

Image Data Processing

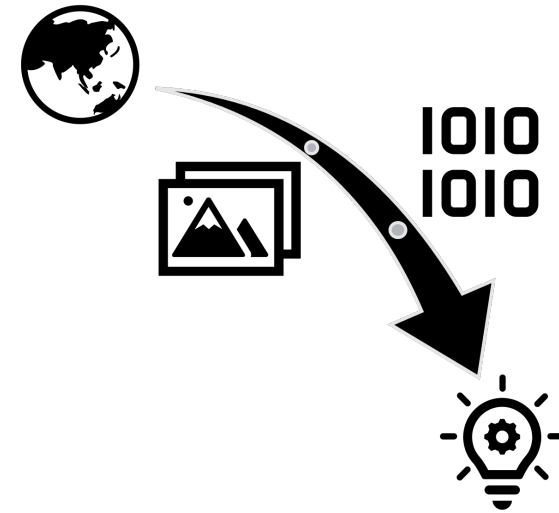
Mir Riyanul Islam

Postdoctoral Researcher

IDT/CSE

mir.riyanul.islam@mdu.se

2024-04-02



Preamble



- What do you see?
- How do you know it?
- Is it difficult to identify?

Preamble



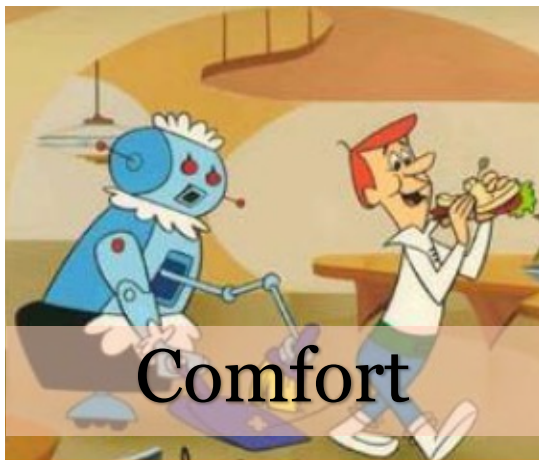
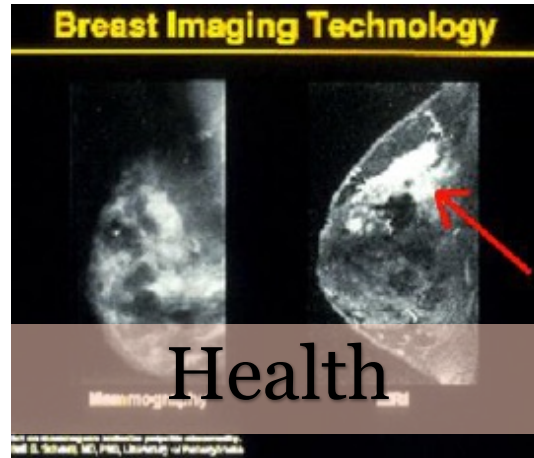
- Cats and Dogs.
- Individual features -
 - Enables proper identification.

Preamble

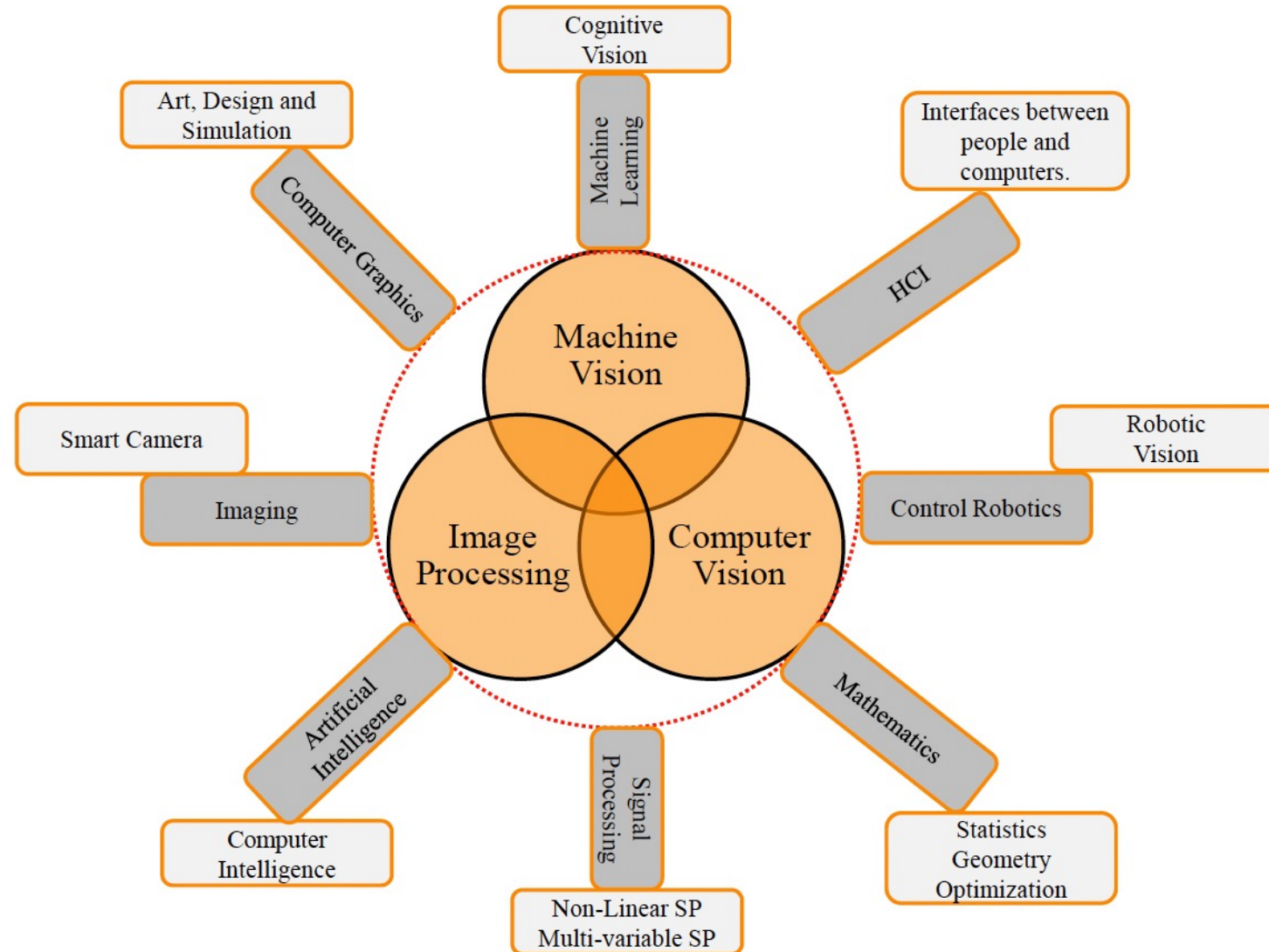


- Vision is an amazing feature of natural intelligence.
- More human brain is devoted to vision than anything else.

