



IMAGE PROCESSING

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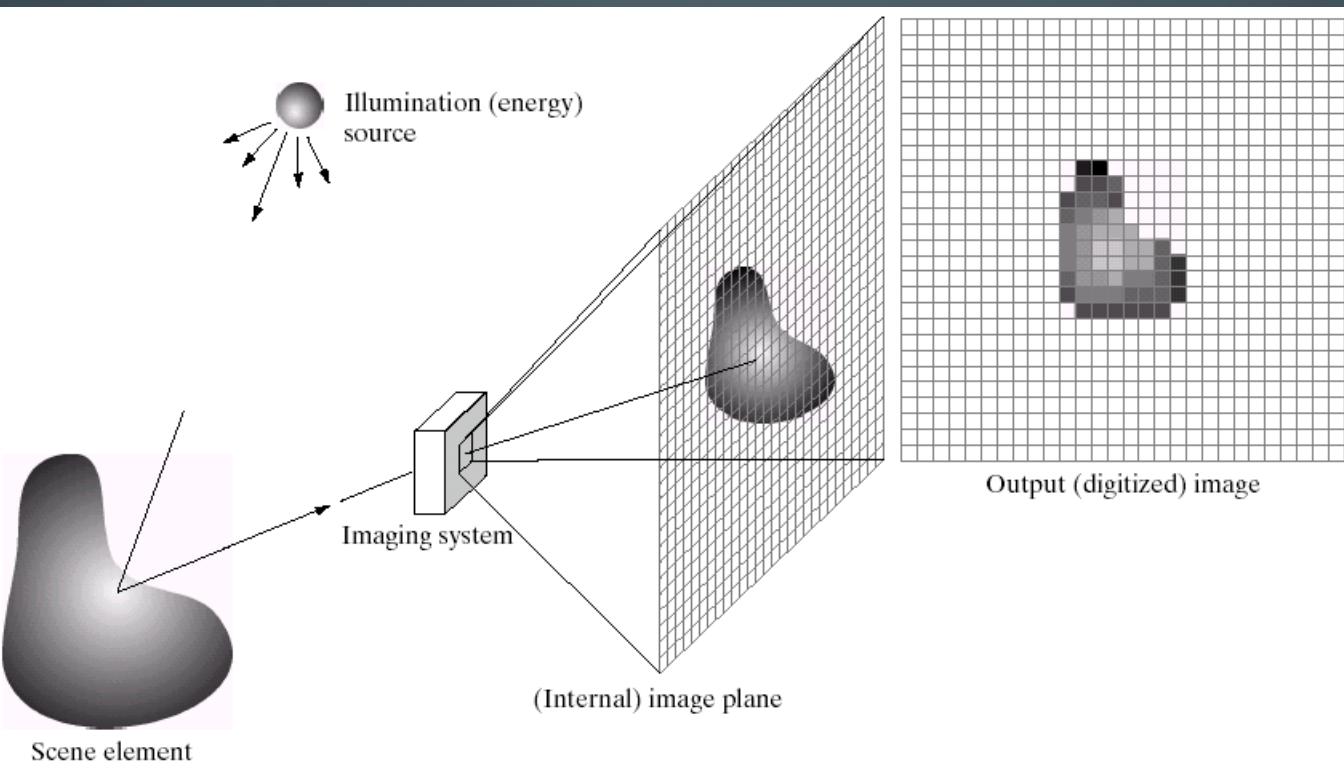
CONTENTS

- This presentation covers:

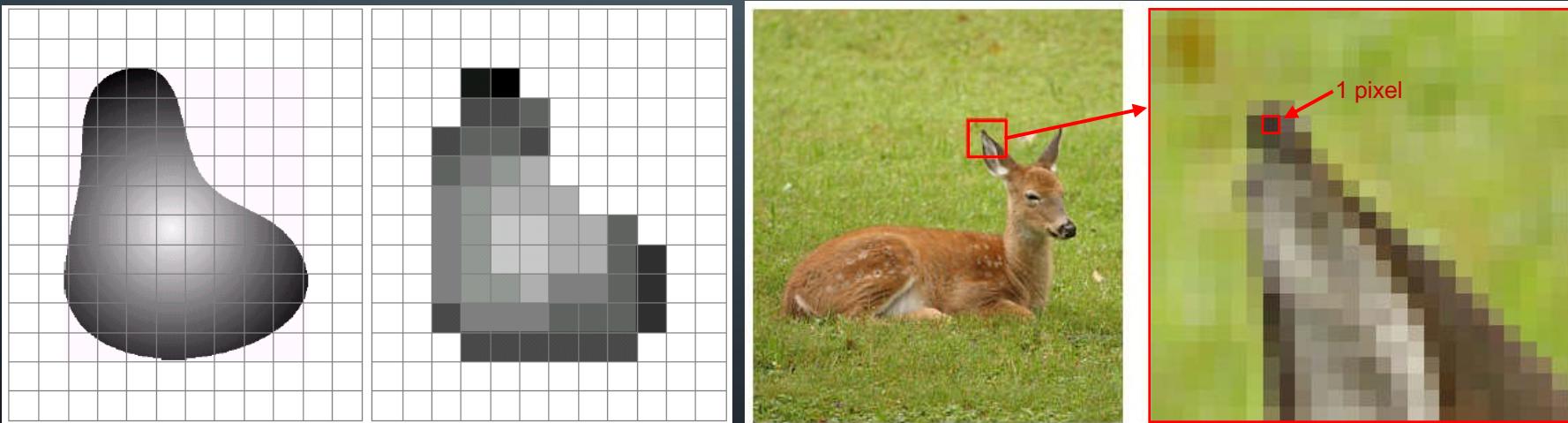
- What is a digital image?
- What is digital image processing?
- History of digital image processing
- State of the art examples of digital image processing
- Key stages in digital image processing
- Basic applications

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



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



- 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”, a.k.a. Opacity)
- For most of this presentation we will focus on grayscale images.



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

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

Low Level Process

Input: Image

Output: Image

Examples: Noise removal, image sharpening

Mid Level Process

Input: Image

Output: Attributes

Examples: Object recognition, segmentation

High Level Process

Input: Attributes

Output: Understanding

Examples: Scene understanding, autonomous navigation

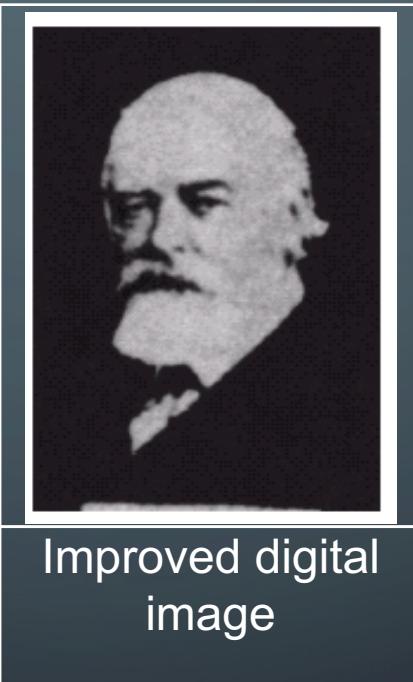
HISTORY OF DIGITAL IMAGE PROCESSING

- Early 1920s: One of the first applications 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



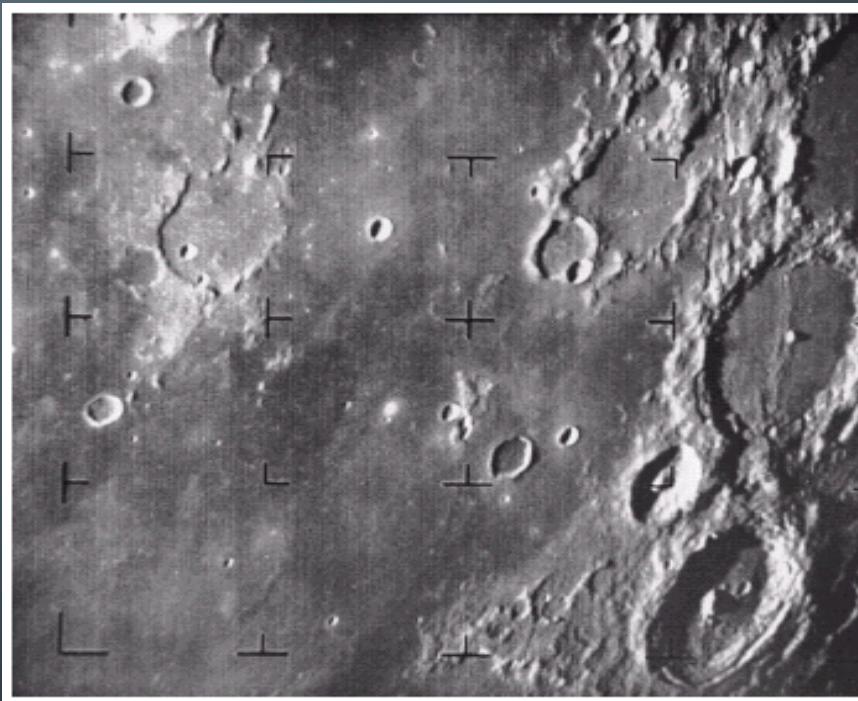
- Mid to late 1920s: Improvements to the Bartlane system resulted in higher quality images

