

Digital Image Processing

Ch1

Introduction

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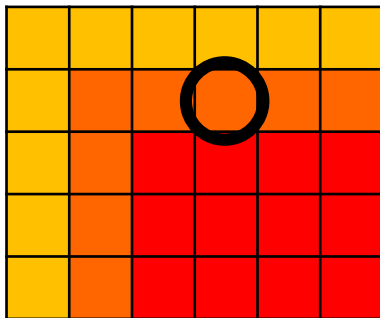
Introduction

- The propose of DIP :
 - (1) Improvement of Pictorial Information for Human Interpretation
 - (2) Processing of Image Data for Storage, Transmission and Representation for Autonomous Machine Perception

1.1 Introduction

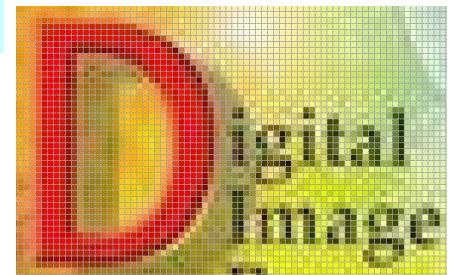
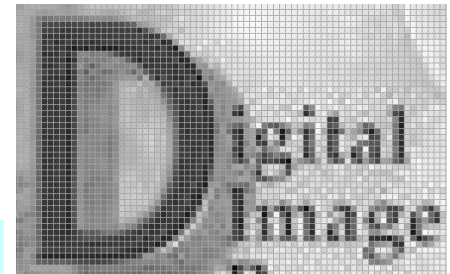
Definition

- An **Image** can be defined as a continuous 2D function $f(x, y)$
 - x, y : Spatial Coordinate
 - $f(.)$: The intensity or gray level of each point, called **pixel**
- **Digital** : x, y, f are all discrete



$$f(x, y) \rightarrow I(m, n)$$

discrete

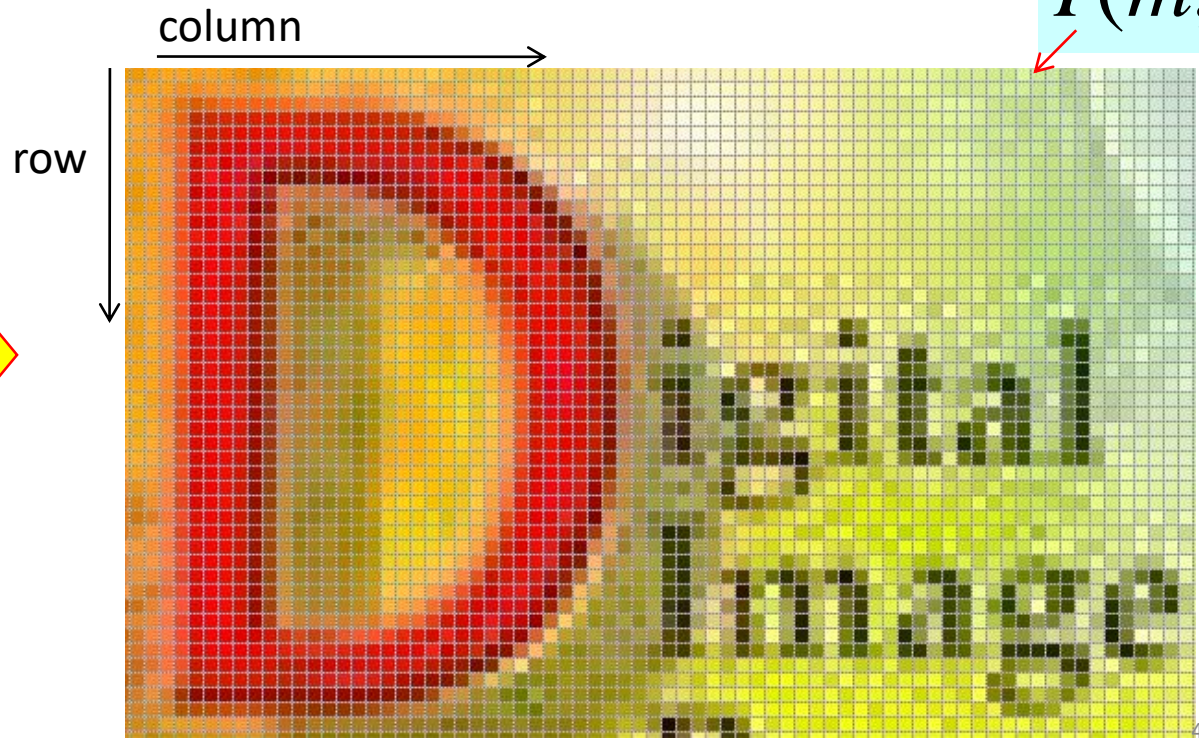
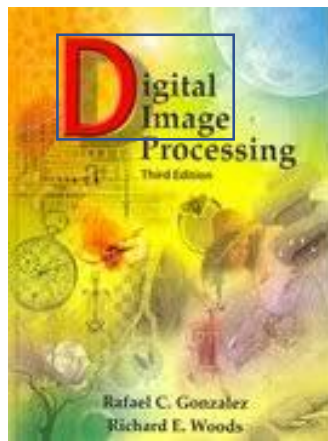


1.1 Introduction

Definition

- Digital Image is composed by finite elements, each element has its position and value, called **pixel**, **per**, **dot**, or...

$$I(m, n)$$



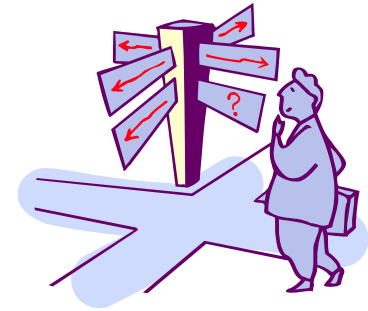
1.1 Introduction

DIP Definition:

A Discipline in Which Both the Input and Output of a Process are Images.



1. What is Digital Image Processing?



**Image
Processing**

Image Analysis

Vision



**Low-Level
Process**

- Reduce Noise
- Contrast Enhancement
- Image Sharpening



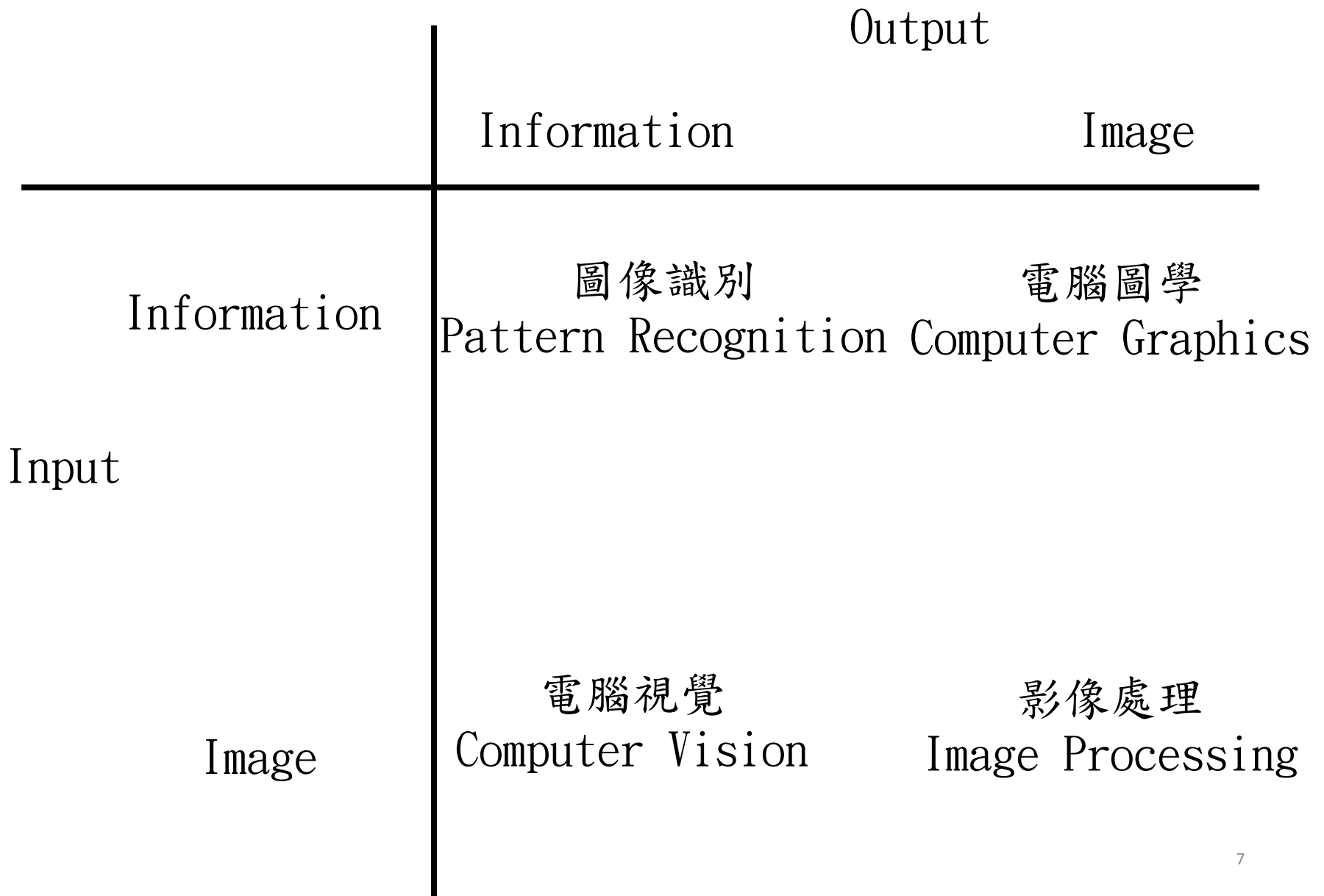
**Mid-Level
Process**

- Segmentation
- Classification



**High-Level
Process**

Making Sense of an
Ensemble of
Recognized Objects



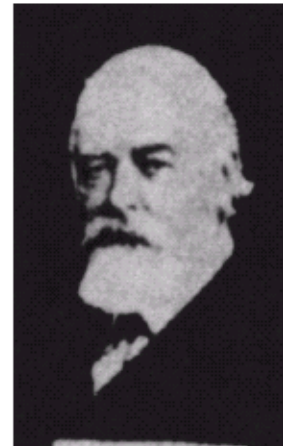
1.2 The Origin

- The first application of DIP : newspapers



FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.)

FIGURE 1.2 A digital picture made in 1922 from a tape punched after the signals had crossed the Atlantic twice. Some errors are visible. (McFarlane.)



1.2 The Origin

FIGURE 1.3

Unretouched
cable picture of
Generals Pershing
and Foch,
transmitted in
1929 from
London to New
York by 15-tone
equipment.
(McFarlane.)



- The above image is *Digital Image* (discrete, **transmit** by coded data), but is not *Digital Image Processing* because we didn't use computer to process it.
- DIP needs amount of **storage space** and **computing power**.

1.2 The Origin

- In early 1960 , Computer has the ability to process Image.



FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger 7* took this image on July 31, 1964 at 9:09 A.M. EDT, about 17 minutes before impacting the lunar surface. (Courtesy of NASA.)

1.3 Fields

- Gamma-Ray Imaging Gamma射線成像
- X-ray Imaging X光成像
- Imaging in the Ultraviolet Band 紫外光頻帶成像
- Imaging in the Visible and Infrared Bands 可見光與紅外光頻帶成像
- Imaging in the Microwave Band 微波頻帶成像
- Imaging in the Radio Band 無線電波成像
- Imageing in sound, ultrasound, and...

