DIGITAL IMAGE PROCESSING TECHNOLOGY: AN INTRODUCTION

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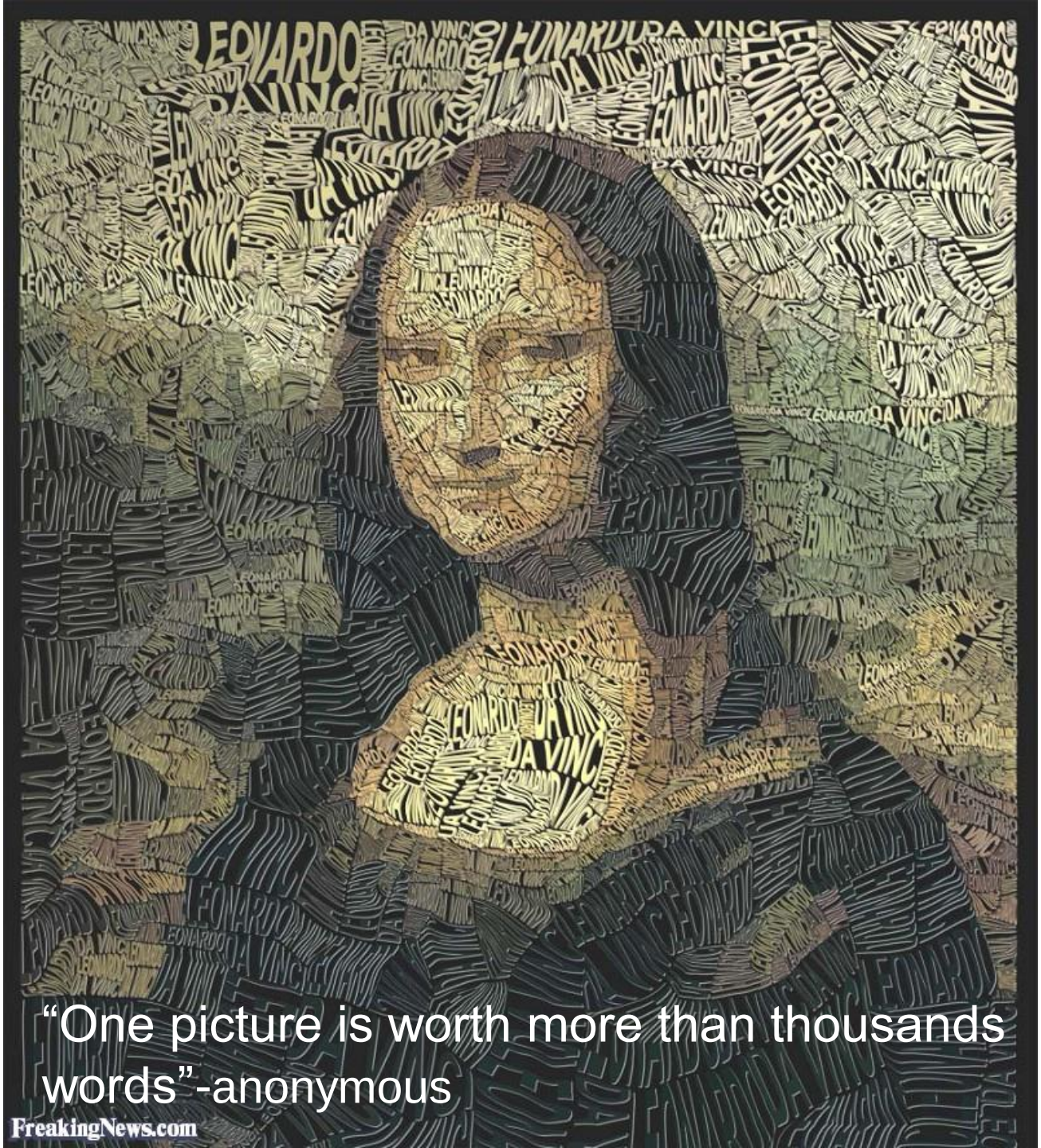
UMY
Universitas
Muhammadiyah
Yogyakarta

…beautiful scenery of mimiji

(matcha-jp.com)



"One picture is worth more than thousands words"-anonymous

How Image Processing Will Change Your World

What Is It?

A TECHNICAL analysis that breaks down an image to its basic features – shapes, textures, shadows, lines – to understand what lies inside

How Big a Business Can It Be?

THE POSSIBILITIES are infinite and only starting now. **The medical image processing market alone is slated to grow to $13 billion by 2014**, thanks to rise in 3-D medical imaging systems. Industry players estimate the image search market to be 30% of traditional search market over the next 3 years

Where all can it be used?...Anywhere, as is evident from these five applications

DISABILITY

ROBOTIC navigation systems for the visually-challenged will create real-time 3D maps. Vibrating sensors would convey instructions to the user aiding navigation

CRIME

ARTIFICIAL intelligence software can scour through millions of photographs and videos in a few minutes to nab a fugitive-on-the-run

DEFENCE

MILITARY robots with a greater visual sense can carry out, with the help of real-time footage, remote rescue operations

HEALTHCARE

3D images can help doctors perform surgeries of delicate areas like inside veins, which they otherwise could not have

TRAFFIC

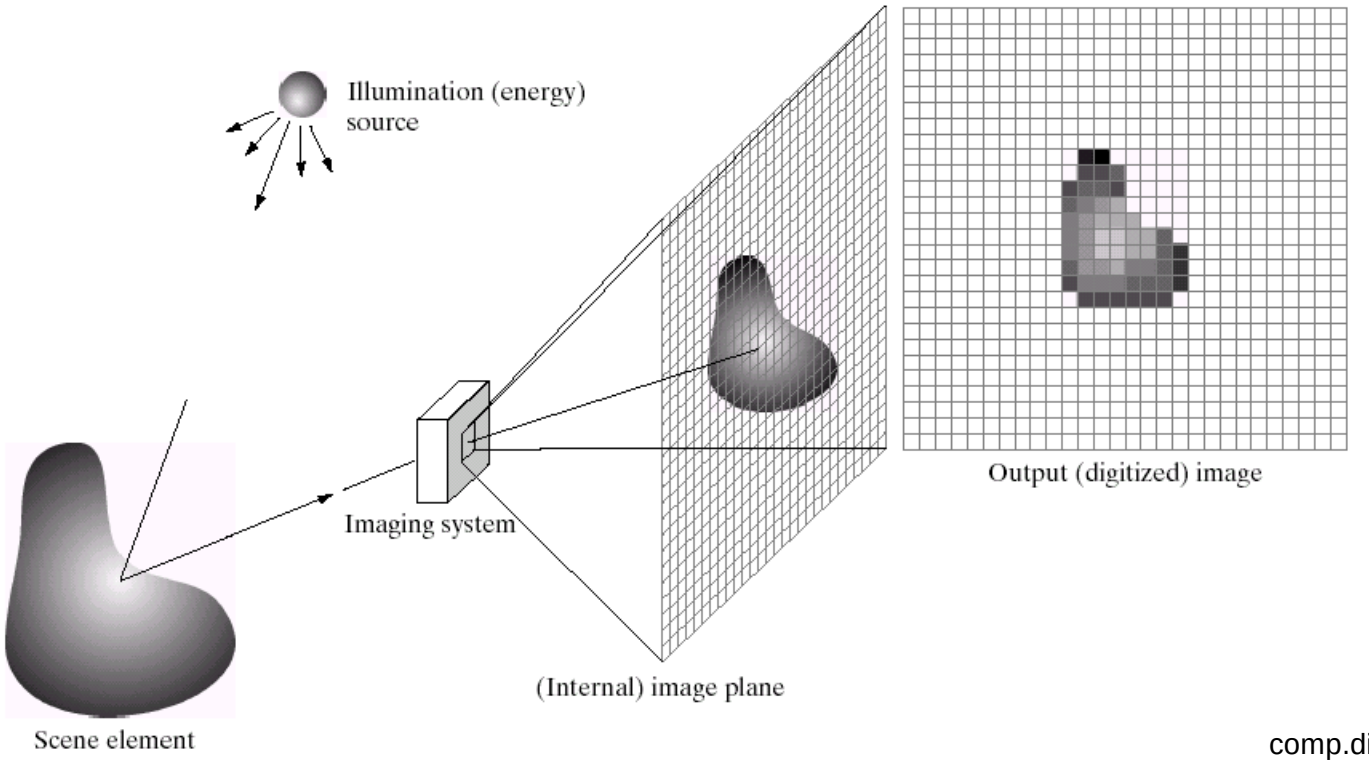
DRONES will shoot and process real-time images of traffic and send them to your mobile. Consequently, you can drive safely & bypass congestions

PHOTOGRAPHY

CAMERAS get smarter. For one, Valley startup Lytro's upcoming cameras let you fix mistakes after the photo has been taken

What is a Digital Image?