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



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

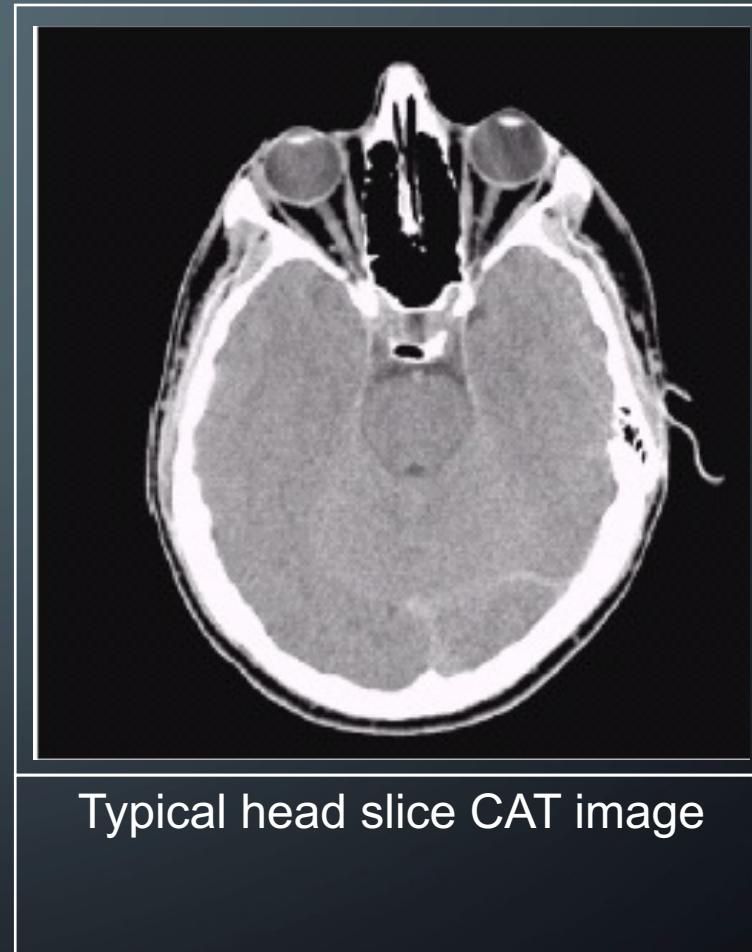
- 1964: Computers used to improve the quality of images of the moon taken by the *Ranger 7* probe
- Such techniques were used in other space missions including the Apollo landings



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

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

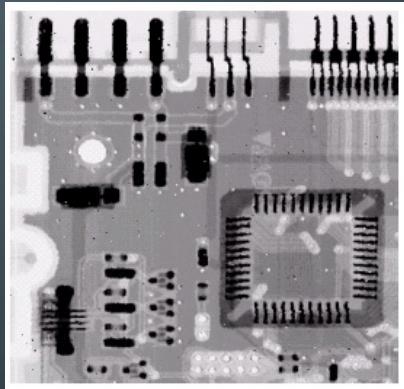
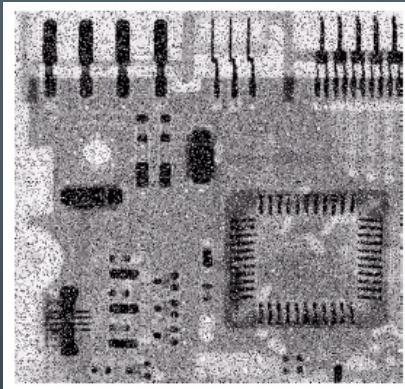
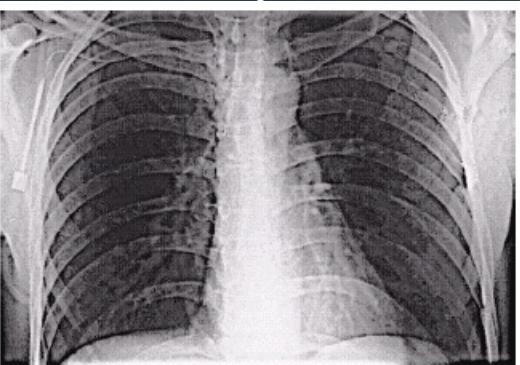
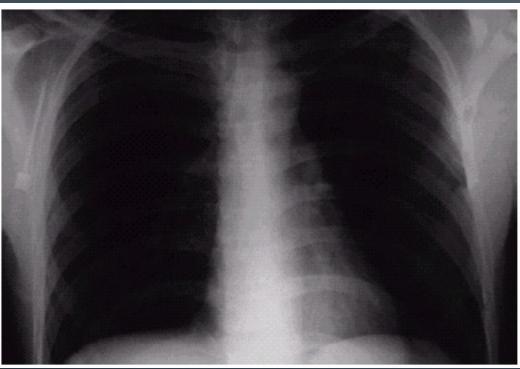
- 1979: Sir Godfrey N. Hounsfield & Prof. Allan M. Cormack share the Nobel Prize in medicine for the invention of tomography, the technology behind Computerised Axial Tomography (CAT) scans