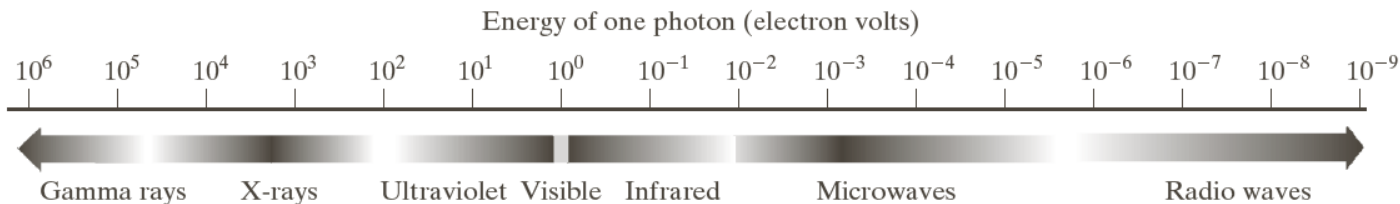
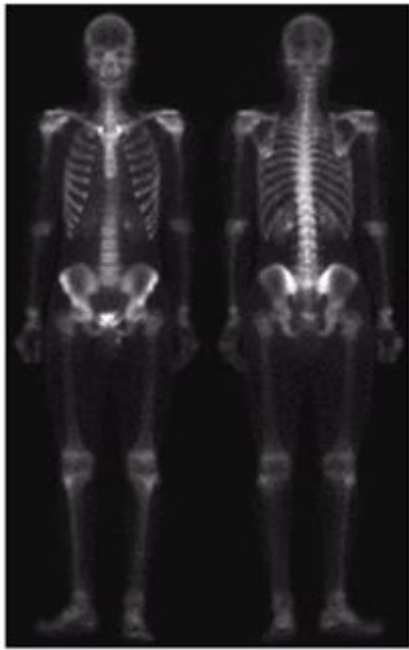
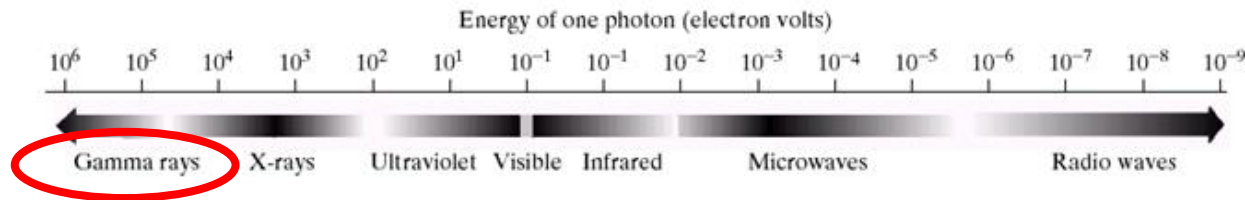


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

1.3.1 Gamma-Ray

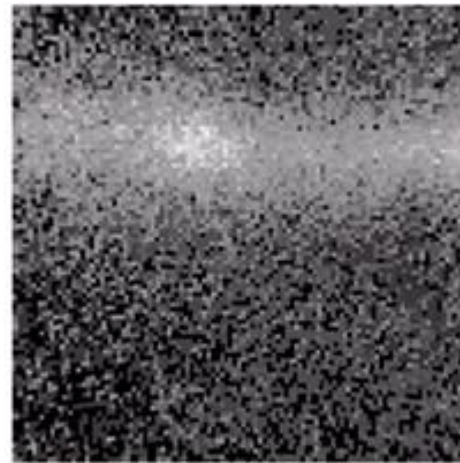
- 醫學診斷
- 天文觀察



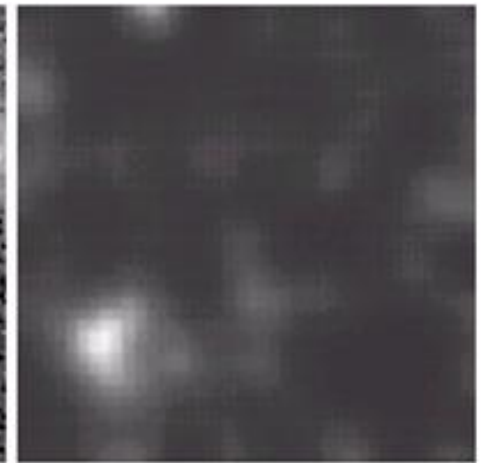
骨骼掃描



正電子斷層掃描，顯示腫瘤

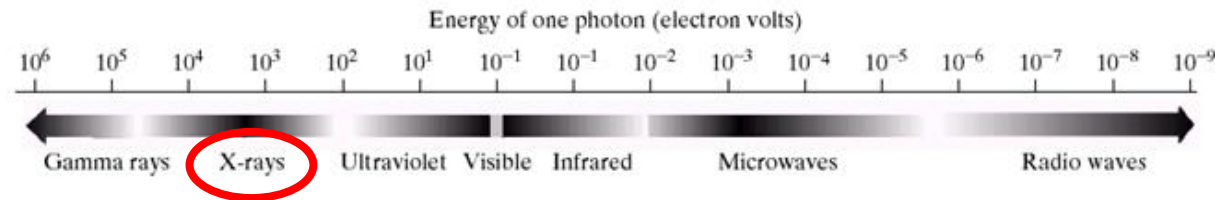


天鵝座星環

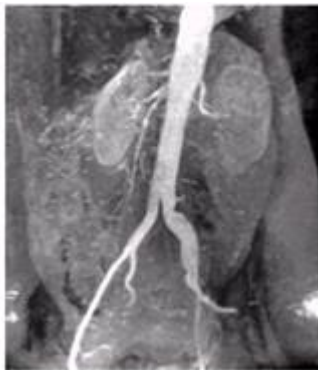


核子反應閥，顯示左下有一放射較強的區域

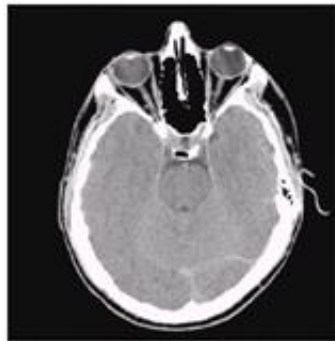
1.3.2 X-Ray



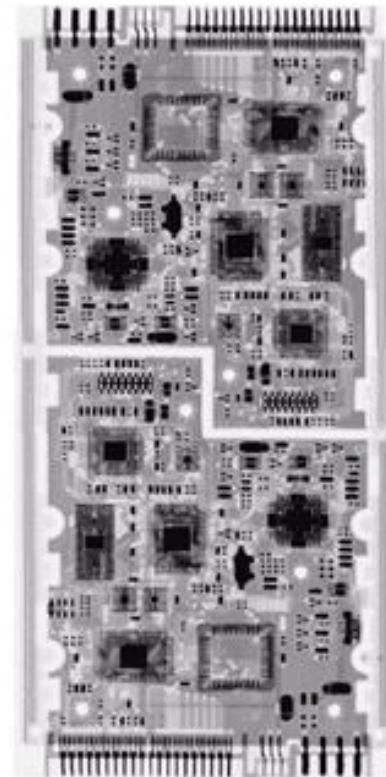
胸部X光



動脈血管圖

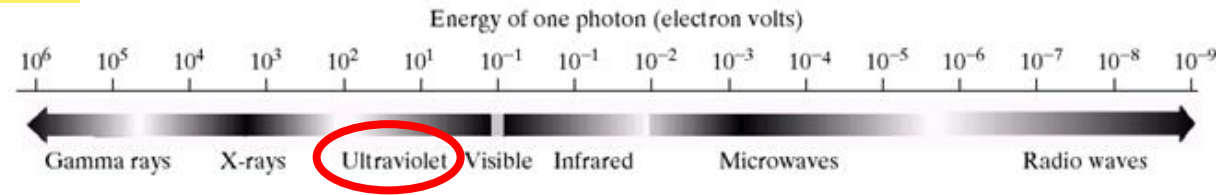


頭部
斷層切片

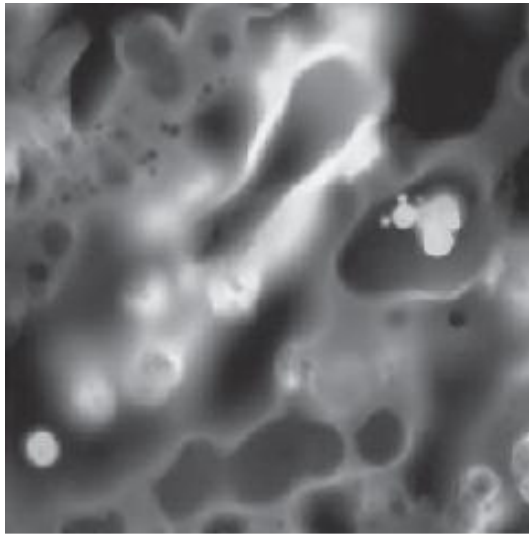


電路板

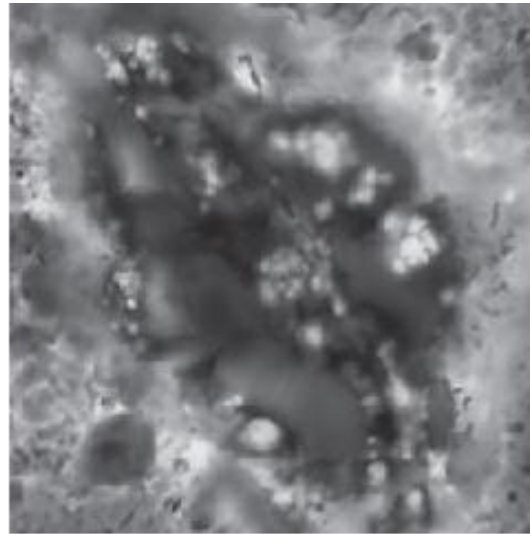
1.3.3 Ultraviolet Band



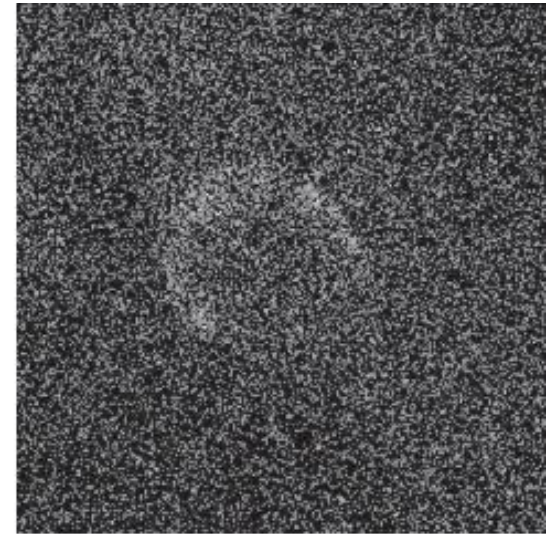
- Ultraviolet Band in microscope



螢光顯微鏡
正常玉蜀黍



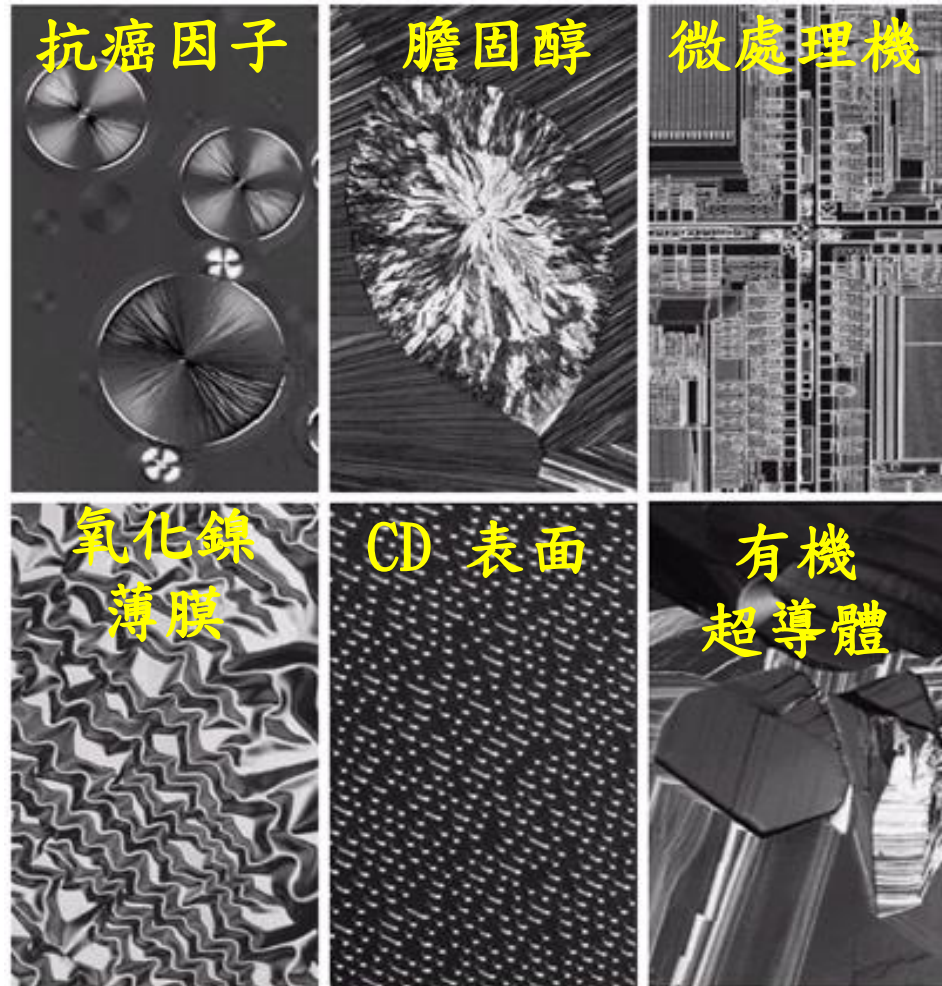
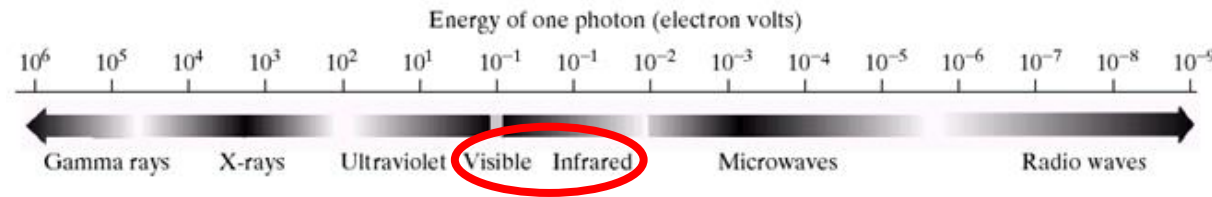
螢光顯微鏡
染病玉蜀黍