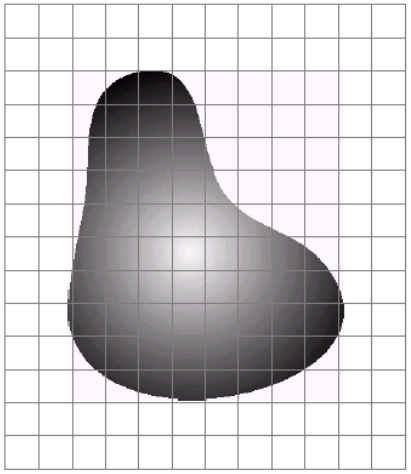
- A **digital image** is a representation of a two-dimensional image as a finite set of digital values, called picture elements or pixels

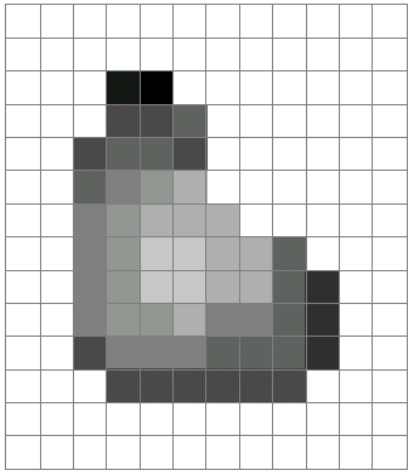


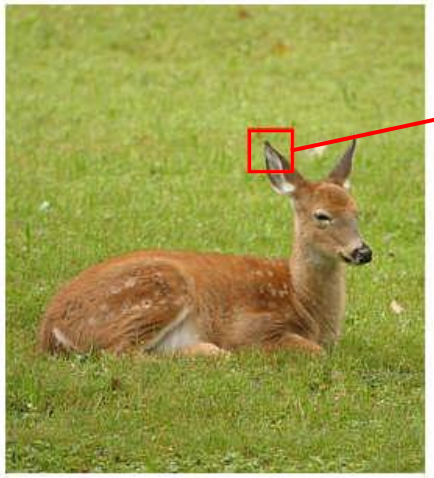
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

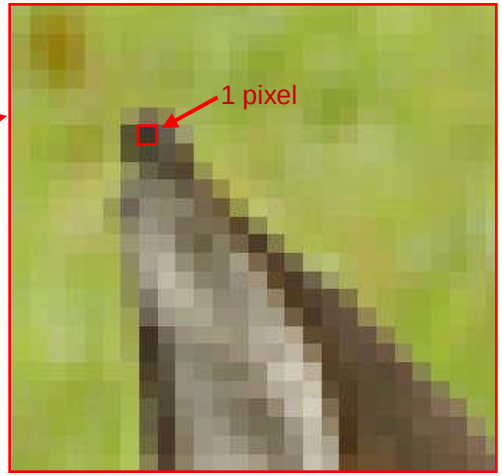
What is a Digital Image? (cont…)

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









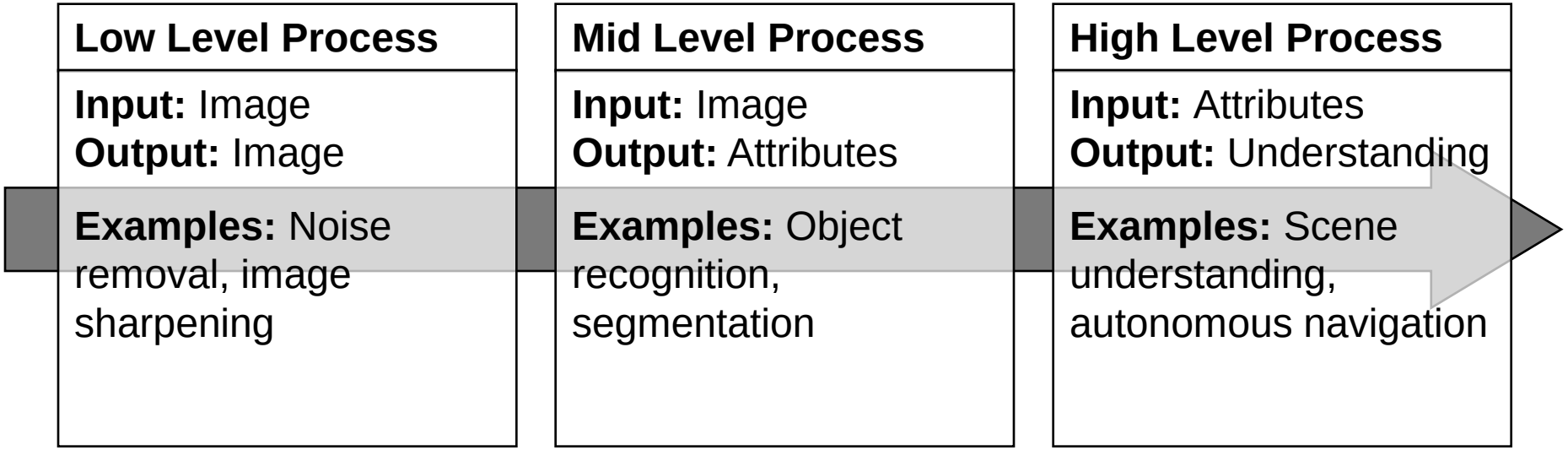
What is Digital Image Processing?

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

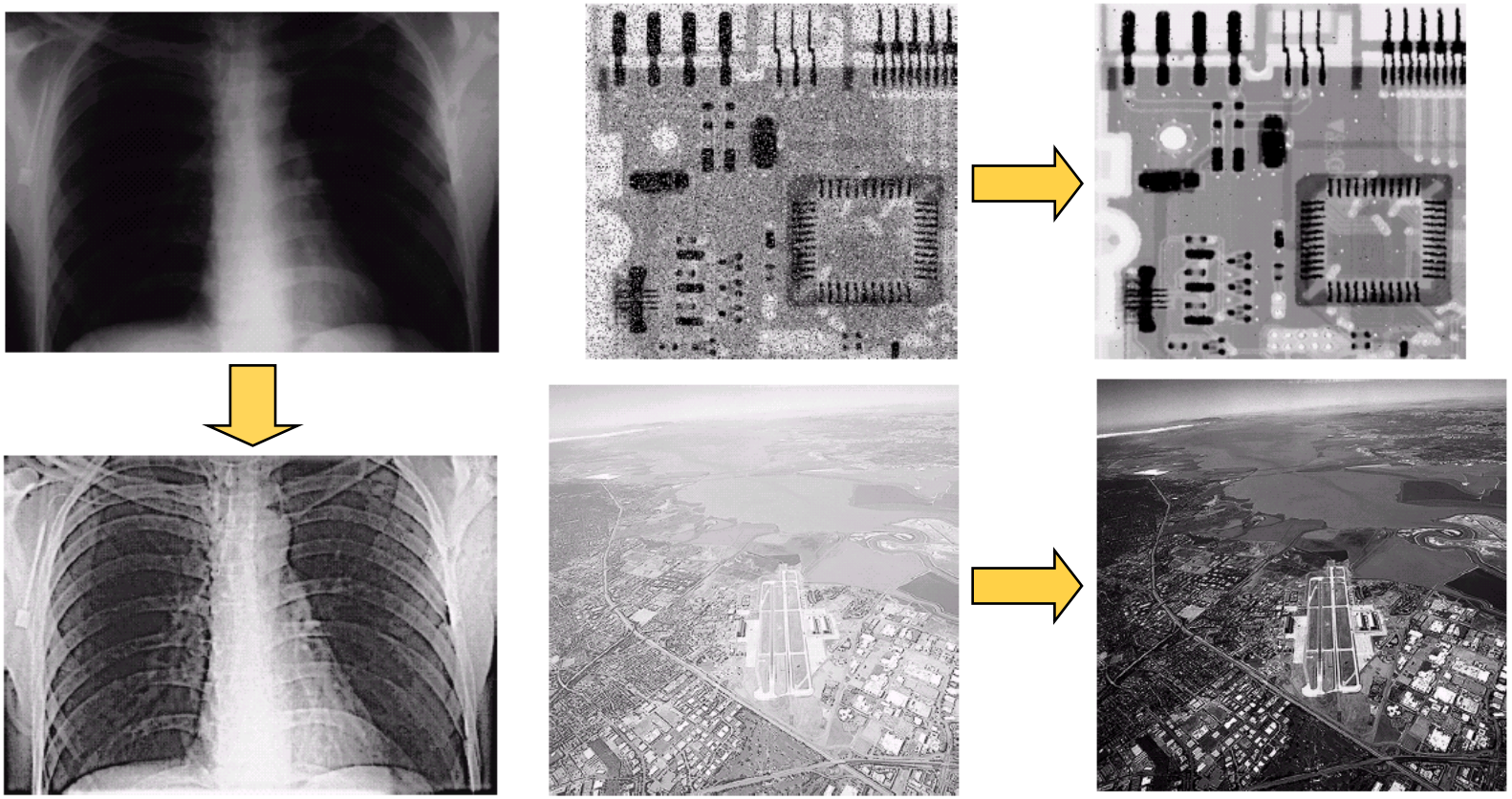
What is DIP? (cont…)