- 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

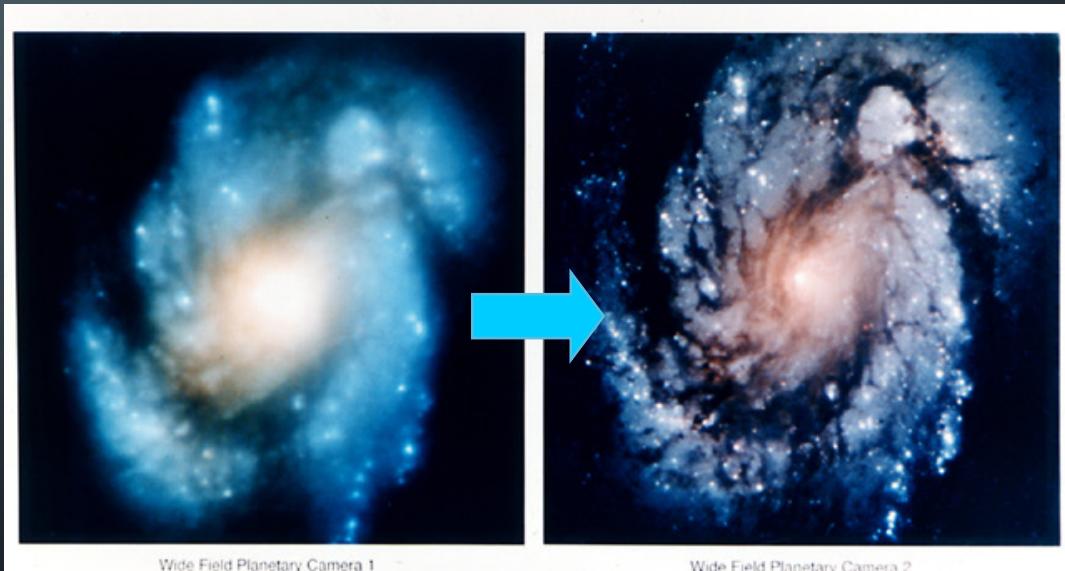
EXAMPLES: IMAGE ENHANCEMENT

- 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

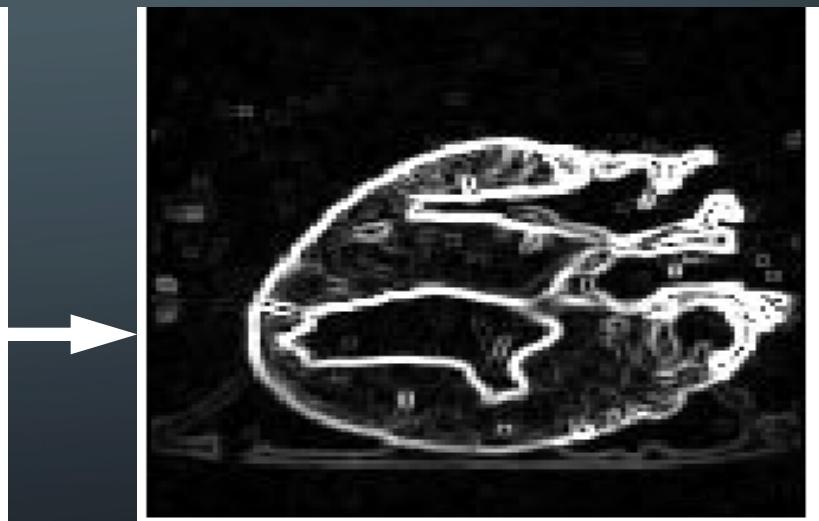


EXAMPLES: MEDICINE

- 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

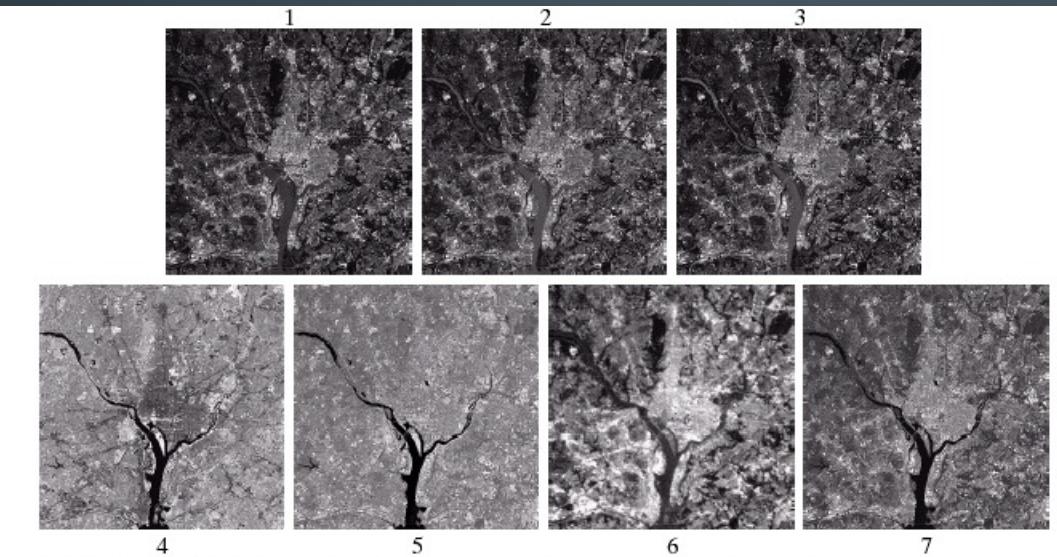


Edge Detection Image

EXAMPLES: GIS

- Geographic Information Systems

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

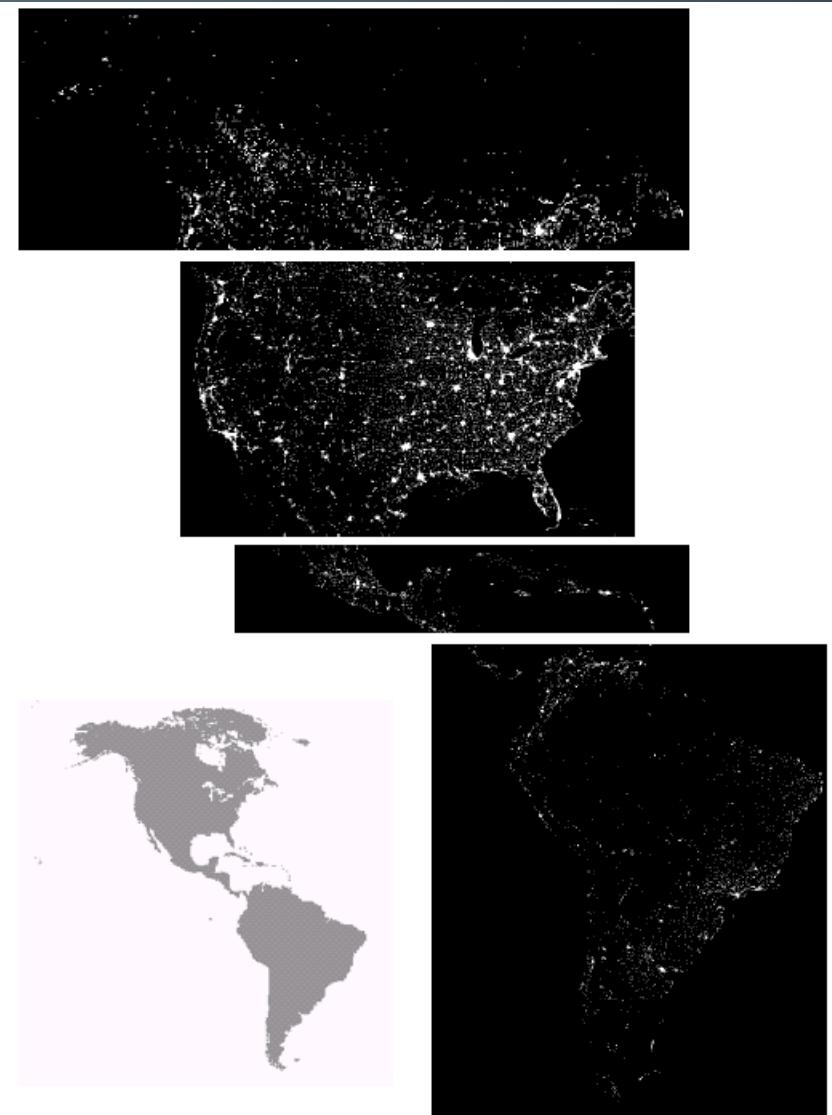


EXAMPLES: GIS (CONT...)

- *Night-Time Lights of the World*

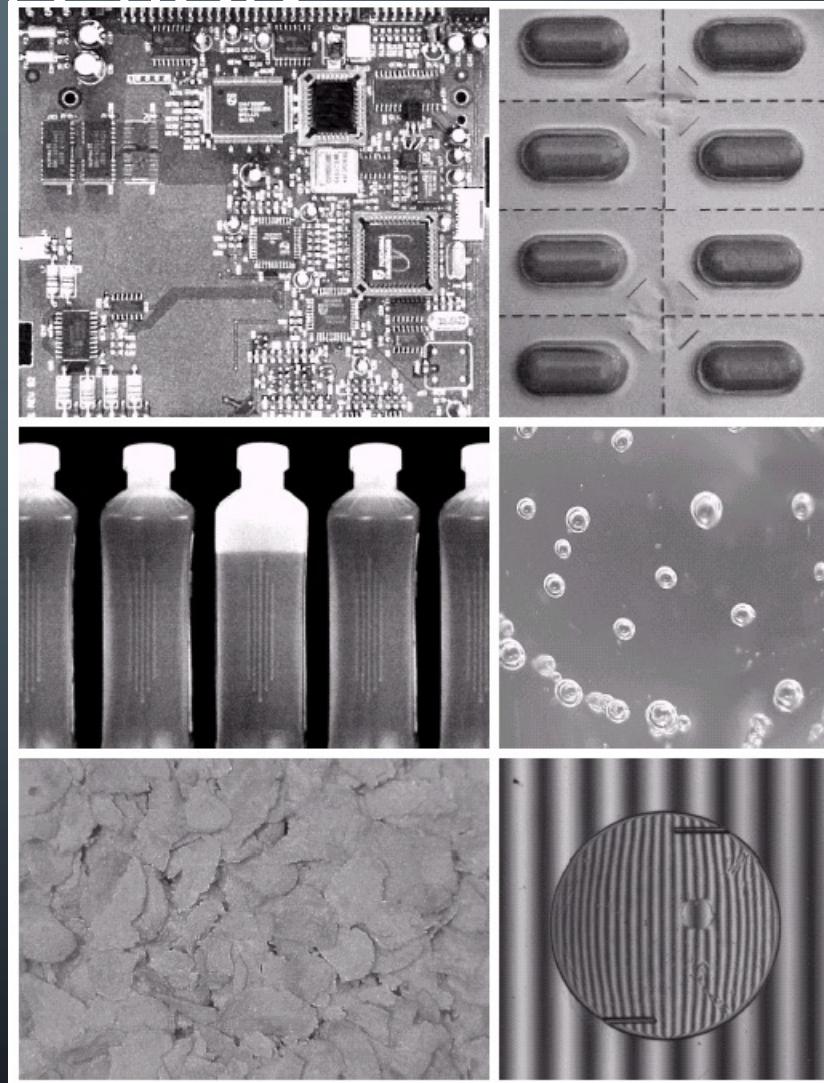
data set

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



EXAMPLES: INDUSTRIAL INSPECTION

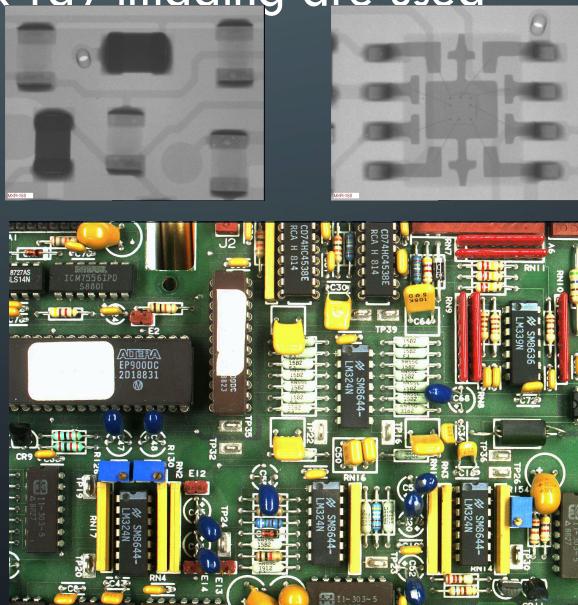
- Human operators are expensive, slow and unreliable
- Make machines do the job instead
- Industrial vision systems are used in all kinds of industries
- Can we trust them?