Datafication of Images across Applications



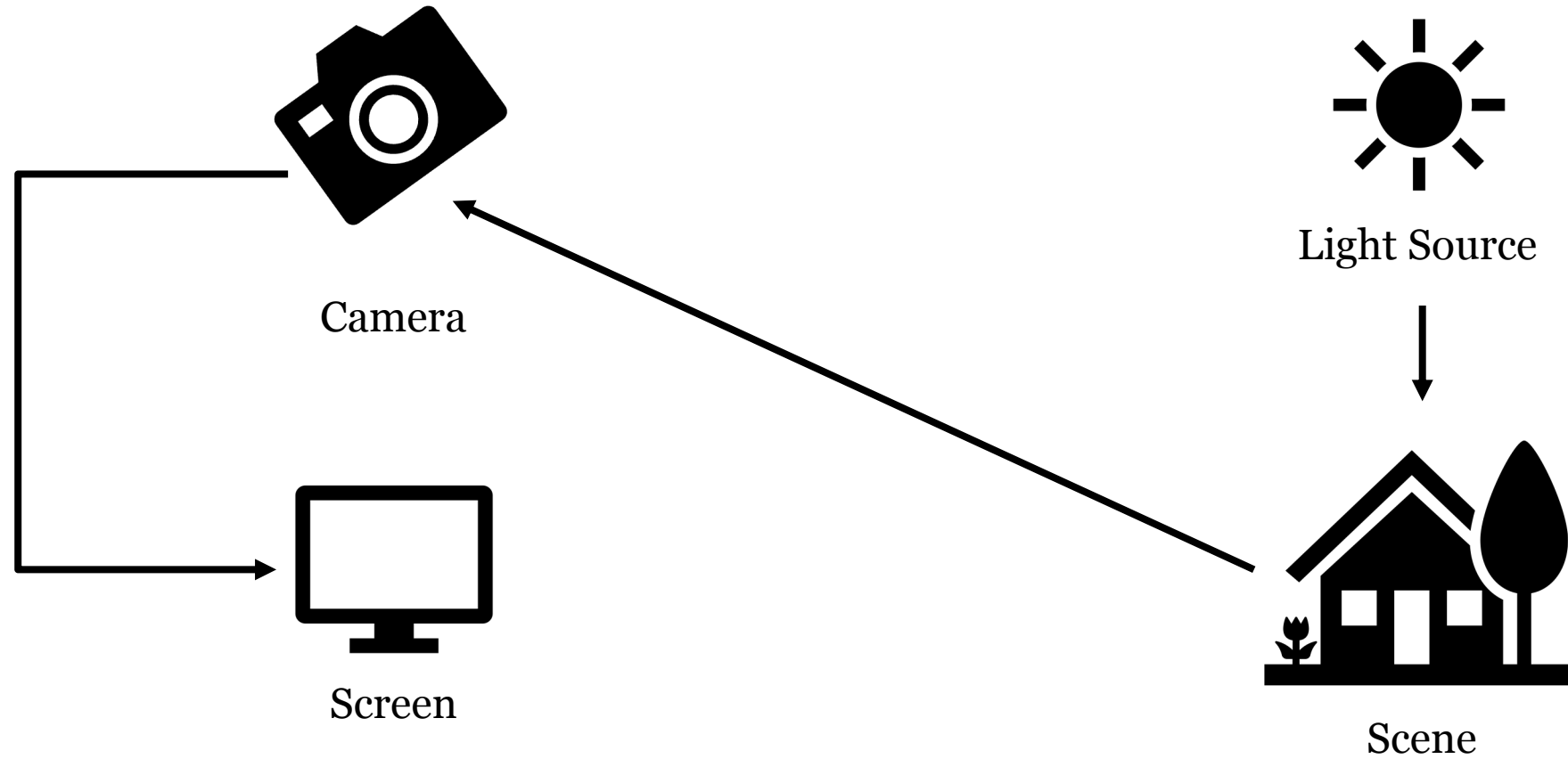
Multidisciplinary Images Data Processing



Image

- Image -
 - is a presentation of the external form of a person or object in art (real or imaginary!).
 - is a visible impression obtained by a device (camera, telescope, microscope, etc.) and displayed on a computer or video screen.
 - is an optical appearance or counterpart produced by light from an object reflected in a mirror or refracted through a lens.
- In general, An image is a visual representation of an object.

Digital Imaging



Digital Image

- A **digital image** is a two-dimensional function $f(x, y)$ - x and y are spatial coordinates (i.e., related to space).
- The amplitude of f is called intensity or gray level at the point (x, y) .

	0	1	2	3	4	5	6	7	8	9
0	(0, 0)									
1									(8, 1)	
2					(4, 2)					
3										
4					(4, 4)					
5		(1, 5)					(6, 5)			
6										
7										
8			(2, 8)							
9										(9, 9)

Spatial Coordinates

Digital Image - Pixel

- A pixel is a single point in a digital image (smallest element of a picture).

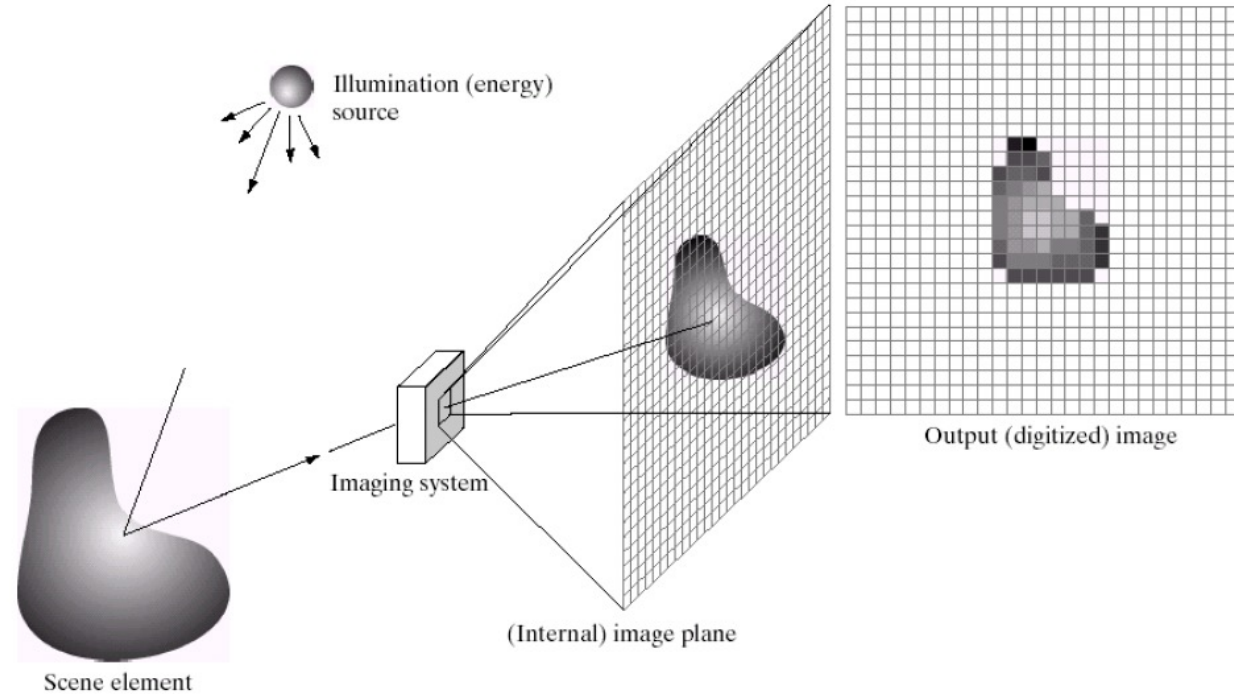


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Digital Image - Pixel

- Pixel values typically represent gray levels, colors, heights, opacities etc.
- Digitization implies that a digital image is an approximation of a real scene.

