DSIP – Lecturer 01

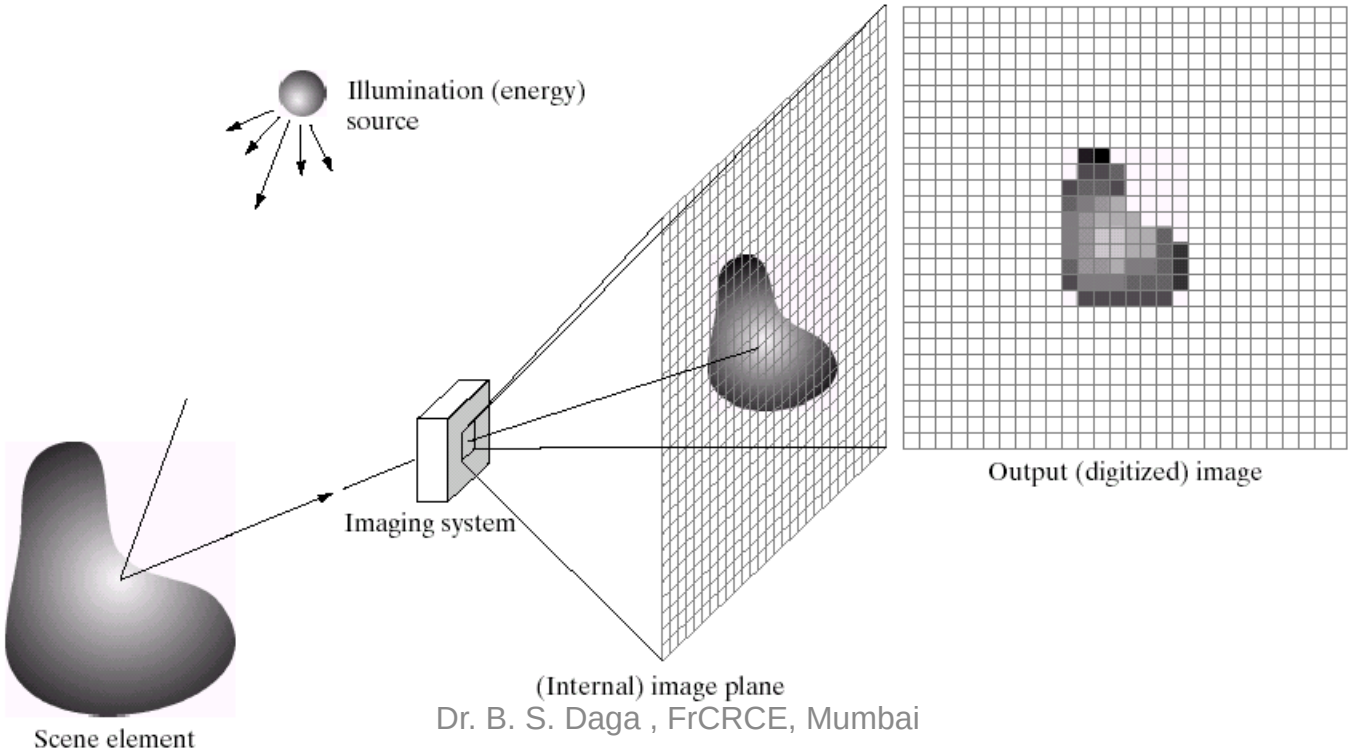
Contents

- 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

One picture is worth more than ten thousand words

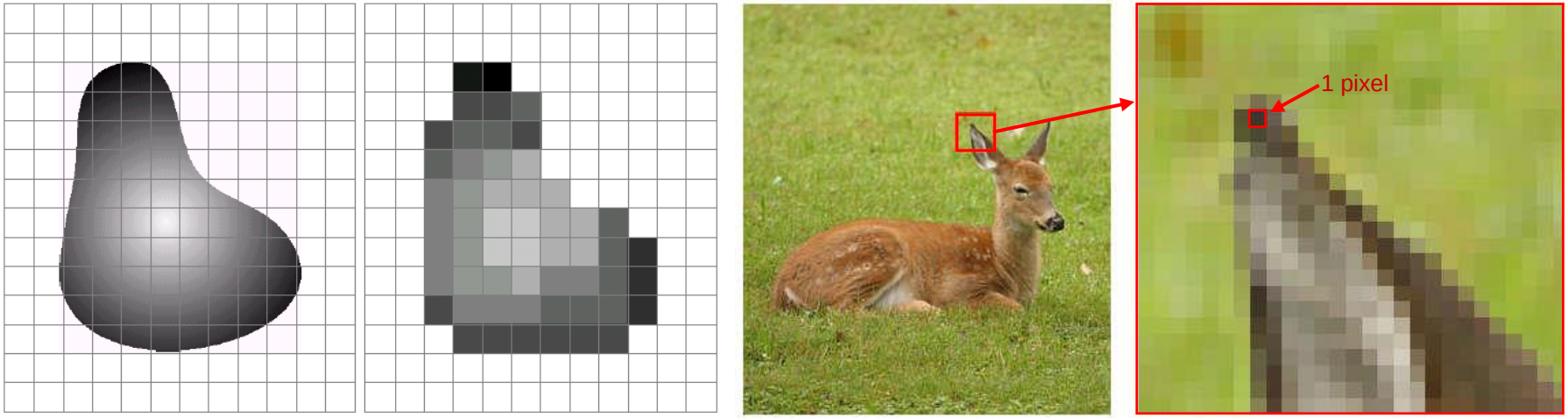
What is a Digital Image?

- 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…)

- Pixel values typically represent gray levels, colors, heights, opacities etc
- **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)
  - 4 samples per point (Red, Green, Blue, and “Alpha”, a.k.a. Opacity)

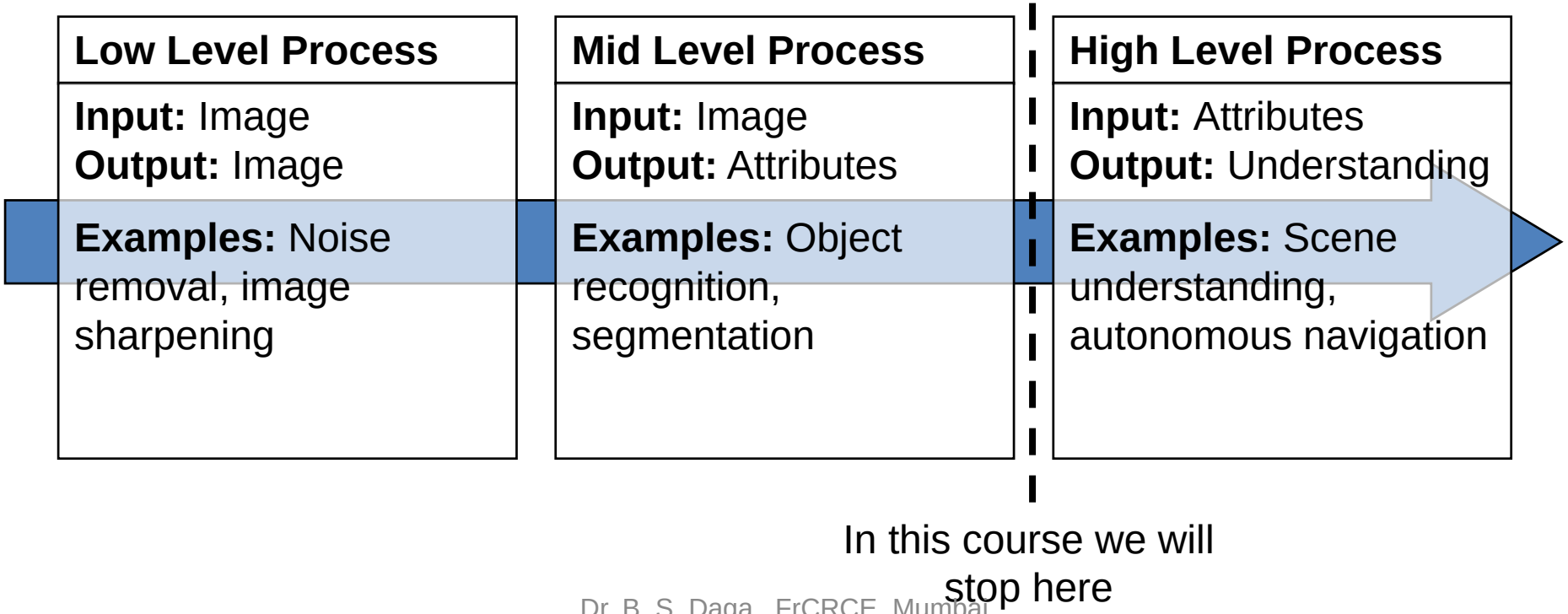
- Fo se we will focus on grey

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

What is DIP? (cont…)