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



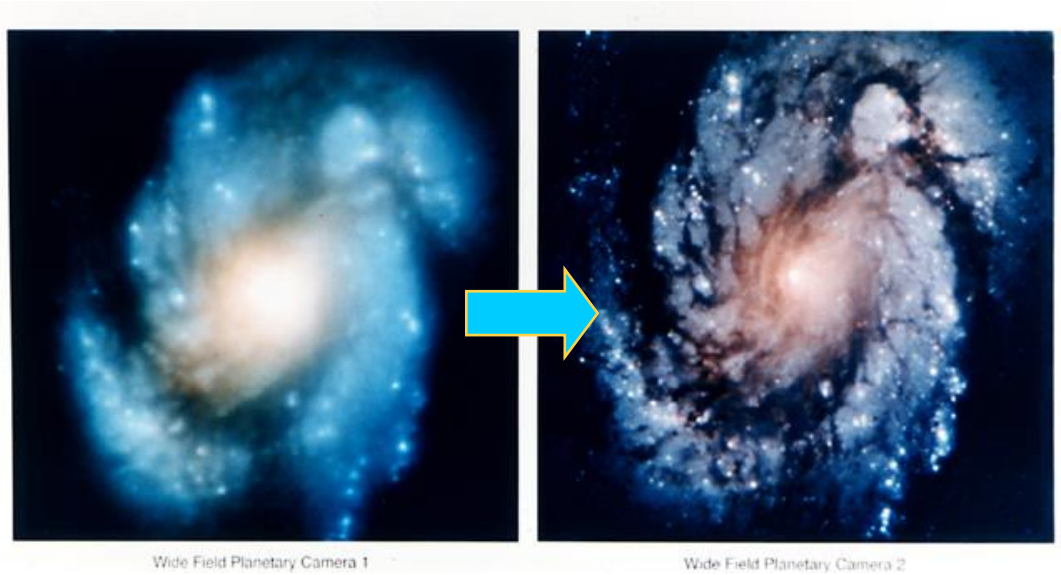
Examples: Image Enhancement

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



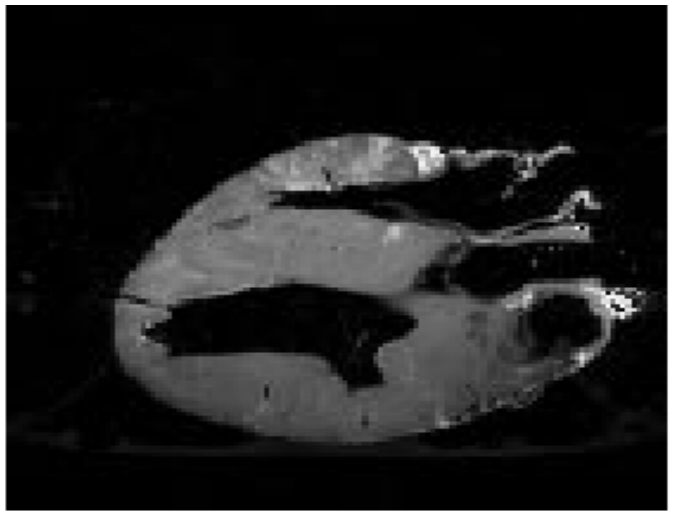
Examples: The Hubble Telescope

- 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

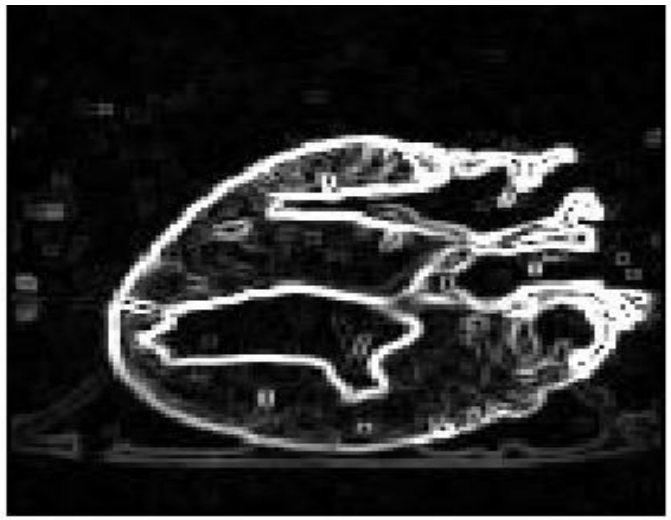


Examples: Medicine

- 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

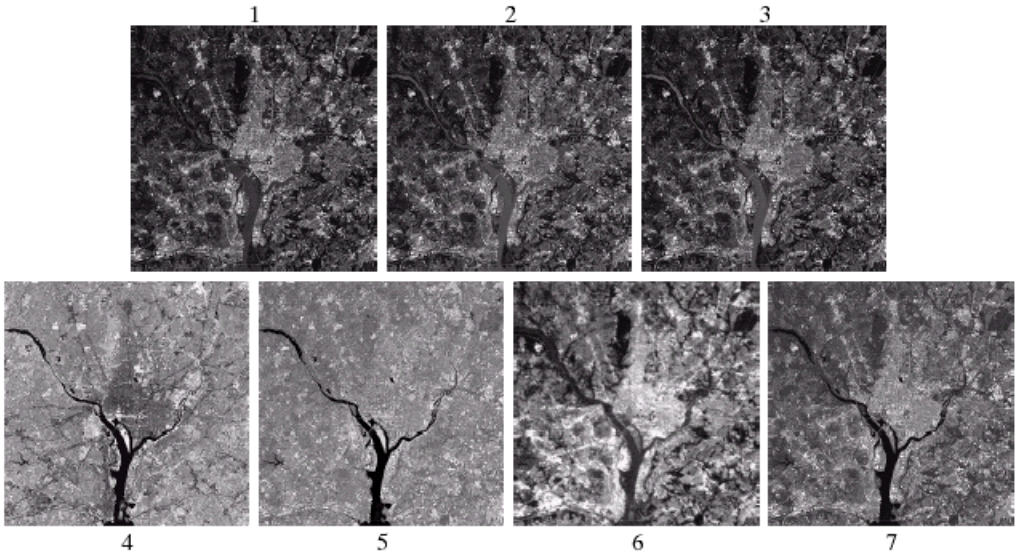


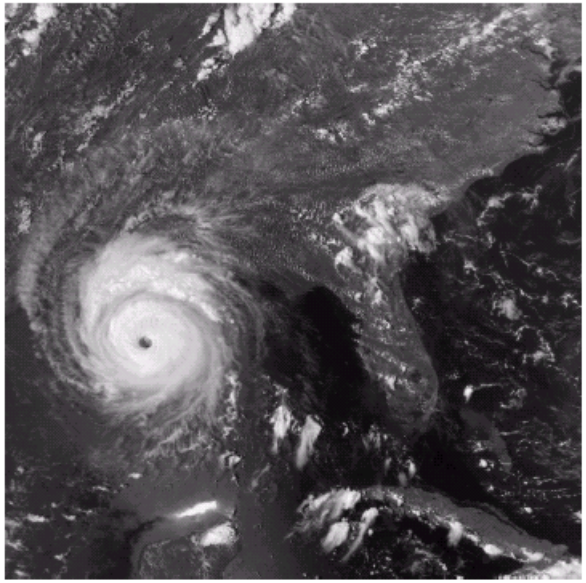
Edge Detection Image

Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Examples: GIS

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

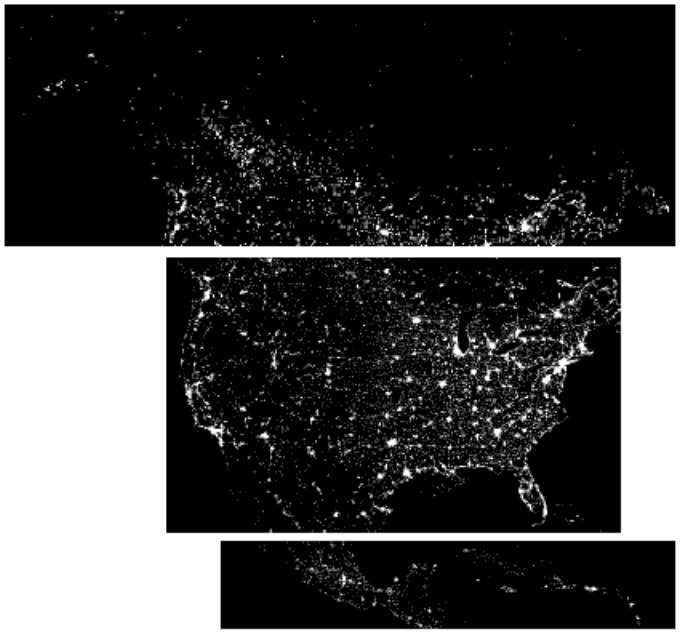




Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Examples: GIS (cont…)

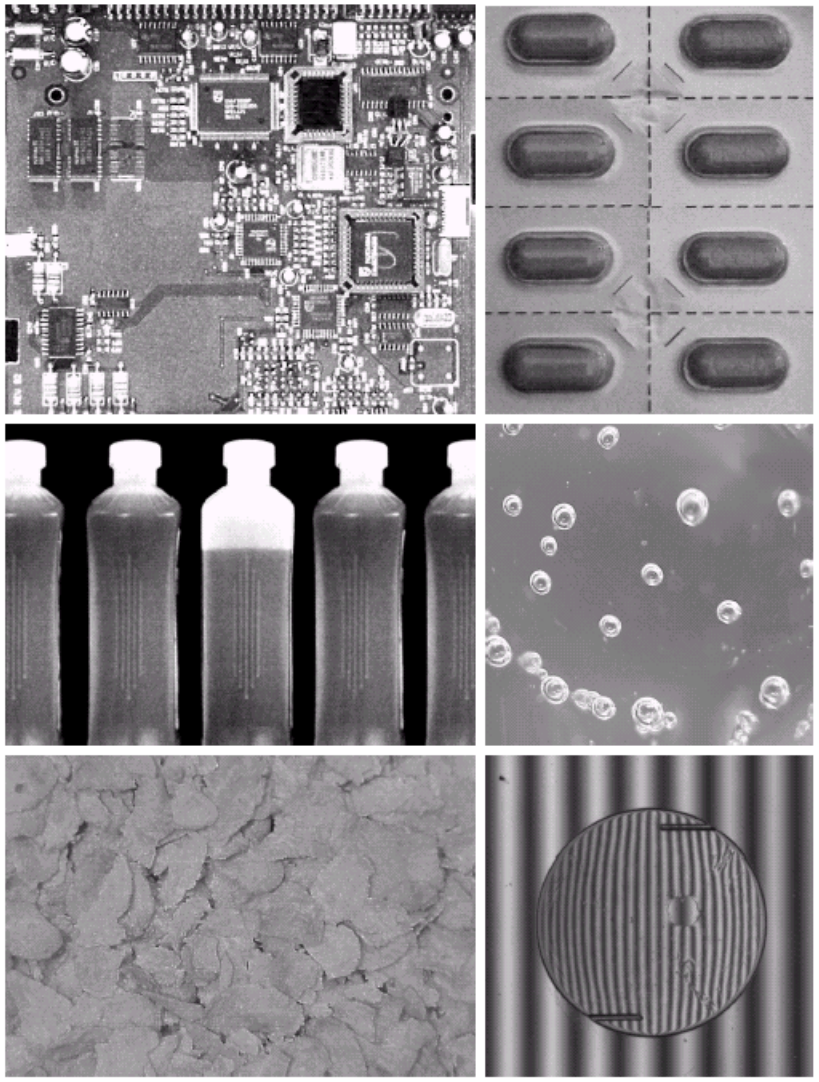
- *Night-Time Lights of the World* data set
  - Global inventory of human settlement
  - Not hard to imagine the kind of analysis that might be done using this data



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Examples: Industrial Inspection

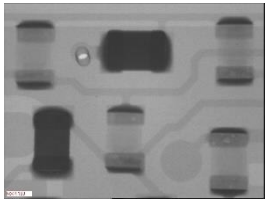
- Human operators are expensive, slow and unreliable
- Make machines do the job instead
- Industrial vision systems are used in all kinds of industries