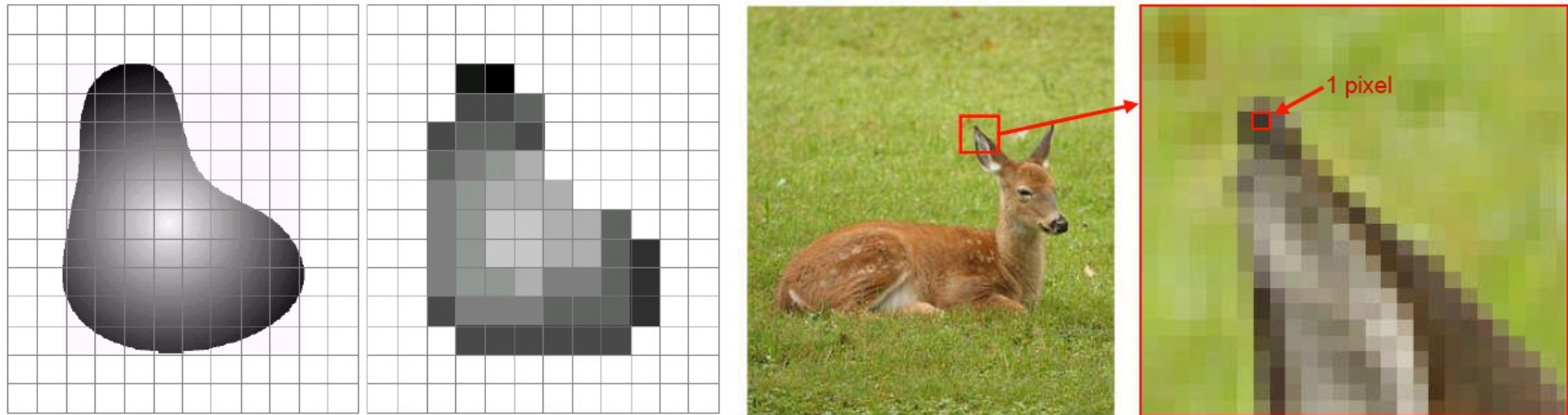


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Digital Image - Pixel

- For grayscale images, pixel values are just the brightness values $[0, 255]$ representing darker to brighter shades.

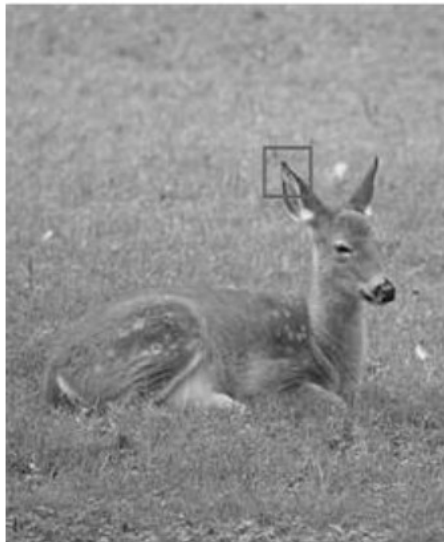
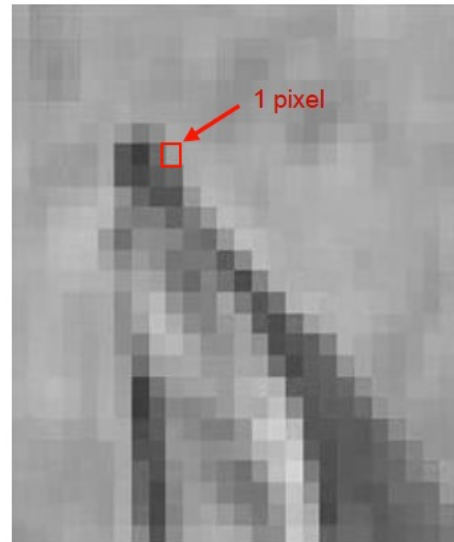


Image of a Deer



Magnification of the Ear

227	218	224	222	216	223	227	228	229
233	229	236	233	225	231	236	238	243
234	235	241	237	234	237	244	249	255
232	237	245	243	239	242	246	252	255
228	237	247	248	246	247	249	250	255
223	235	246	246	247	250	252	252	255
224	237	242	242	243	247	254	255	255
222	234	242	244	245	249	255	255	254
222	232	237	237	244	247	253	255	252

Intensity value of the Ear

Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Colour Image

- A color digital image has several color matrix;
- RGB image has Red, Green and Blue color matrices.

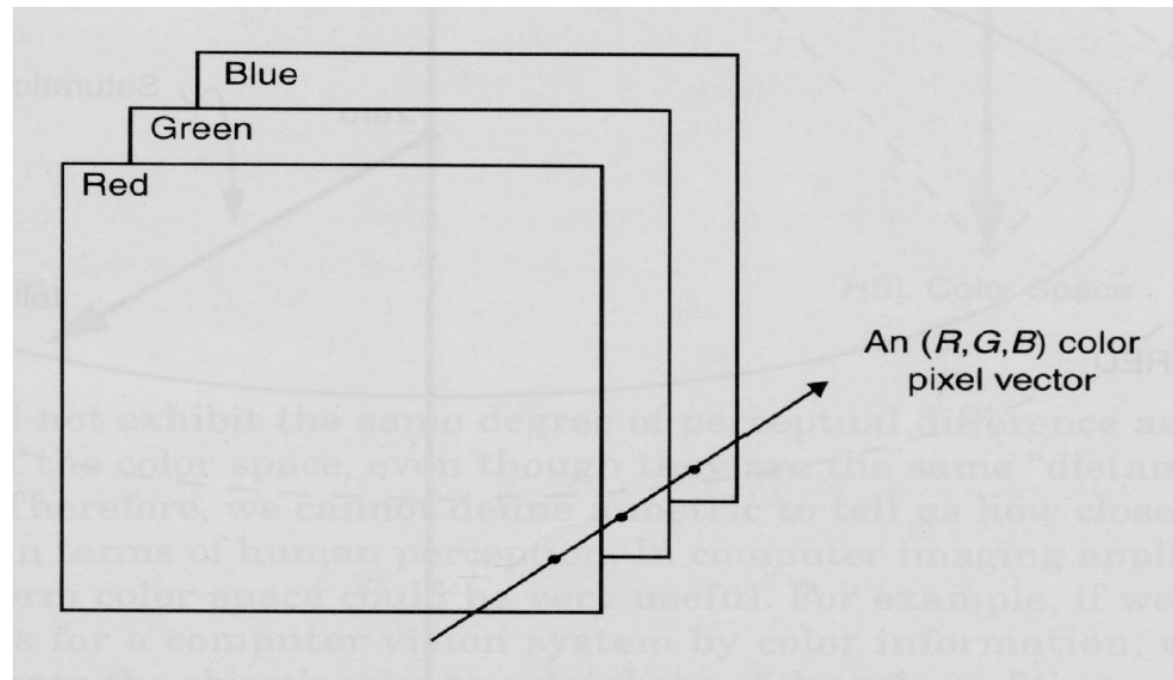
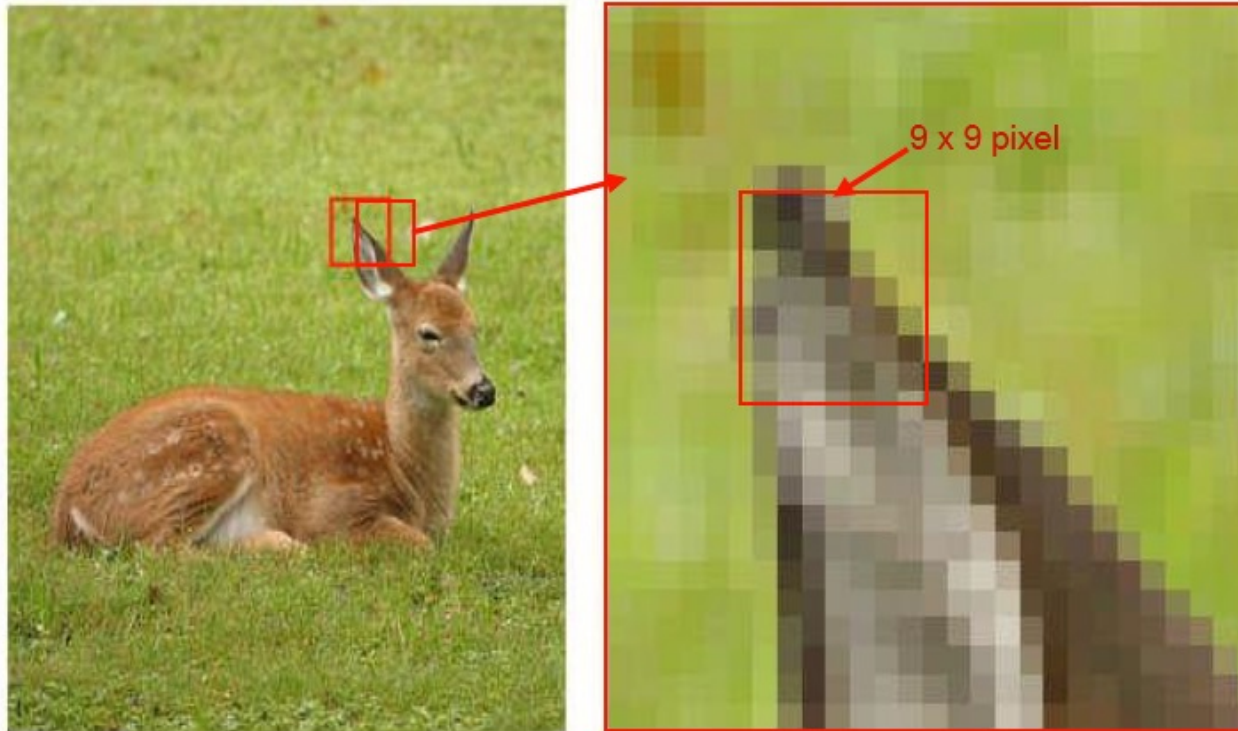