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



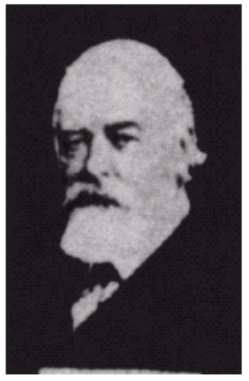
History of Digital Image Processing

- **Early 1920s:** One of the first applications of digital imaging was in the news-paper industry
  - The Bart lane 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

Early digital image

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

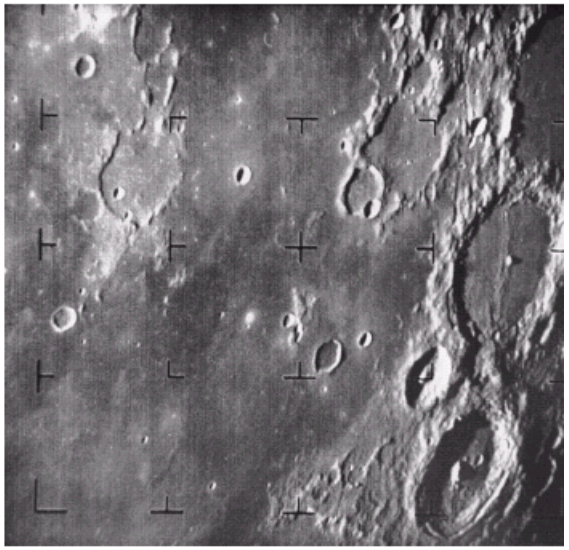


Improved digital image

Early 15 tone digital image

History of DIP (cont…)

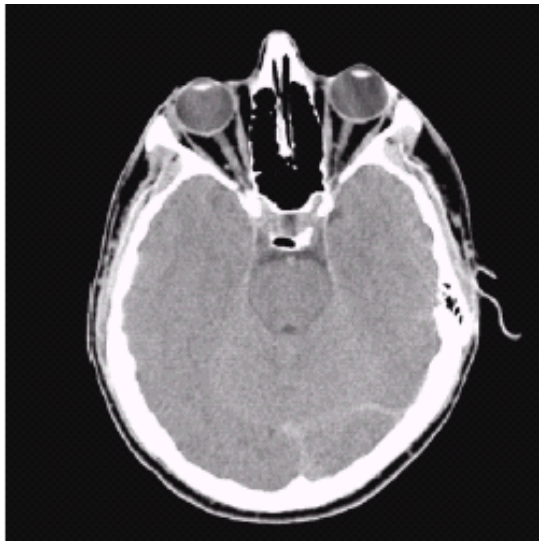
- **1960s:** Improvements in computing technology and the onset of the space race led to a surge of work in digital image processing
  - **1964:** Computers used to improve the quality of images of the moon taken by the *Ranger 7* probe
  - Such techniques were used in other space missions including 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, the technology behind Computerised Axial Tomography (CAT) scans