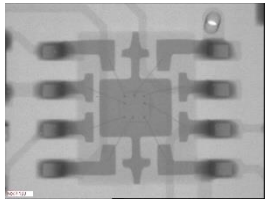


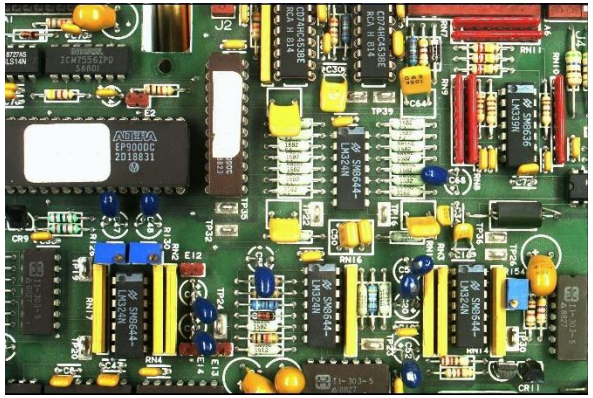
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

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

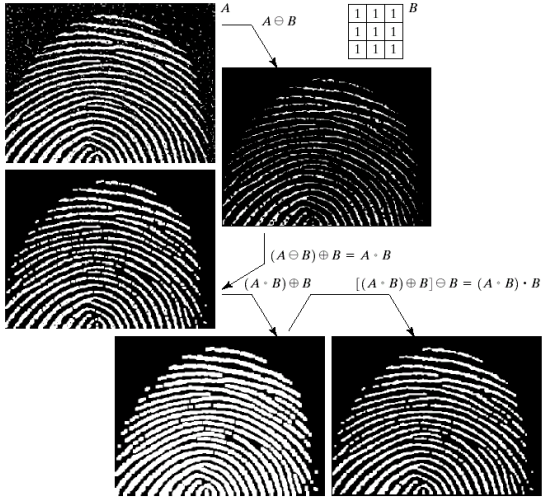






Examples: Law Enforcement

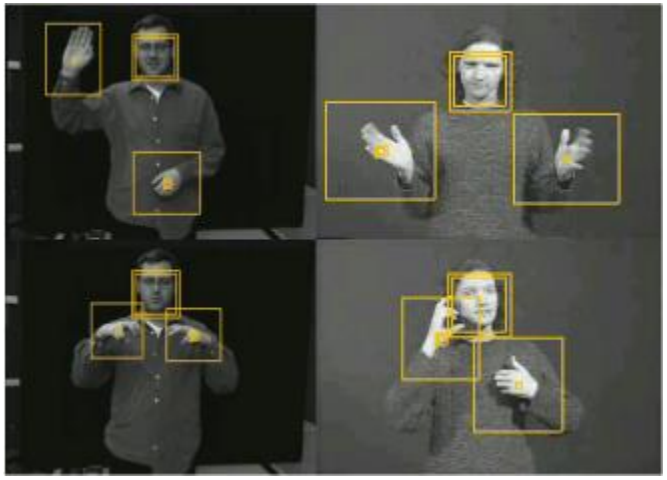
- Image processing techniques are used extensively by law enforcers
  - Number plate recognition for speed cameras/automated toll systems
  - Fingerprint recognition
  - Enhancement of CCTV images

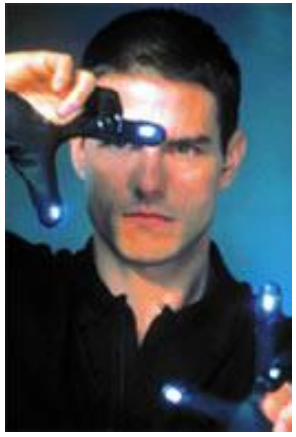


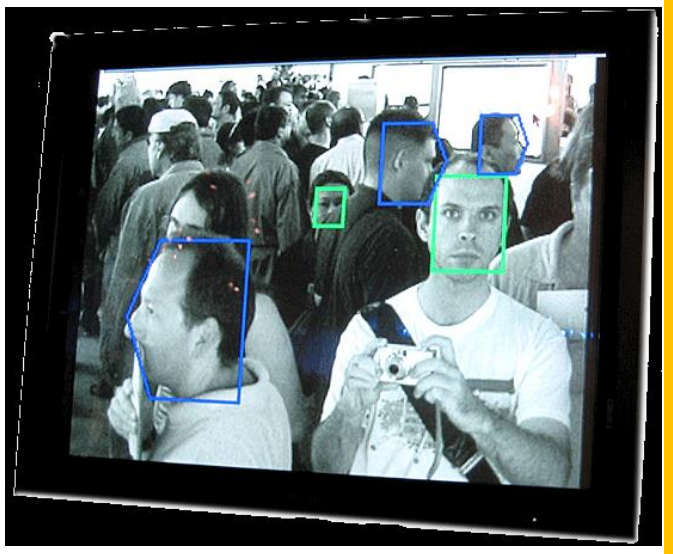
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Examples: HCI

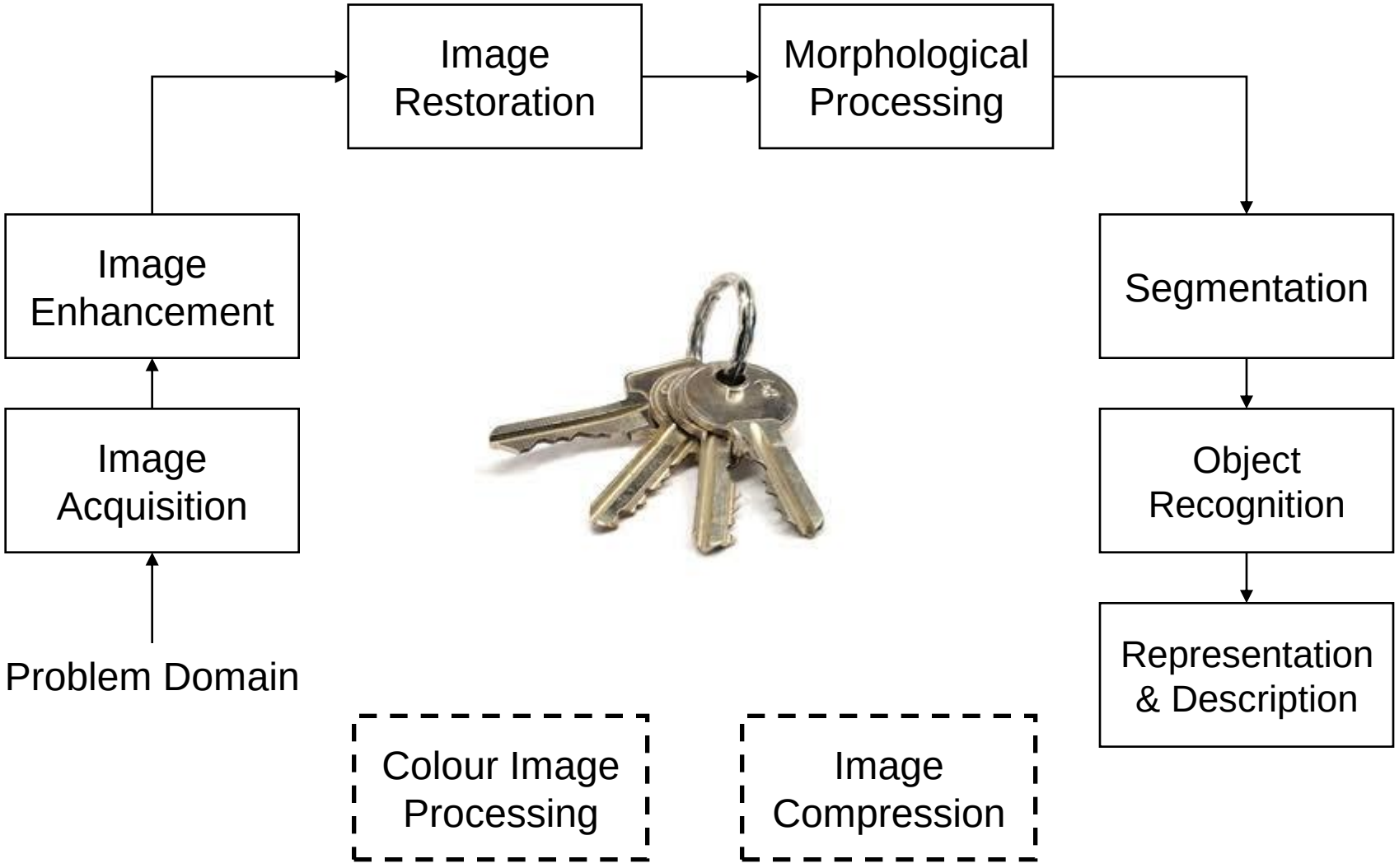
- Try to make human computer interfaces more natural
  - Face recognition
  - Gesture recognition
  - Augmented reality (https://www.youtube.com/watch?v=D0ojxzS1fCw)







Key Stages in Digital Image Processing



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Key Stages in Digital Image Processing: Image Aquisition

