digital image is an approximation of a real scene.



What is a Digital Image?

Common image format include:

- 1 sample per point (Black and white, or Grayscale)
- 3 samples per point (Red, Green, and Blue)
- 4 samples per point (Red, Green, Blue, and “Alpha”, a.k.a. Opacity)



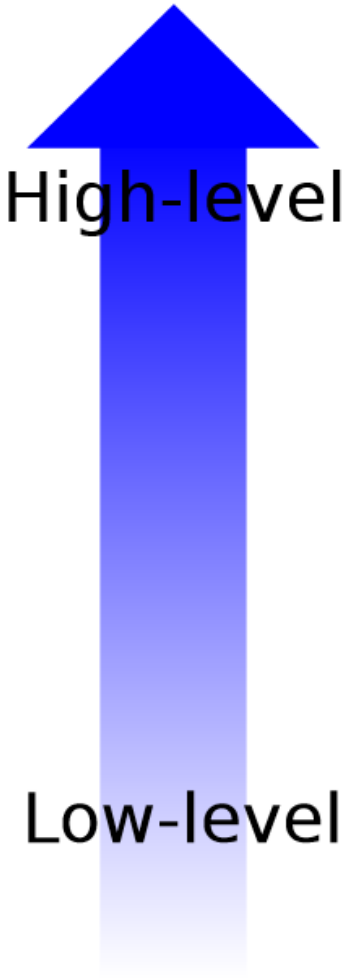
What is Digital Image Processing?

Digital Image Processing (DIP) focuses on two major tasks:

- Improve of pictorial information for human interpretation
- Processing of image data for storage, transmission and representation for autonomous machine perception.

Distinguish between Image Processing, Image Analysis, and Computer Vision?

What is Digital Image Processing?



Computer Vision

Object detection, recognition, shape analysis, tracking
Use of Artificial Intelligence and Machine Learning

Image Analysis

Segmentation, image registration, matching

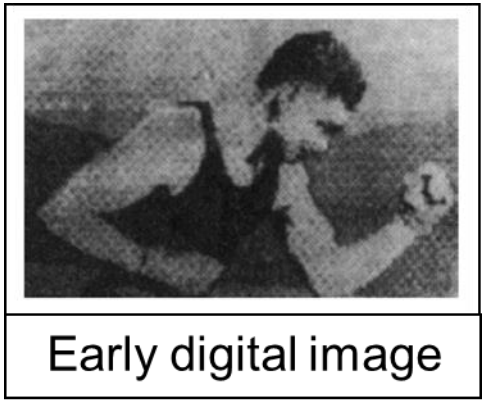
Image Processing

Image enhancement, noise removal, restoration,
feature detection, compression

History of Digital Image Processing

Early 1920s: One of the first application of digital image was in the newspaper industry.

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



Early digital image

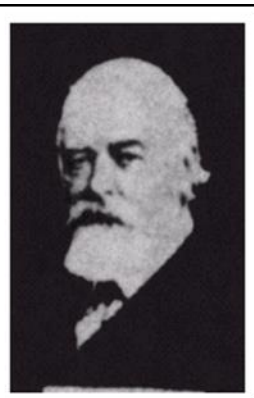
History of Digital Image Processing (Cont…)

Mid to late 1920s:

Improvements to the Bartlane system

Resulted in higher quality images.

- New production processes based on photographic techniques
- Increase number of tones in Reproduced images.



Improved digital image

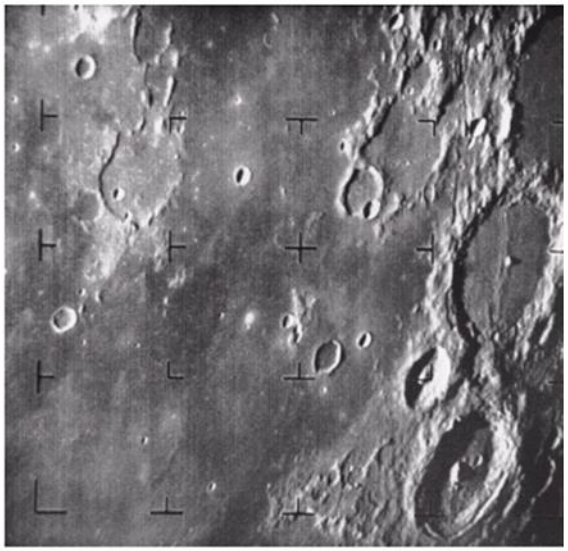
Early 15 tone digital image

History of Digital Image Processing (Cont…)

1960s:

Improvement in computing technology and the onset of the space race led to a surge of work in DIP.

- 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.



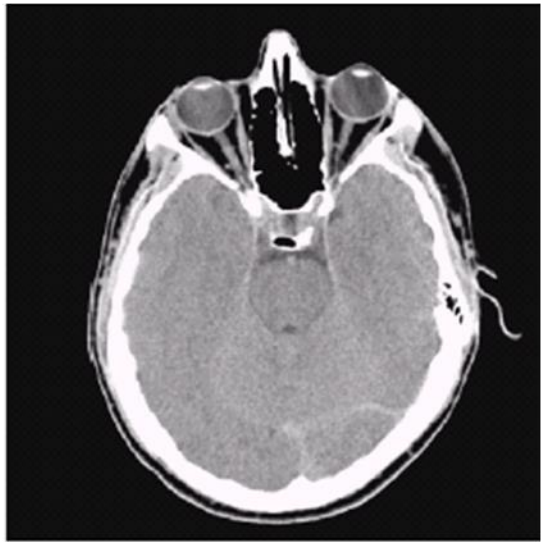
A picture of the moon taken by the Ranger 7 probe minutes before landing

History of Digital Image Processing (Cont…)

1970s:

DIP 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 Computerised Axial Tomography (CAT) scans



Typical head slice CAT image

History of Digital Image Processing (Cont…)

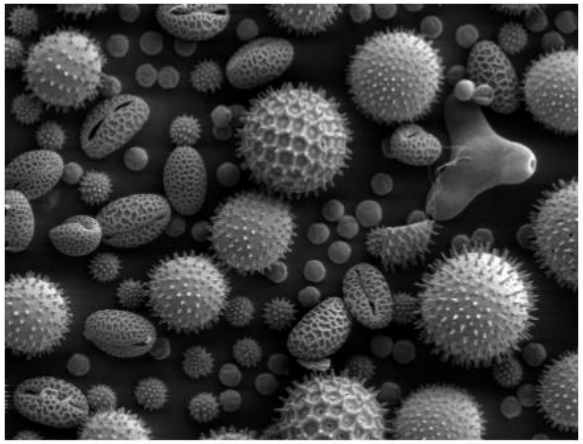
1980s - today:

The use of DIP 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.
- …

Some Applications of Digital Image Processing

Biology



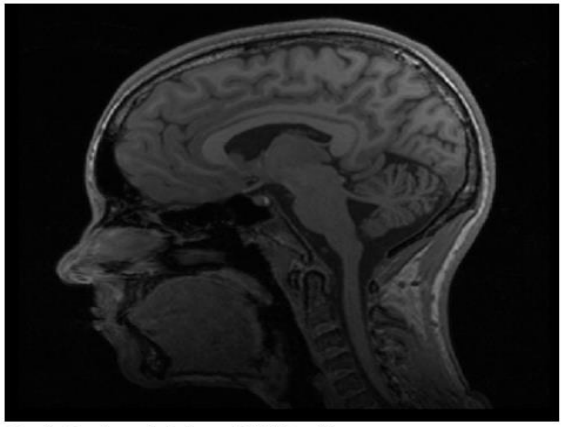
Credit: Dartmouth Electron Microscopy Facility