EXAMPLES: PCB INSPECTION

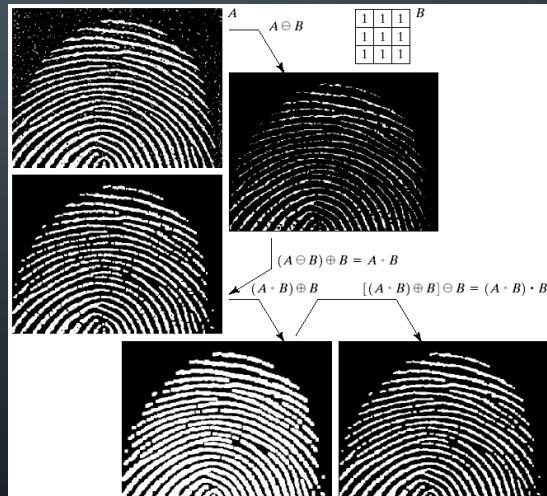
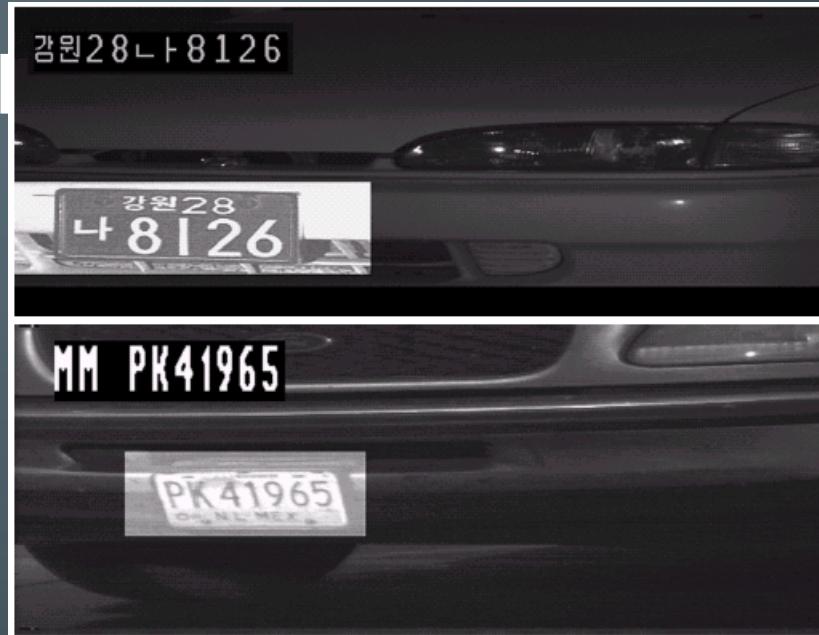
- Printed Circuit Board (PCB) inspection

- 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



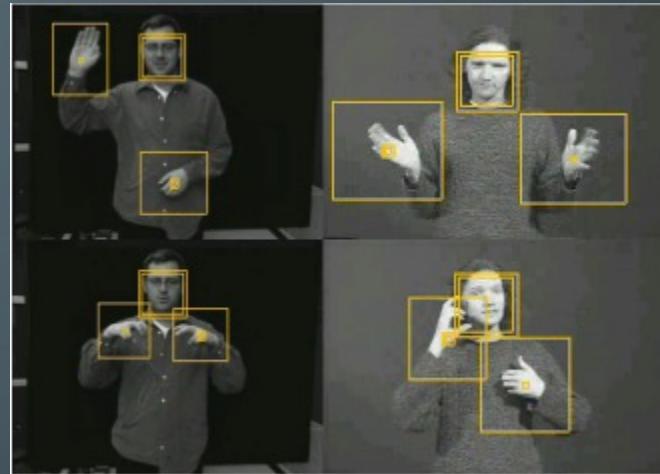
EXAMPLES: LAW ENFORCEMENT

- Image processing techniques are used extensively by law enforcers
 - Number plate recognition for speed cameras/automated toll systems
 - Fingerprint recognition
 - Enhancement of CCTV images