Problem Domain

Image Acquisition

Image Enhancement

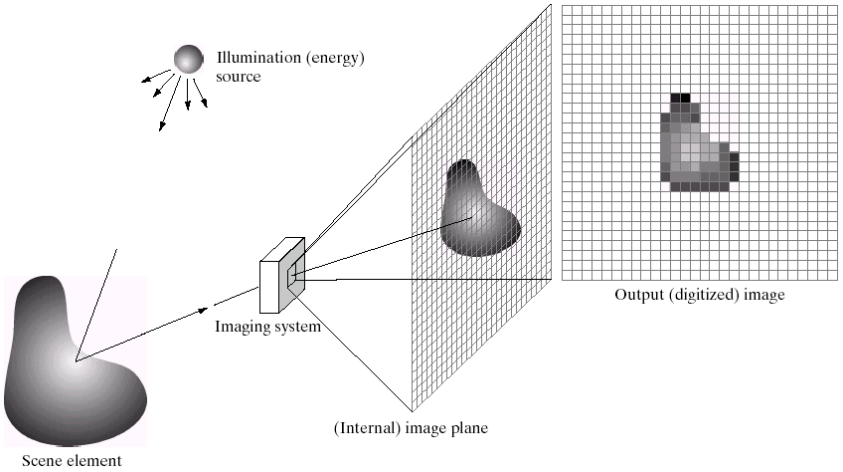
Image Restoration

Morphological Processing

Segmentation

Object Recognition

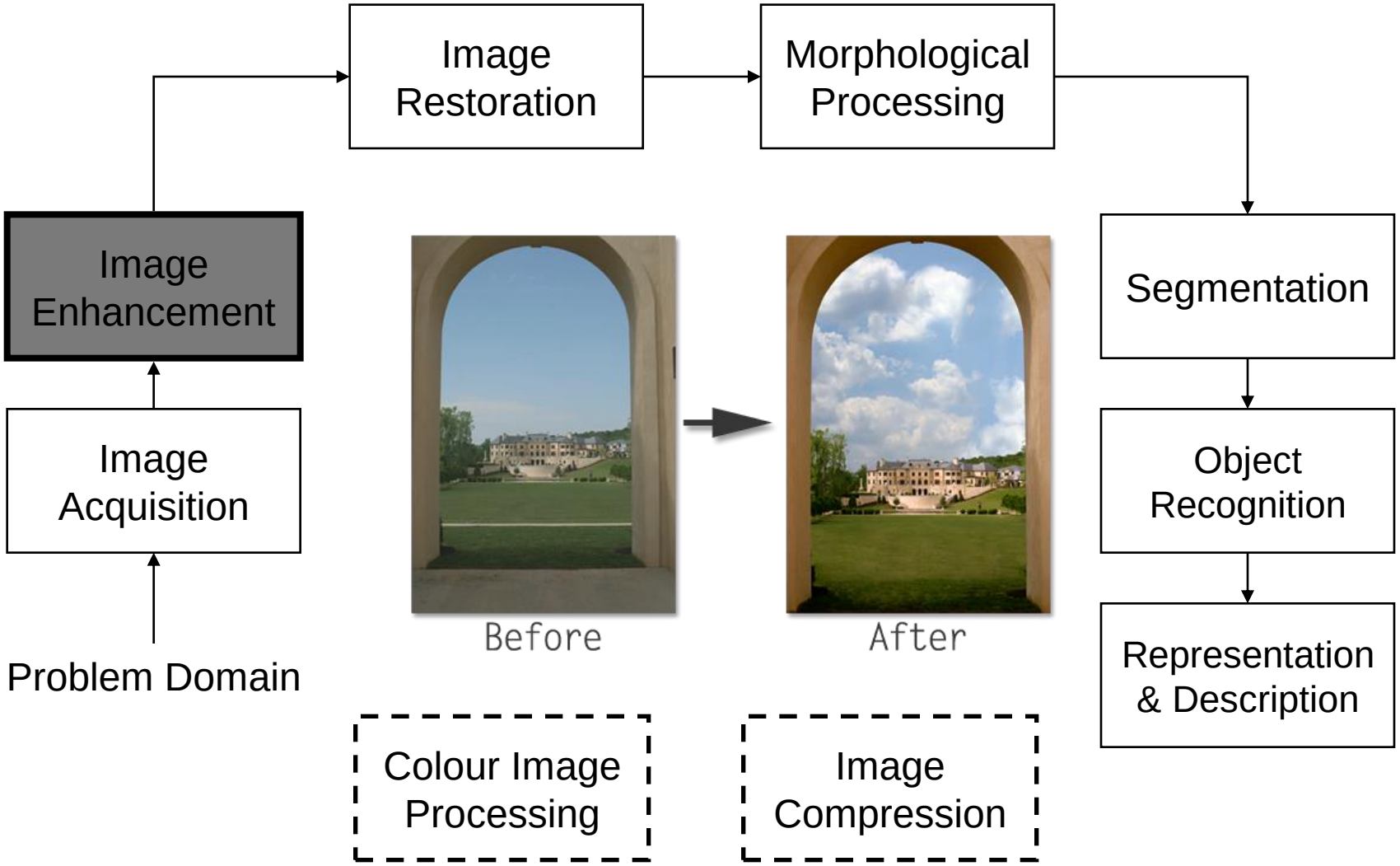
Representation & Description



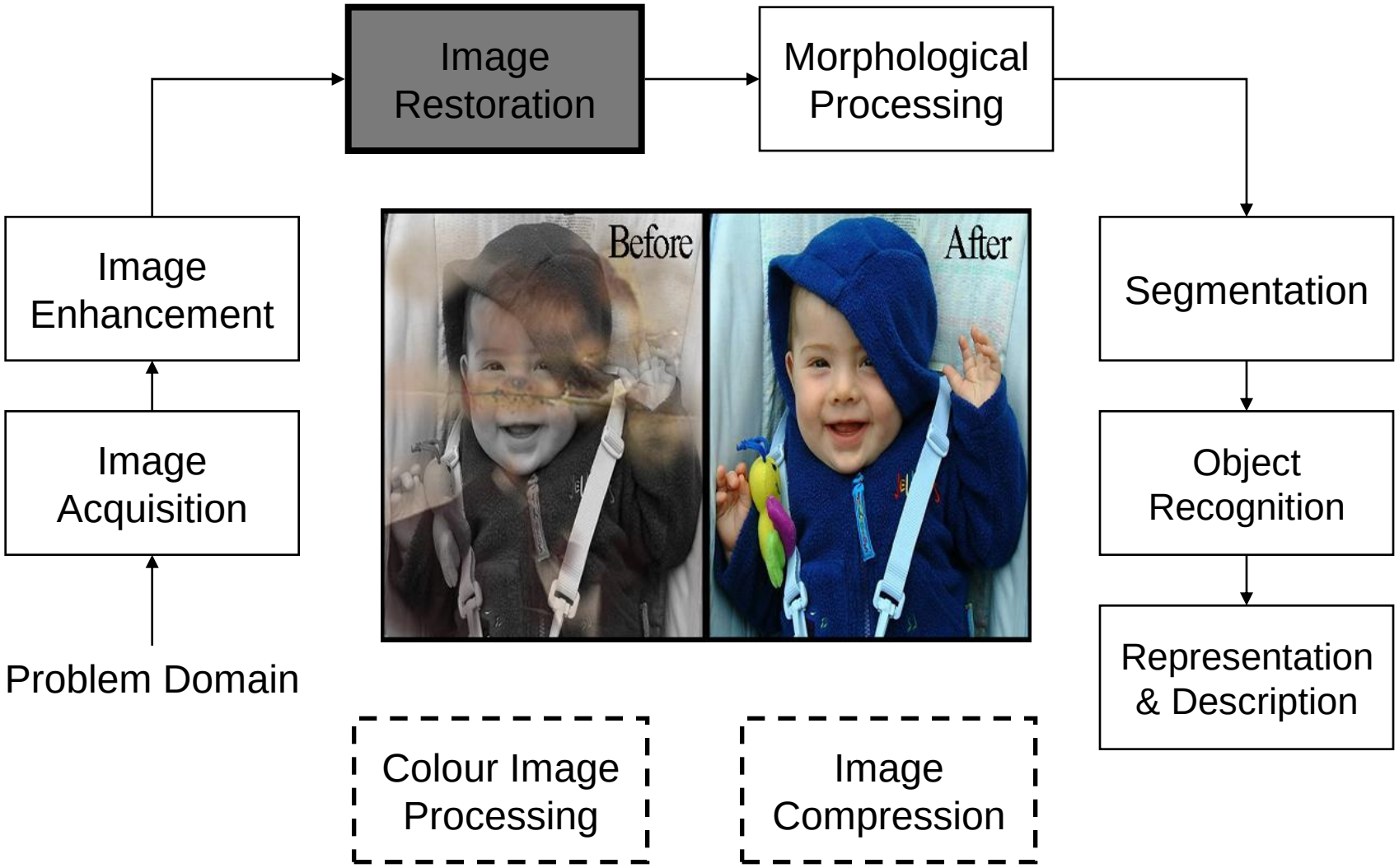
Colour Image Processing

Image Compression

Key Stages in Digital Image Processing: Image Enhancement