Security, Biometrics

Satellite Imagery

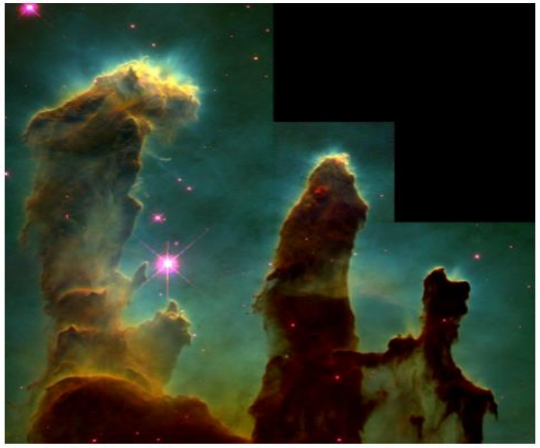
Credit: NASA

Medicine



Credit: Dr. Janet Lainhart, UofU Psychiatry

Astronomy

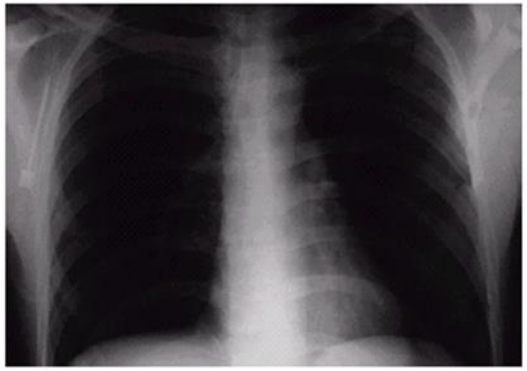


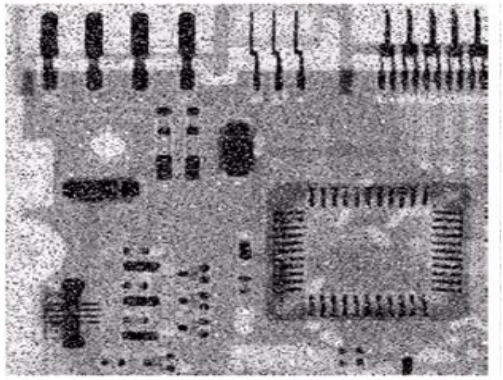
Credit: NASA, Jeff Hester, and Paul Scowen (Arizona State)
More info here

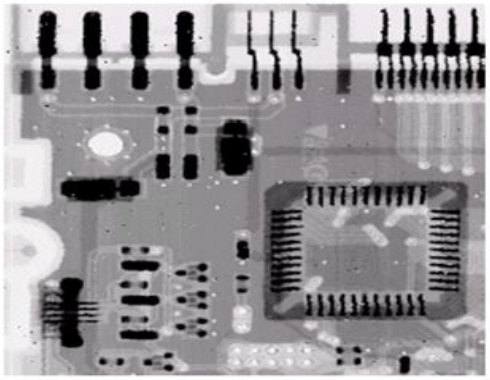
Application of Image Processing

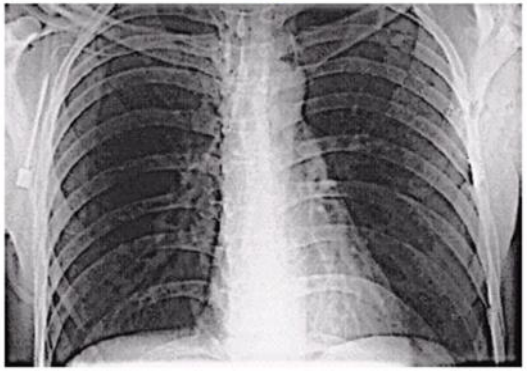
Image Enhancement

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









Application of Image Processing

The Hubble Telescope

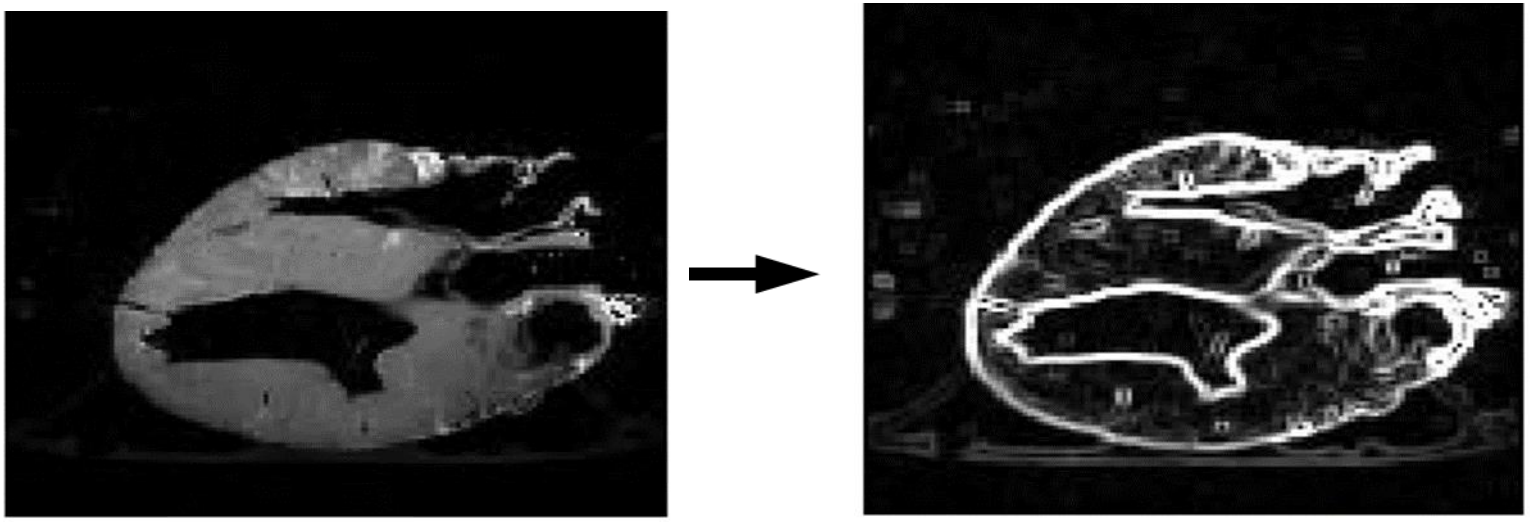
Launched in 1990, the Hubble telescope can take images of very distant object. However, an incorrect mirror made many of Hubble's images useless. Image processing techniques were used to fix this.