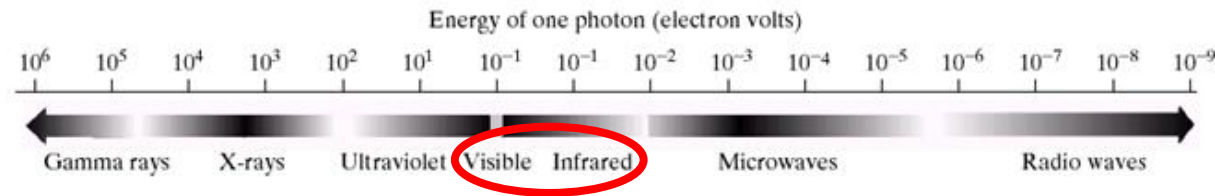
天鵝座環狀
星雲

1.3.4 Visible and Infrared Bands

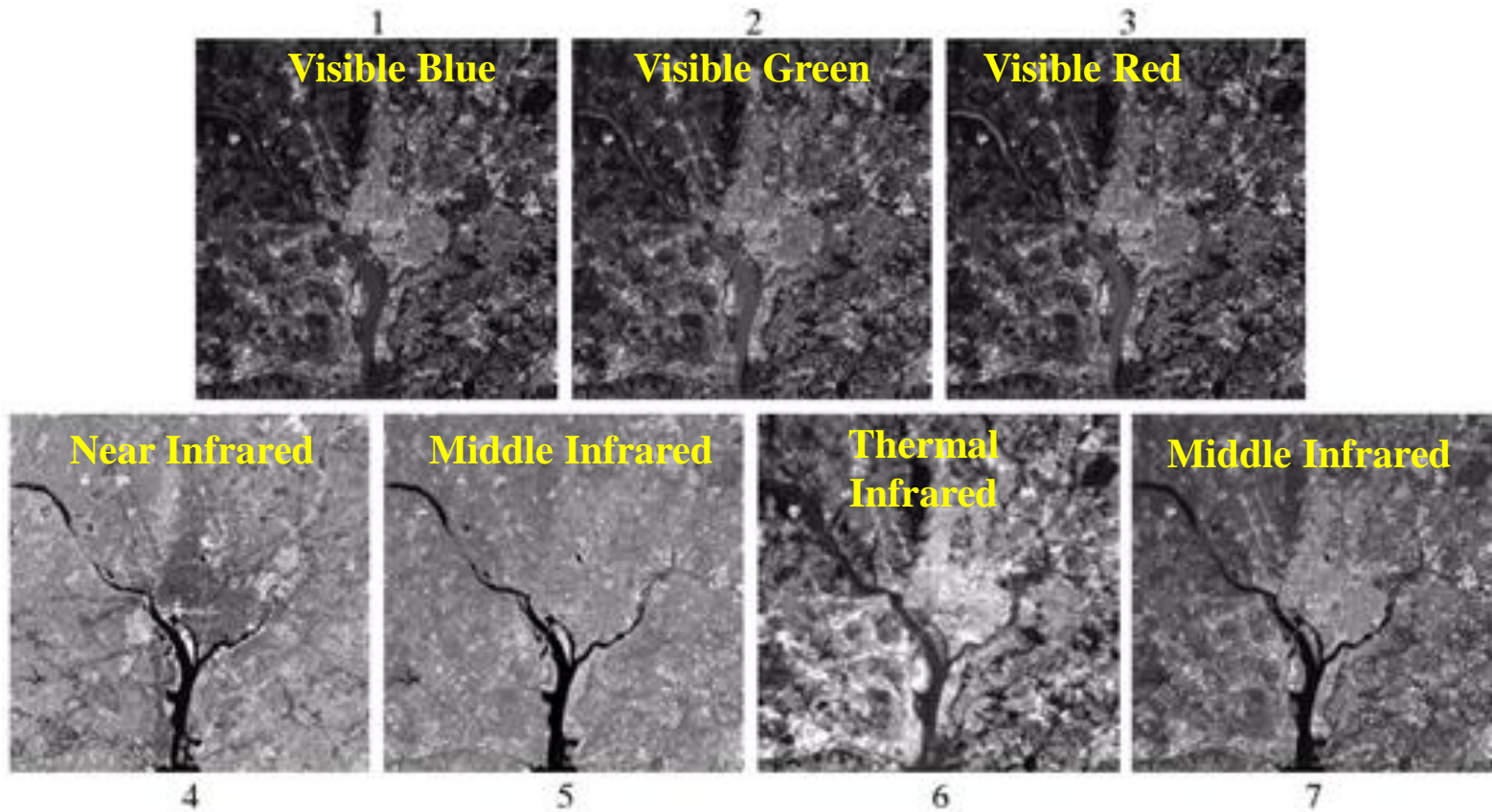
- 可見光



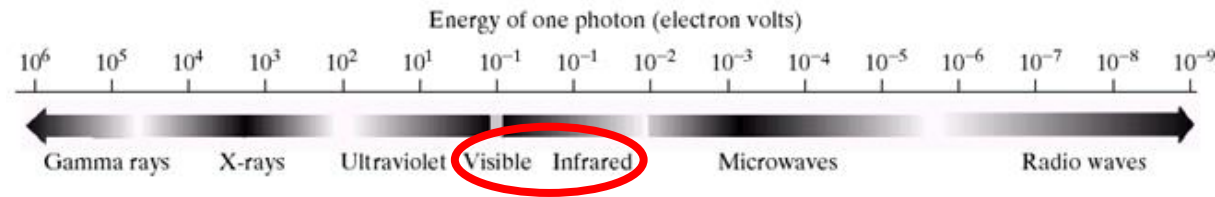
1.3.4 Visible and Infrared Bands



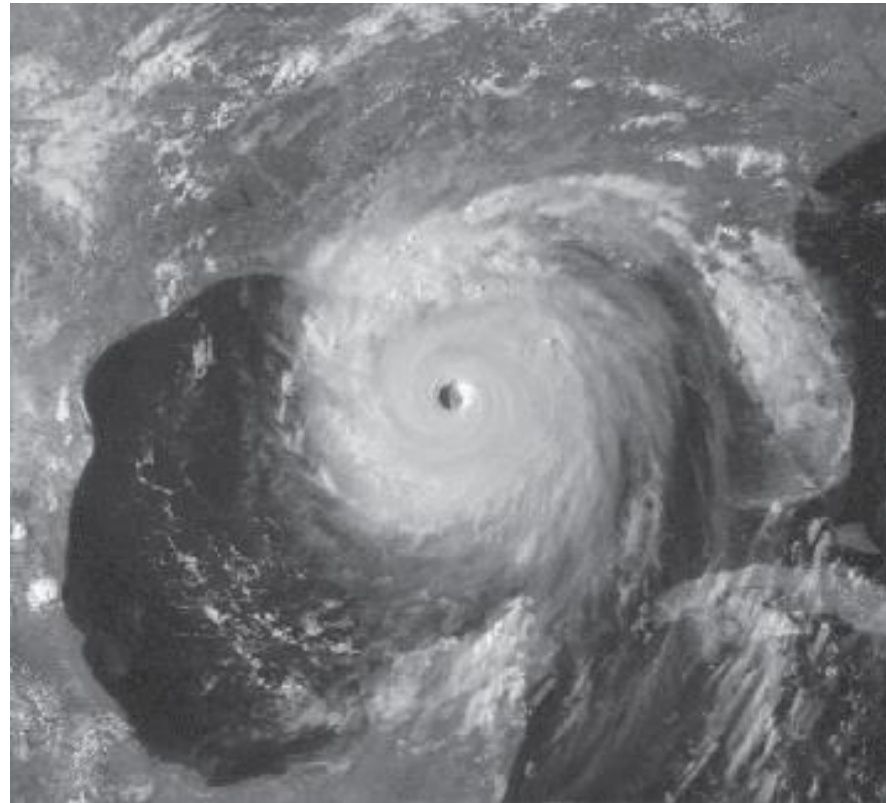
NASA 華盛頓空照衛星圖（不同波長所感測到的影像）



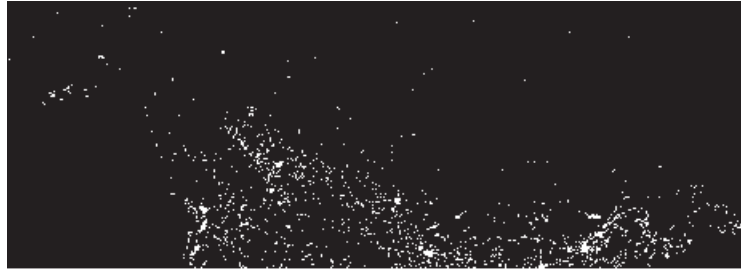
1.3.4 Visible and Infrared Bands



NOAA衛星用可見
光及紅外光頻帶的
感應器所拍得
Katrina颱風之衛星
影像



1.3.4 Visible and Infrared Bands

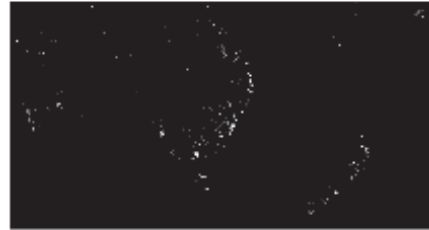


美洲的紅外線衛星影像



1.3.4 Visible and Infrared Bands

紅外線衛星影像



1.3.4 Visible and Infrared Bands

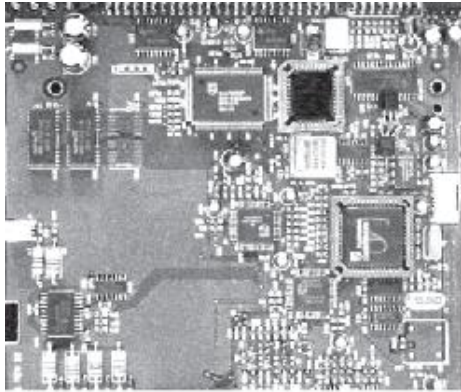
紅外線衛星影像
(提高亮度)