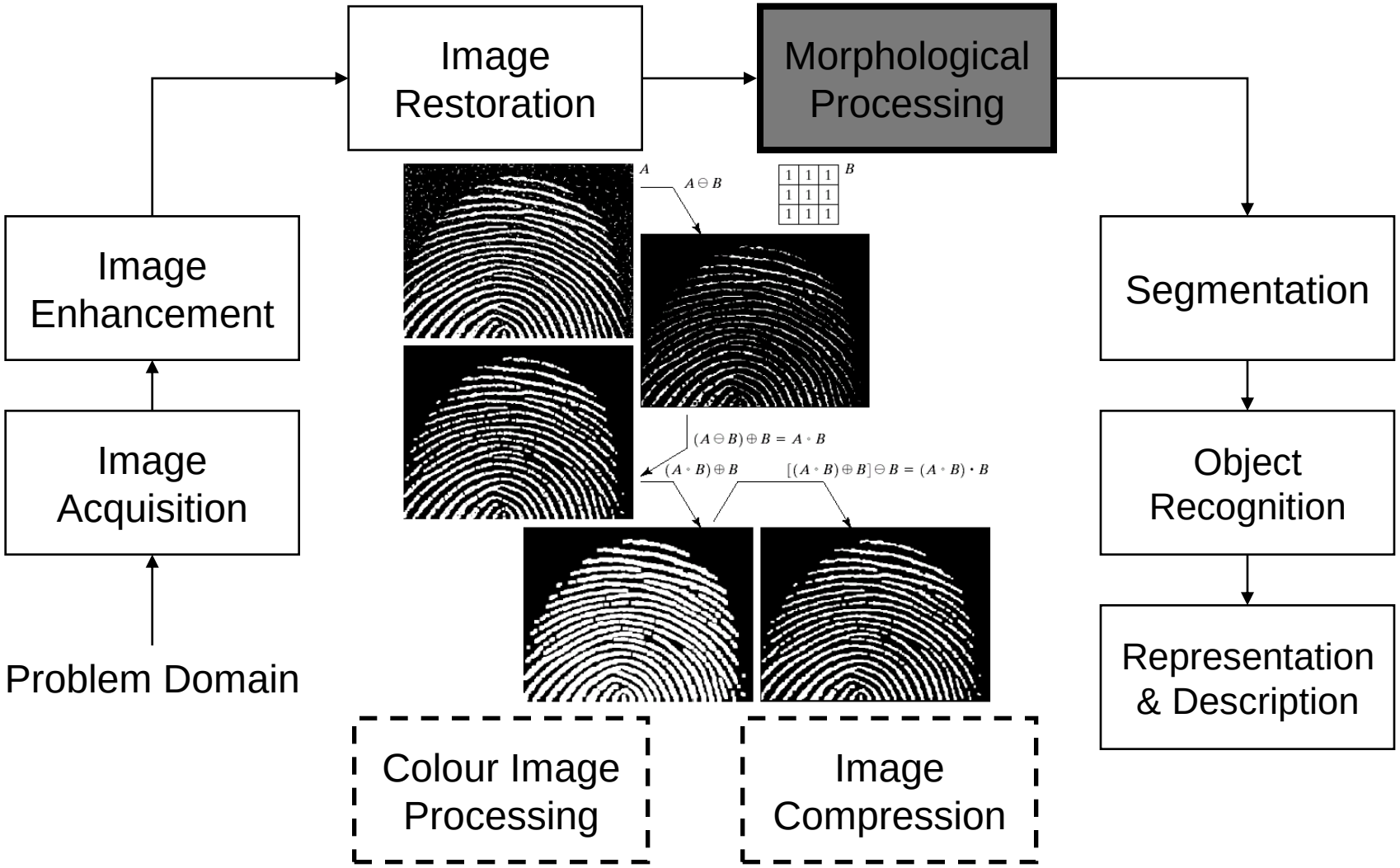


Key Stages in Digital Image Processing: Image Restoration



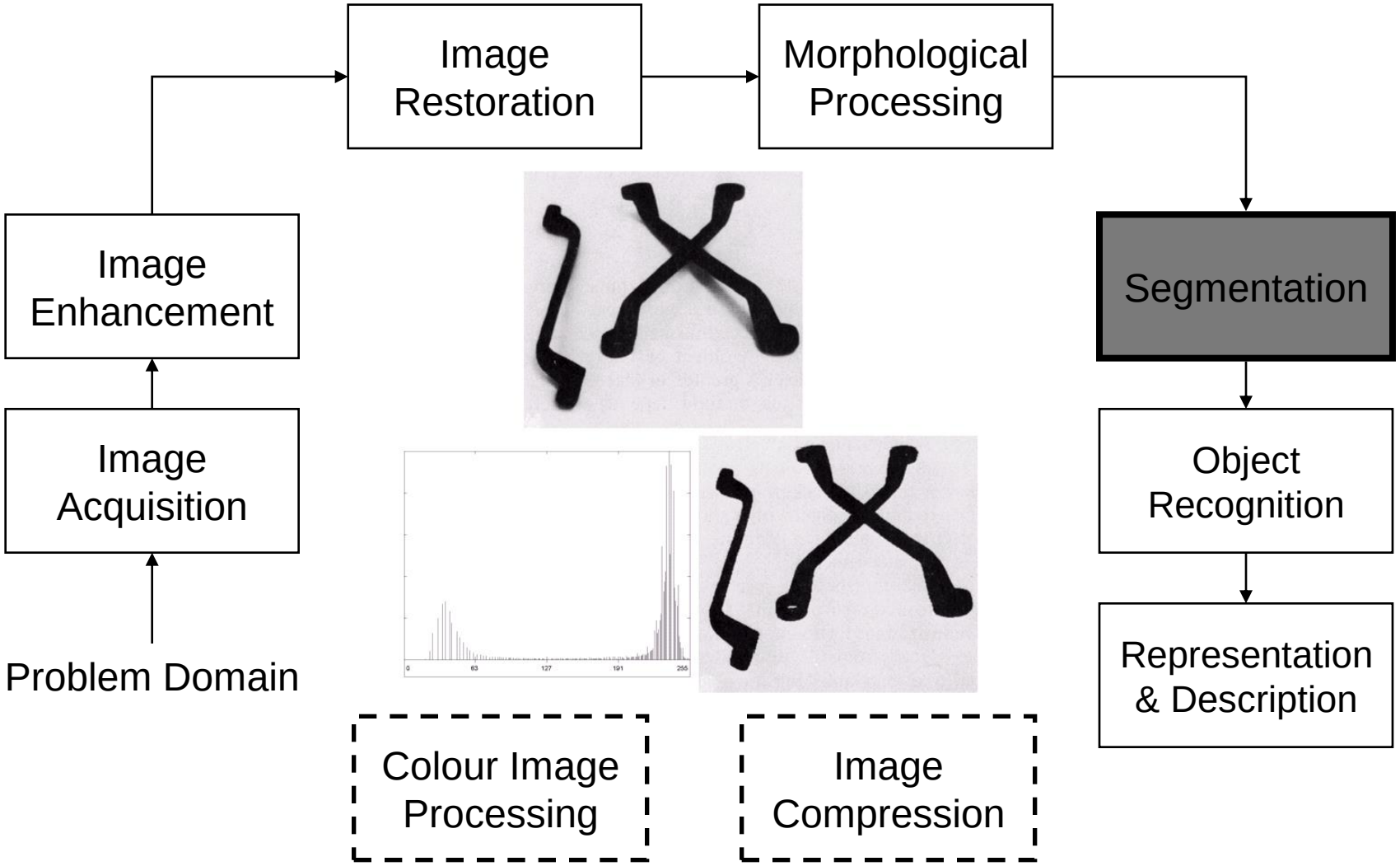
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Key Stages in Digital Image Processing: Morphological Processing



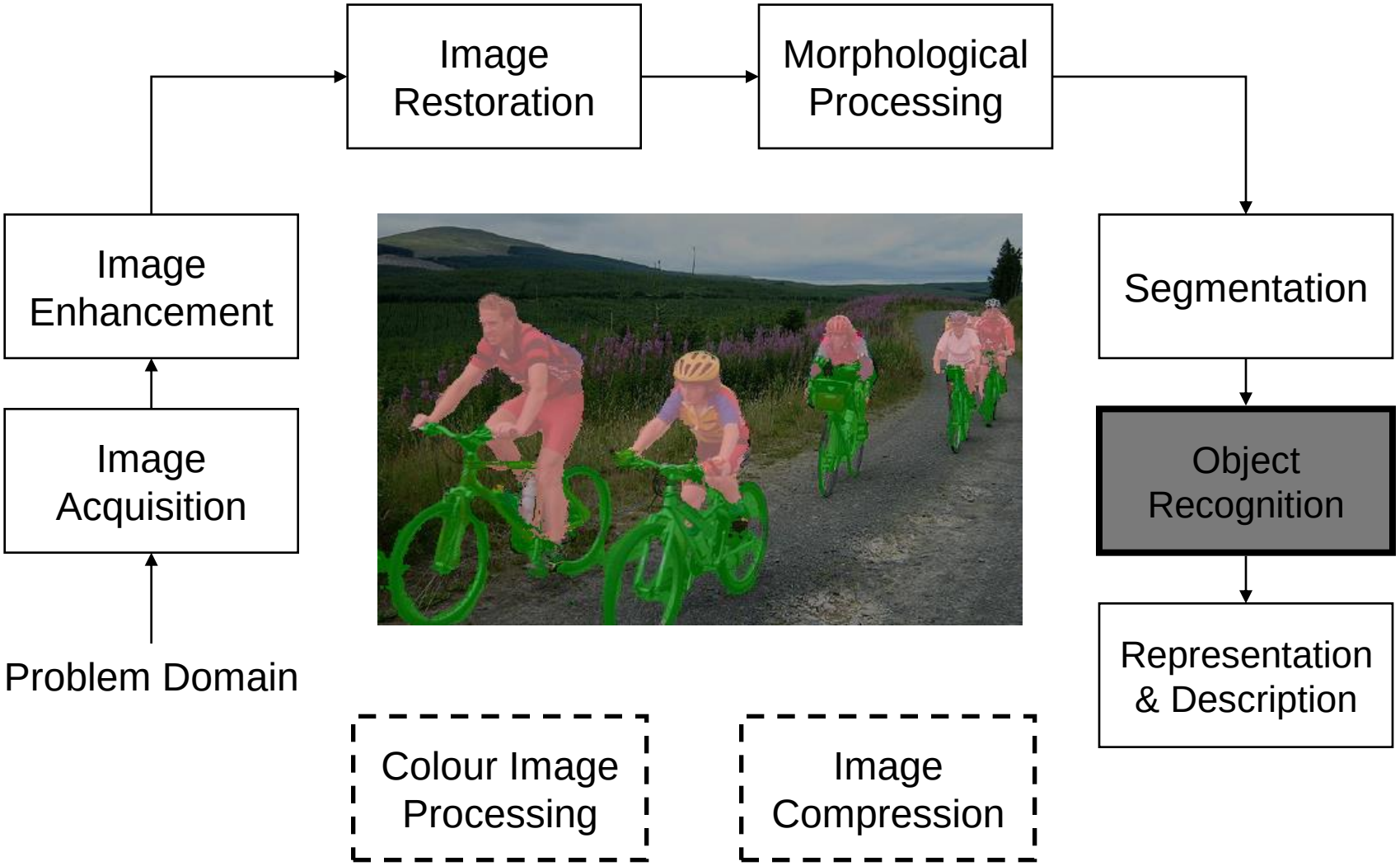
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Key Stages in Digital Image Processing: Segmentation