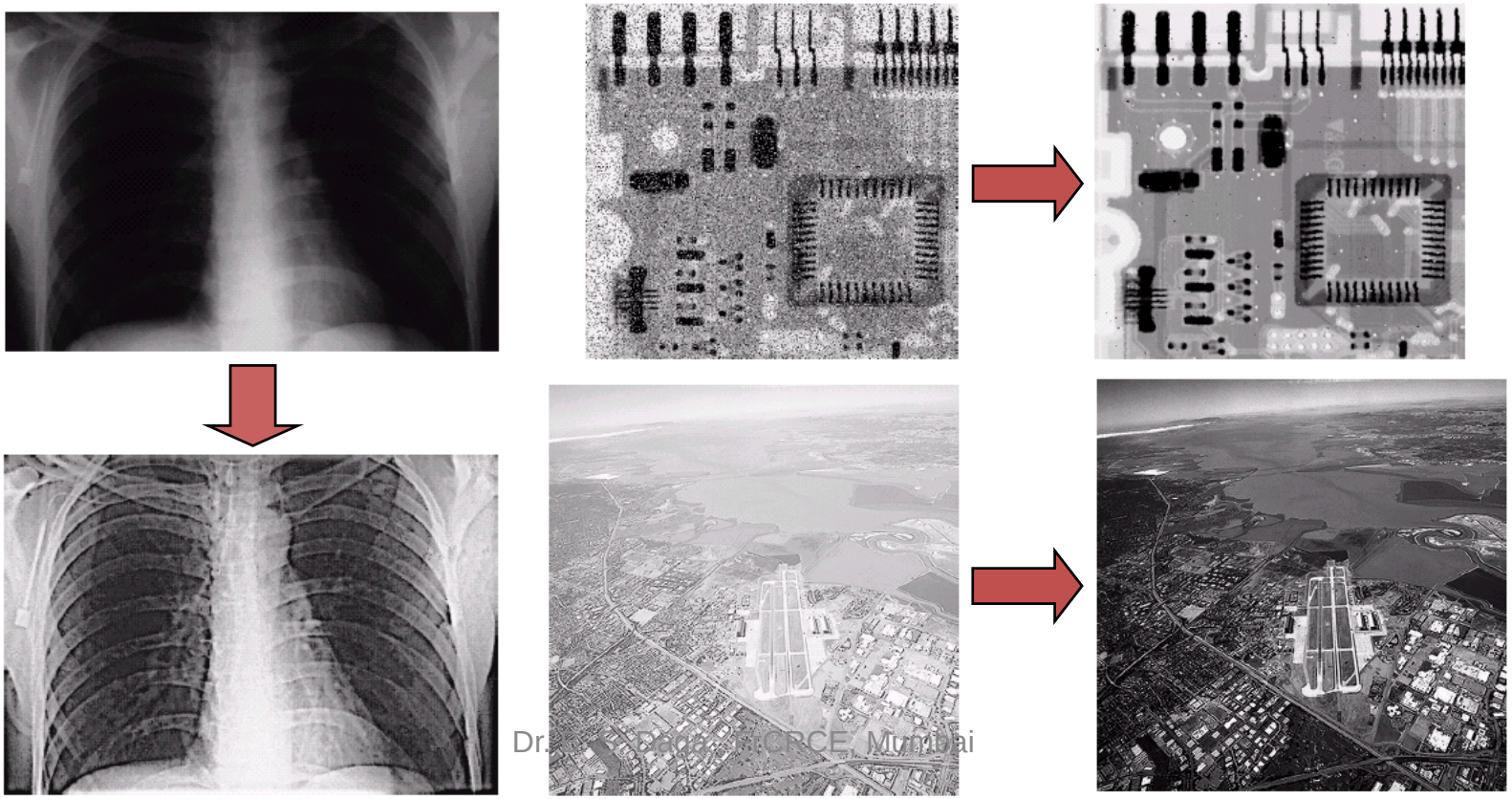
Typical head slice CAT image

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

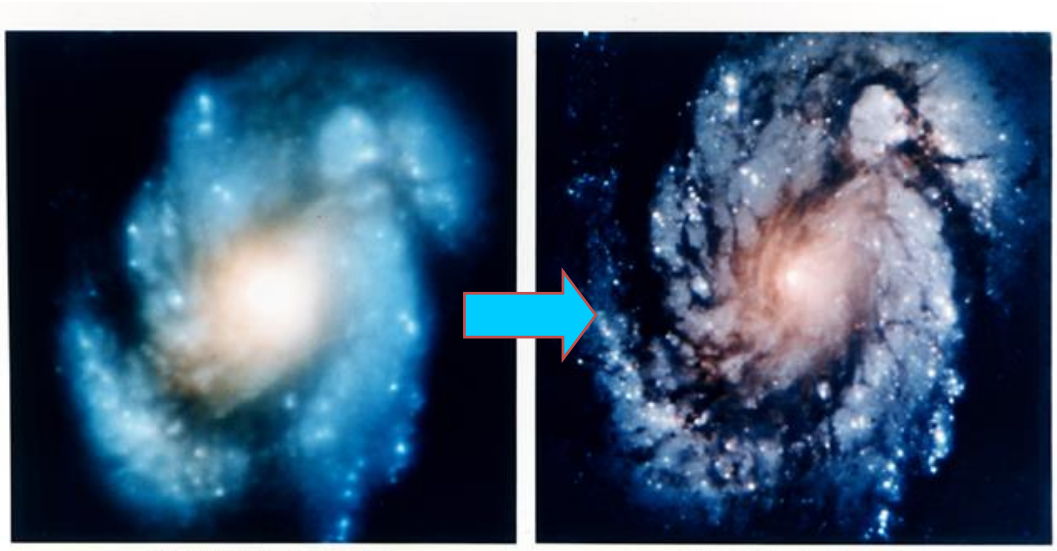
Examples: Image Enhancement

- 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

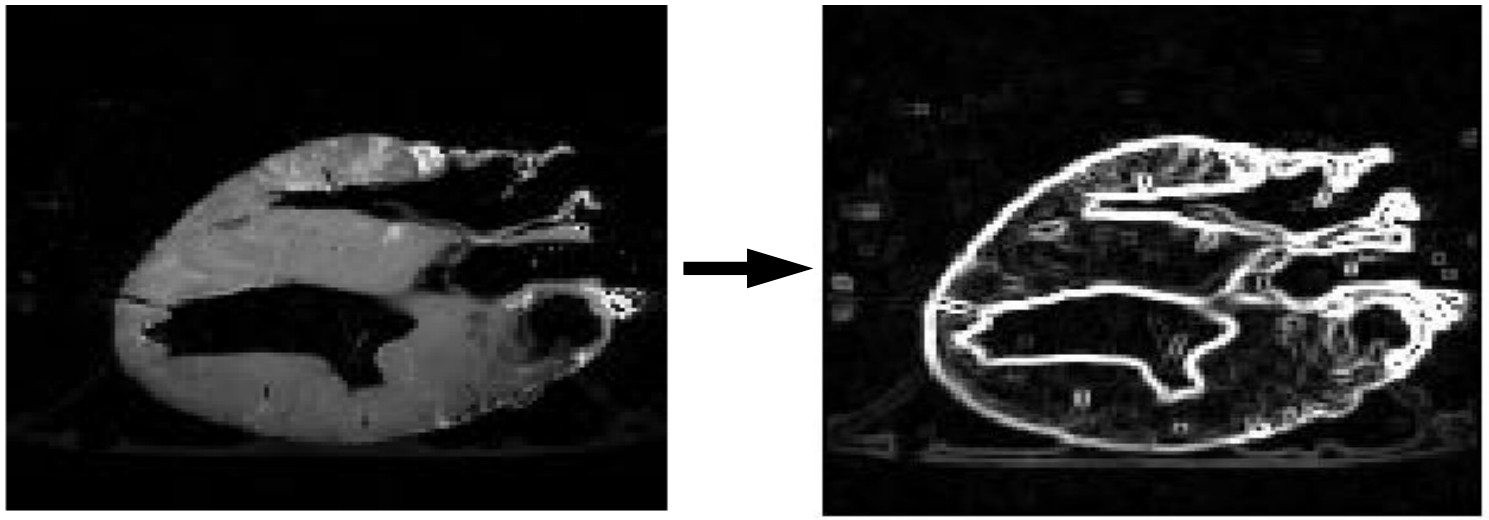


Examples: Artistic Effects

- 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

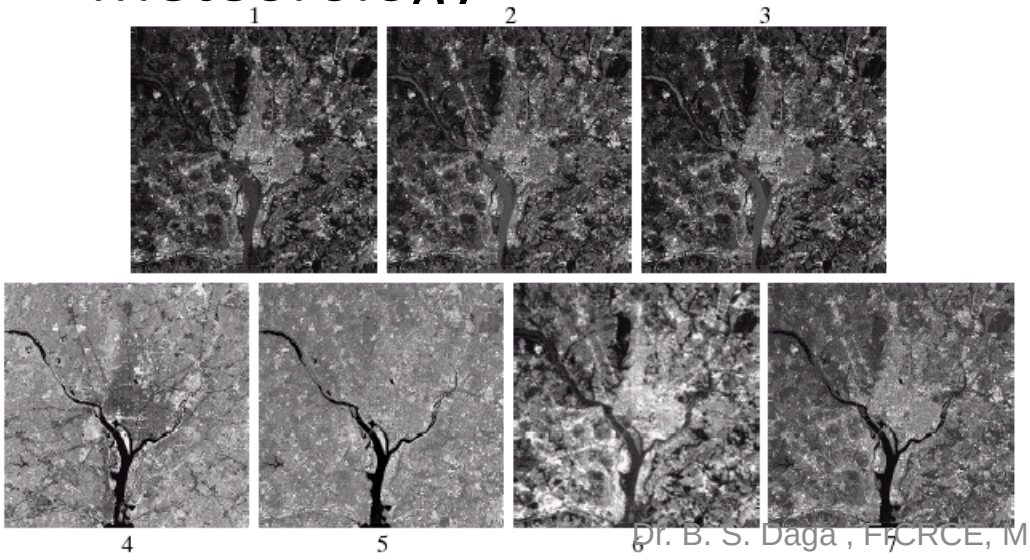


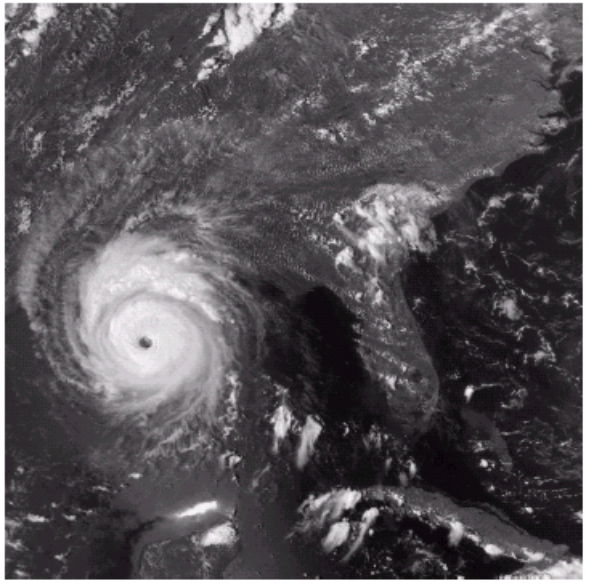
Original MRI Image of a Dog Heart

Edge Detection Image

Examples: GIS

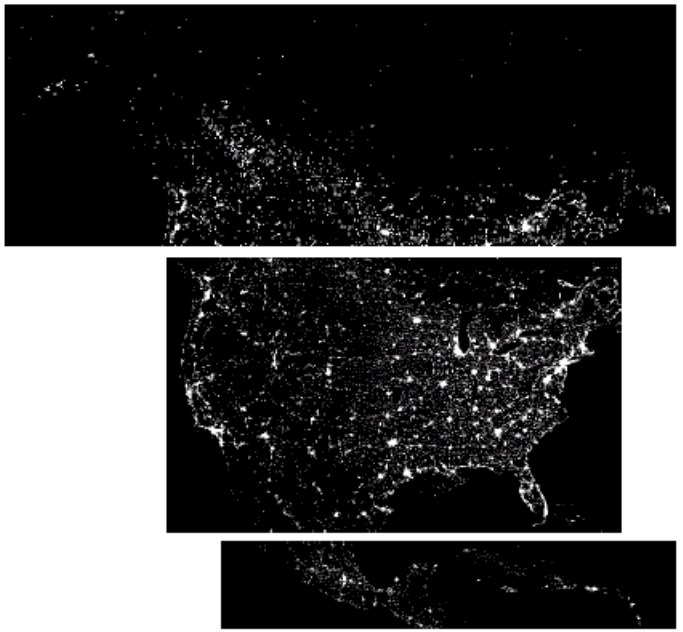
- Geographic Information Systems
  - Digital image processing techniques are used extensively to manipulate satellite imagery
  - Terrain classification
  - Meteorology





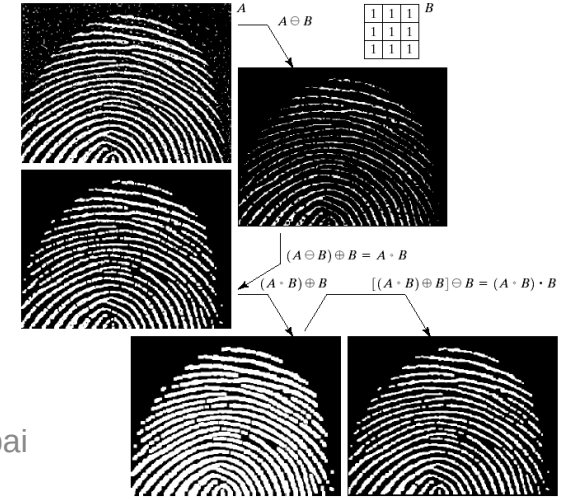
Examples: GIS (cont…)