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Color Image Representation

[illegible]

Intensity values of the ear
9 x 9 Pixels

Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Image Resolution

- Resolution refers to the number of pixels in an image.
- Resolution is sometimes identified by the size of the image as well as the total number of pixels in the image.
- For example, an image is **2048 pixels wide** and **1536 pixels high**;
 - Resolution = (**2048 X 1536**) = 3,145,728 pixels = 3.1e6 = **3.1 Megapixels**.
- More Pixels represents clearer pictures.

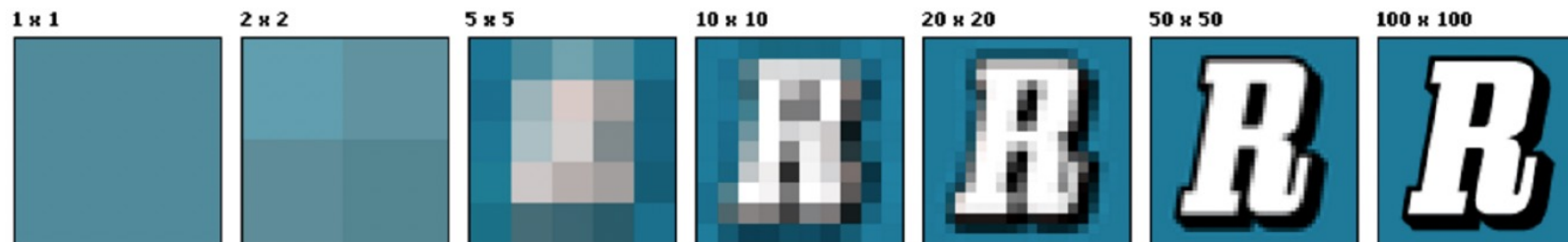
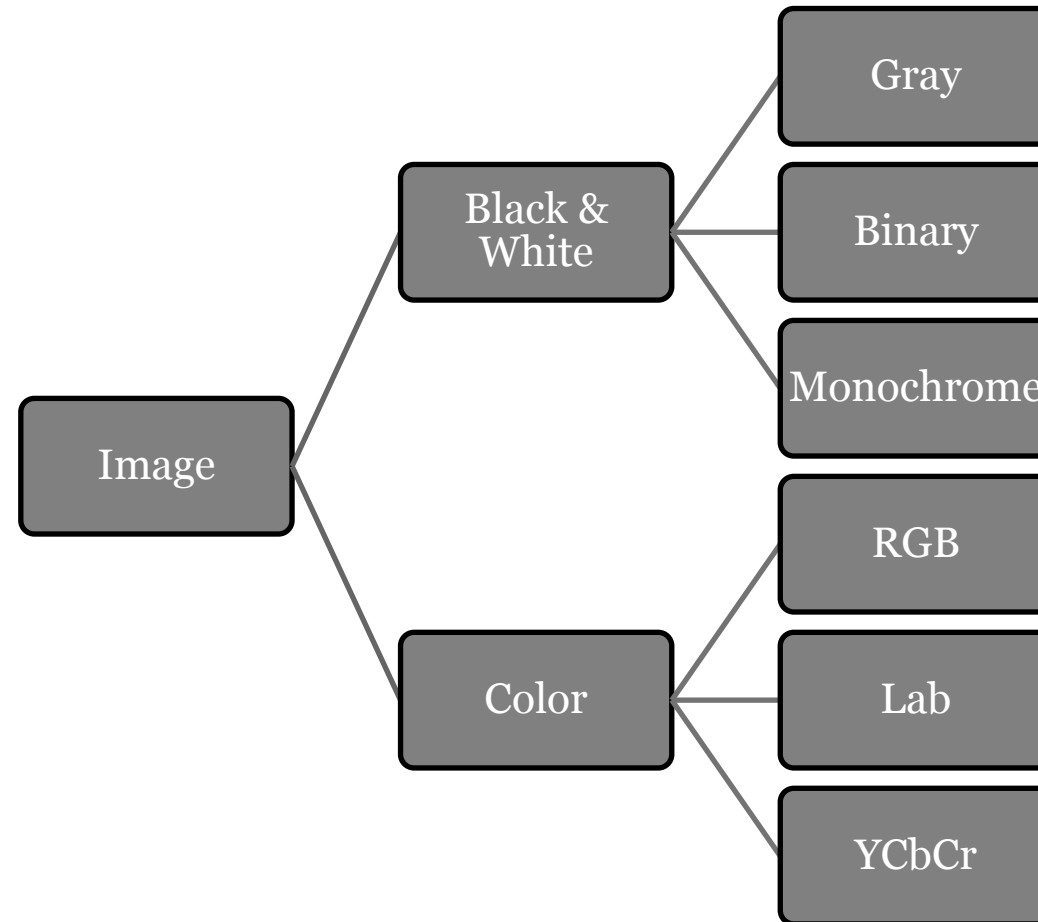