Application of Image Processing

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

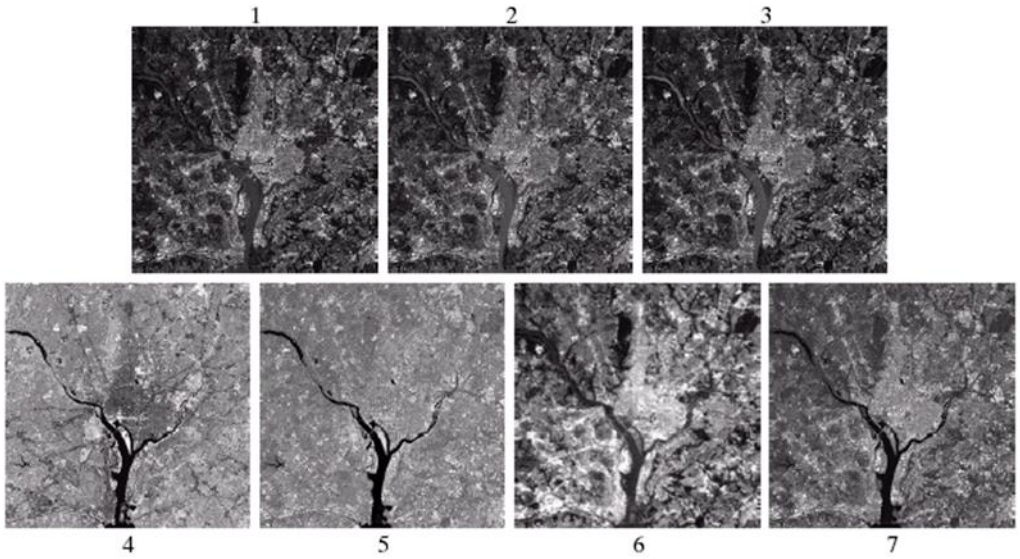


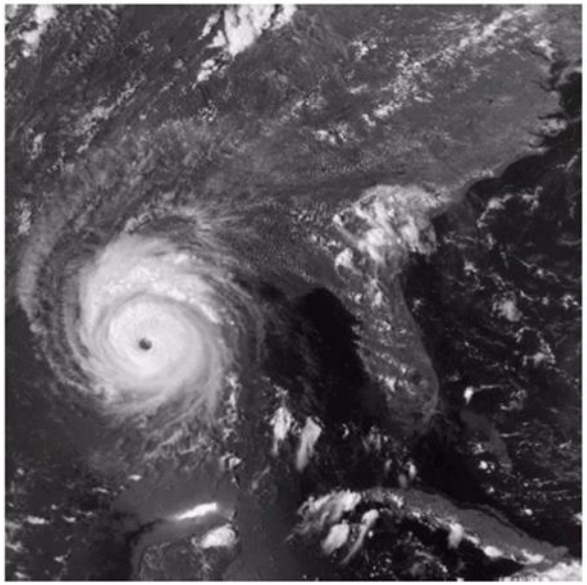
Application of Image Processing

GIS

Geographic Information Systems

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





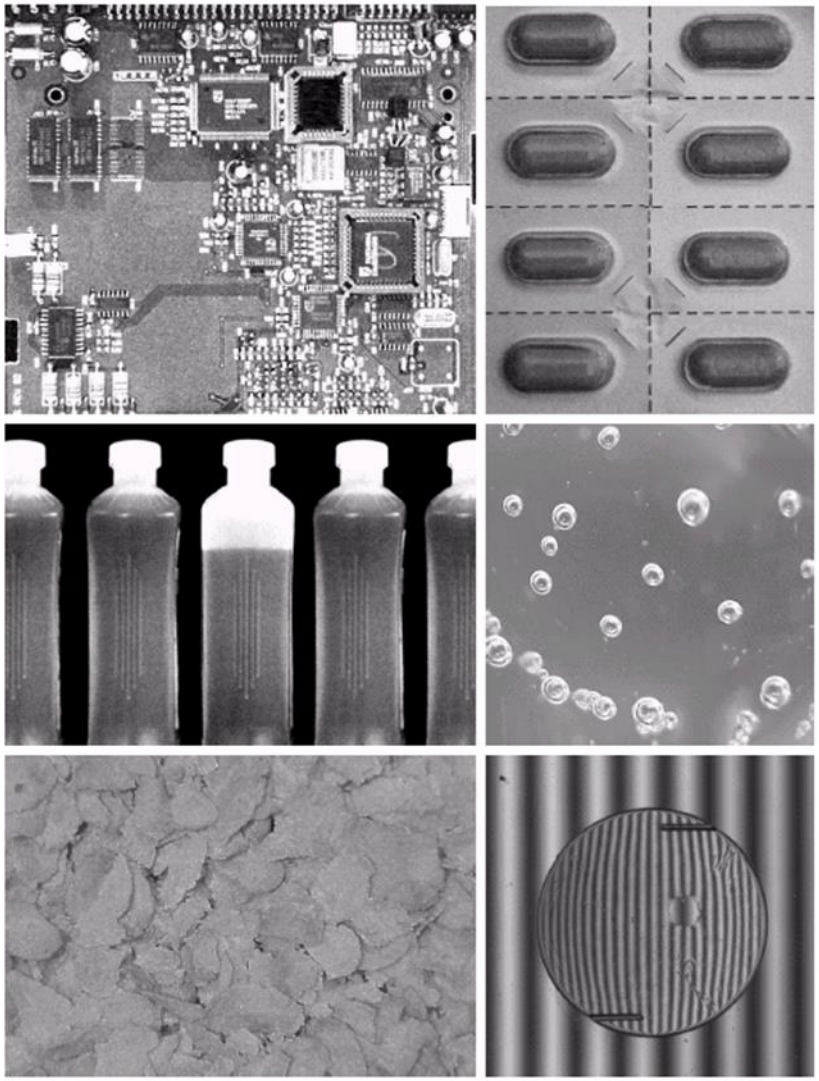
Application of Image Processing

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

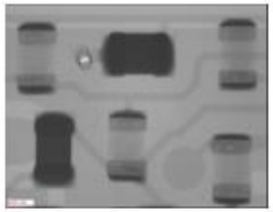


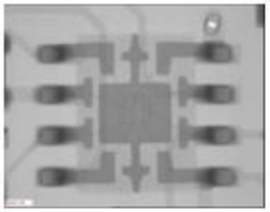
Application of Image Processing

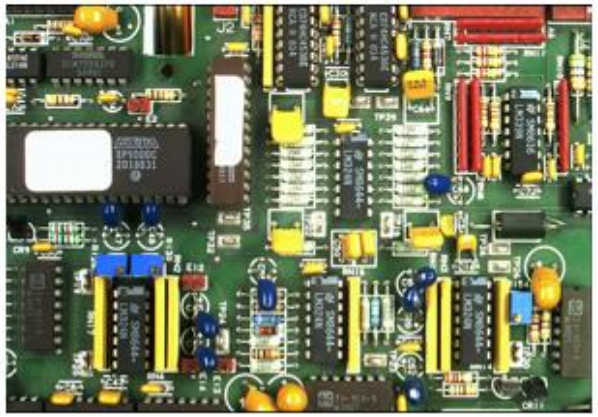
PCB Inspection

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





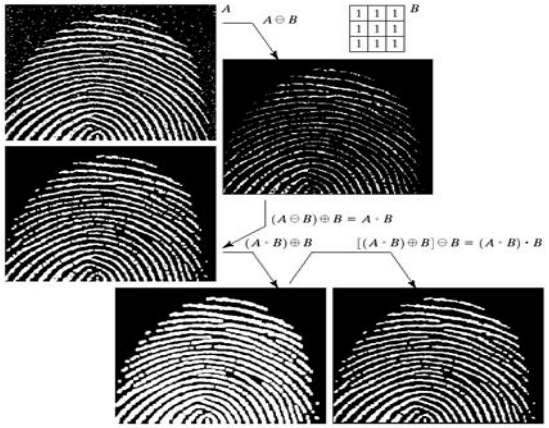


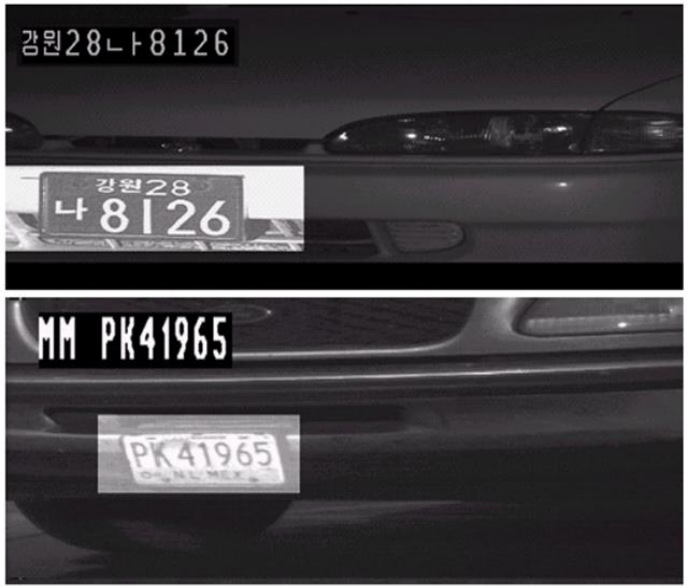
Application of Image Processing

Law Enforcement

Image processing techniques are used extensively by law enforcers

- Number plate recognition for speed cameras/automated toll systems
- Fingerprint recognition
- …