- *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



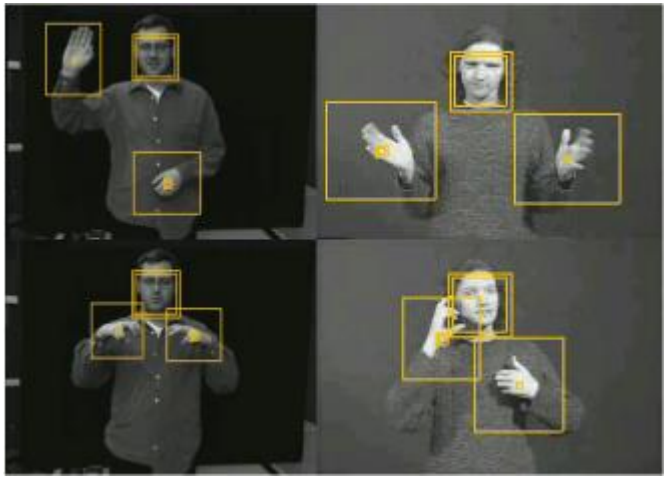
Examples: Law Enforcement

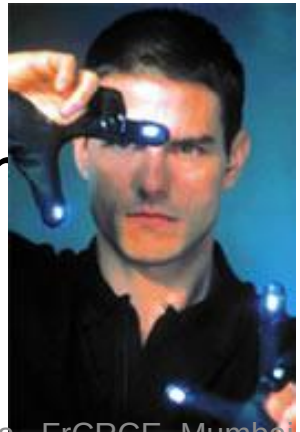
- Image processing techniques are used extensively by law enforcers
  - Number plate recognition for speed cameras/automated toll systems
  - Fingerprint recognition
  - Enhancement of CCTV images