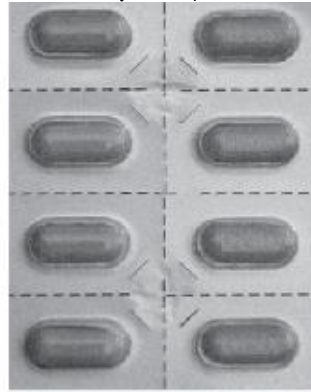
1.3.4 Visible and Infrared Bands

- 常用數位影像處理**檢視**製造產品（瑕疵檢測）

電路板



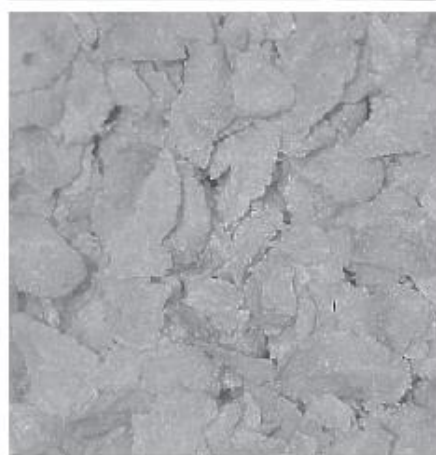
包裝藥丸



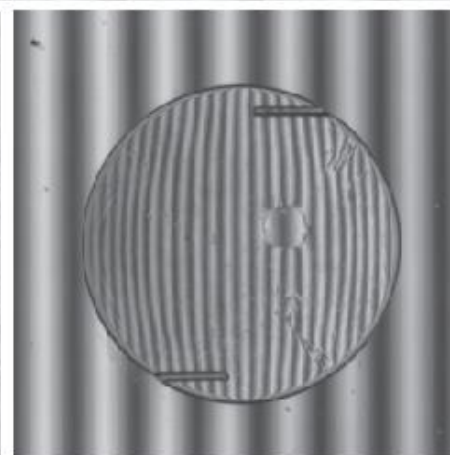
瓶子



塑膠的氣泡



麥片



眼內移植物

1.3.4 Visible and Infrared Bands

- 電腦視覺辨識

指紋辨識



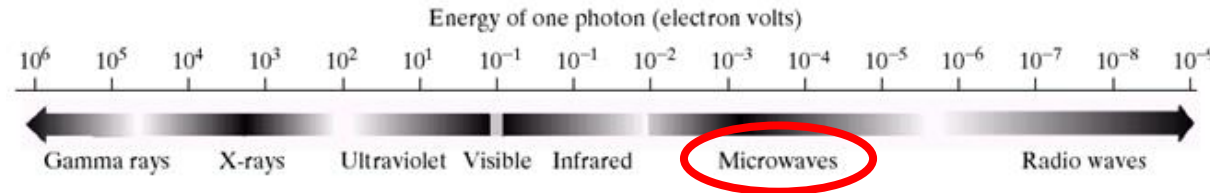
偽鈔辨識



車牌偵測與
文字辨識

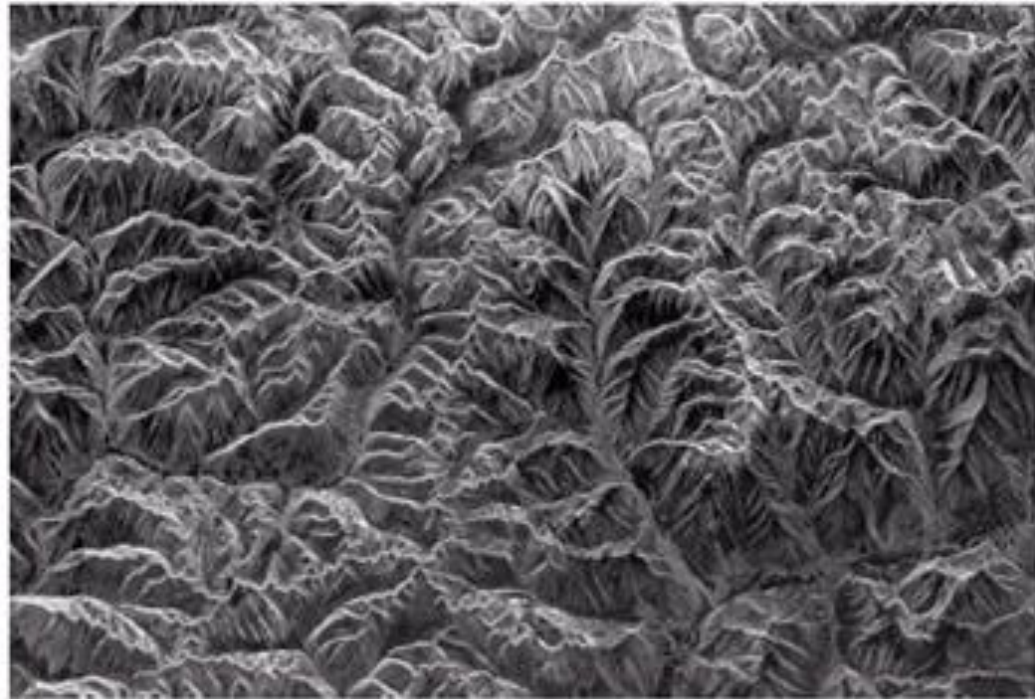


1.3.5 Microwave Band

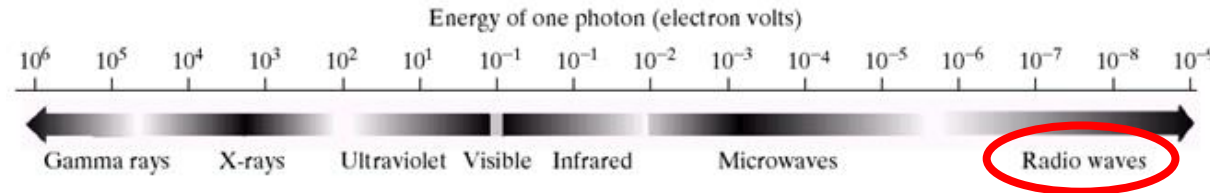


- 微波頻帶成像主要的應用是雷達，不受天候及環境光線影響。

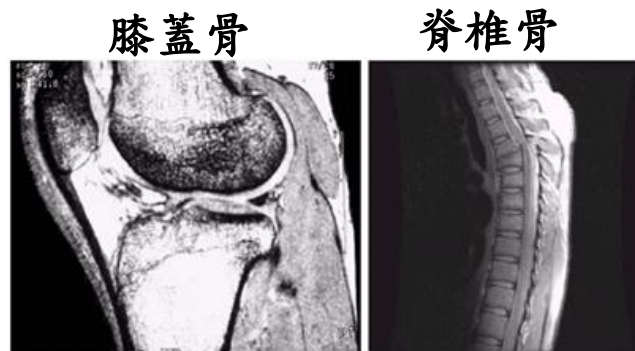
(NASA太空雷達)
西藏東南方山區



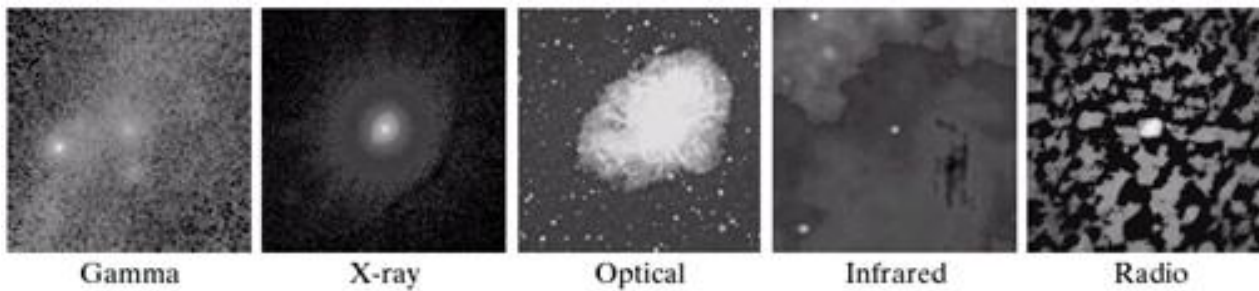
1.3.6 Radio Band



- 主要用在醫學及天文。



磁共振造影術 Magnetic Resonance Imaging (MRI)



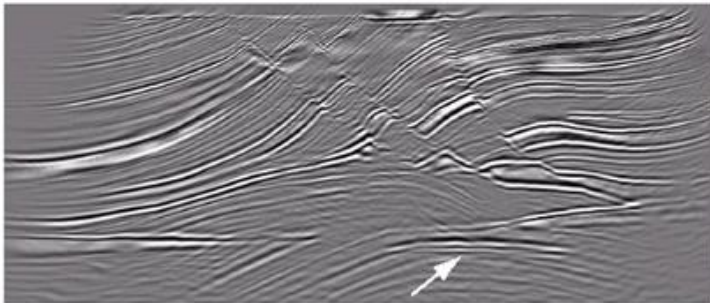
巨蟹星雲

1.3.7 Others

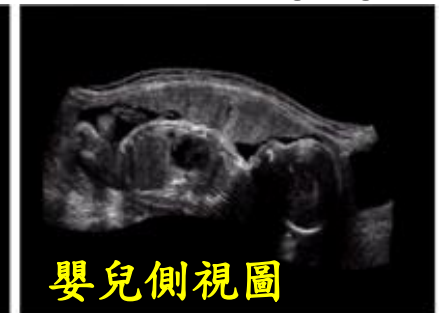
- 前述為常見之光學成像，亦有些是靠**聲學**成像。
- 地質學的應用採聲音頻譜的**低波段**(幾百Hz)，其它領域則用**超音波**(幾百萬Hz)。
- 發射音波至欲探測的物質，藉由回傳的音波強度與速度來分析。

超音波成像 (Ultrasound Imaging)

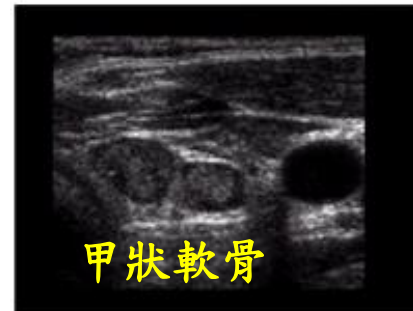
震測影像 (Seismic Imaging)