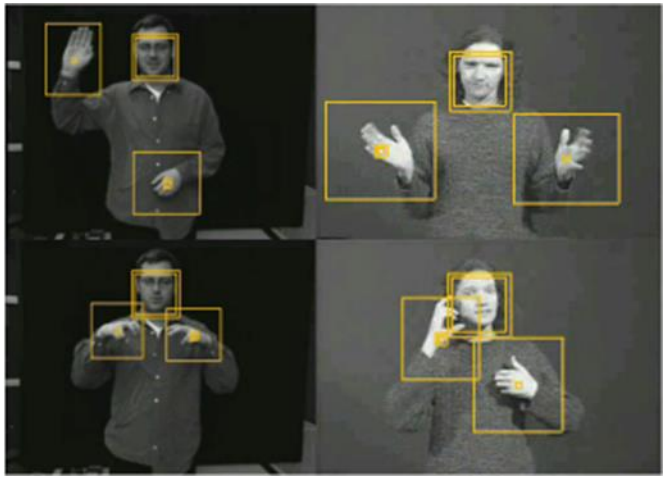


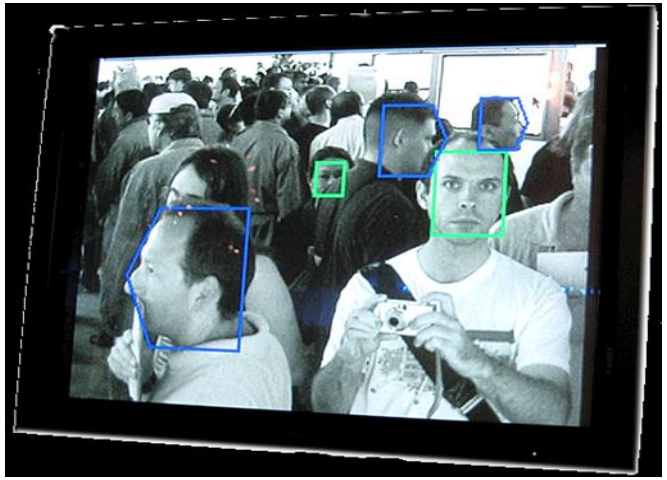
Application of Image Processing

HCI

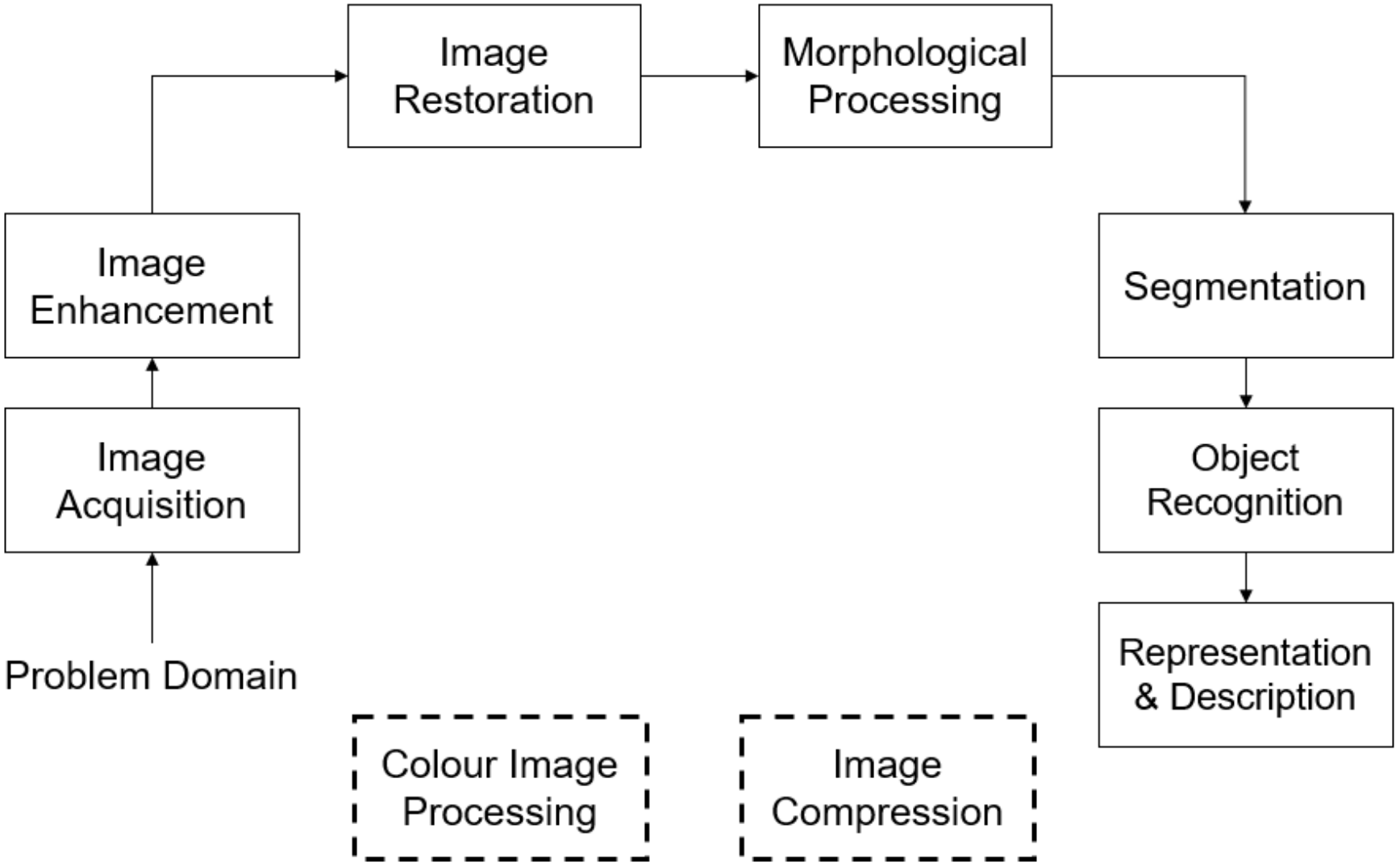
Try to make human computer interfaces more natural

- Face recognition
- Gesture recognition





Key Stages in Digital Image Processing



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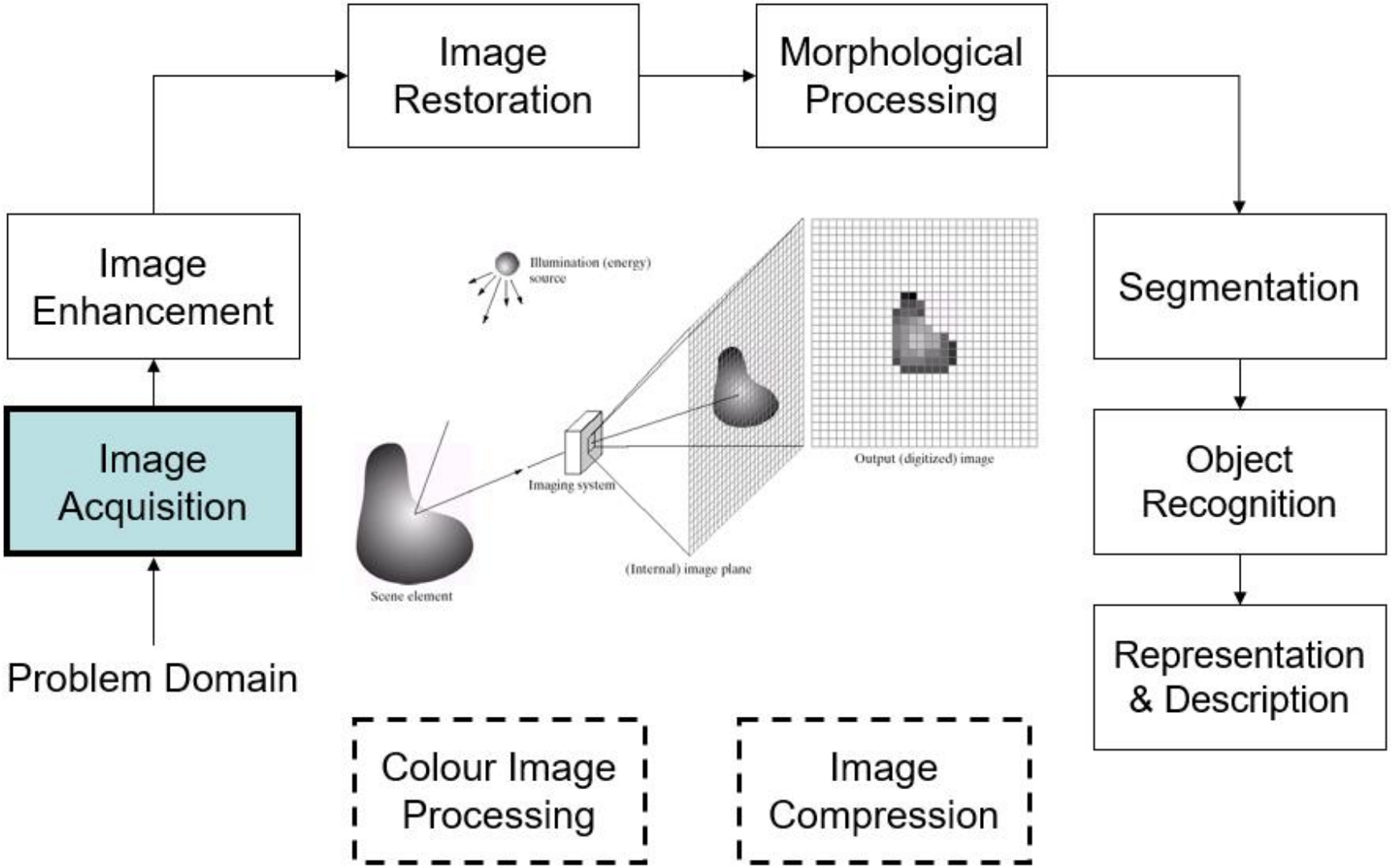