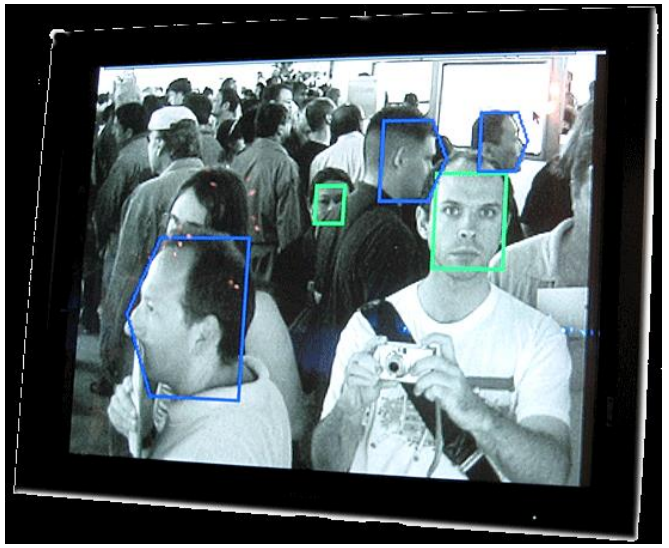


Examples: HCI

- 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 extrer difficult







Key Stages in Digital Image Processing

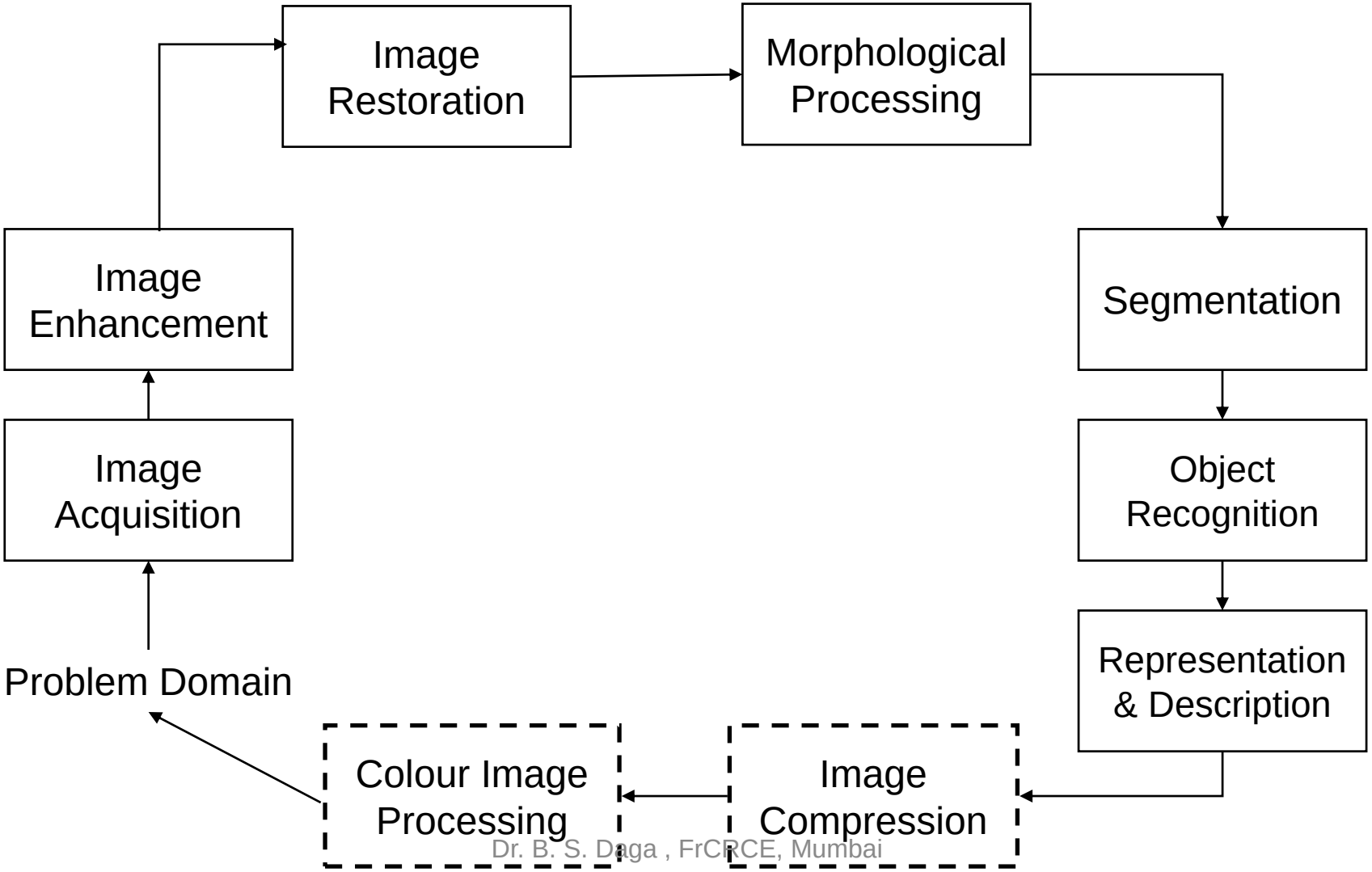