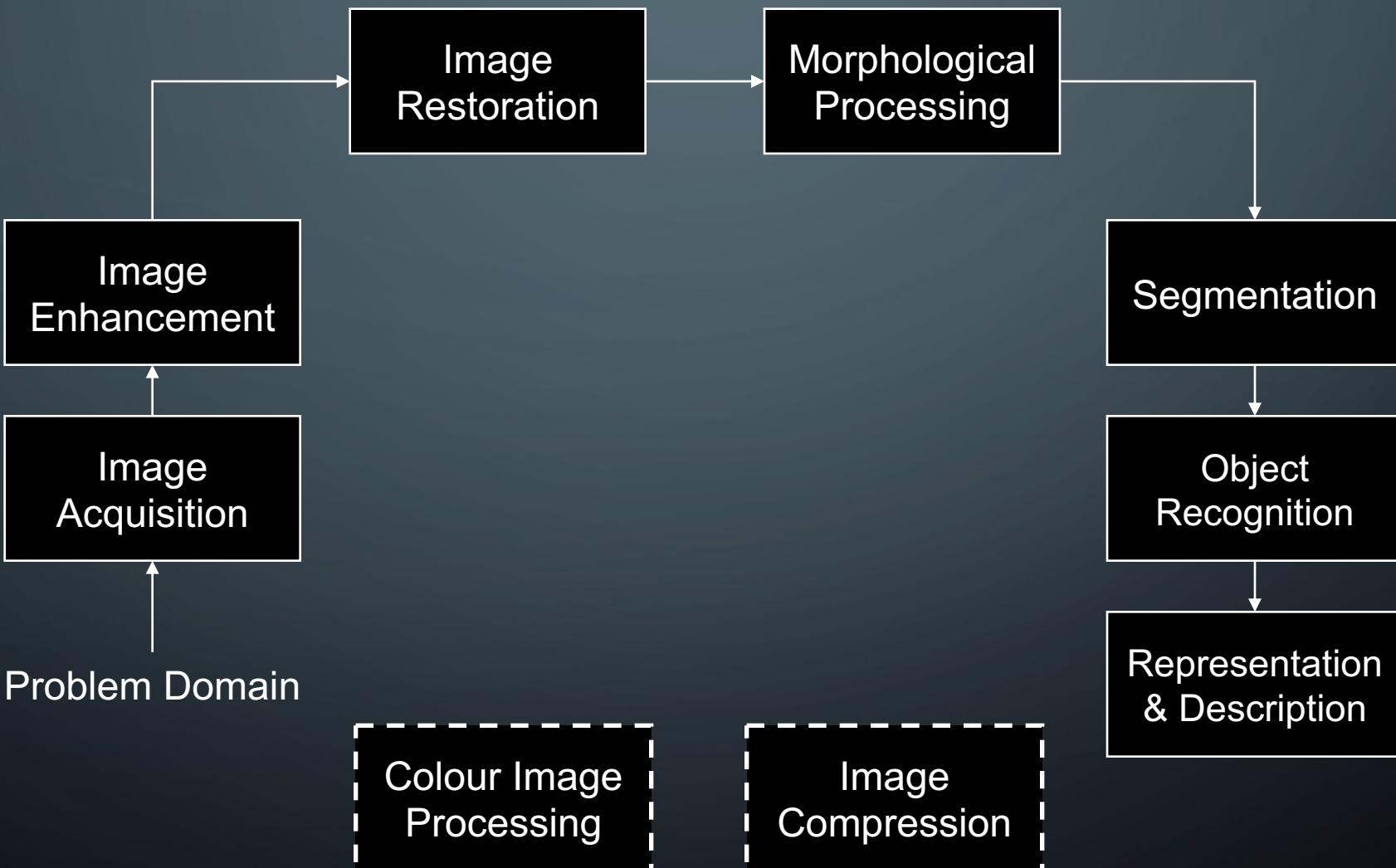


EXAMPLES: HCI

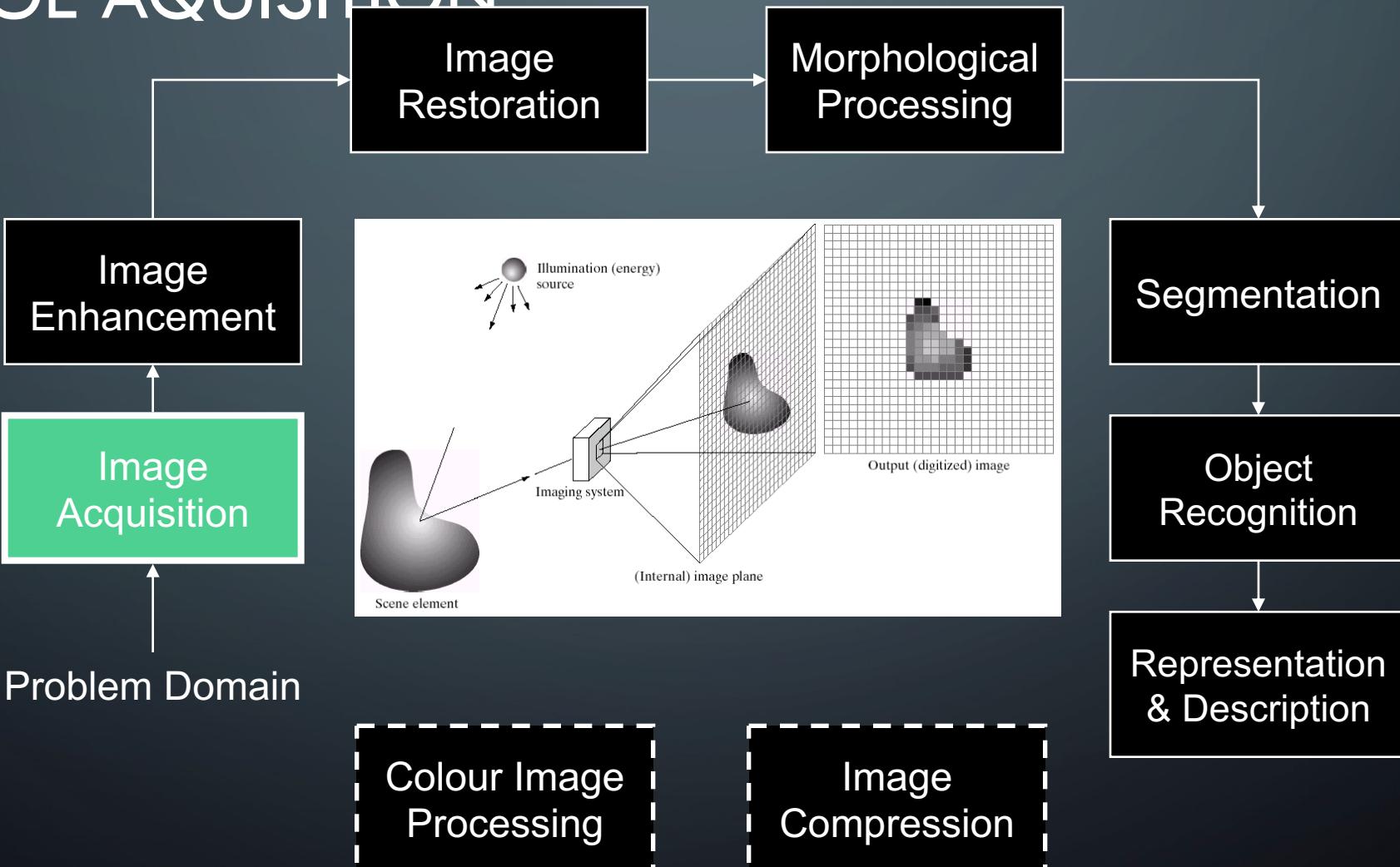
- Try to make human computer interfaces more natural
 - Face recognition
 - Gesture recognition
- Does anyone remember the user interface from “Minority Report”?
- These tasks can be extremely difficult