Image Types



Black & White Image Types

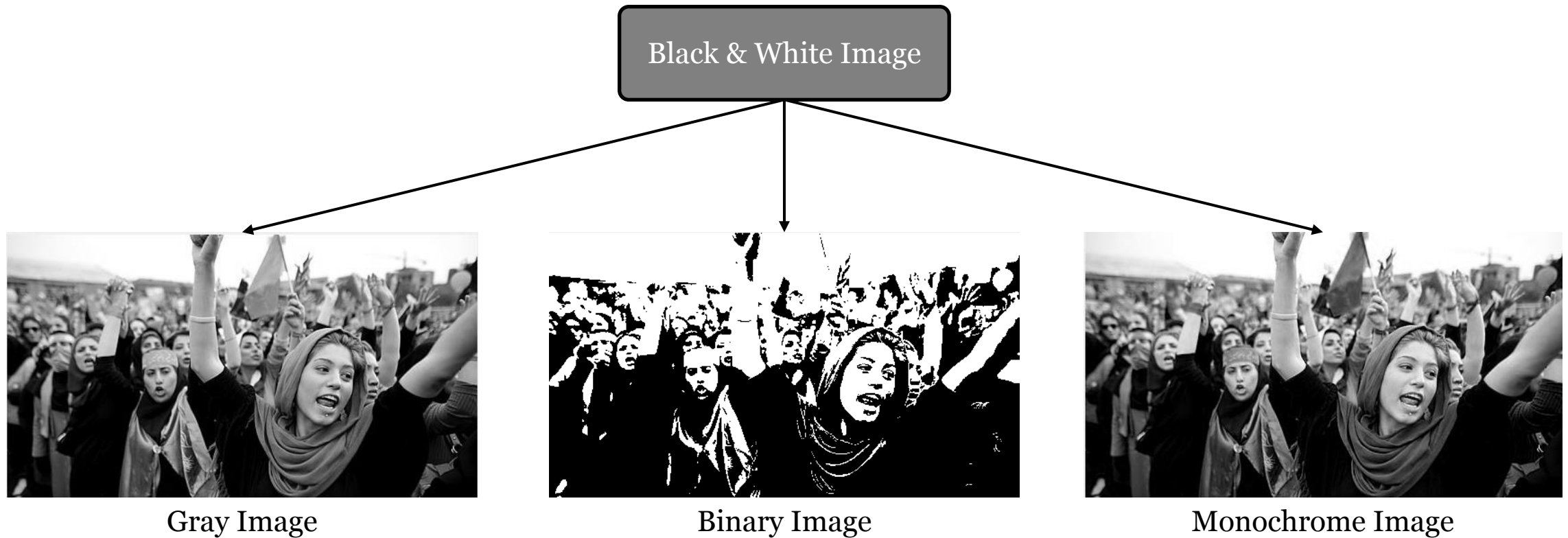
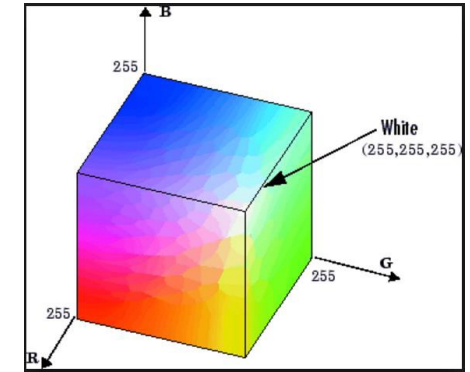


Image in RGB Color Space

RGB



Red



Green



Blue

Image in Lab Color Space

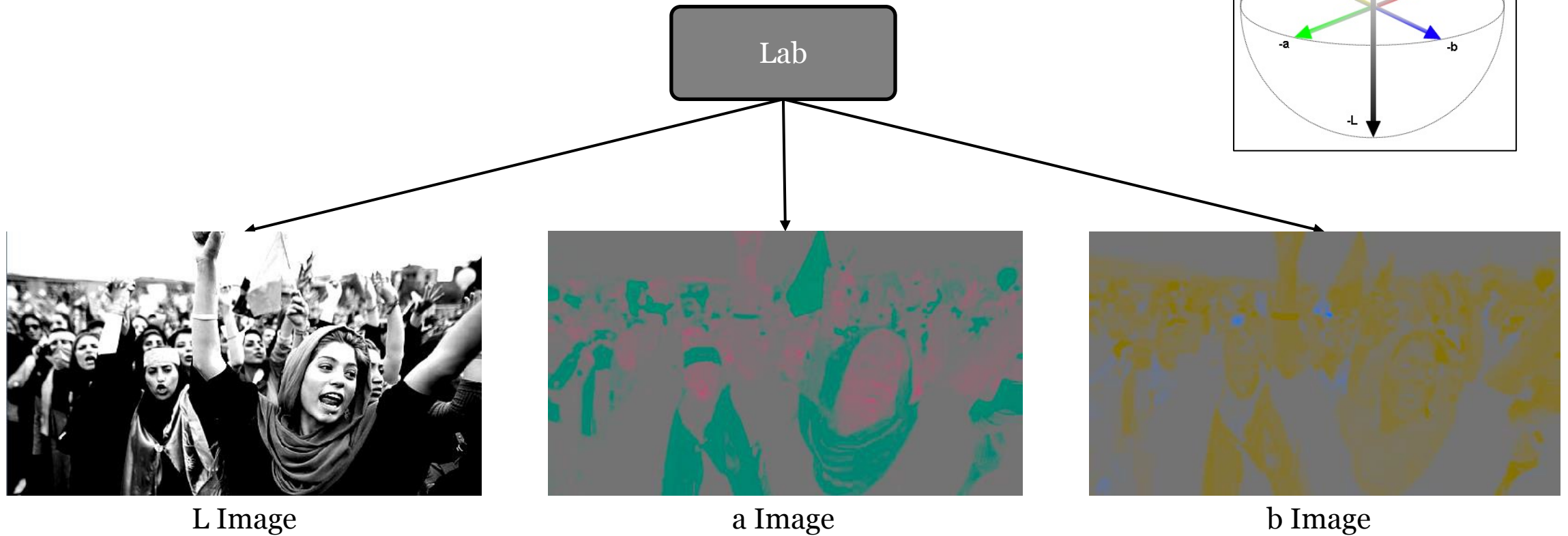
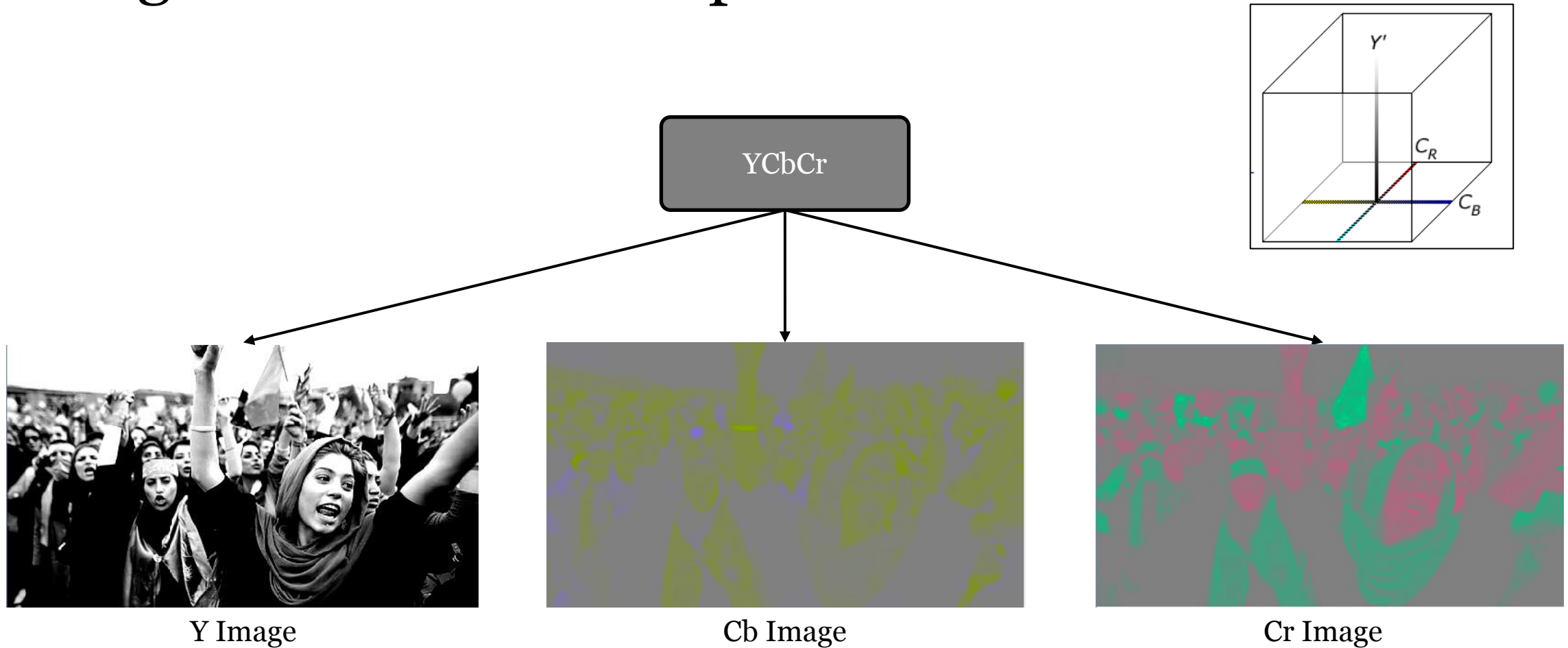