Image Acquisition

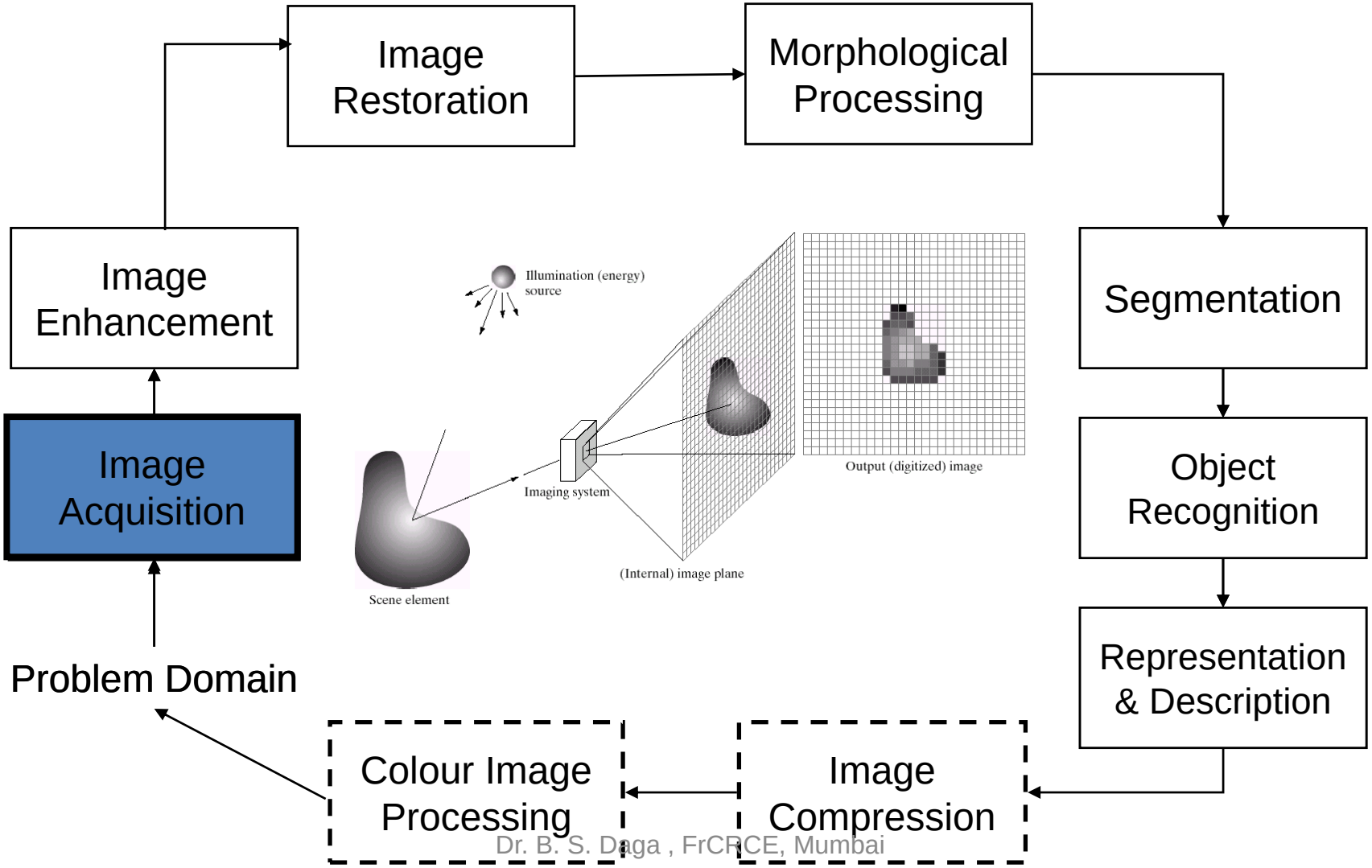


Image Enhancement

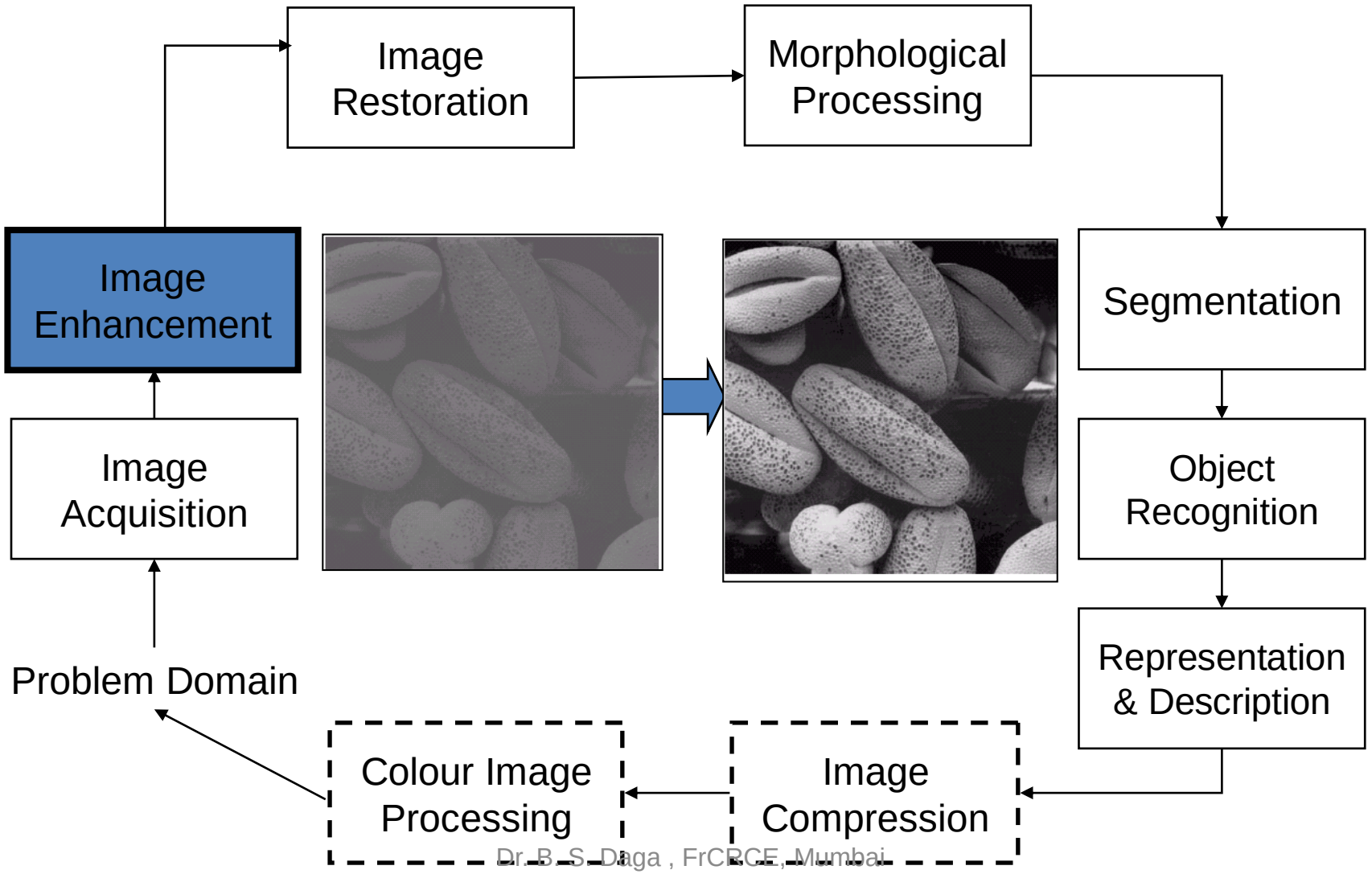
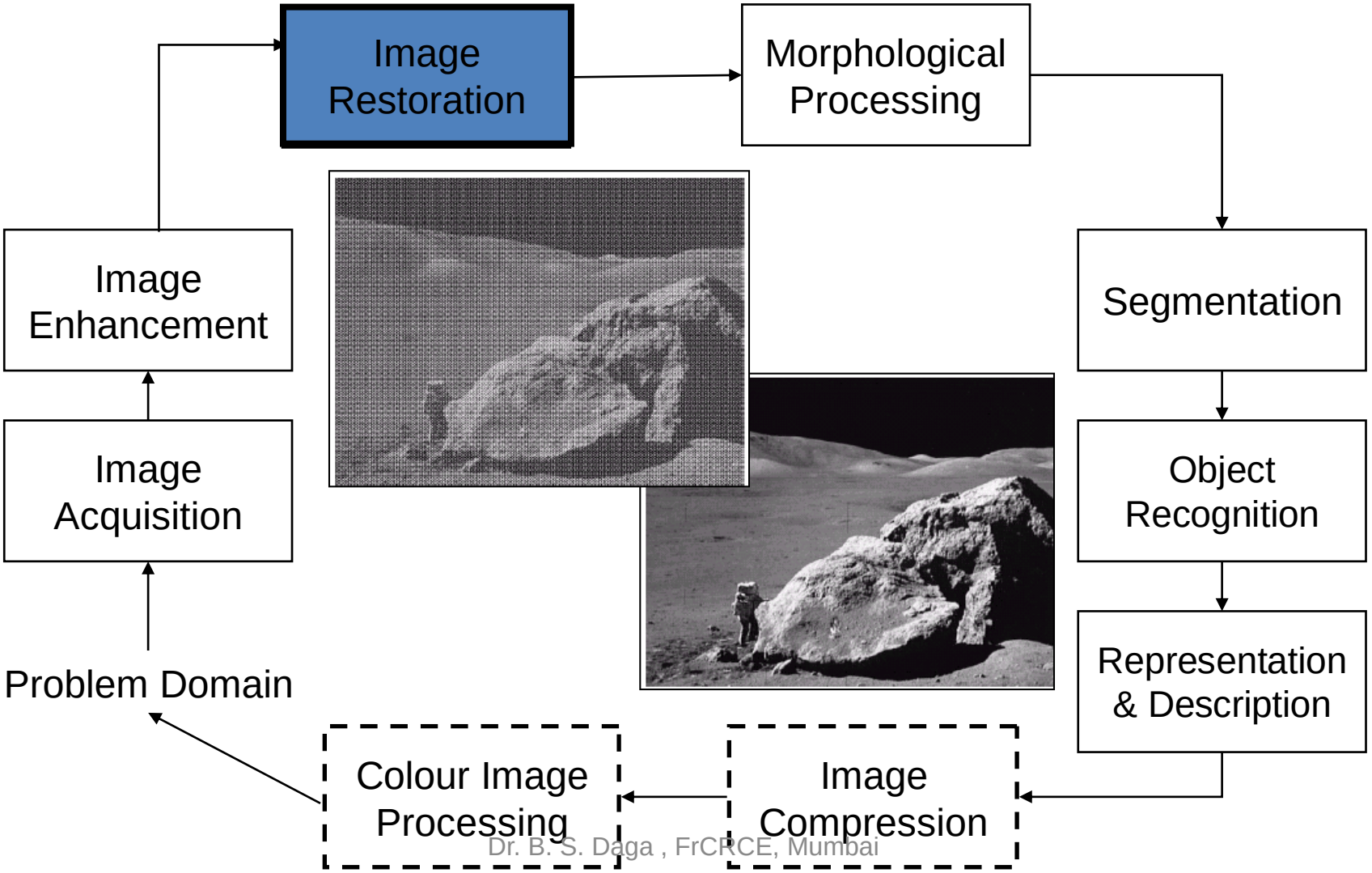
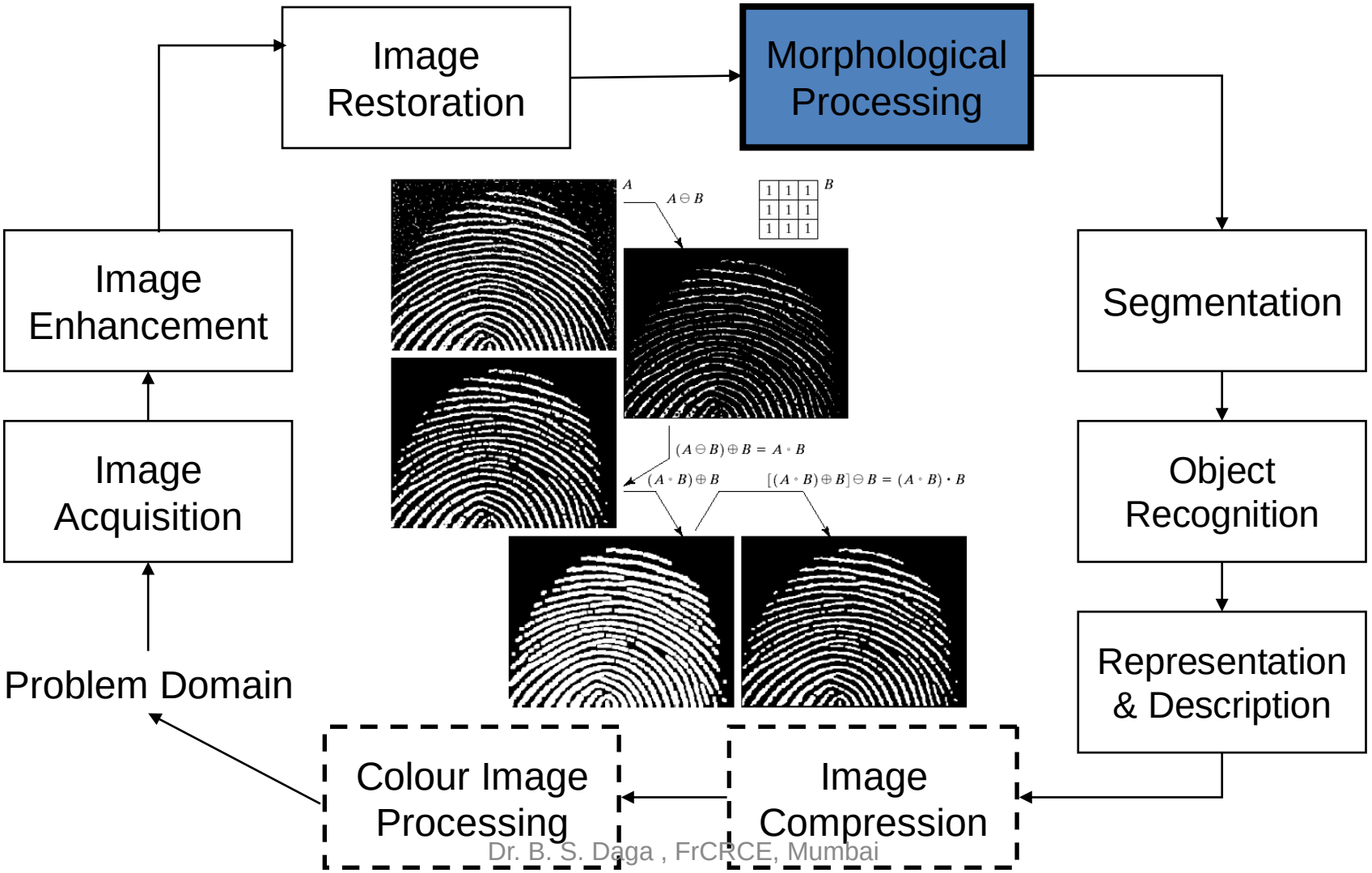