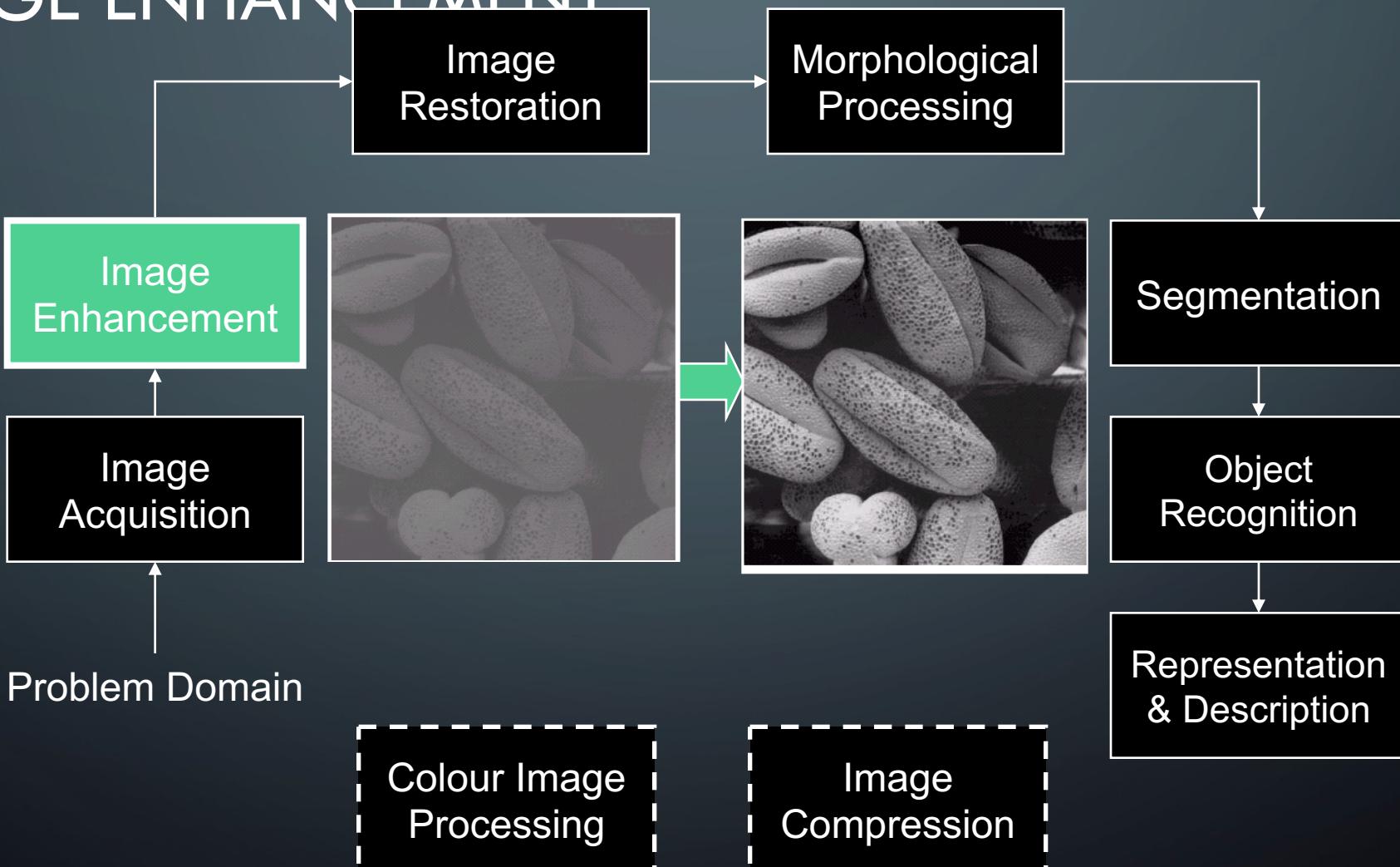
KEY STAGES IN DIGITAL IMAGE PROCESSING



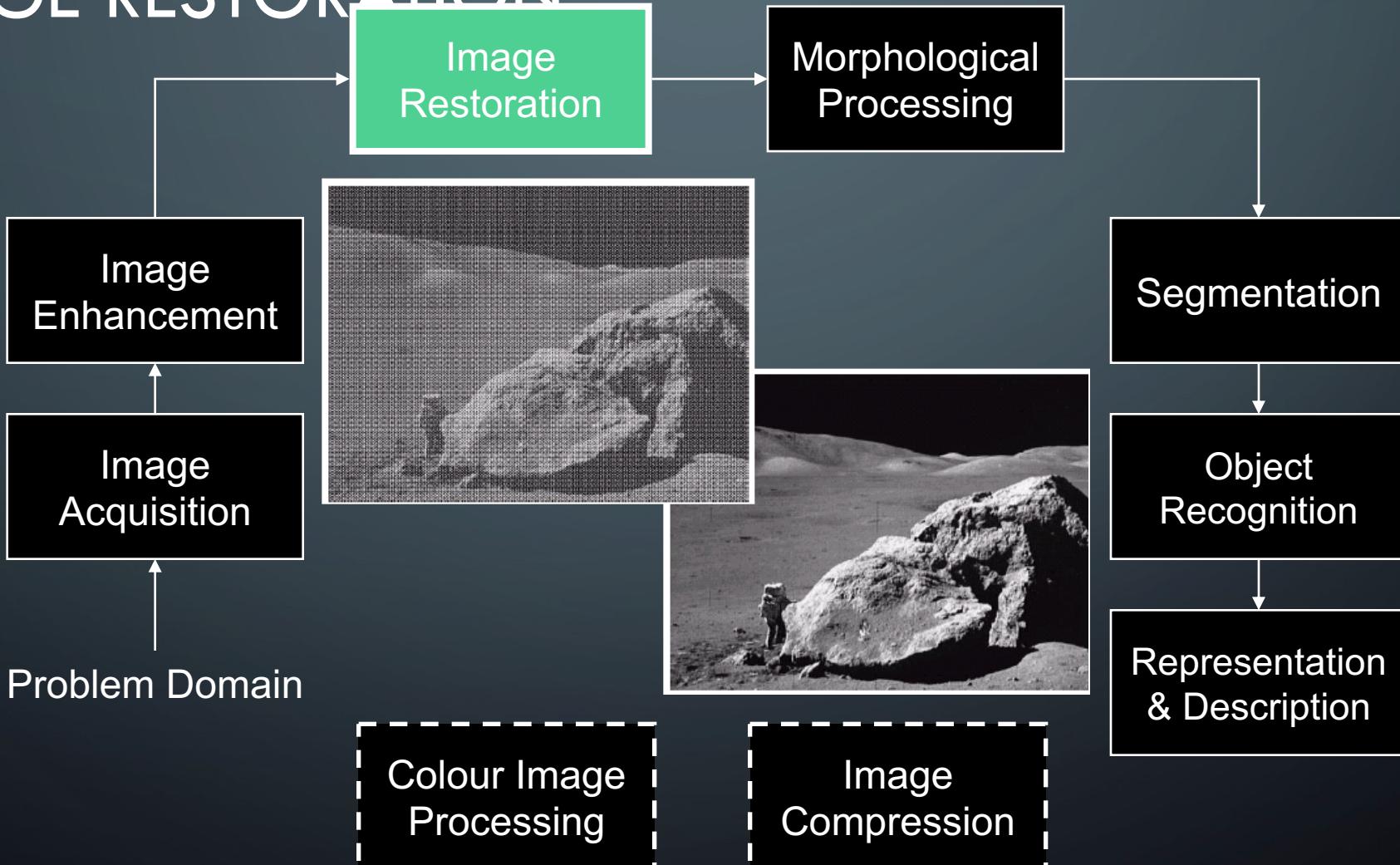
KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE ACQUISITION



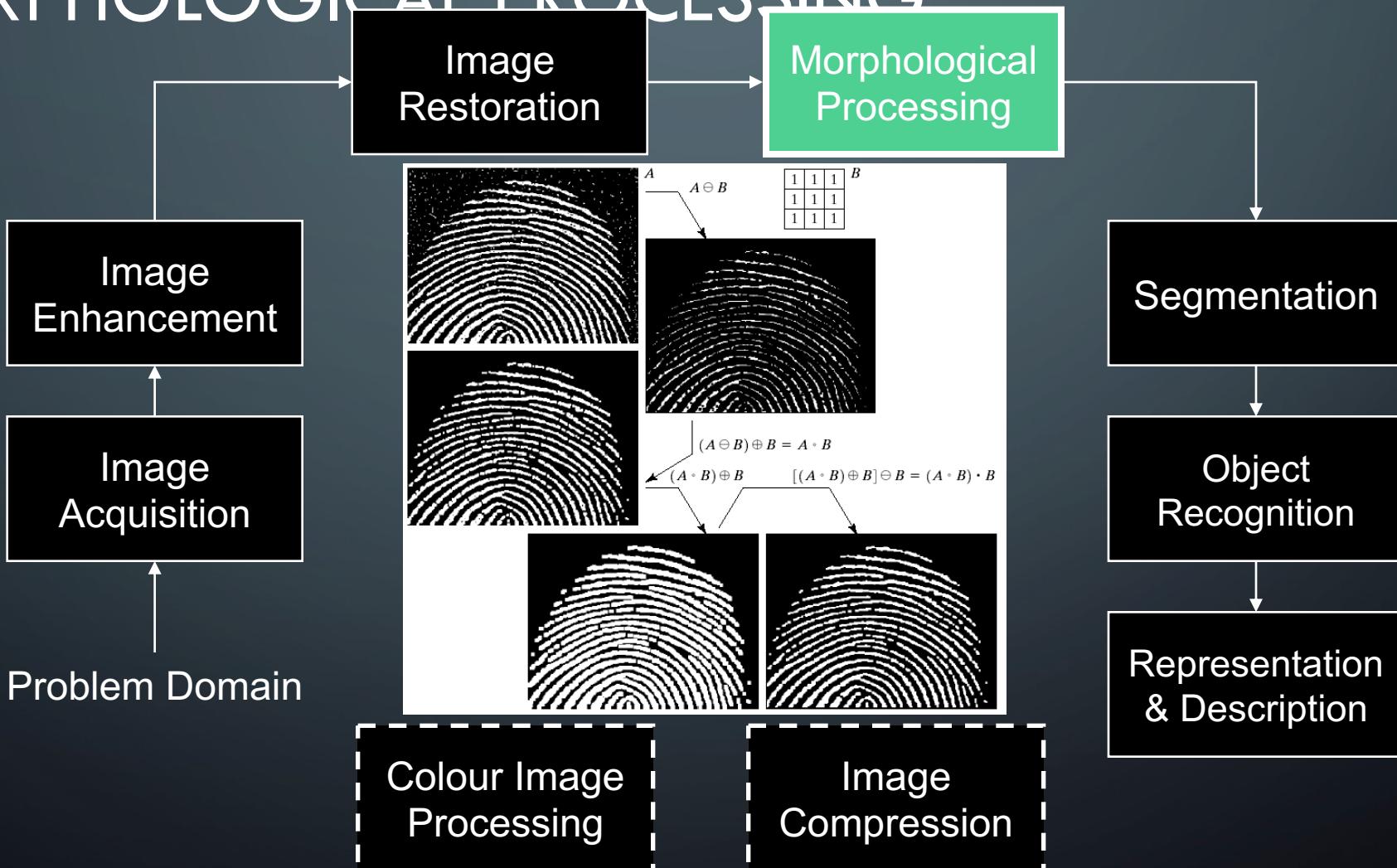
KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE ENHANCEMENT



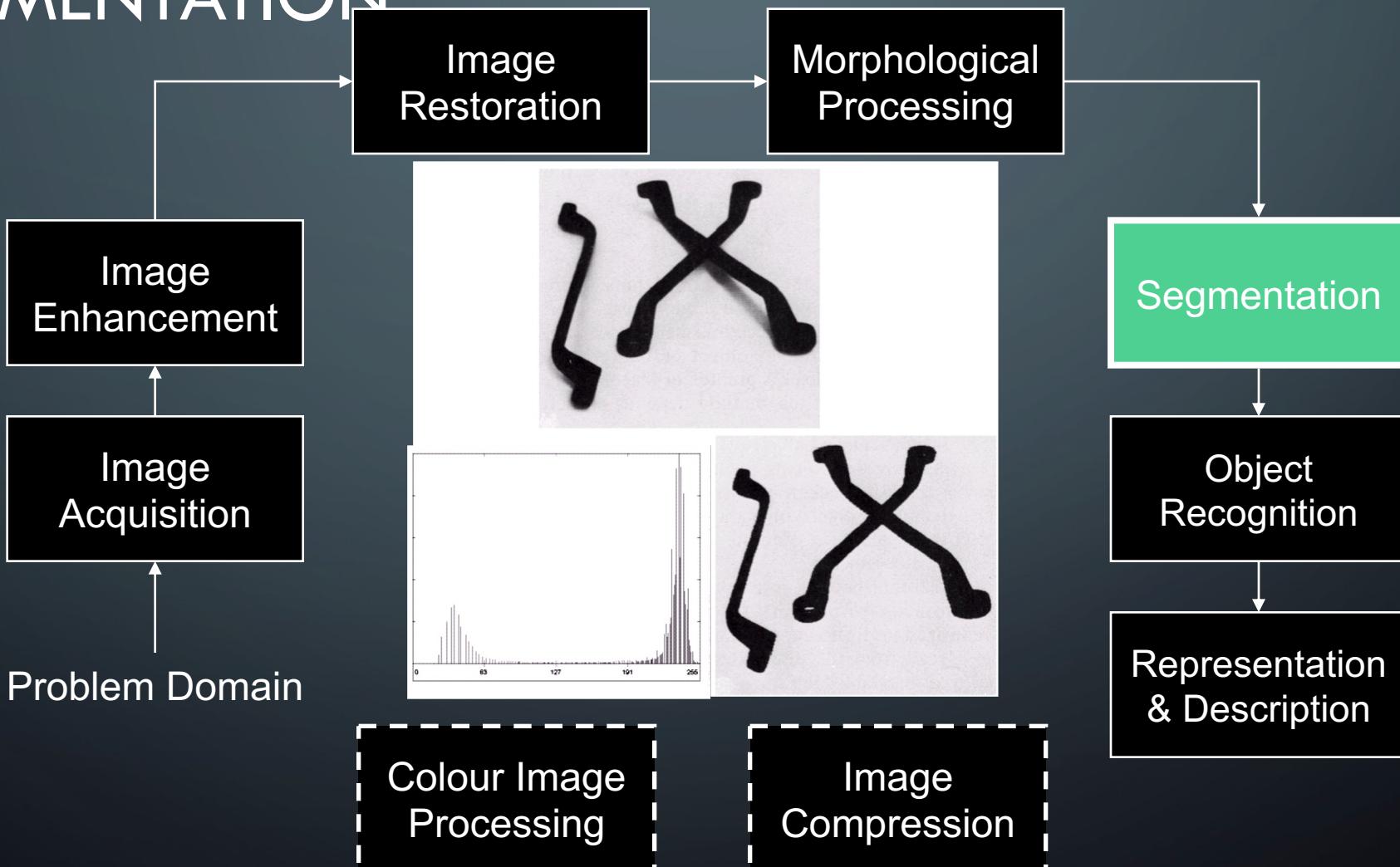
KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE RESTORATION