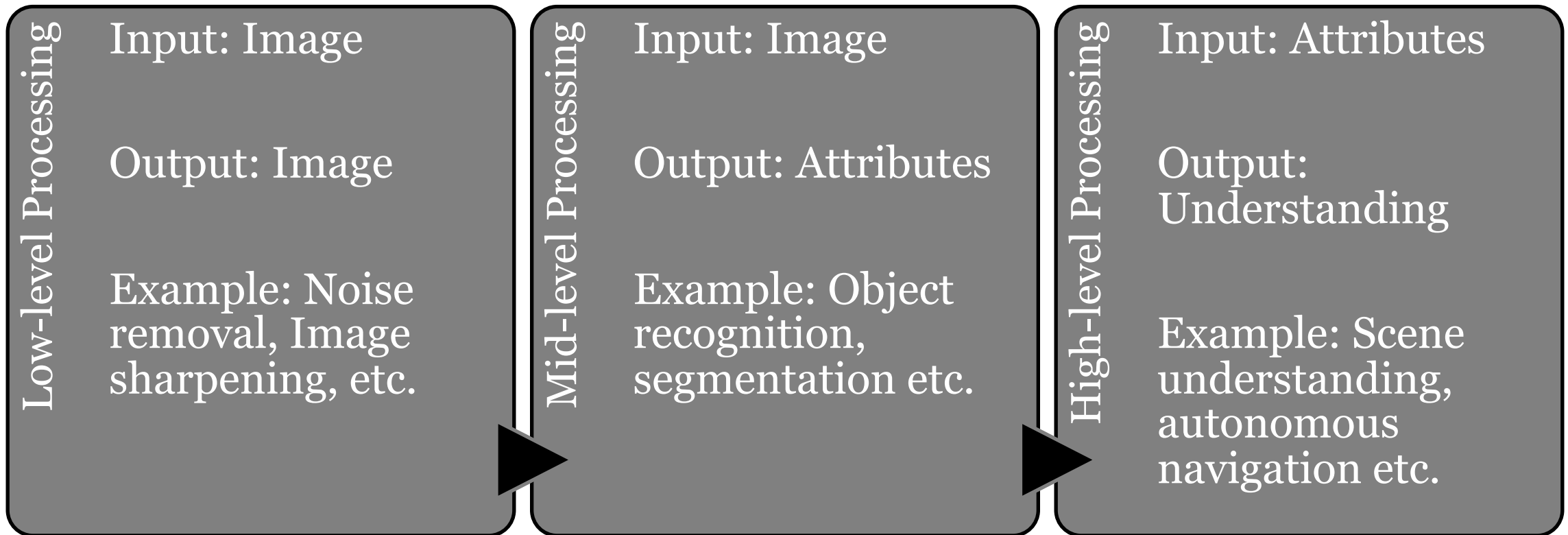
Image in YCbCr Color Space



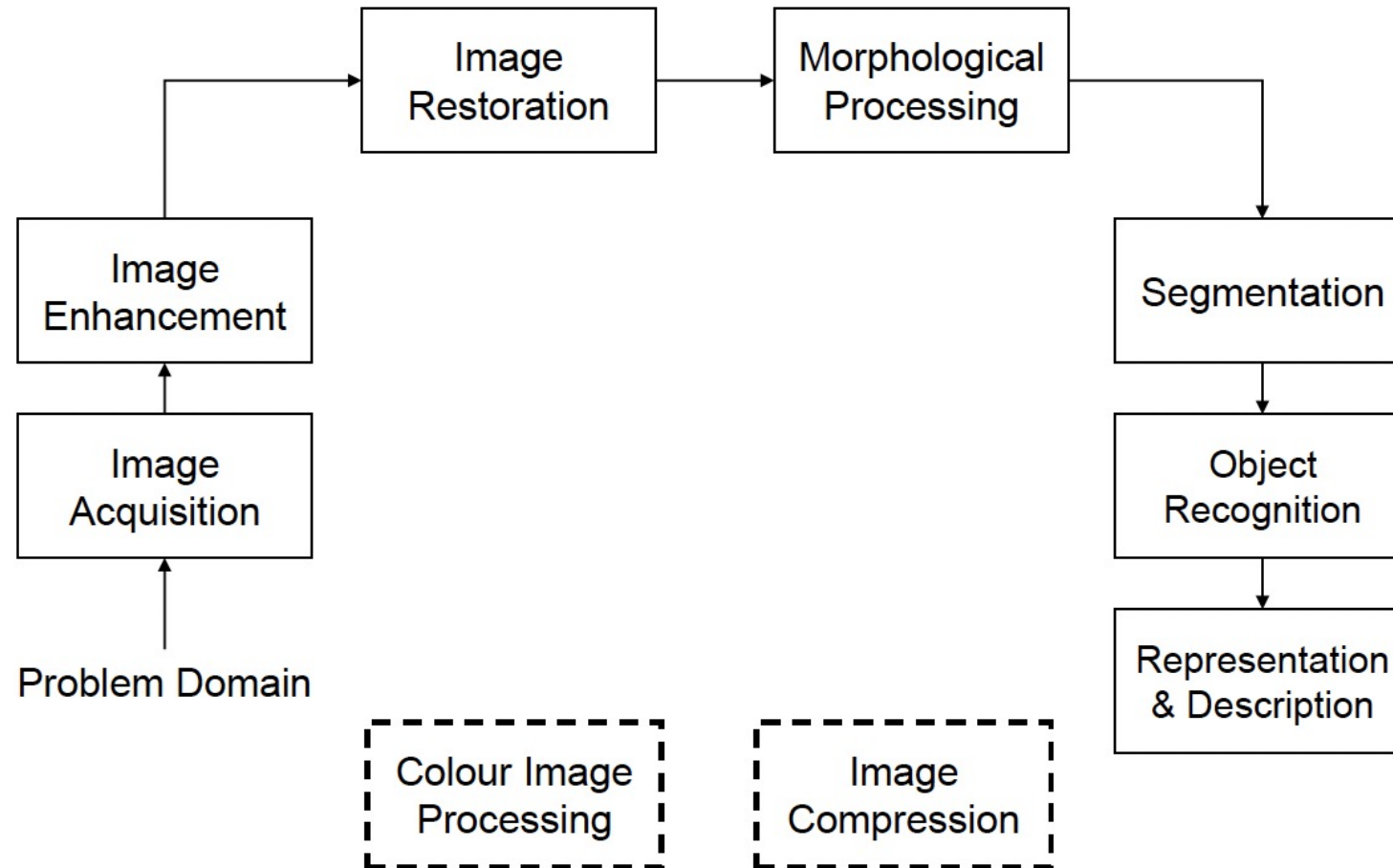
Digital Image Processing

- Digital Image Processing focuses on two major tasks -
 - Improvement of the pictorial information for human interpretation.
 - Processing of image data for storage, transmission and representation for autonomous machine perception.