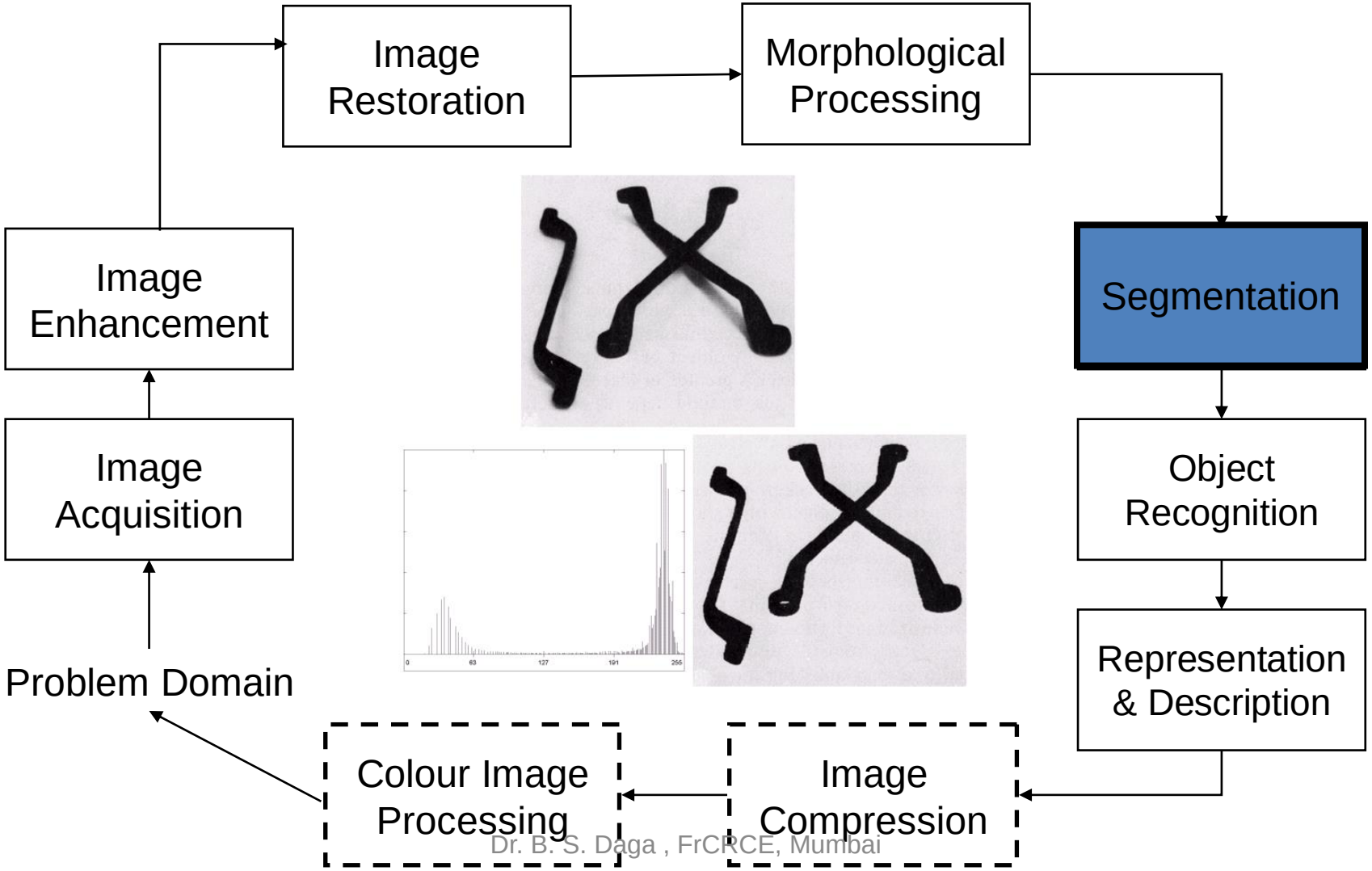
Image Restoration



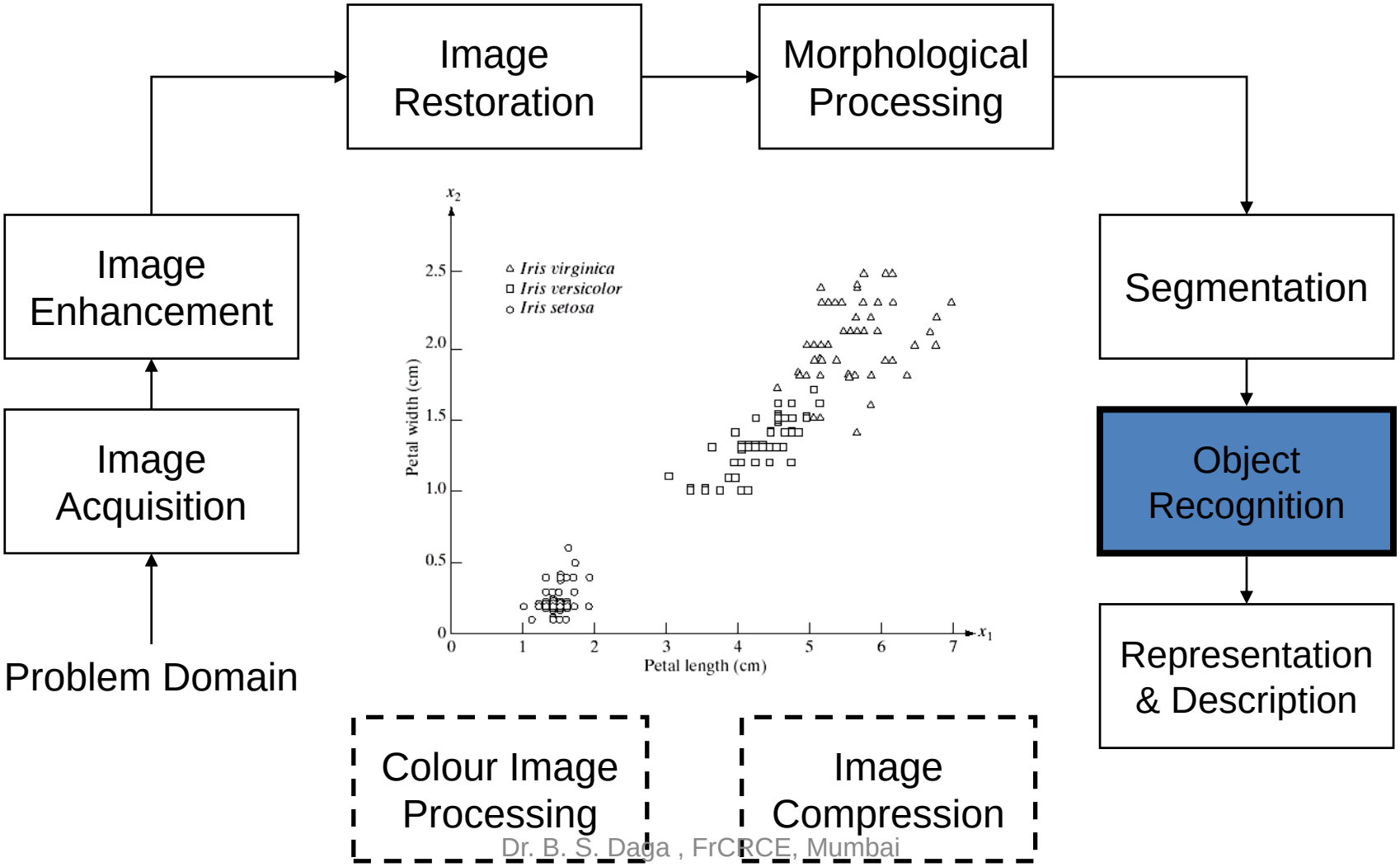
Morphological Processing



Segmentation



Object Recognition



Object Recognition

Image Restoration

Morphological Processing

Segmentation

Object Recognition

Representation & Description

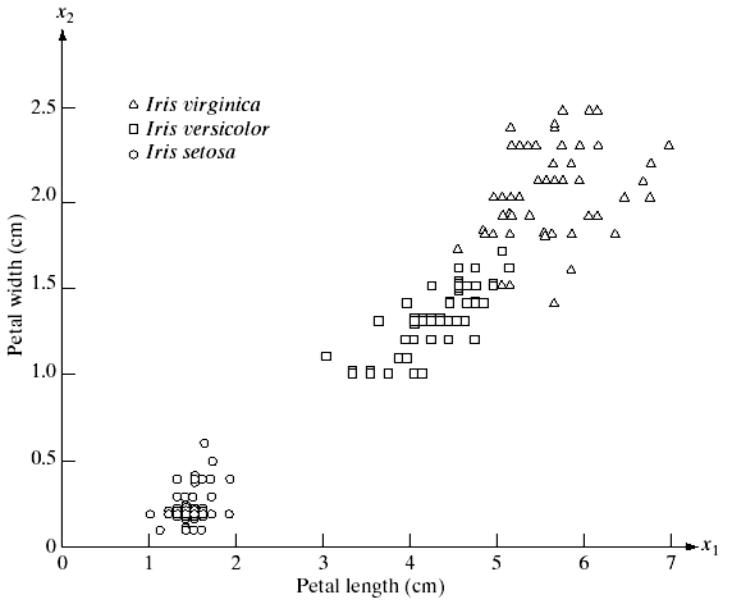