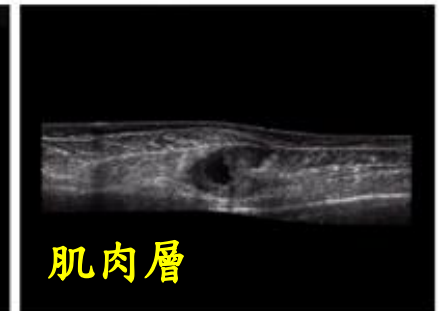
嬰兒



嬰兒側視圖



甲狀軟骨



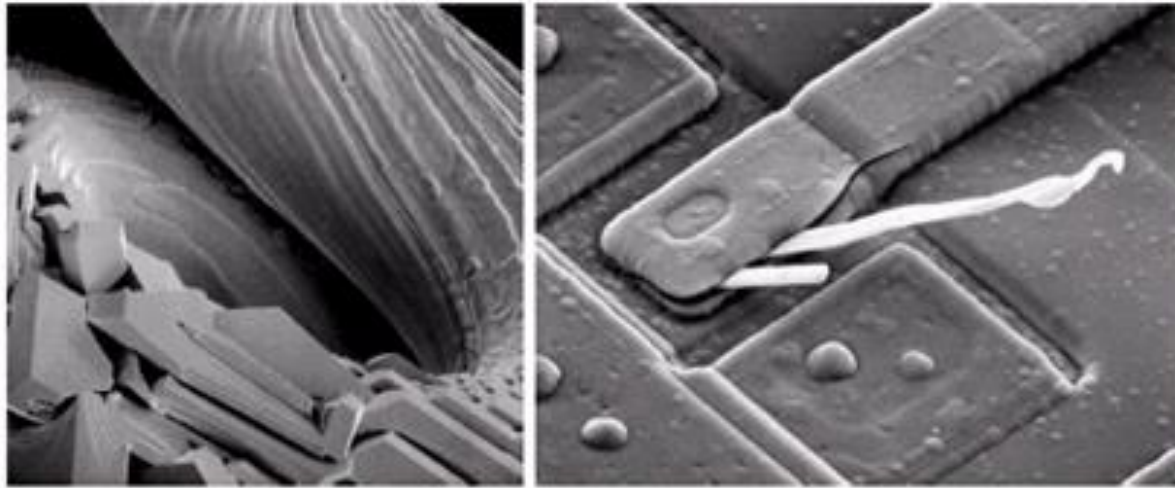
肌肉層

1.3.7 Others

- 掃描式電子顯微鏡：發射電子束掃描樣本，並記錄它們在每一位置的交互作用。

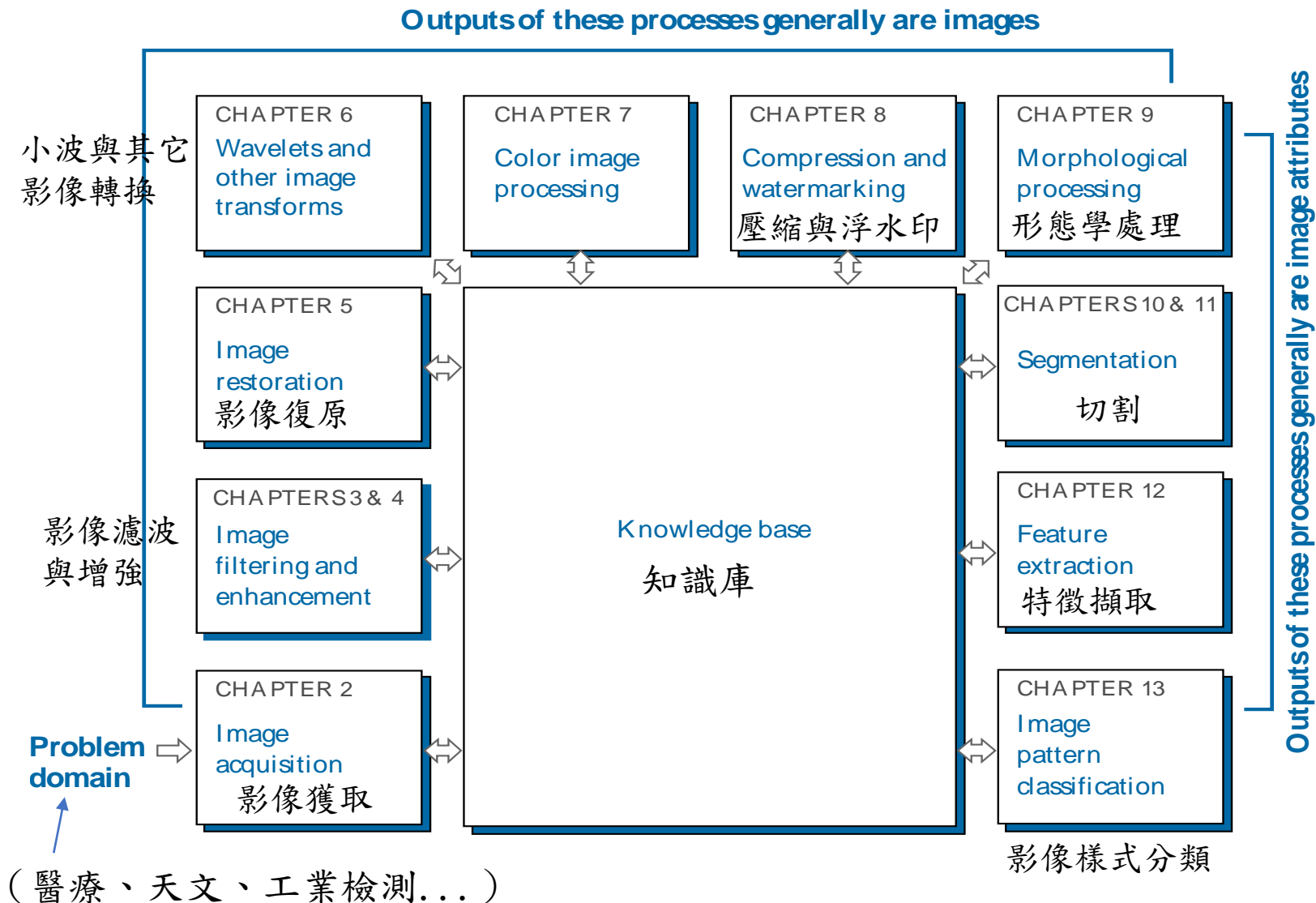
燒斷之鎢絲燈燈泡

損壞之積體電路 (2500倍)

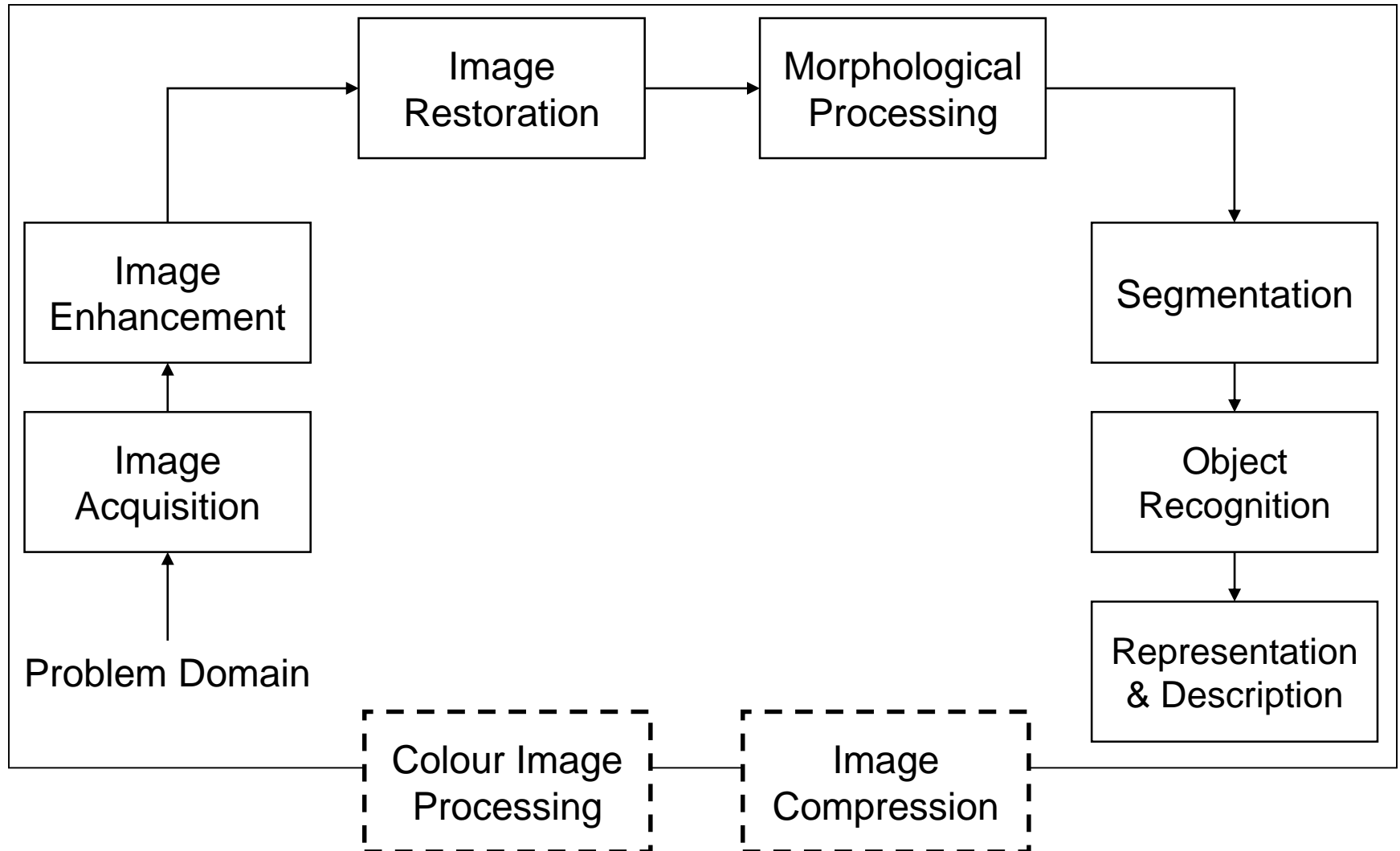


掃描式電子顯微鏡
(Scanning Electronic Microscope (SEM))