Levels of Digital Image Processing



Key stages in Digital Image Processing



Key stages in Digital Image Processing

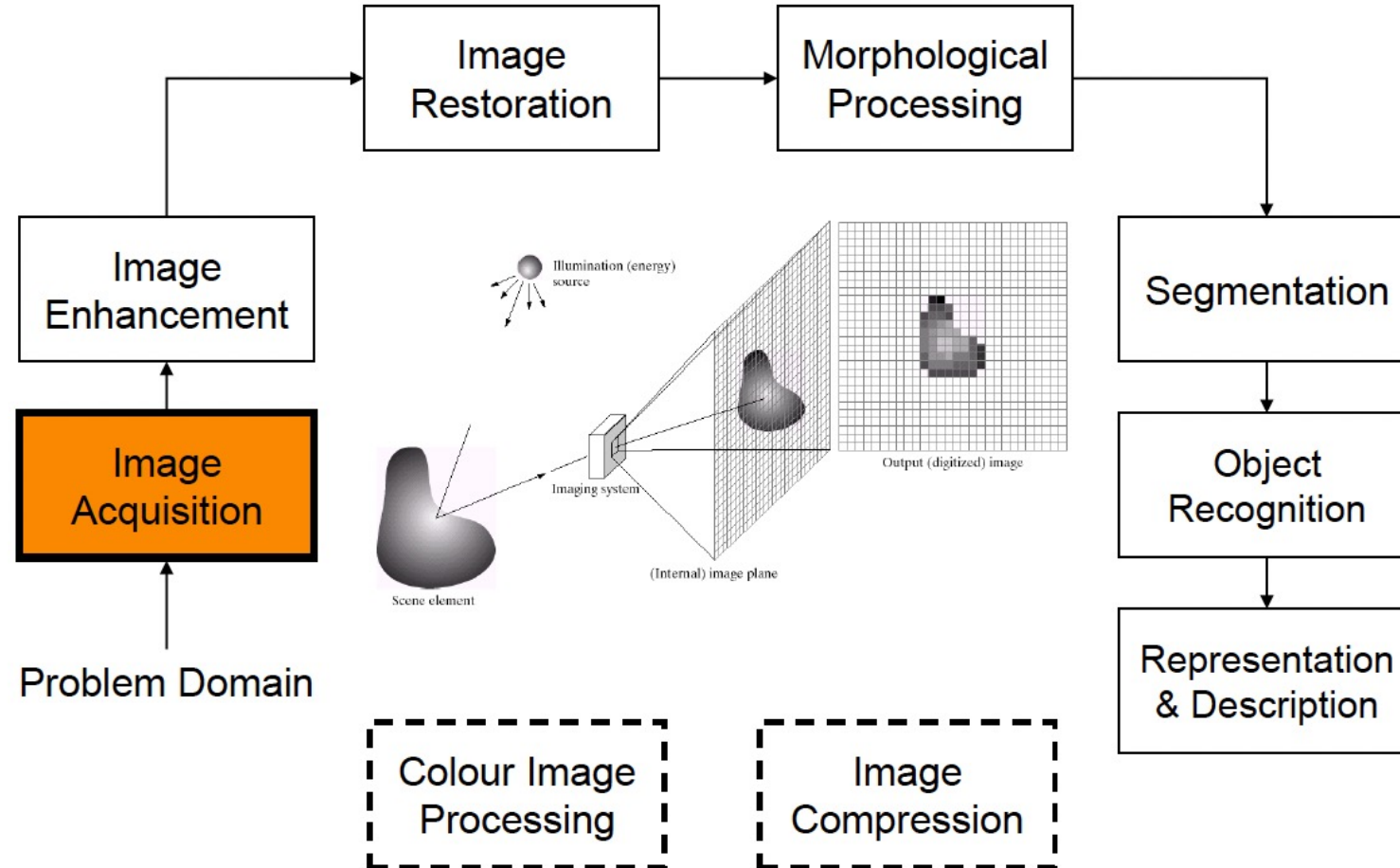


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing

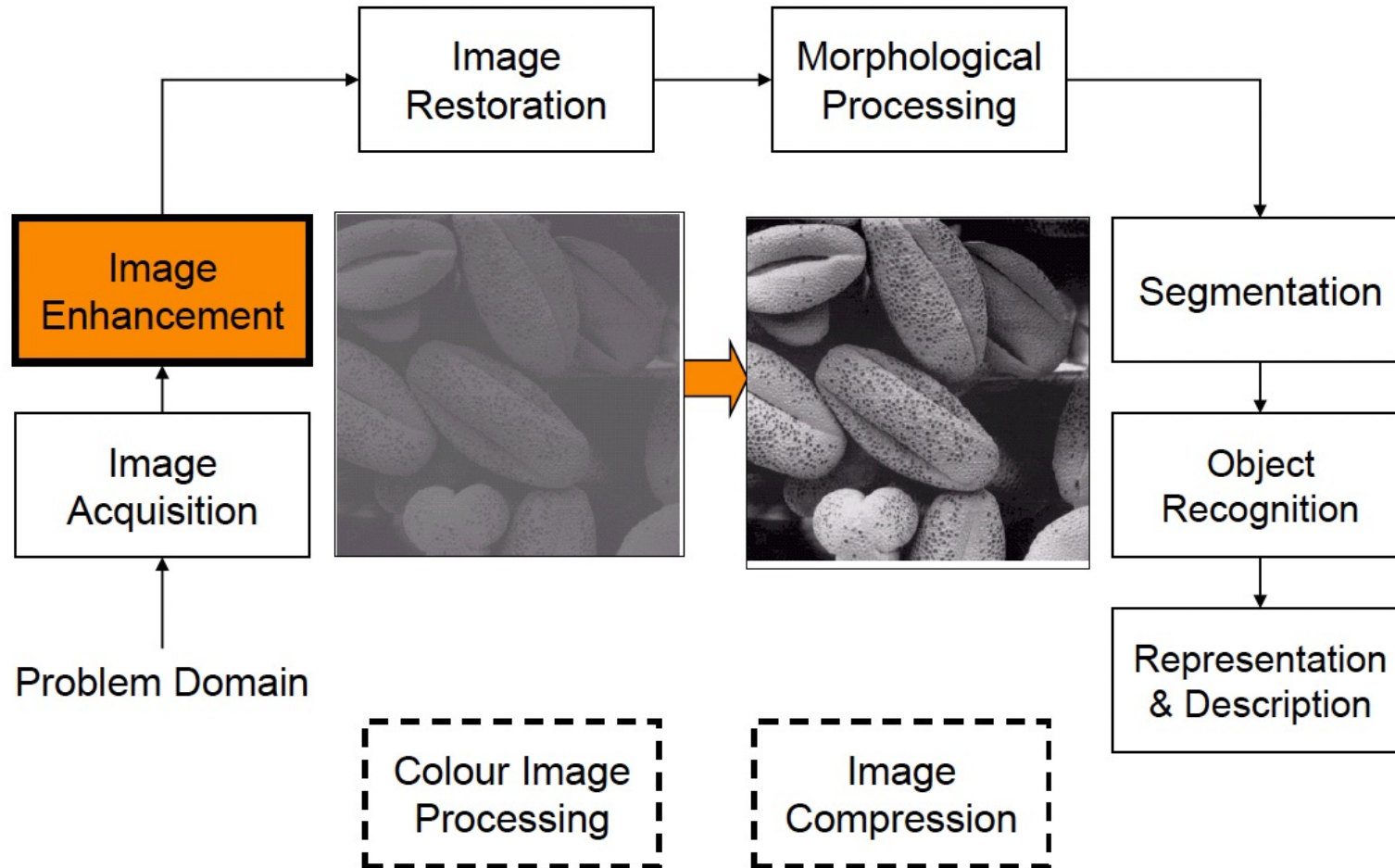