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

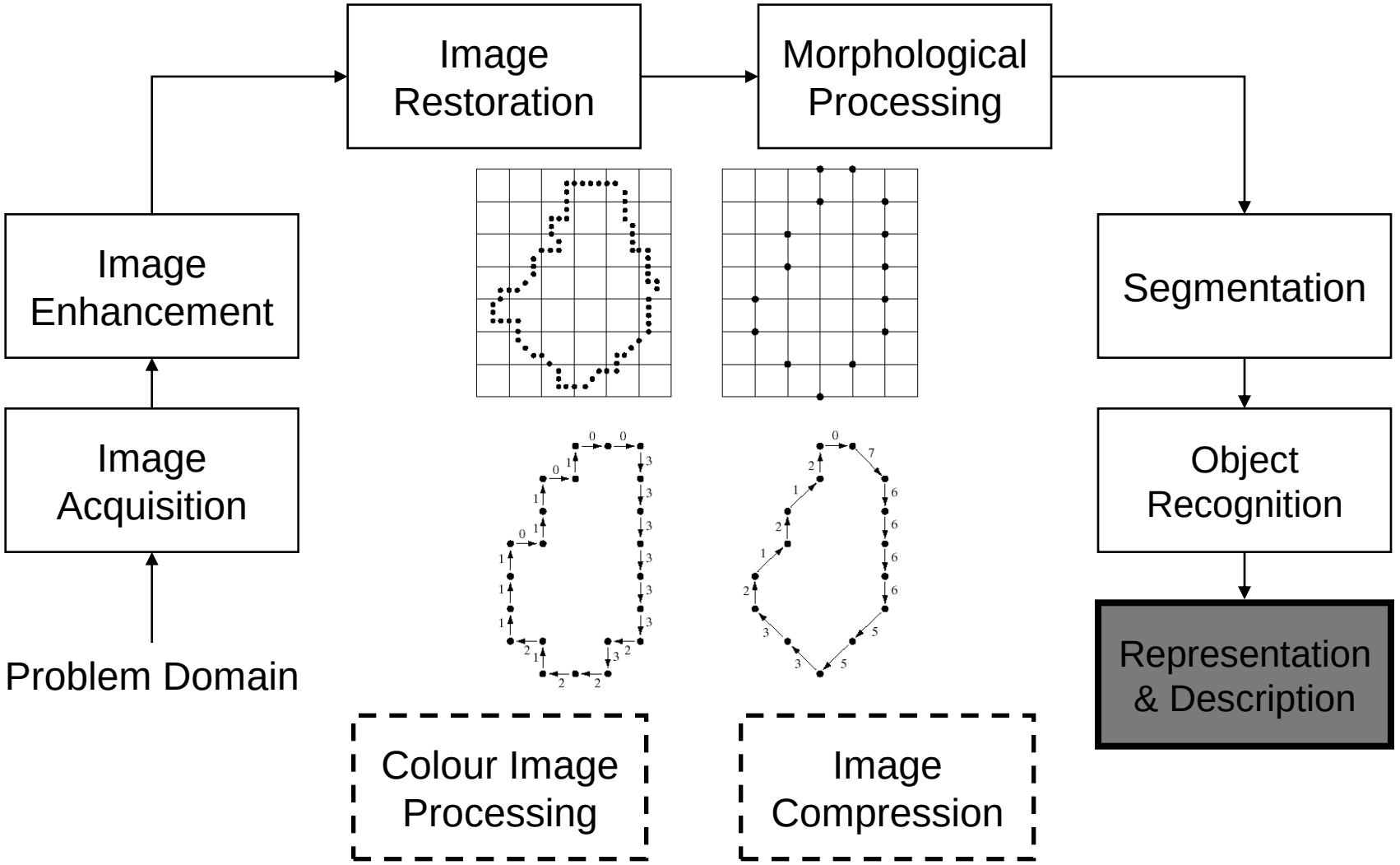
Key Stages in Digital Image Processing: Object Recognition



Images taken from Gonzalez & Woods, Digital Image Processing (2002)

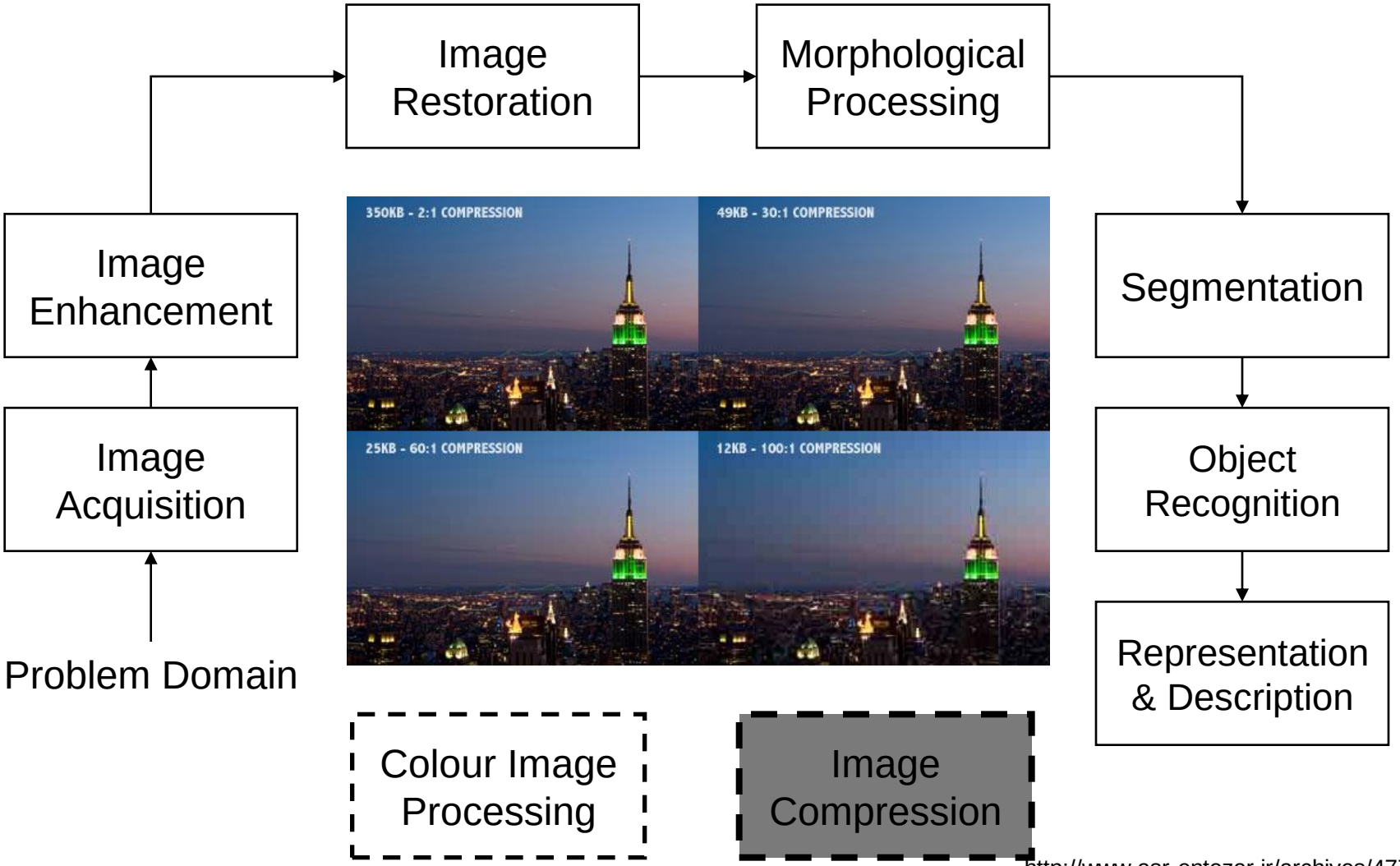
http://www.robots.ox.ac.uk/~szheng/crfasrnndemo

Key Stages in Digital Image Processing: Representation & Description



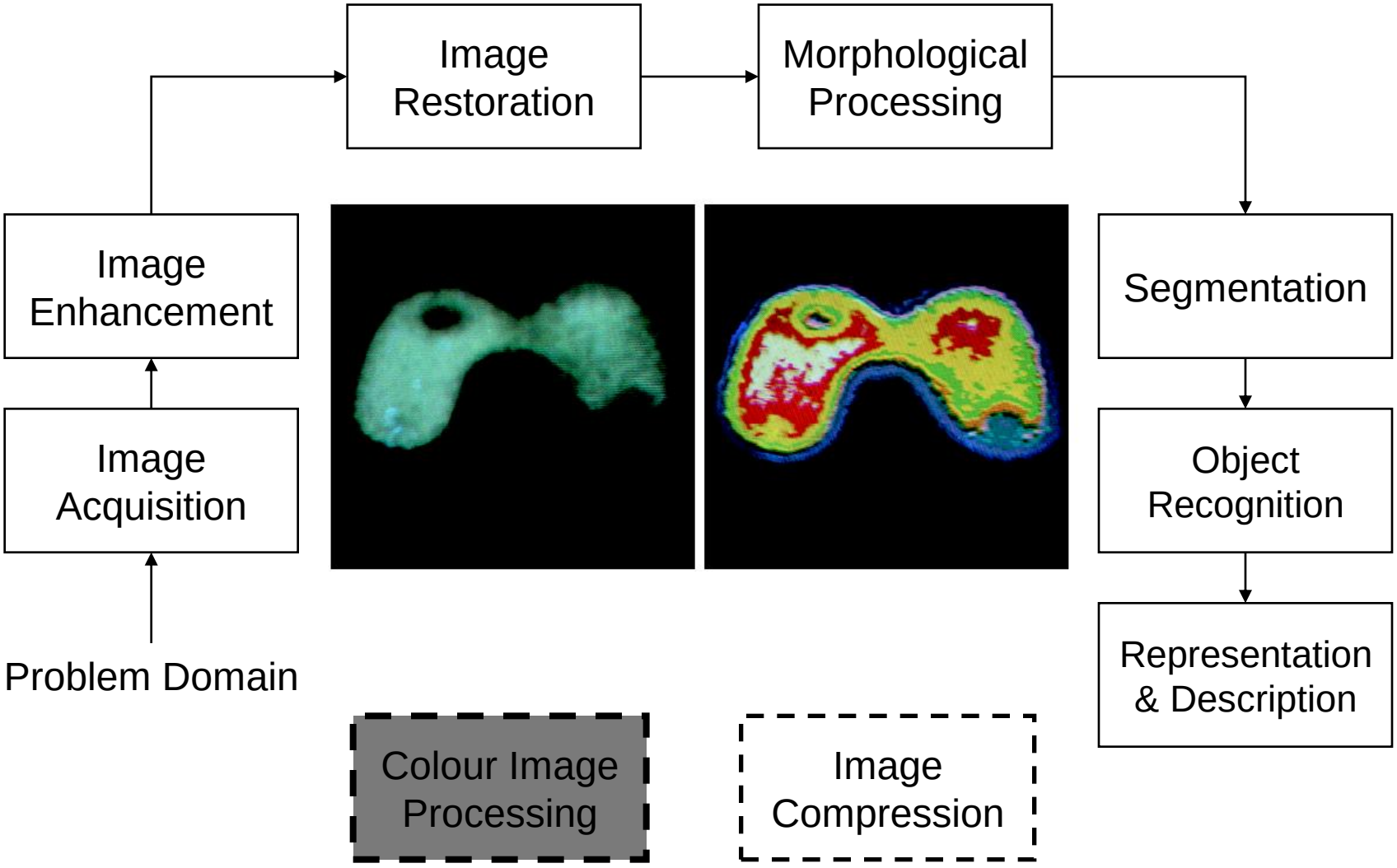
Images taken from Gonzalez & Woods, Digital Image Processing (2002)