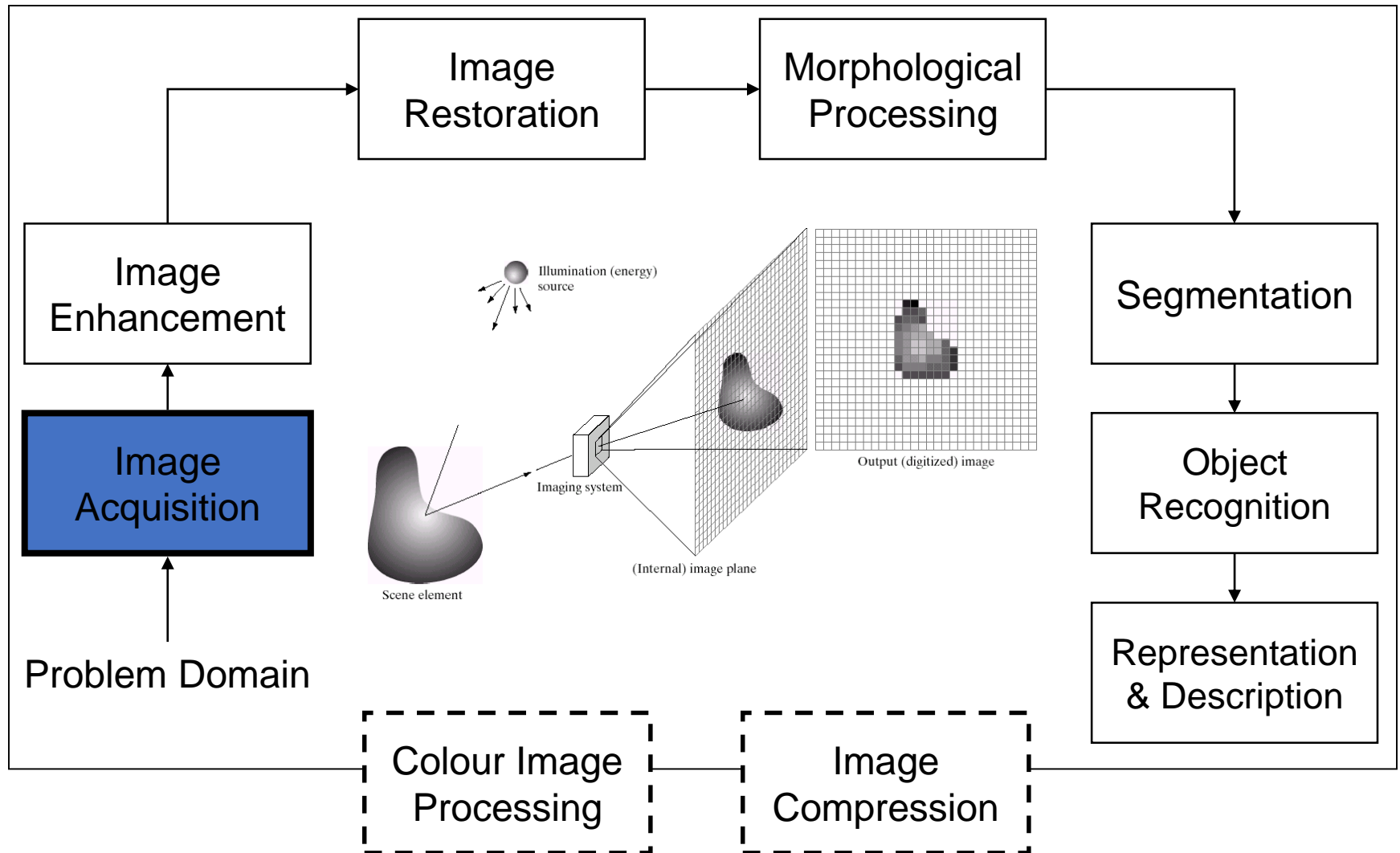
1.4 Fundamental steps in DIP



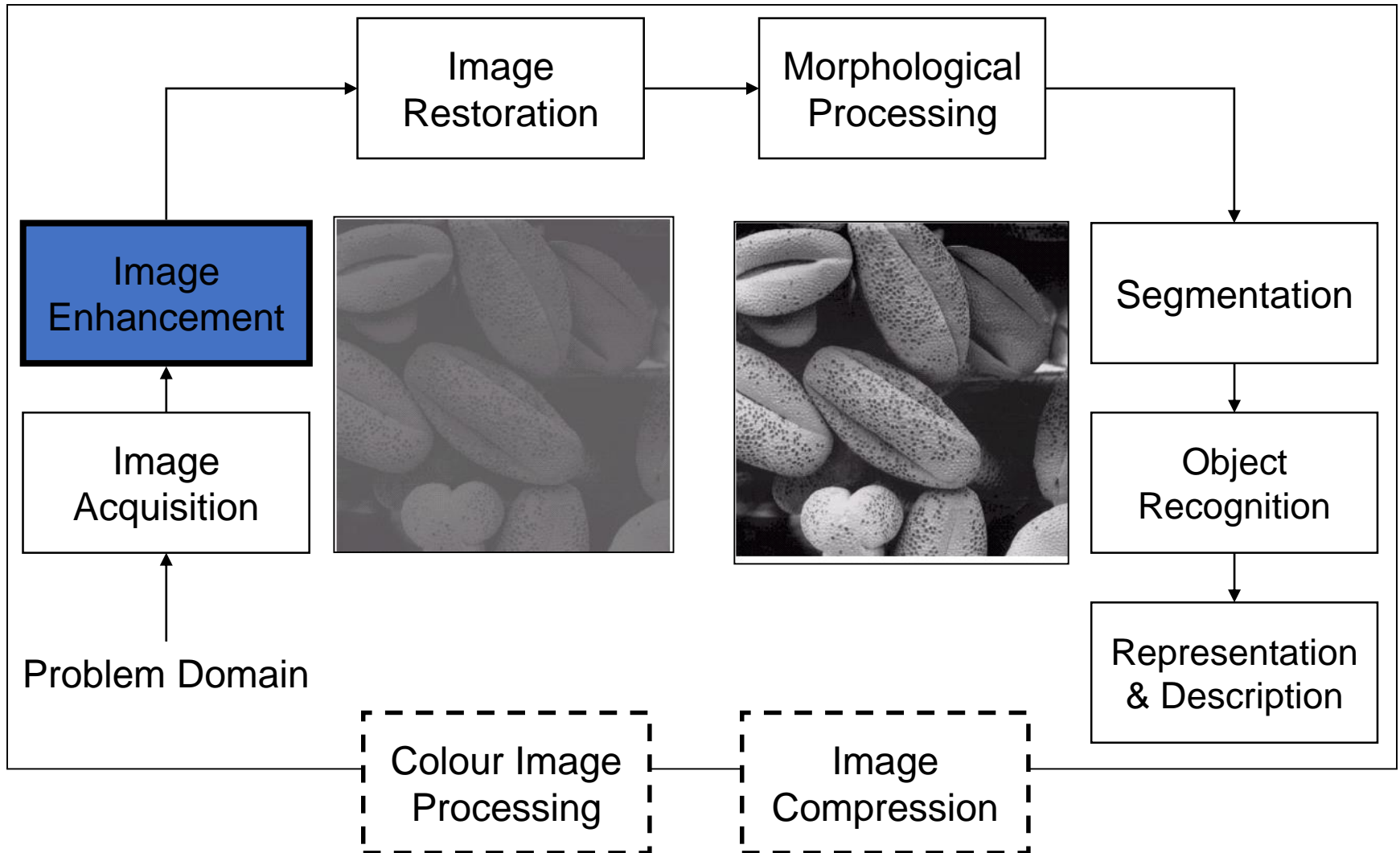
Key Stages in Digital Image Processing



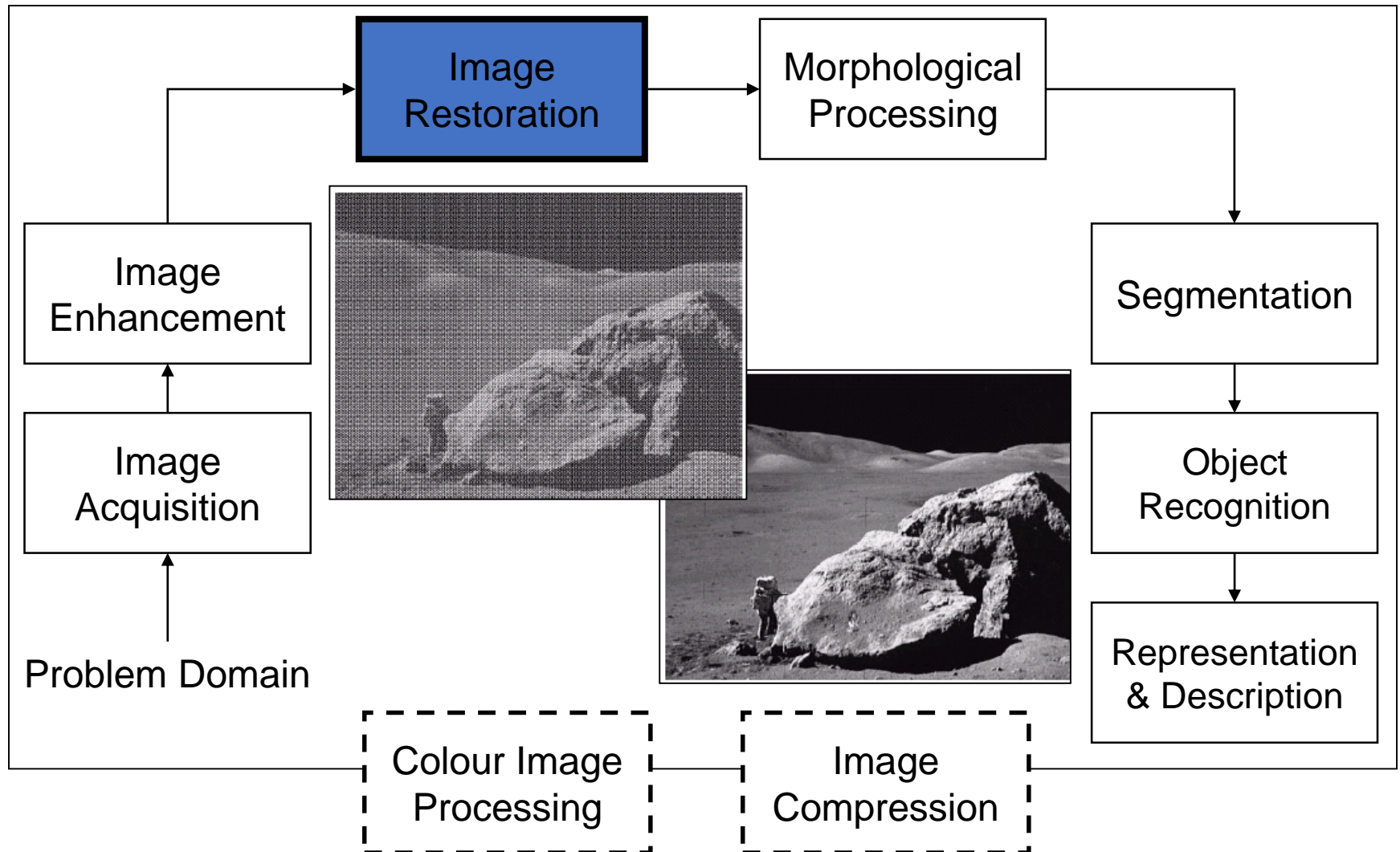
Key Stages in Digital Image Processing: Image Aquisition



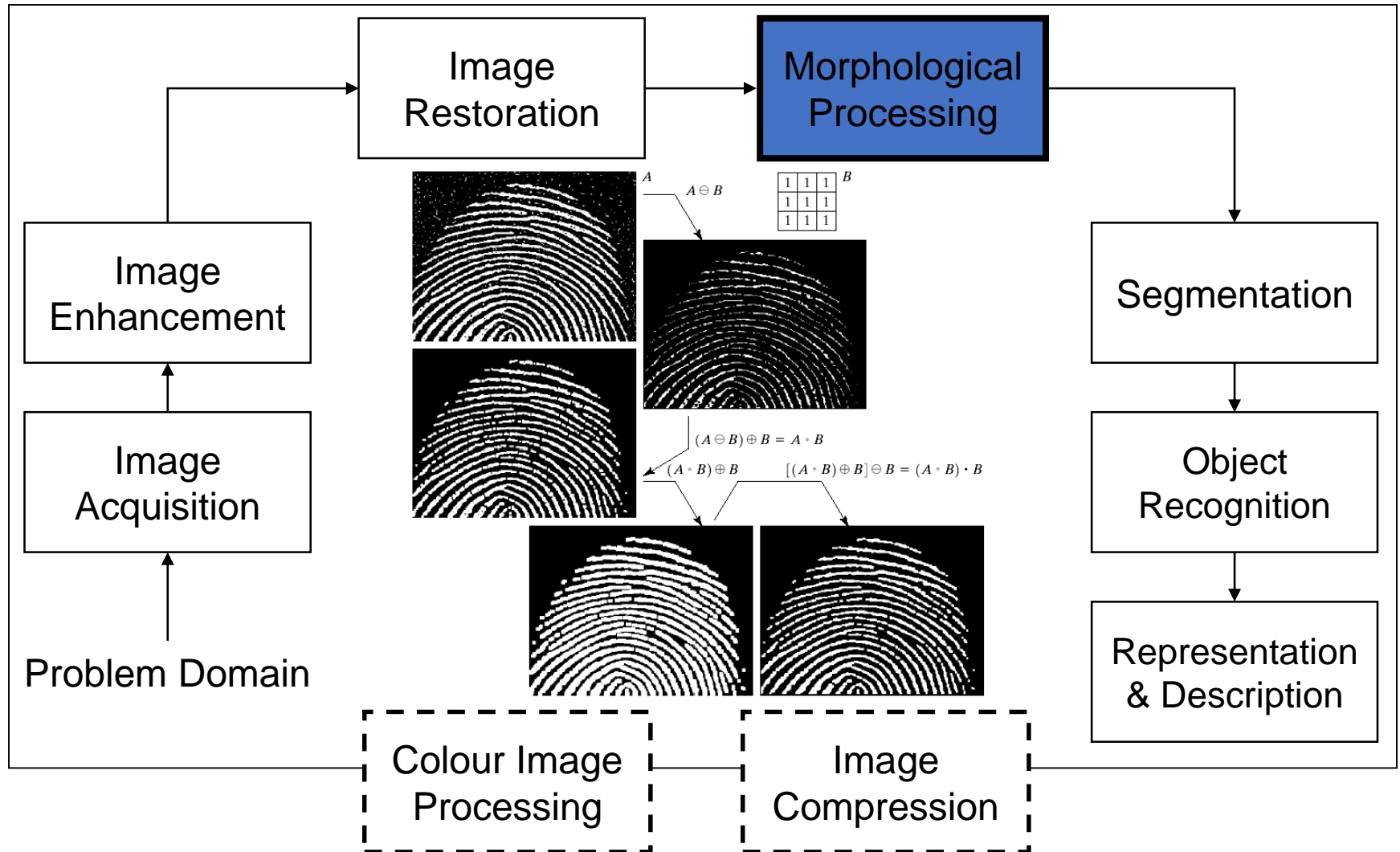
Key Stages in Digital Image Processing: Image Enhancement



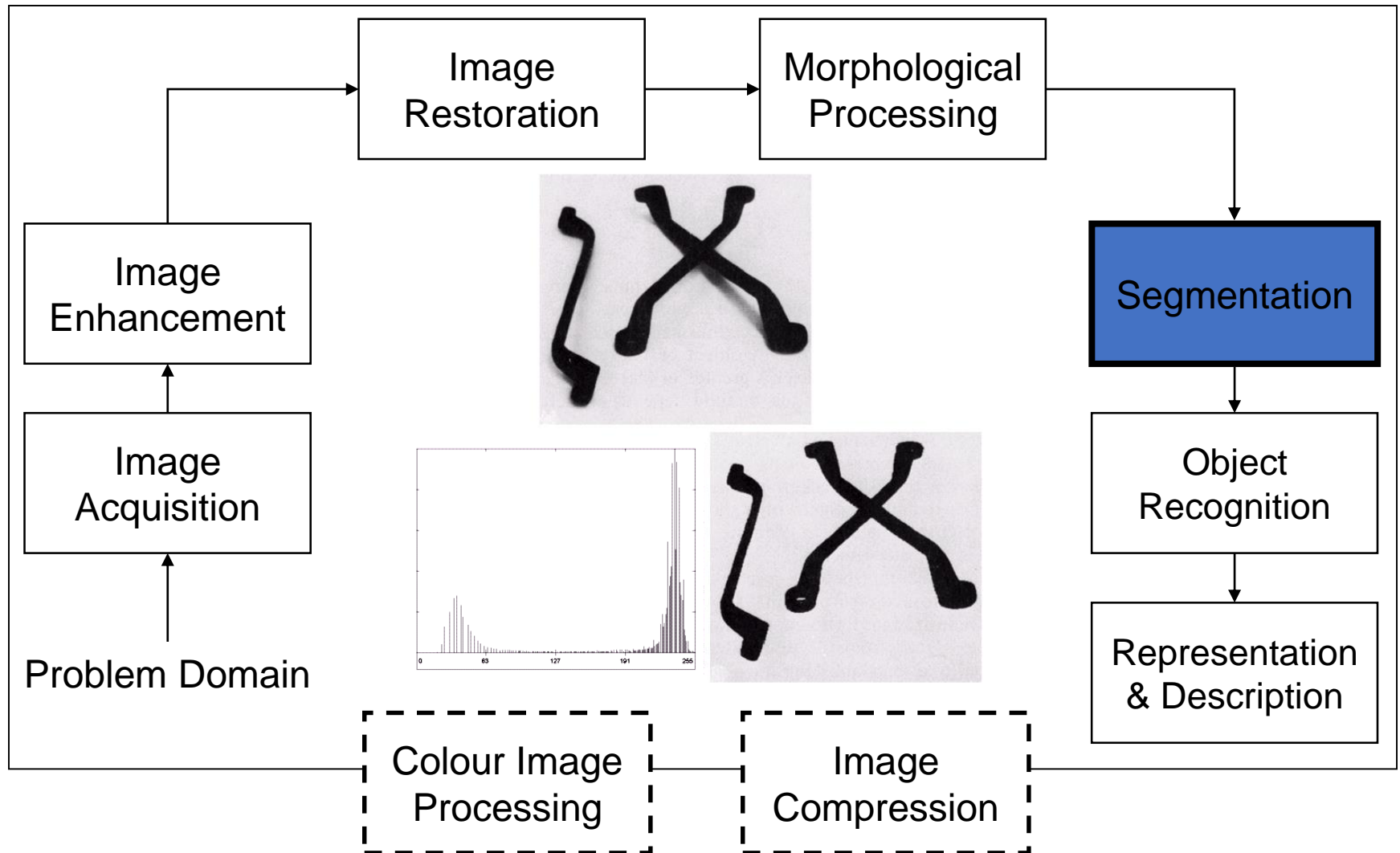
Key Stages in Digital Image Processing: Image Restoration