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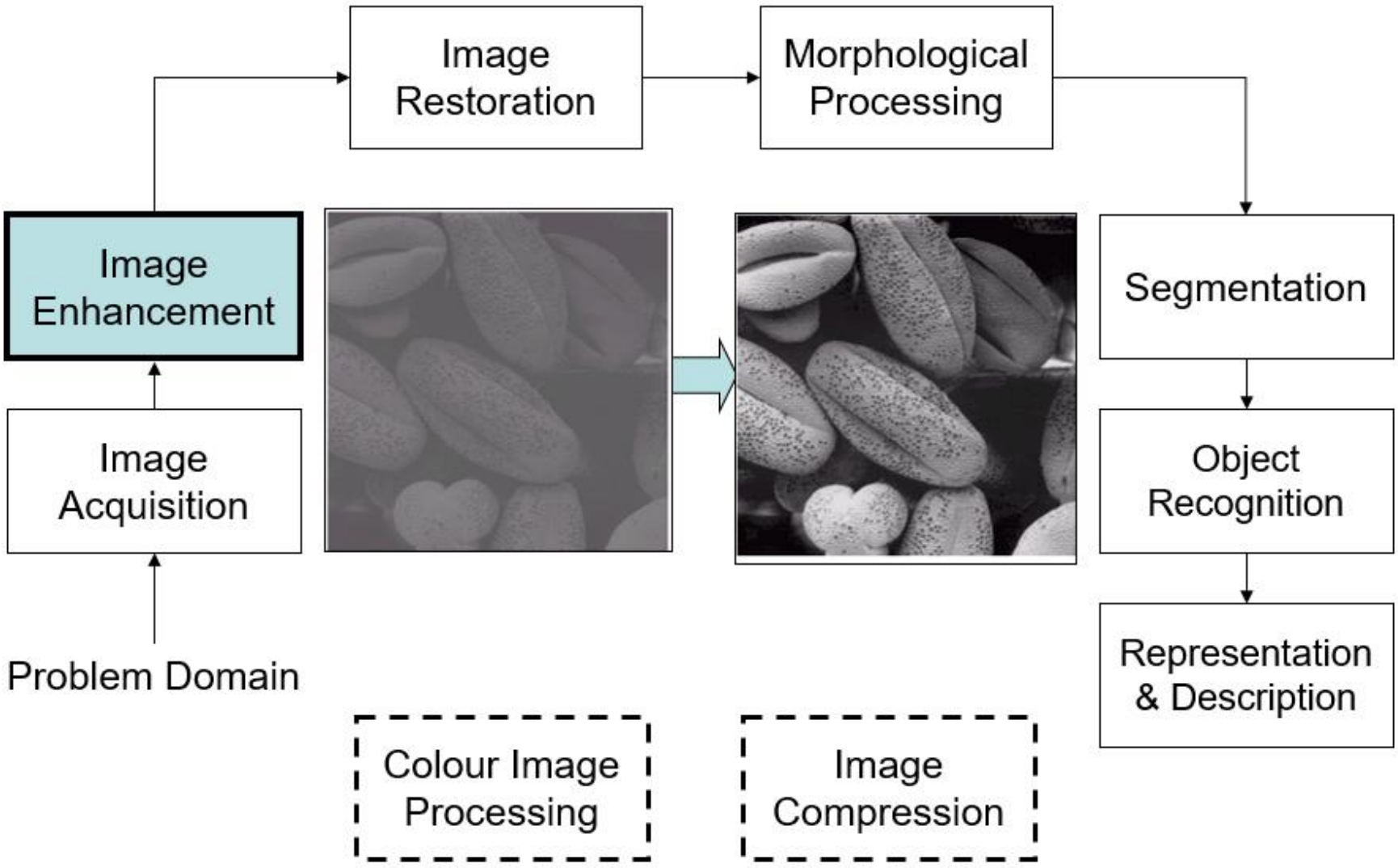

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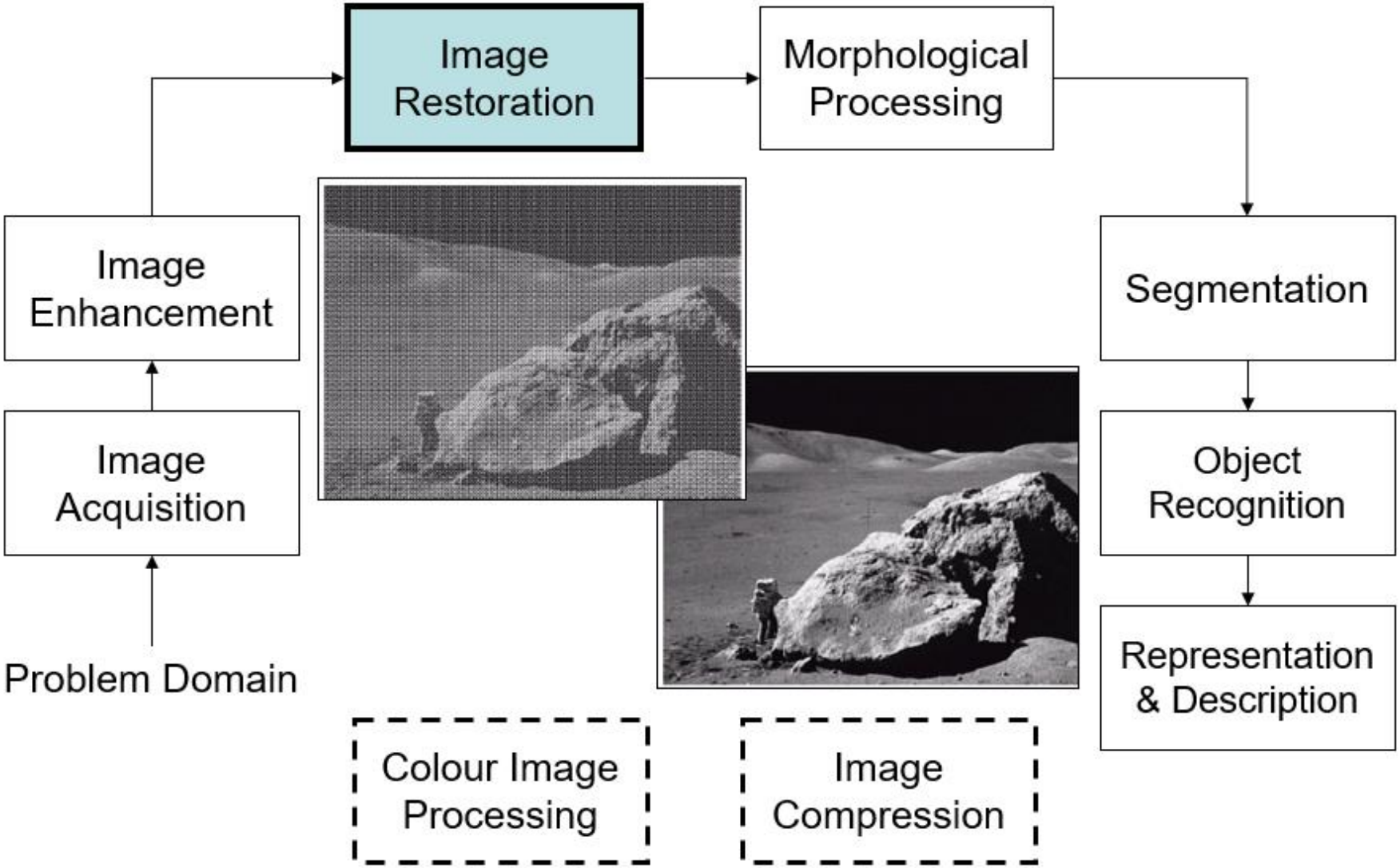