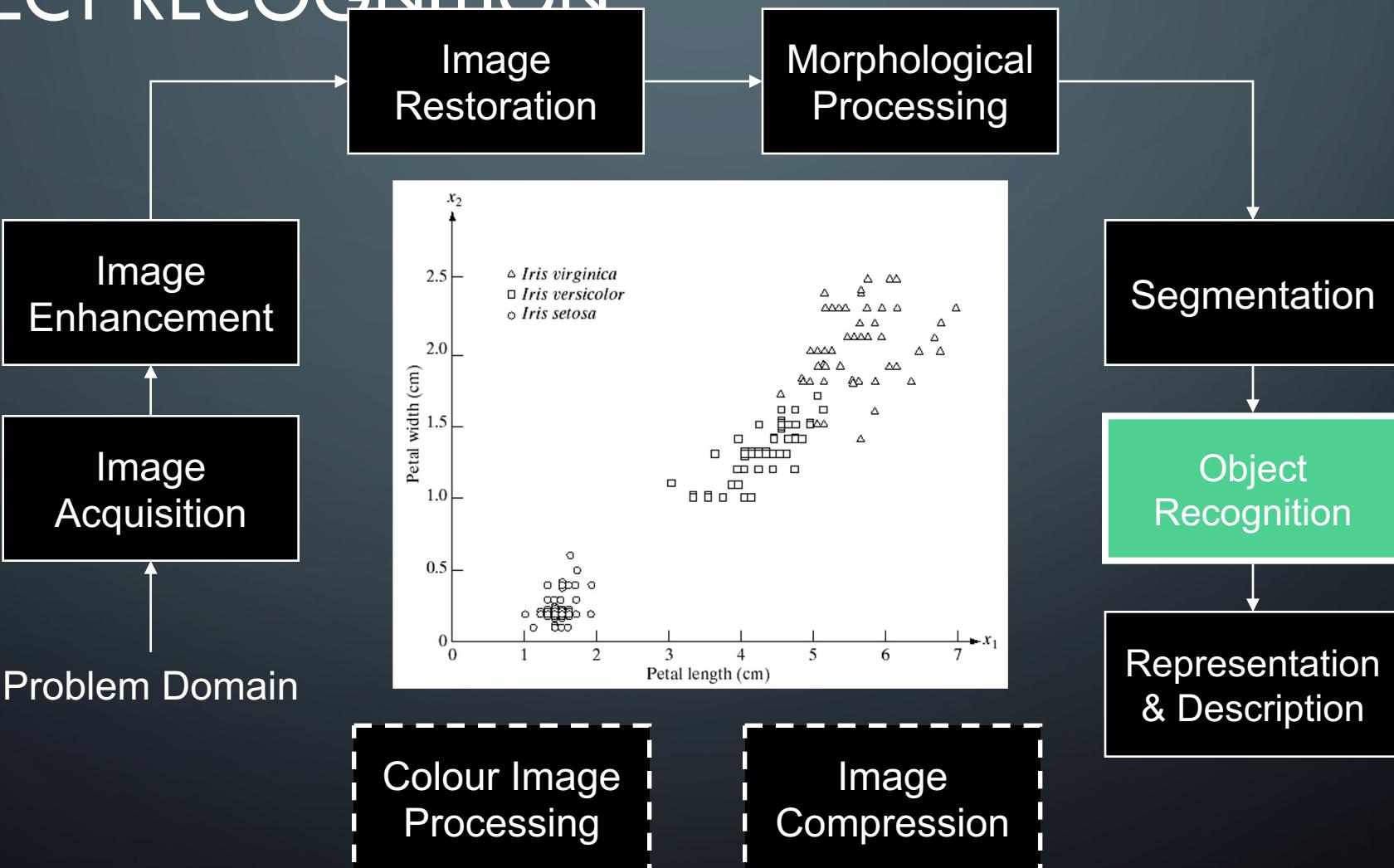
KEY STAGES IN DIGITAL IMAGE PROCESSING: MORPHOLOGICAL PROCESSING



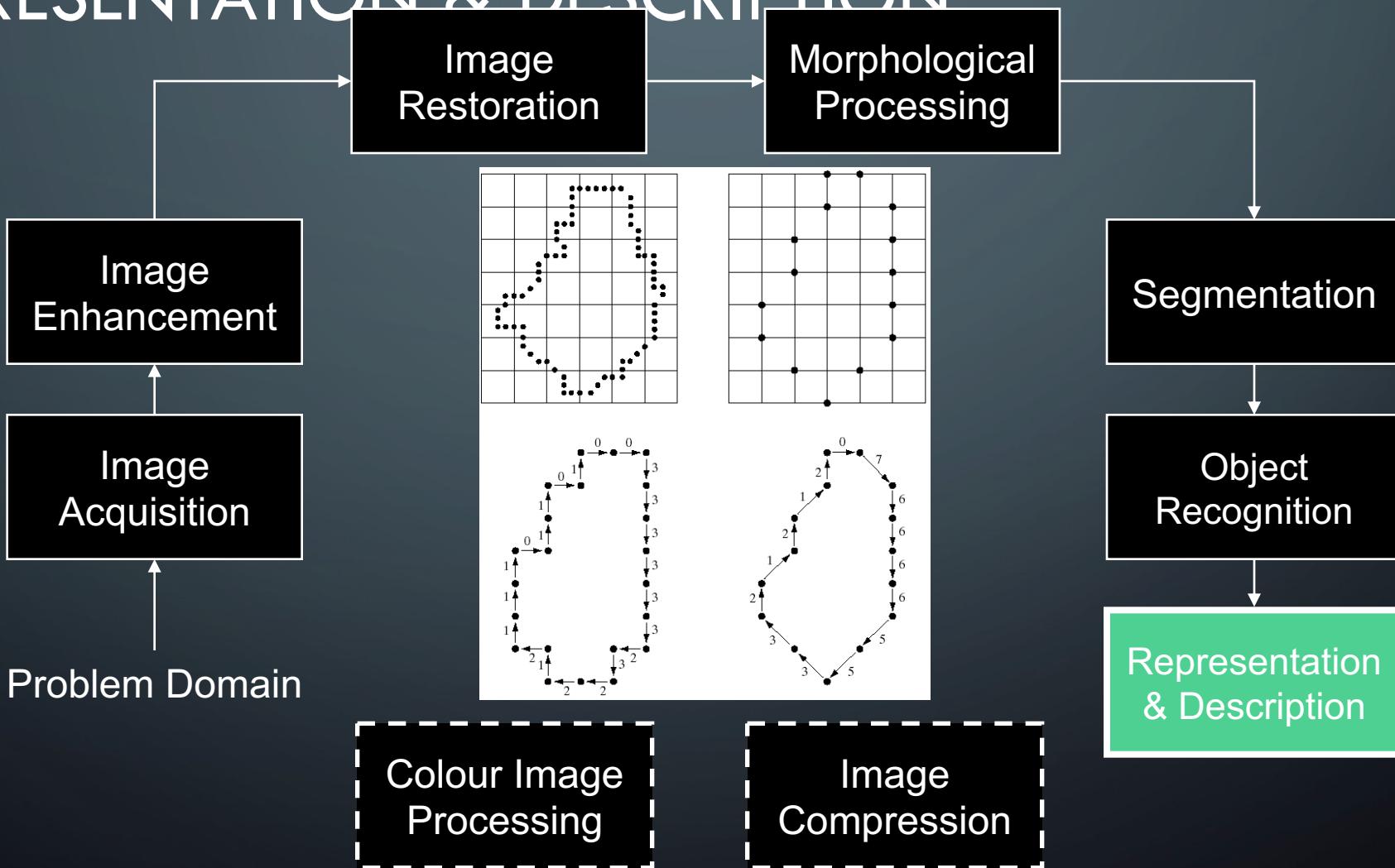
KEY STAGES IN DIGITAL IMAGE PROCESSING: SEGMENTATION



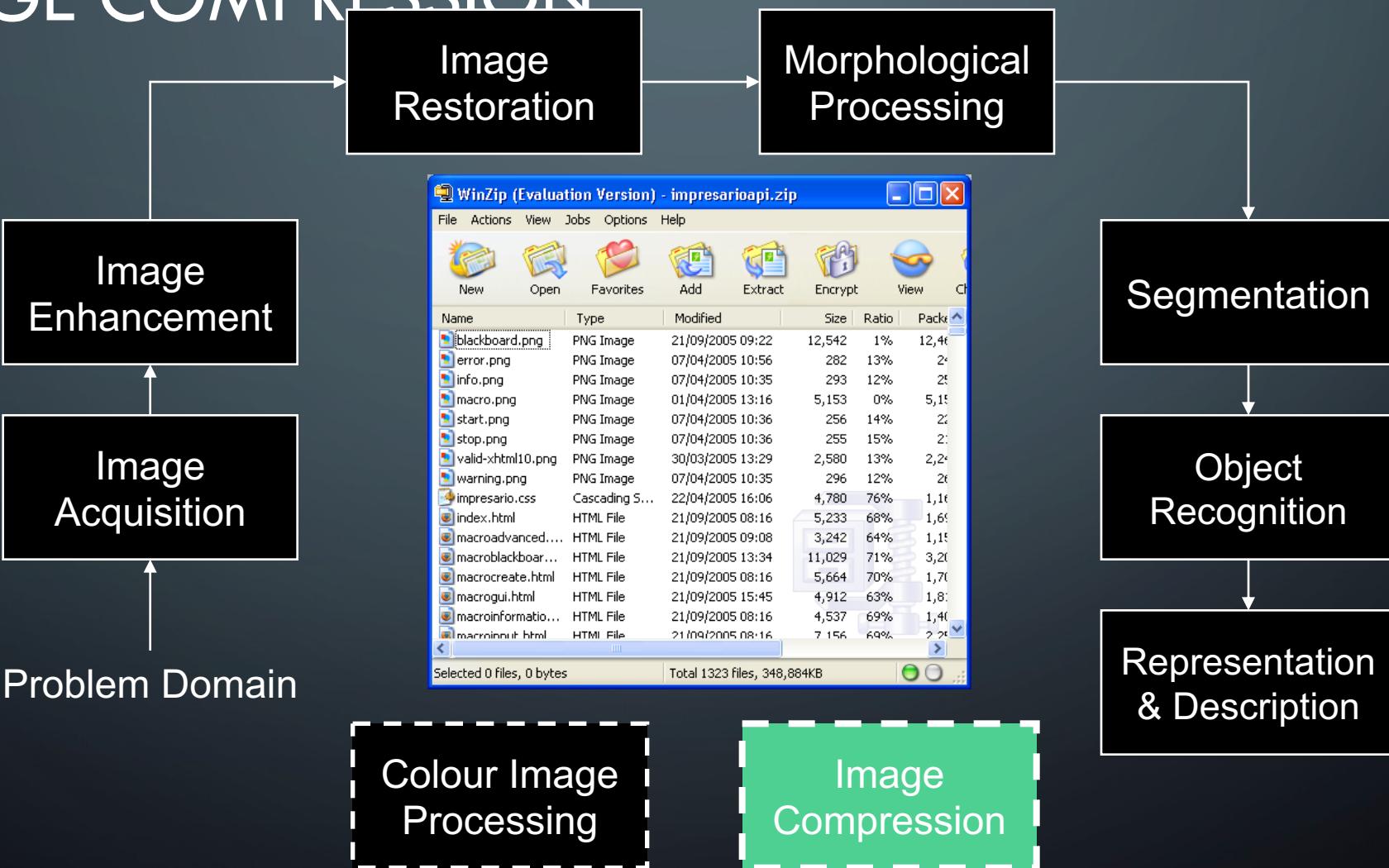
KEY STAGES IN DIGITAL IMAGE PROCESSING: OBJECT RECOGNITION