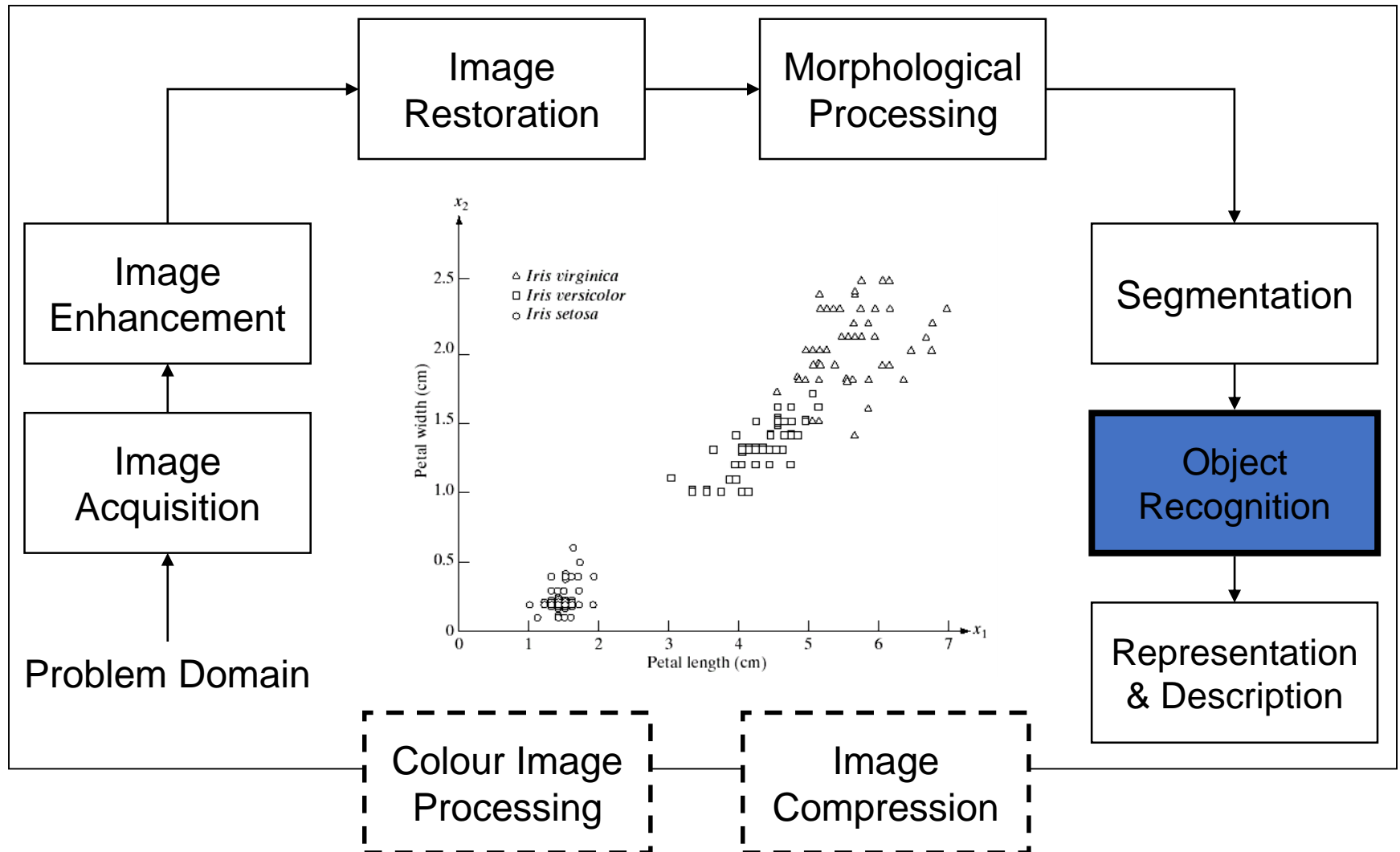
Key Stages in Digital Image Processing: Morphological Processing



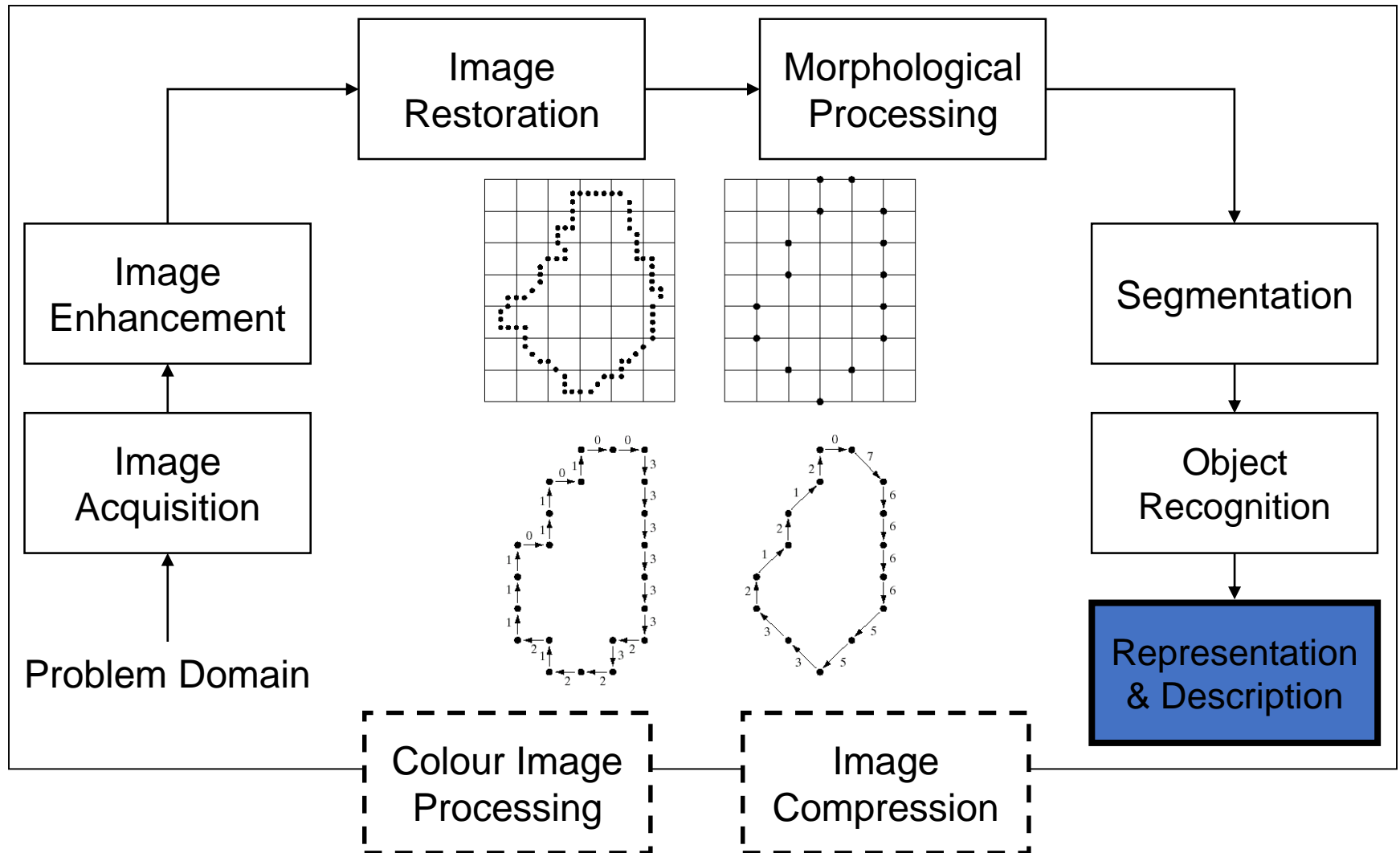
Key Stages in Digital Image Processing: Segmentation



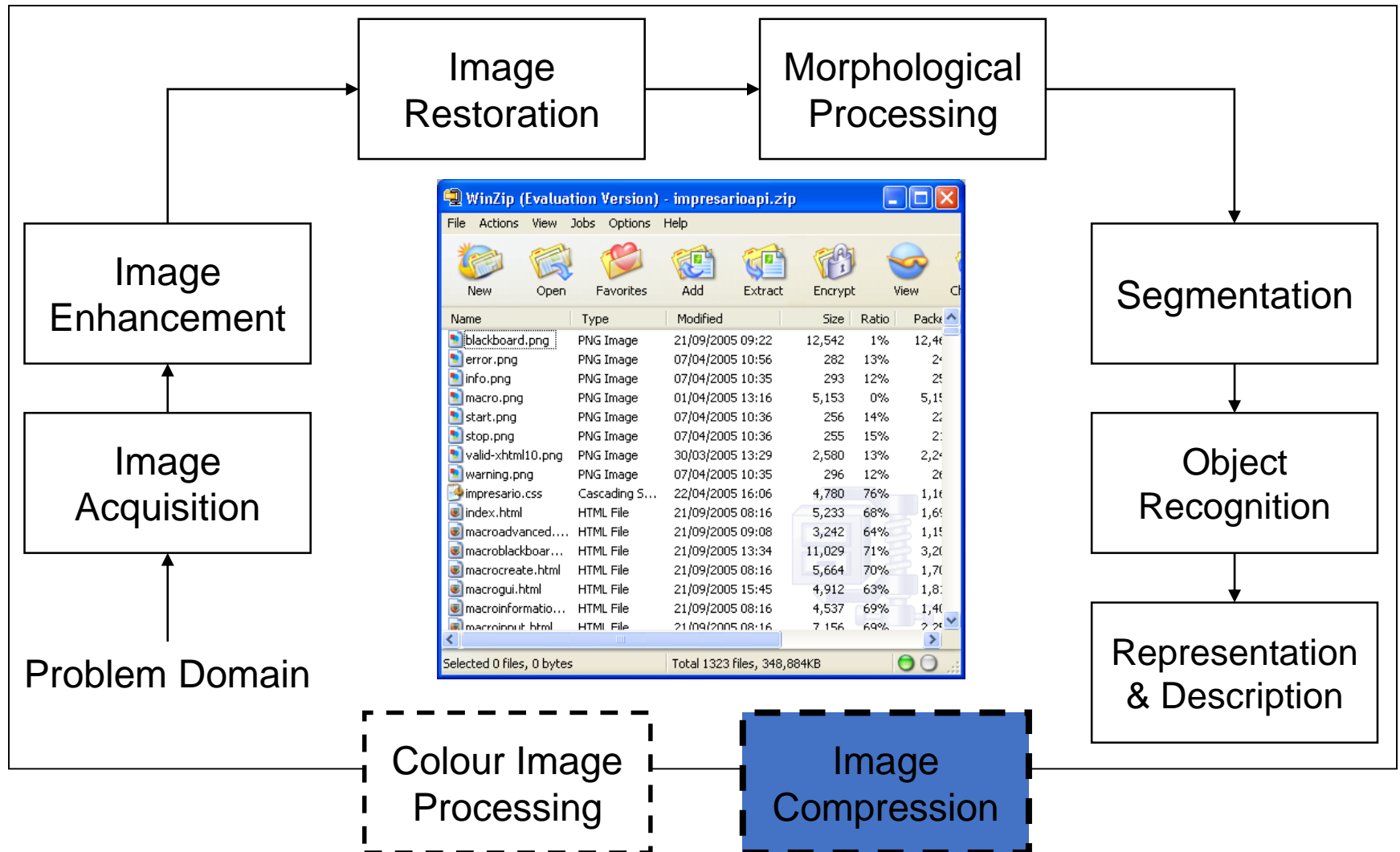
Key Stages in Digital Image Processing: Object Recognition