Key Stages in Digital Image Processing: Image Compression



http://www.asr-entezar.ir/archives/47721

Key Stages in Digital Image Processing: Colour Image Processing

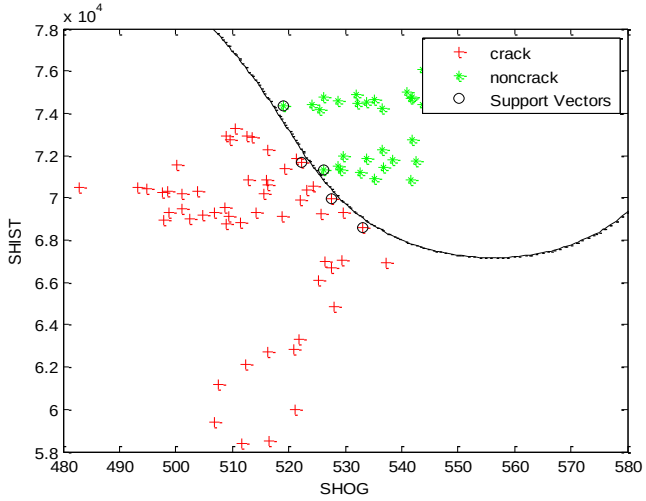


Our research @ UMY

- Road crack detection
- Fruit inspection
- Medical image representation

Road crack detection

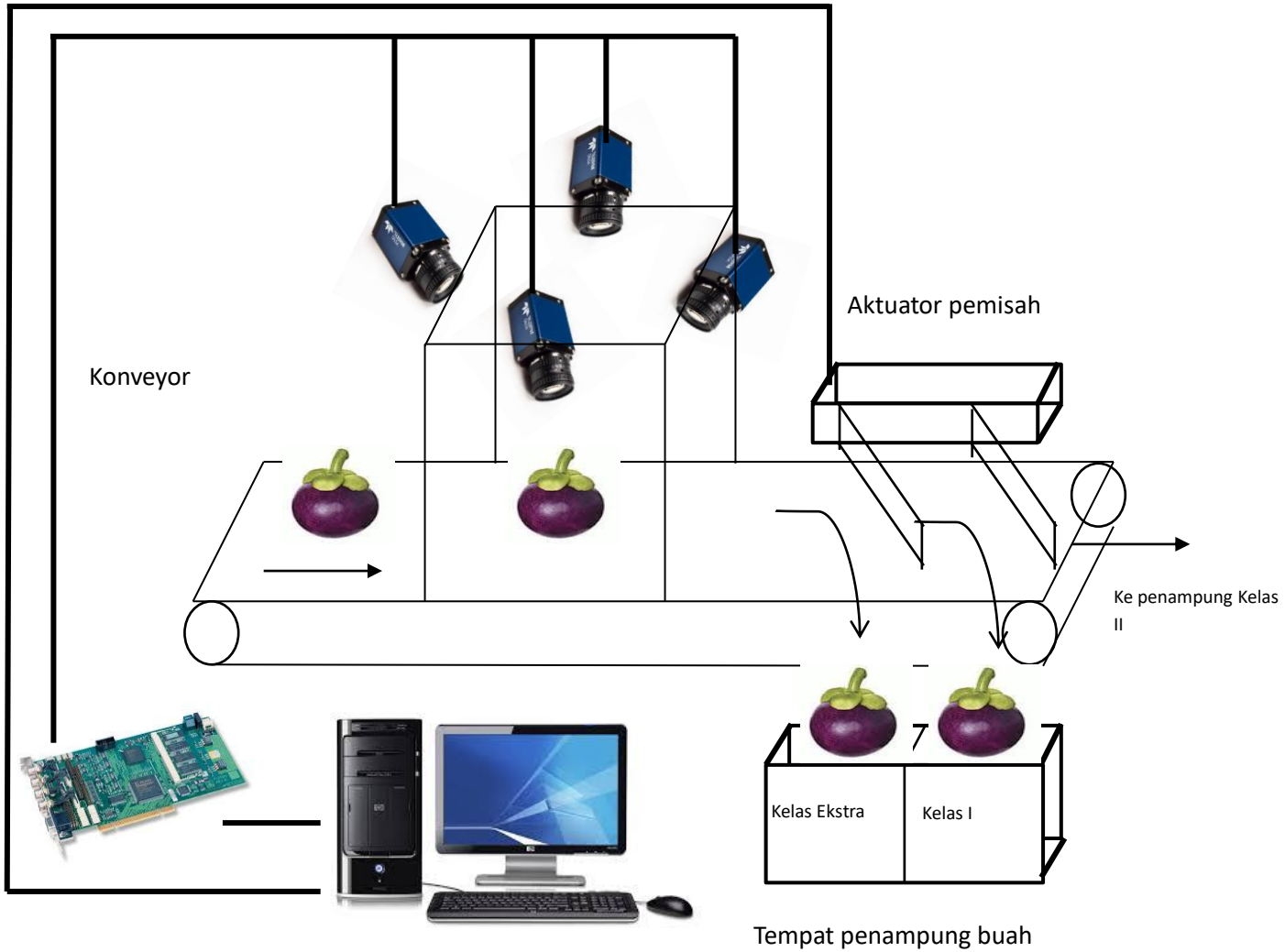
- Objective: to develop low-cost road crack detection system
- Partners:
  - Dept. Civil Engineering UMY
  - Dept. Electrical Engineering TU-Eindhoven Netherlands
- Keypoints
  - Low-cost hardware: using simple data acquisition
  - Multiscale: wavelets, pyramidal analysis
  - Support vector machine



Mangosteen inspection

- Objective: to develop an automatic grading system for mangosteen export
- Partners
  - Dept. of Agriculture UMY
  - Dept. of Electrical Engineering, TU-Eindhoven
- Keypoints
  - Color image processing to detect mangosteen maturity stages
  - Quality inspection (detection of calyx, bruised and scratch)
  - Support vector machine

Kotak pencahayaan dengan 4 buah kamera CCD



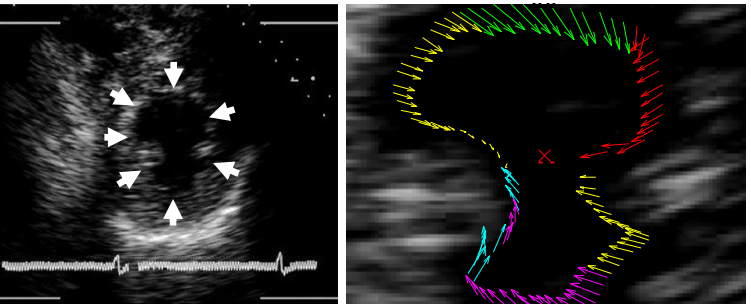
Frame grabber

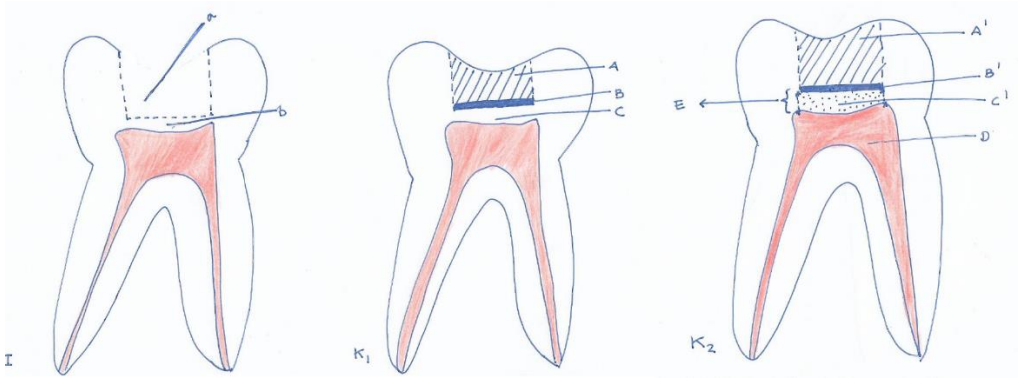
Komputer

Tempat penampung buah

Medical image representation

1. Cardiac motion detection and quantification using optical flow
   - Partner: Dept. Electrical Eng. Univ. Kebangsaan Malaysia
2. Computer aided system to assist pulp capping treatment for dentistry
   - X-ray dental images enhacement using pyramidal Gaussian filter
   - Estimation of tertiary dentin thickness
   - Partner: Dept. of Dentistry UMY





ありがとうございました

“Digital Image Processing”, Rafael C. Gonzalez & Richard E. Woods, Addison-Wesley, 2002

www.comp.dit.ie/bmacnamee/