Image Compression

Colour Image Processing

Problem Domain

Image Acquisition

Image Enhancement



Representation & Description

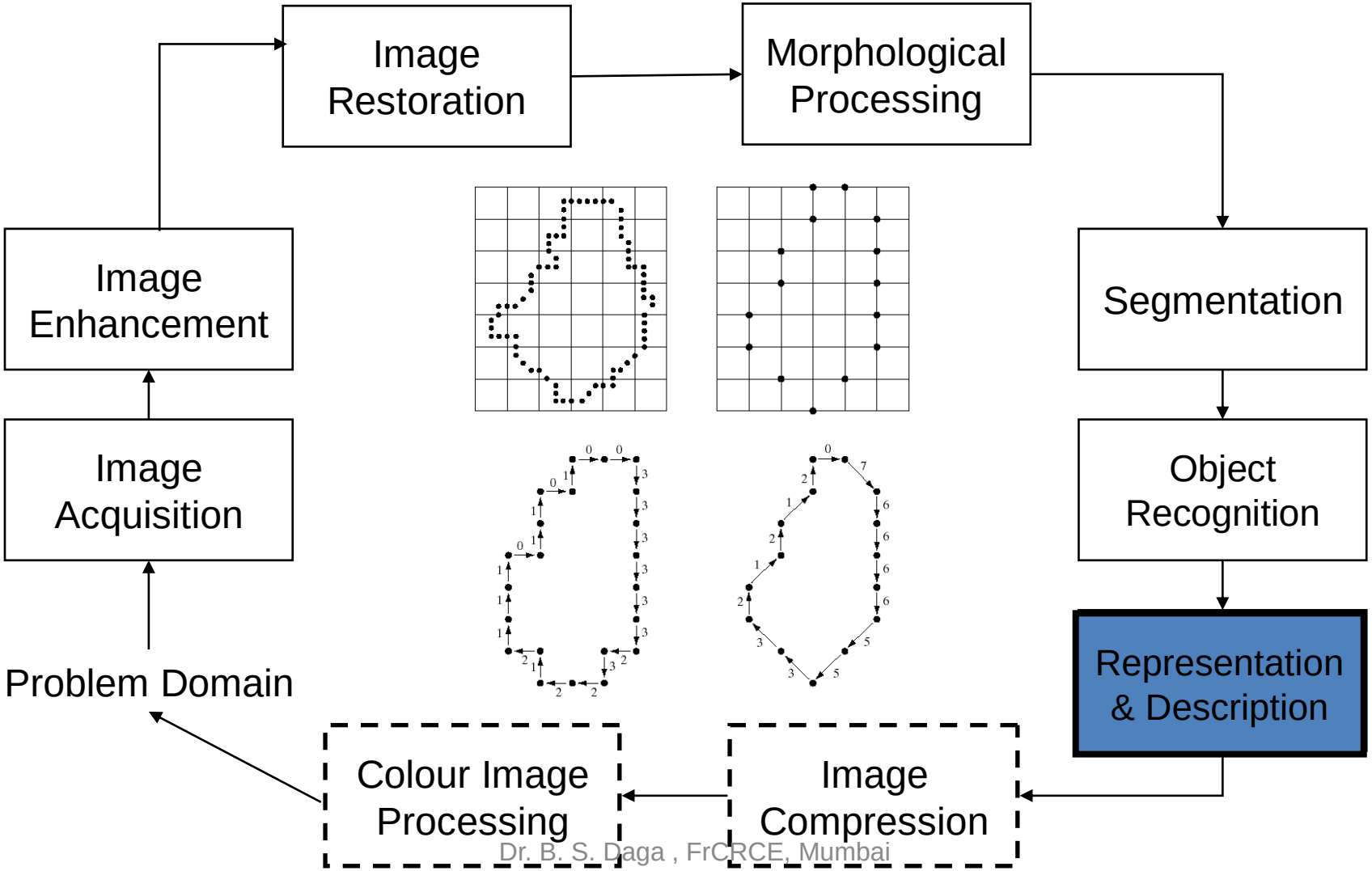
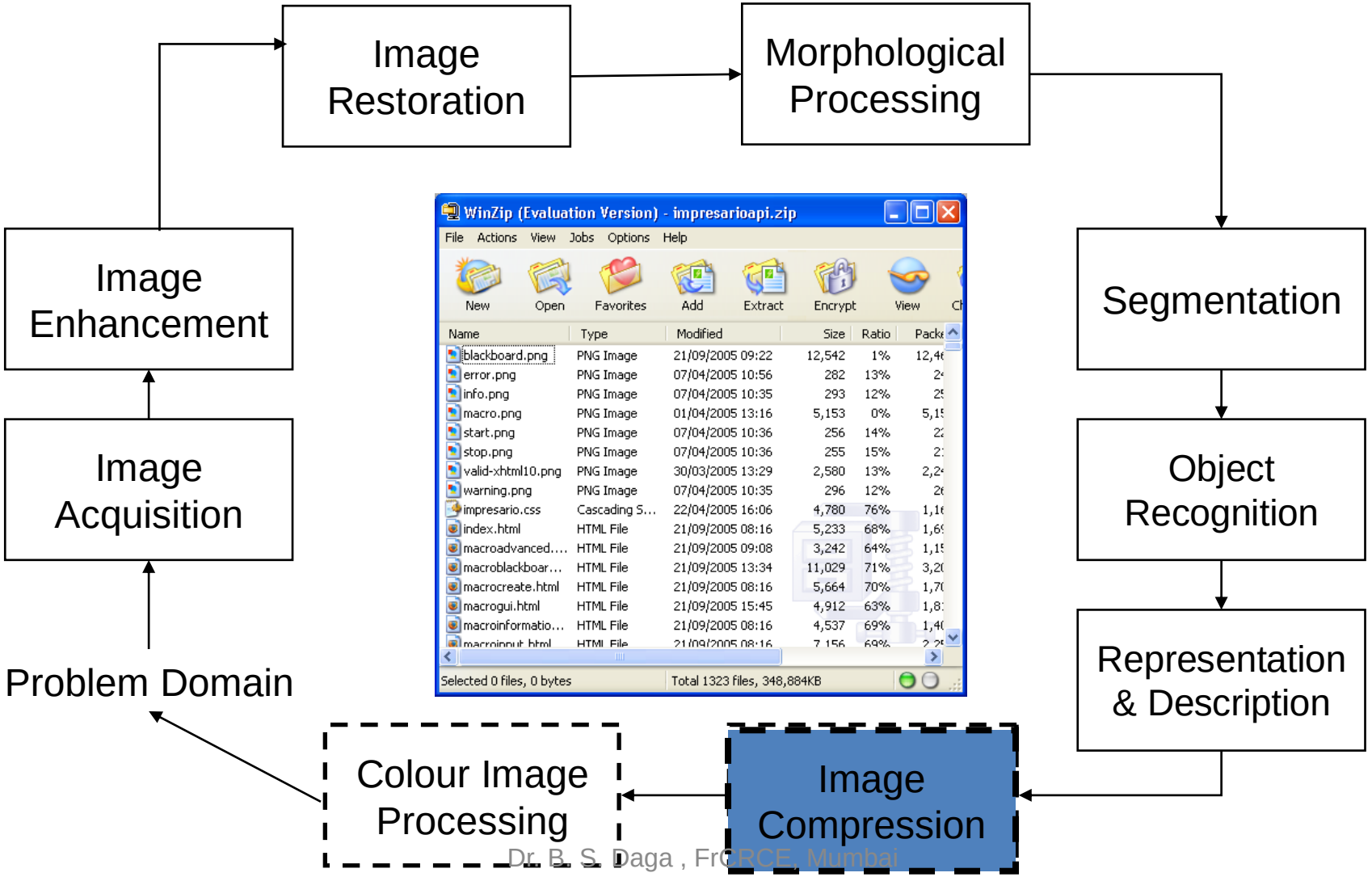
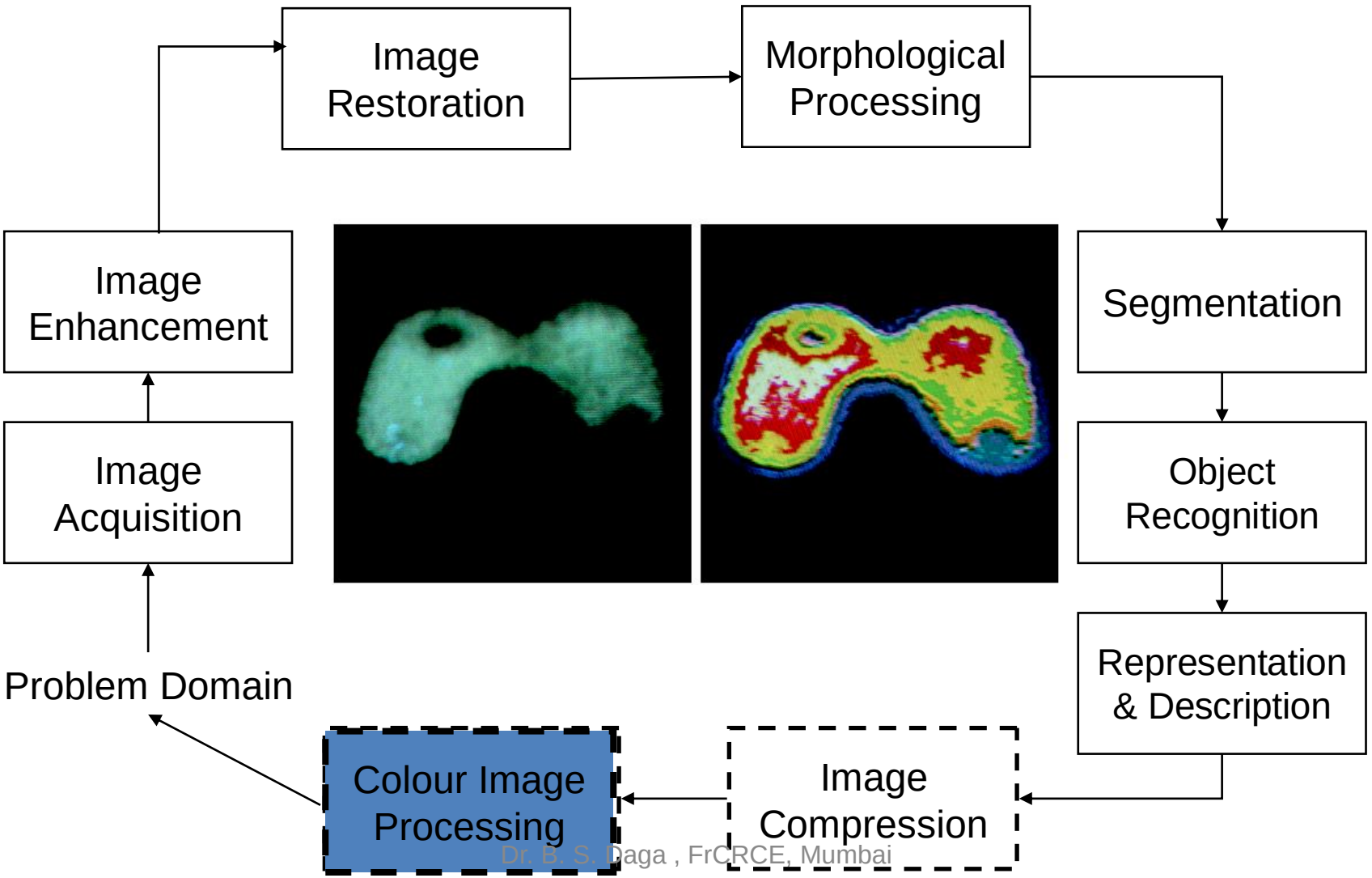


Image Compression



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

- THANK YOU..