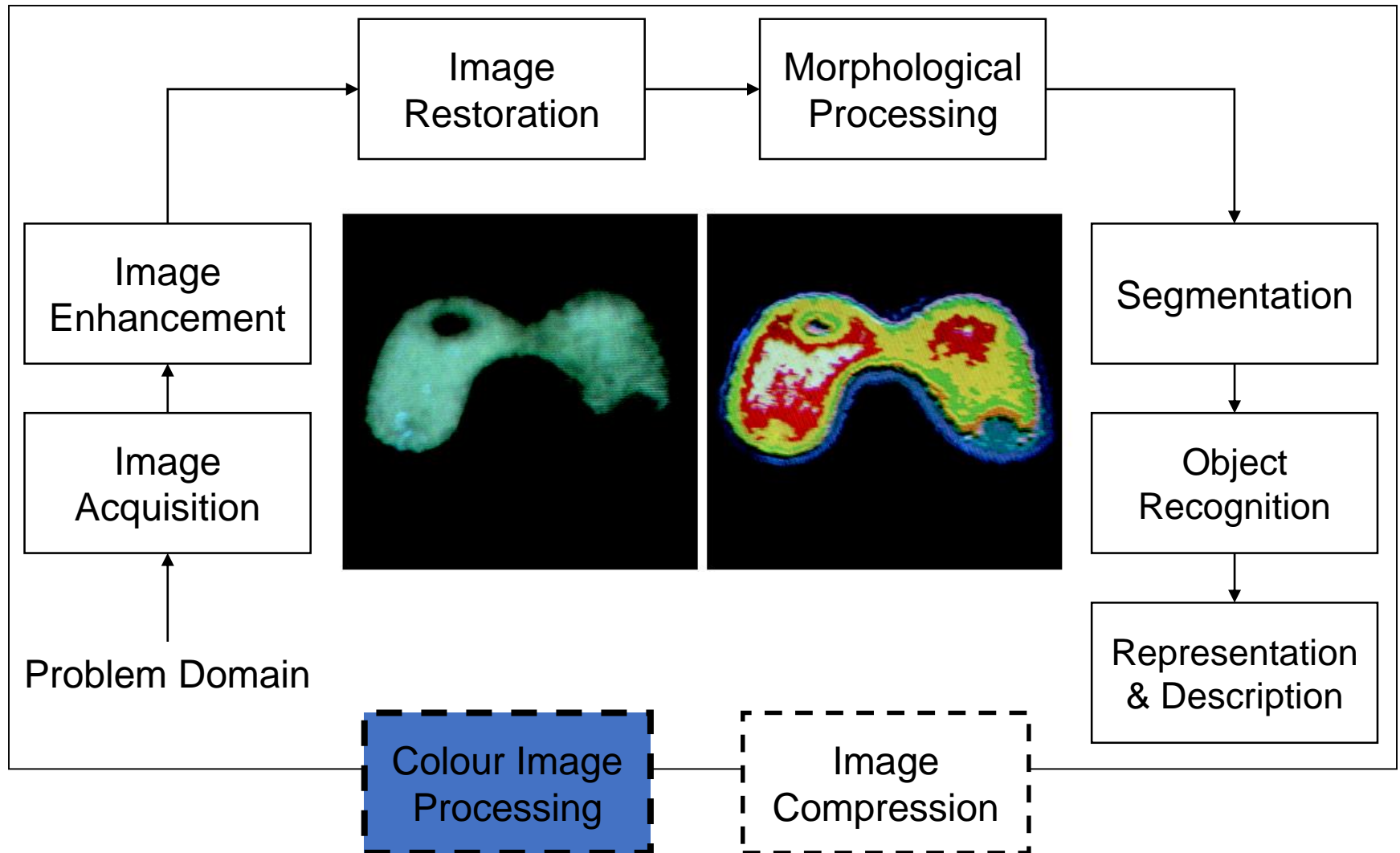
Key Stages in Digital Image Processing: Representation & Description



Key Stages in Digital Image Processing: Image Compression



Key Stages in Digital Image Processing: Colour Image Processing



1.4 數位影像處理的基本步驟

- Image Acquisition：如前述，以不同方式取得數位影像。
- Image Enhancement：操控一張影像的過程，使其結果比原來影像對於**特定應用**而言更適合。



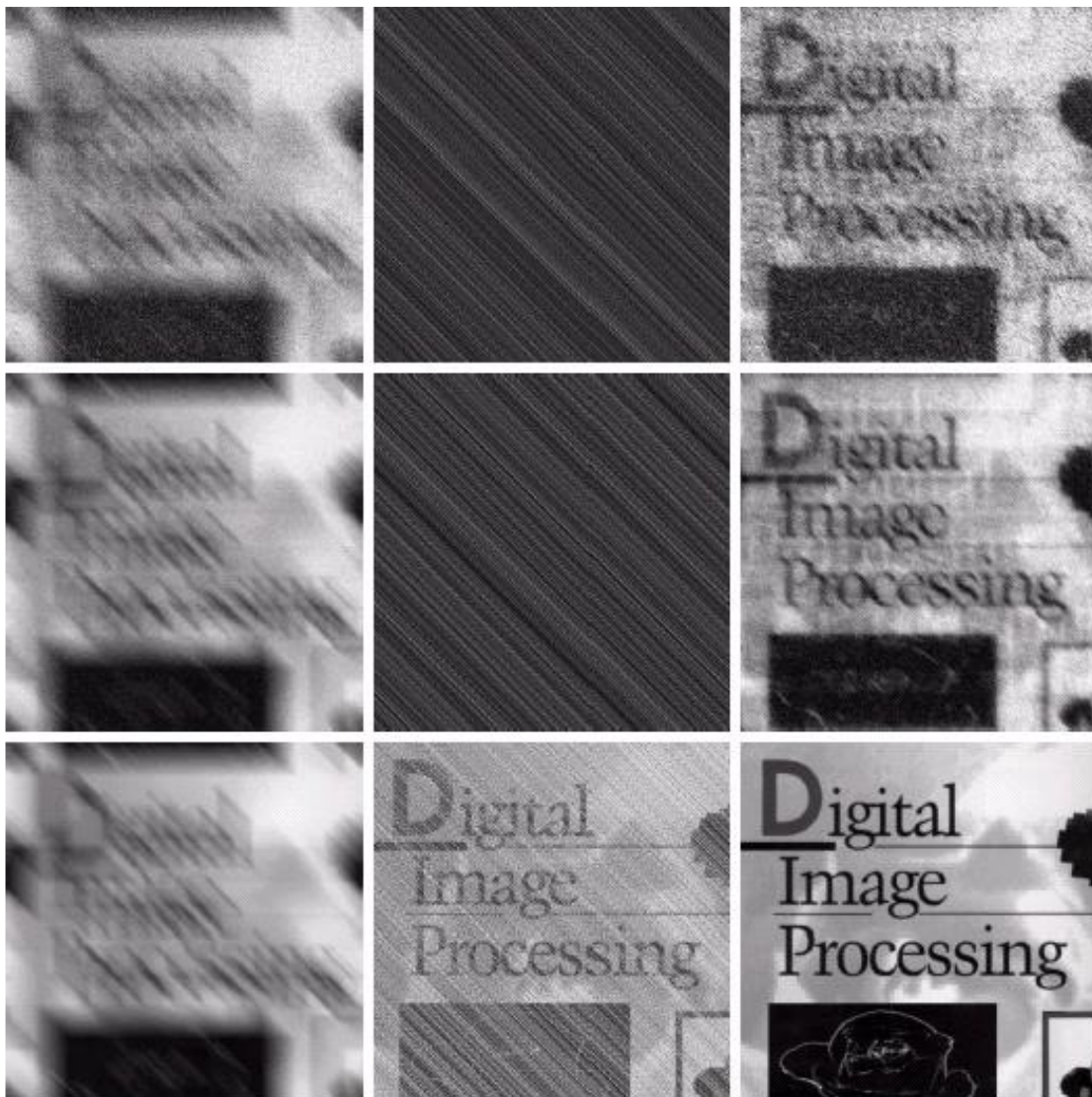
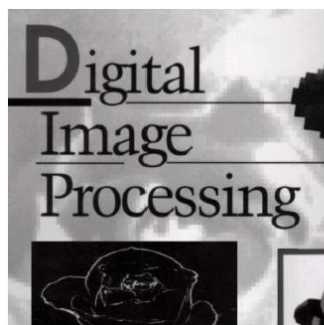
Media Filtering



Histogram Adjustment

1.4 數位影像處理的基本步驟

- Image Restoration



1.4 數位影像處理的基本步驟

- Image Segmentation



Advanced Applications

- Traffic
 - Detection and Tracking cars
 - Car speed estimation

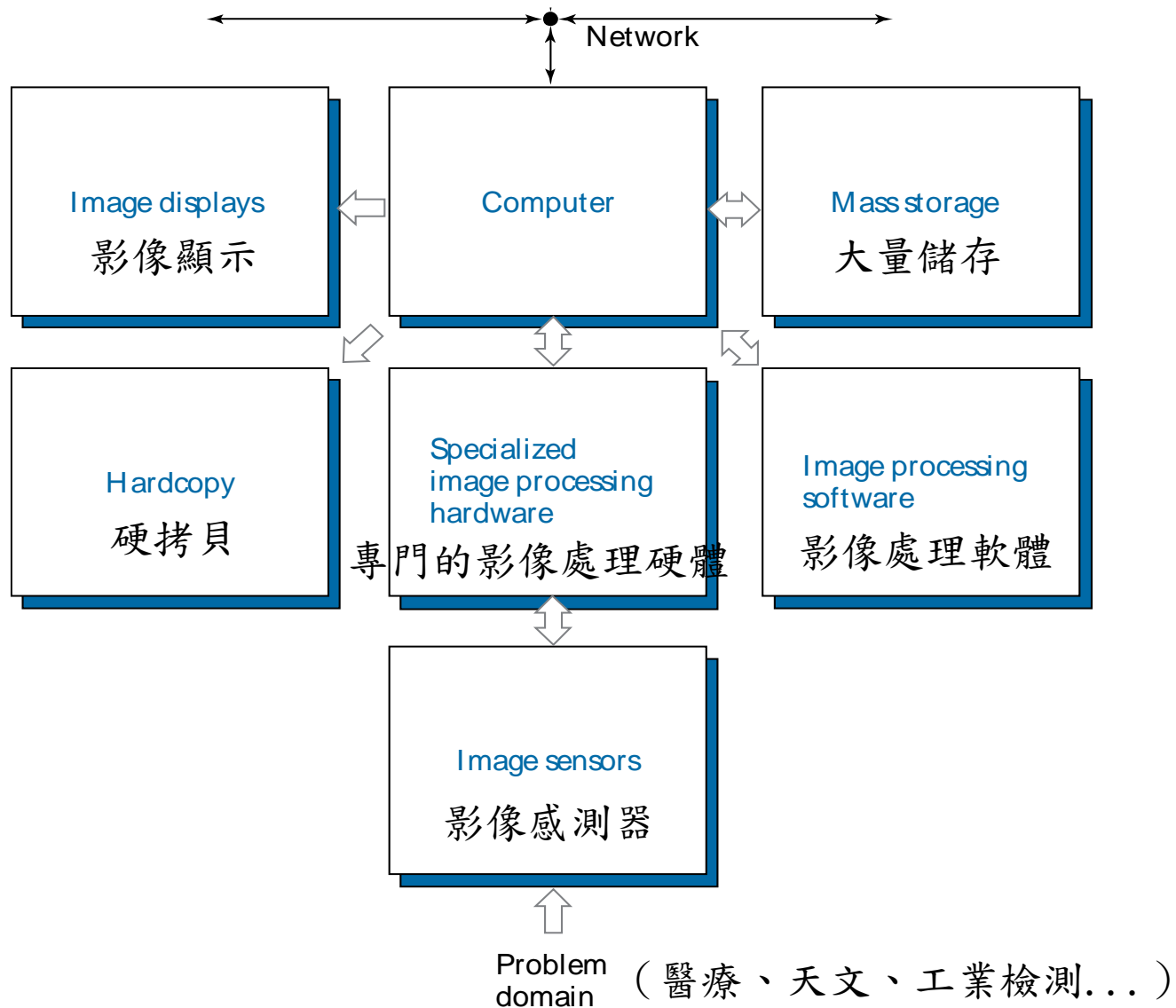


Advanced Applications

- Autonomous cars



1.5 Components of an DIP system



1.5 影像處理系統的組成單元

- Image Sensor
 - Physical device : sensor
 - Digitizer : Transfer physical output to digital data
- Computer
 - General-purpose computer

1.5 影像處理系統的組成單元

- Mass Storage

- Short-Term Storage : Memory in computer
- On-Line Storage : Quickly Read/Write. Disk or Online storage
- Archival Storage : Large amount data, seldom used. Magnetic tapes 、 CD...

- Hardcopy

- Paper, printed images,...

- Q&A
- <https://www.youtube.com/watch?v=Ufp8weYYDE8>
- <https://www.youtube.com/watch?v=mP3fGkpmVM0>
- <https://www.oneesports.gg/lol/illusion-broken-a-closer-look-at-how-riot-used-ar-to-turn-an-empty-room-into-the-worlds-2020-stage/>