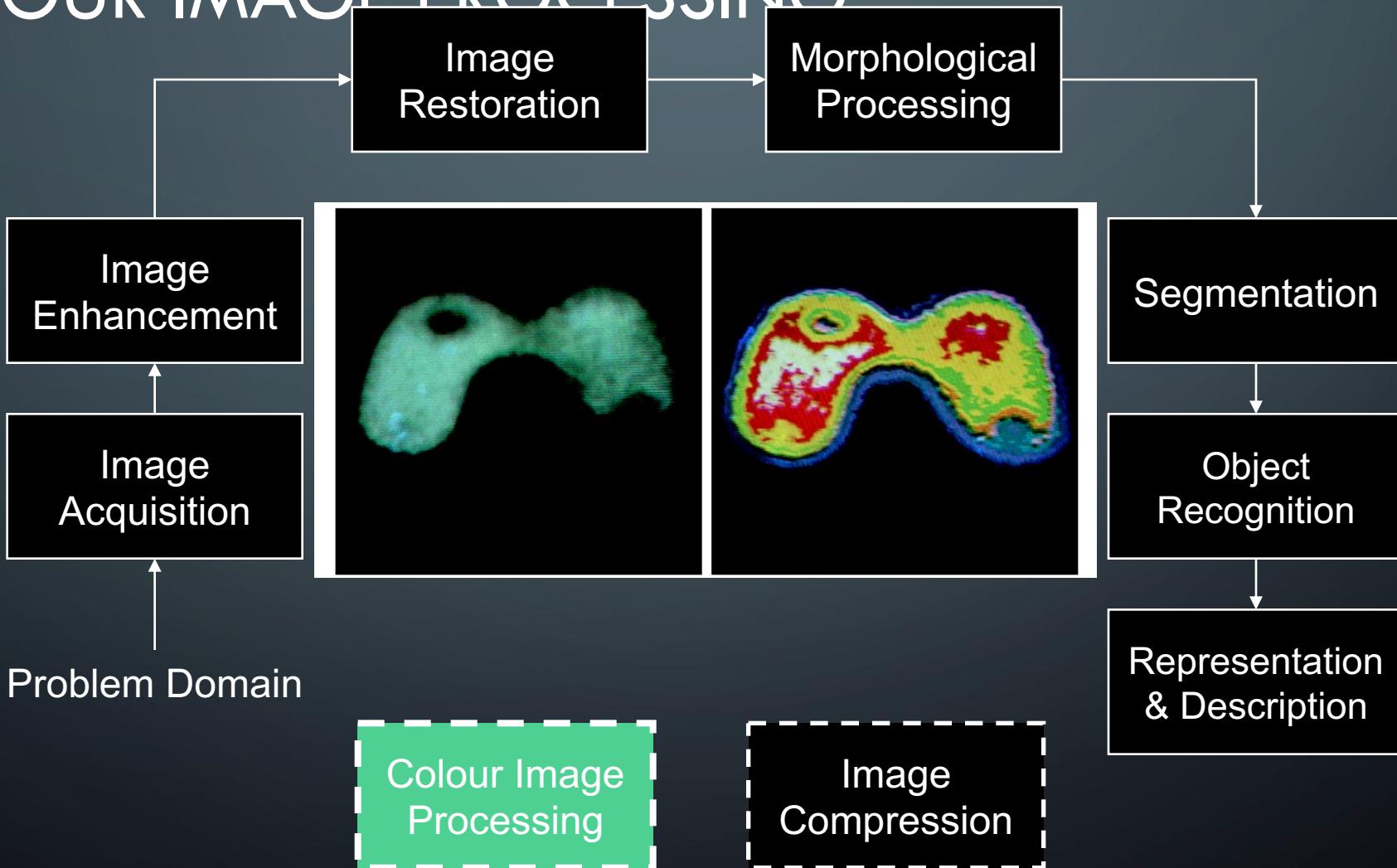
KEY STAGES IN DIGITAL IMAGE PROCESSING: REPRESENTATION & DESCRIPTION



KEY STAGES IN DIGITAL IMAGE PROCESSING: IMAGE COMPRESSION



KEY STAGES IN DIGITAL IMAGE PROCESSING: COLOUR IMAGE PROCESSING





THANKS FOR JOINING

Q&A