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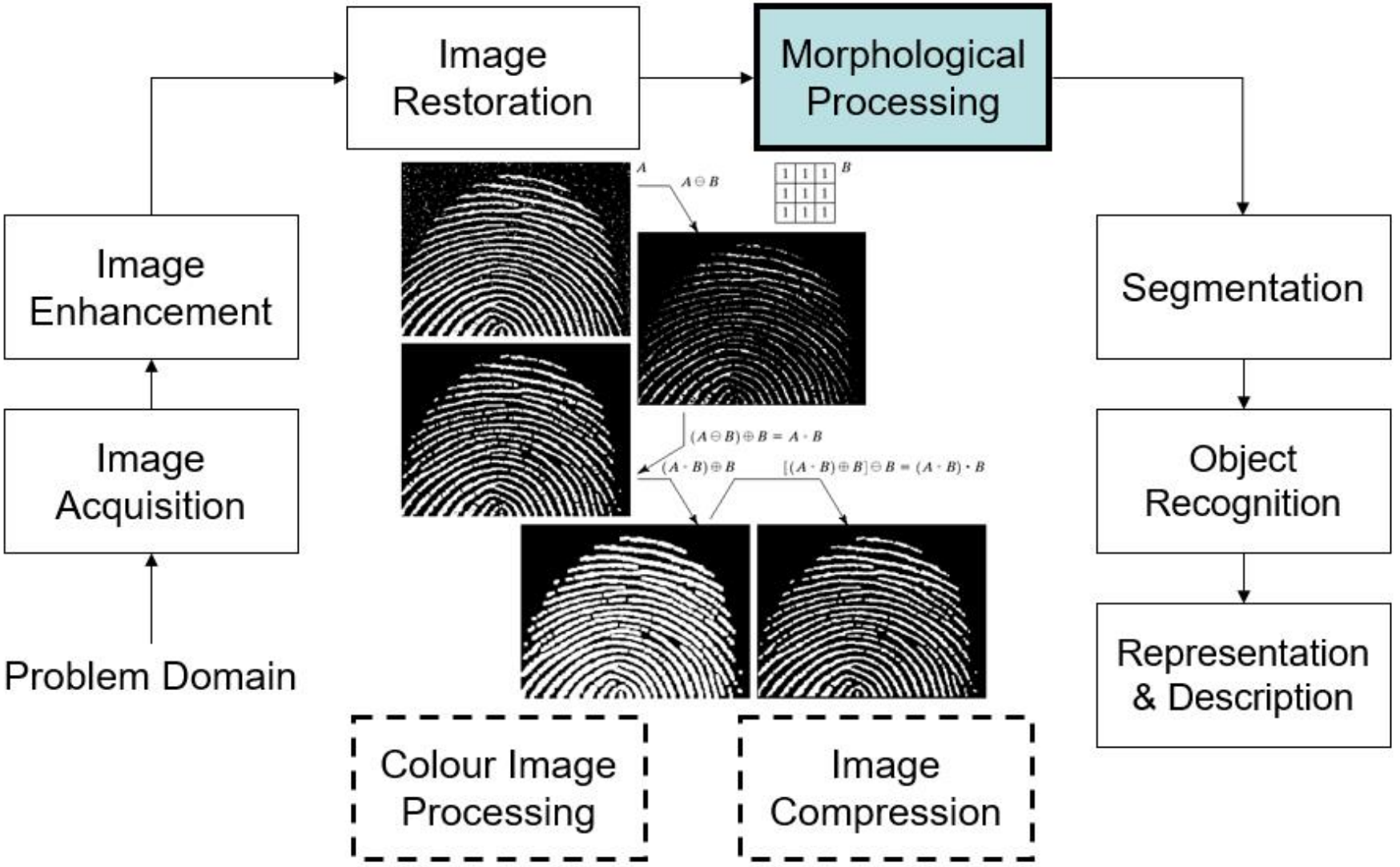

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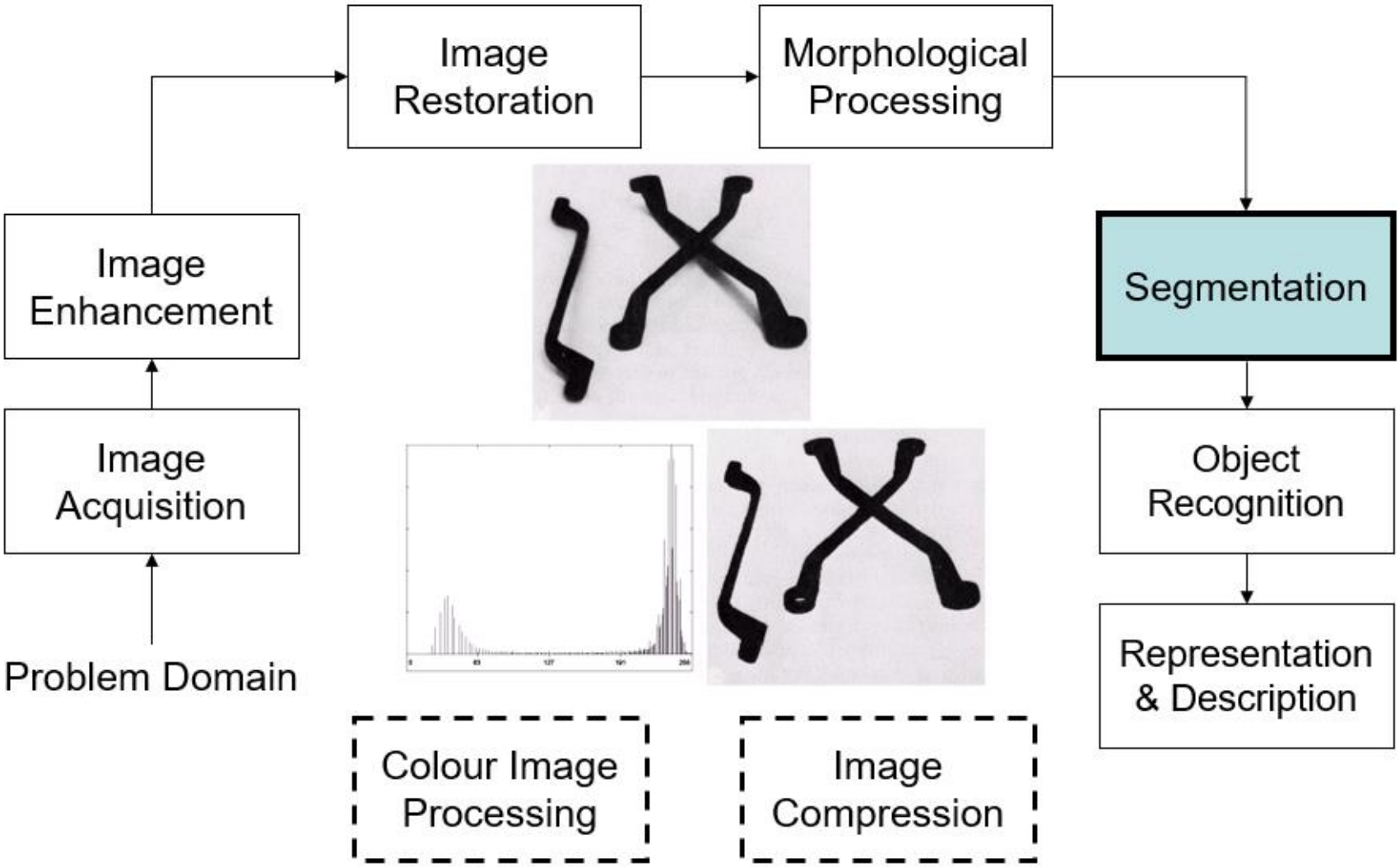

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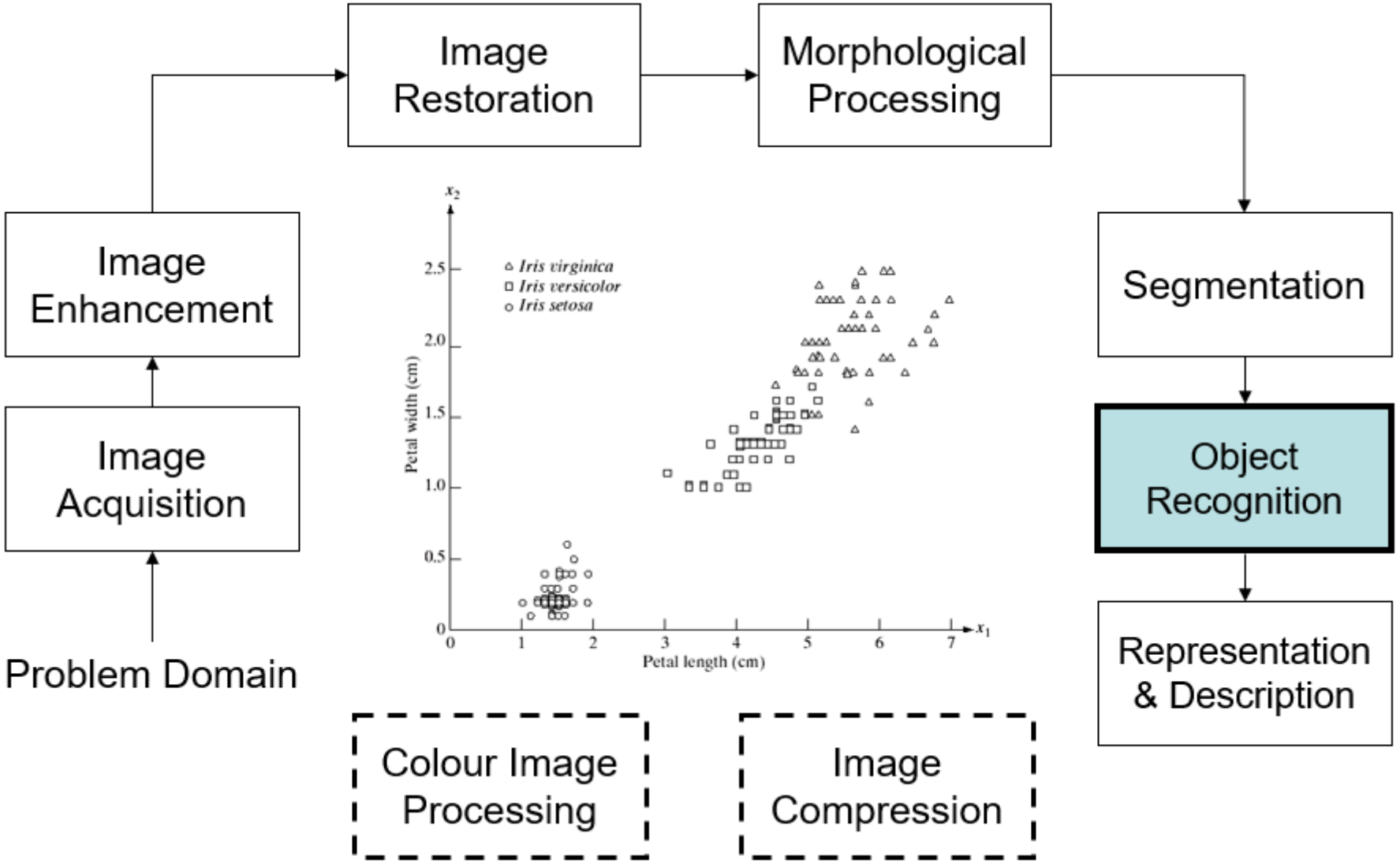

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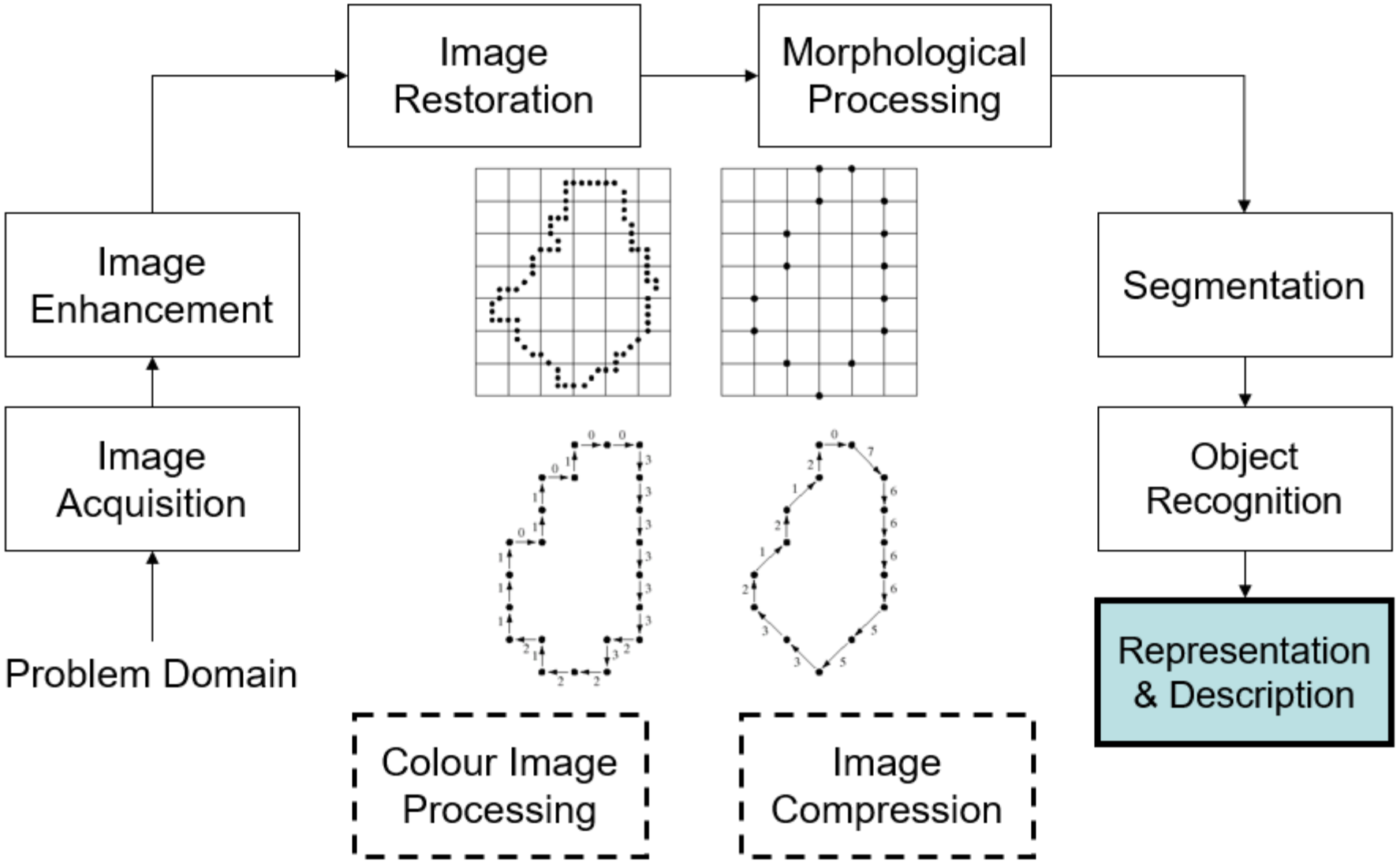

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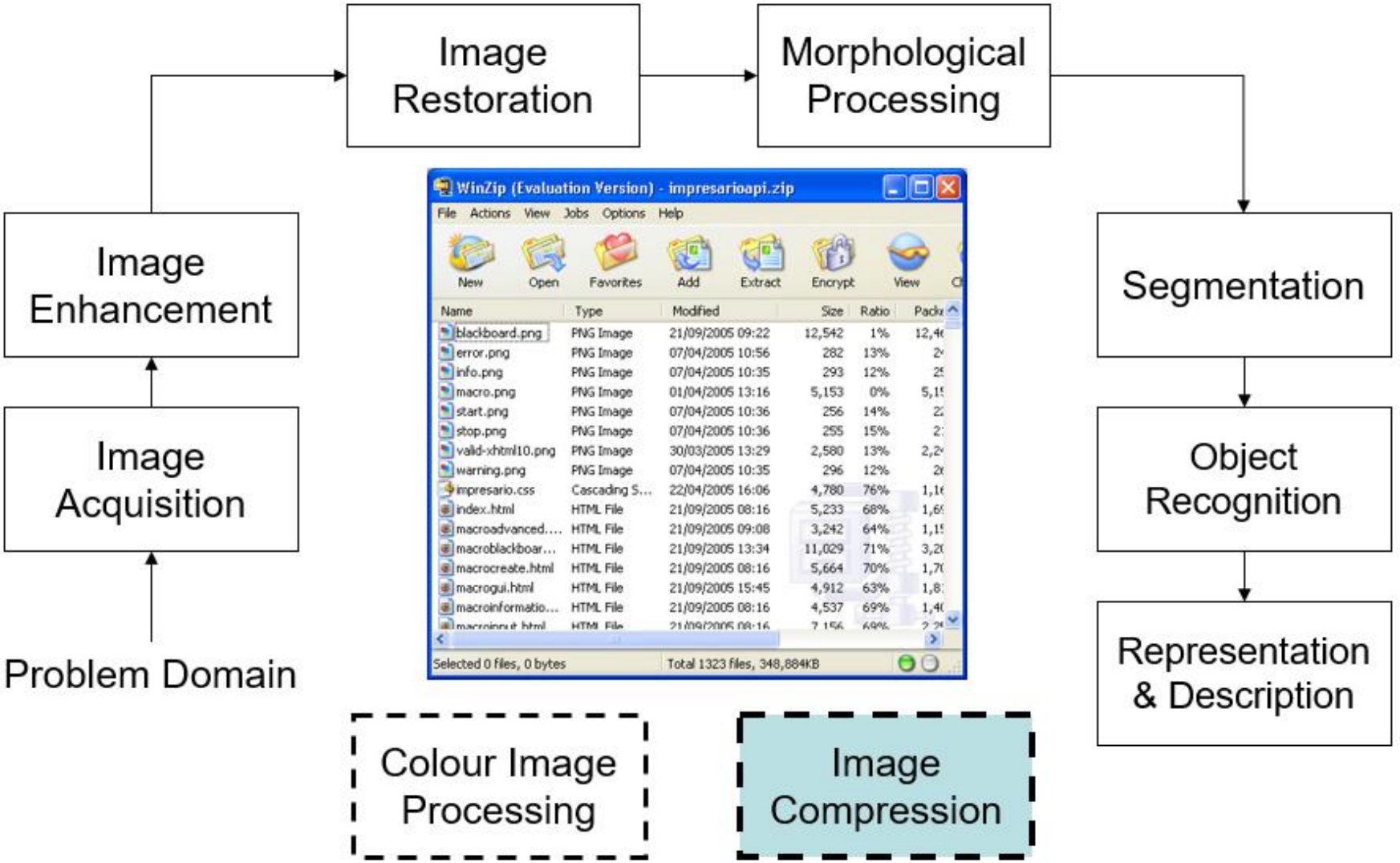

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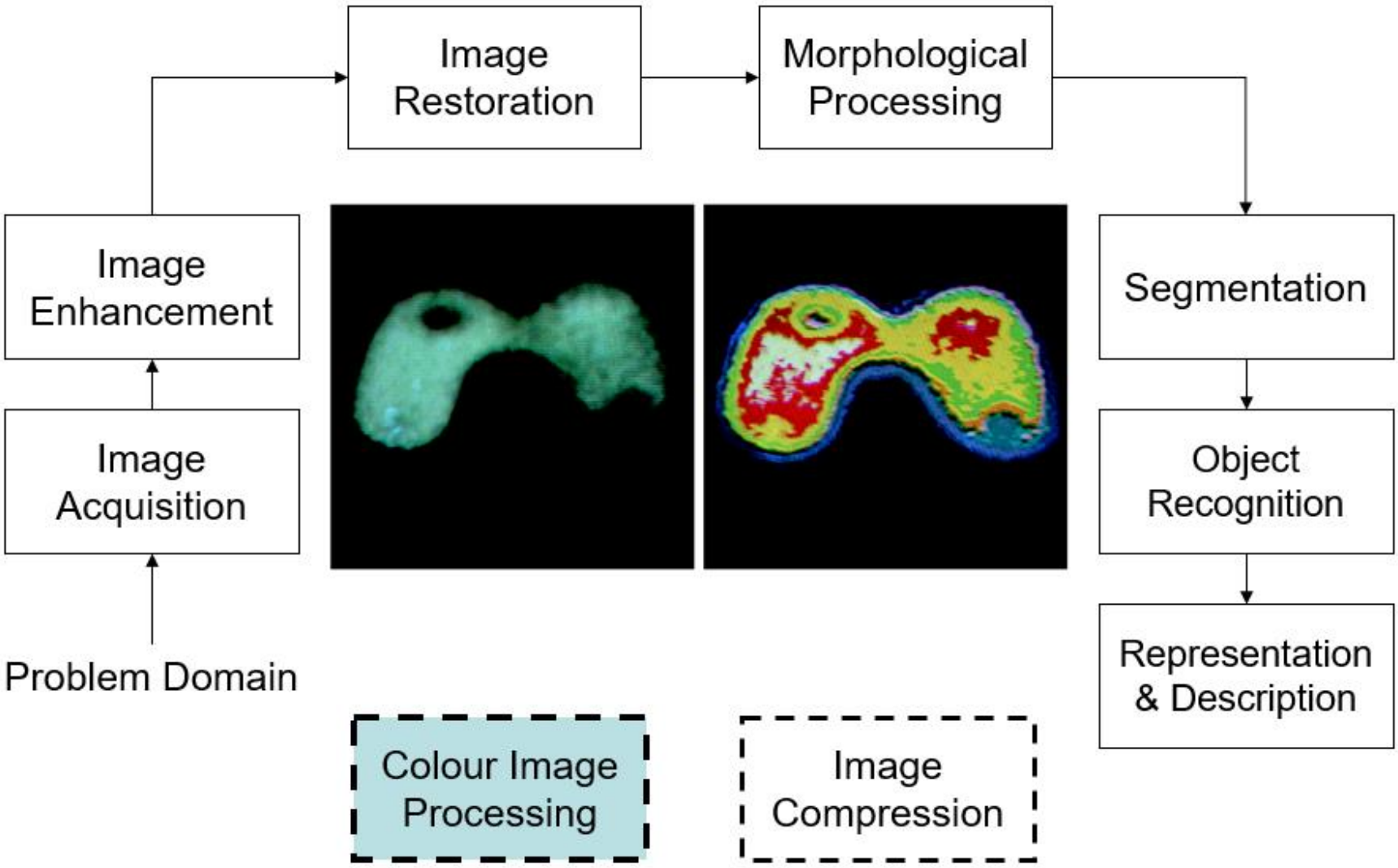

Mathematics in Digital Image Processing

In order to study DIP, you will need the following knowledge in mathematics:

- Calculus
- Linear Algebra
- Probability and Statistics
- Differential Equations (ODEs and PDEs)
- Differential Geometry
- Harmonic Analysis (Fourier, wavelets, etc..)

Summary

We have look at:

- What is digital image?
- What is digital image processing?
- History of digital image processing
- Some applications of digital image processing
- Key stages in digital image processing
- What are the mathematics topics involved?

THANK YOU!