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing

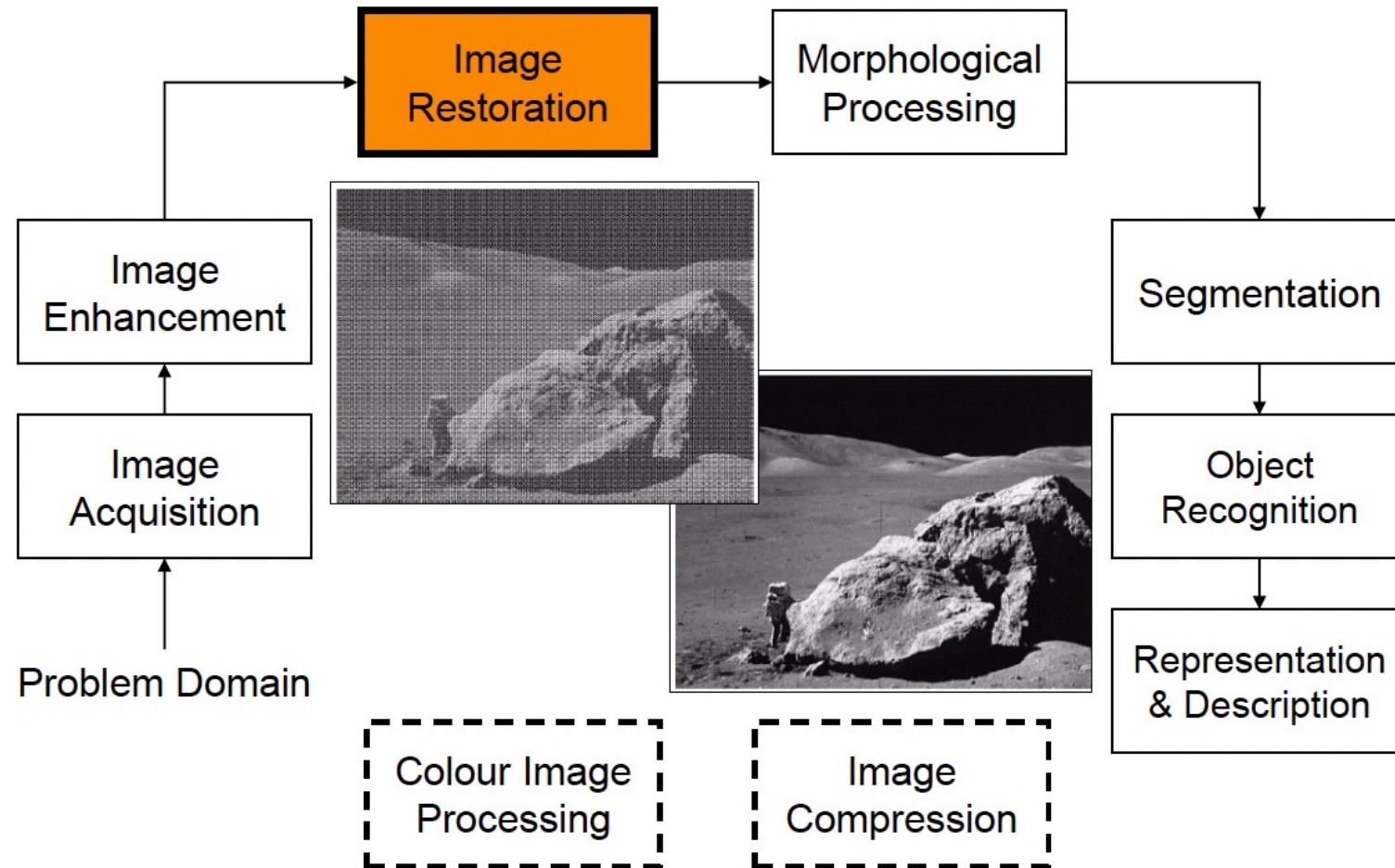


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing

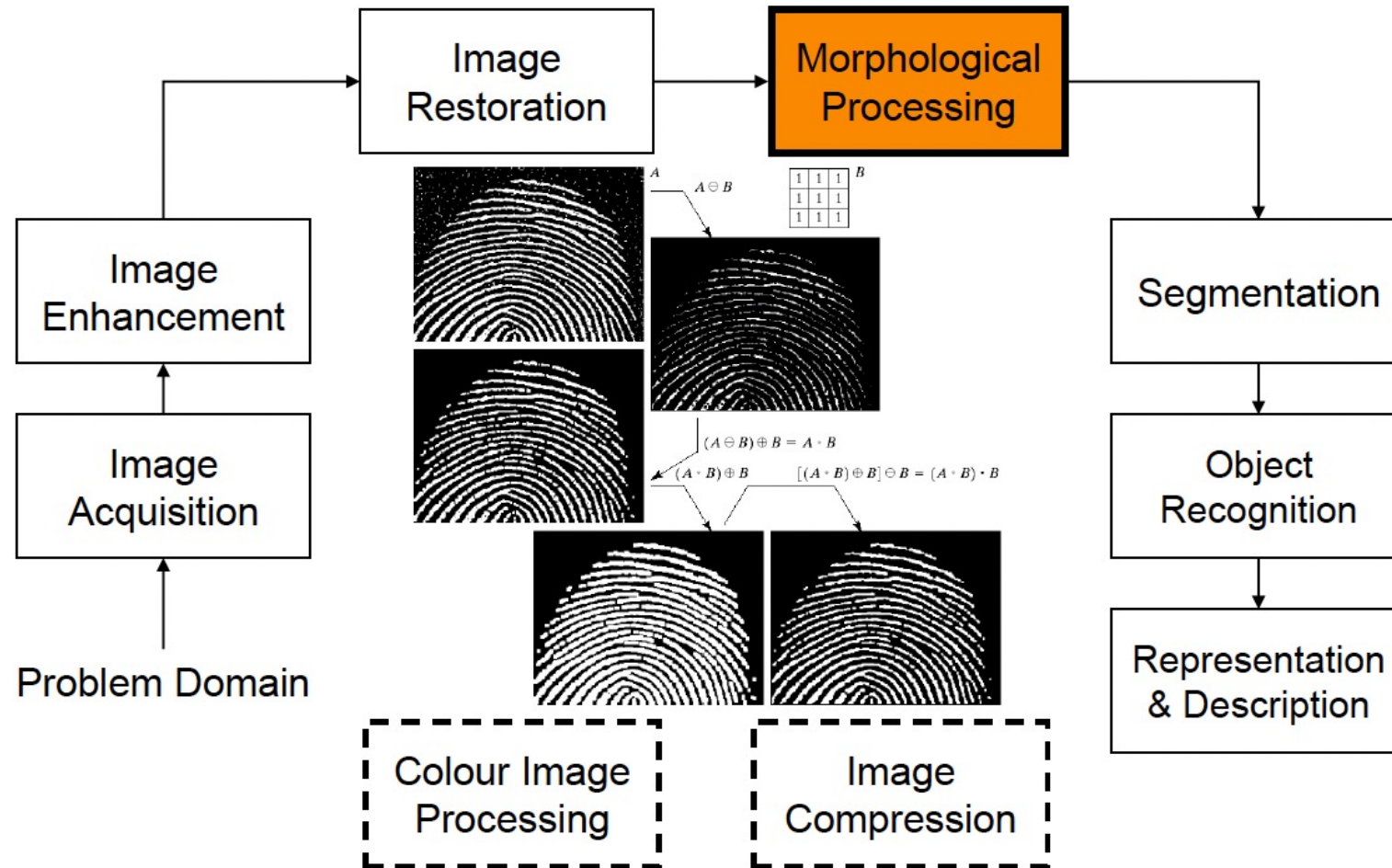


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing

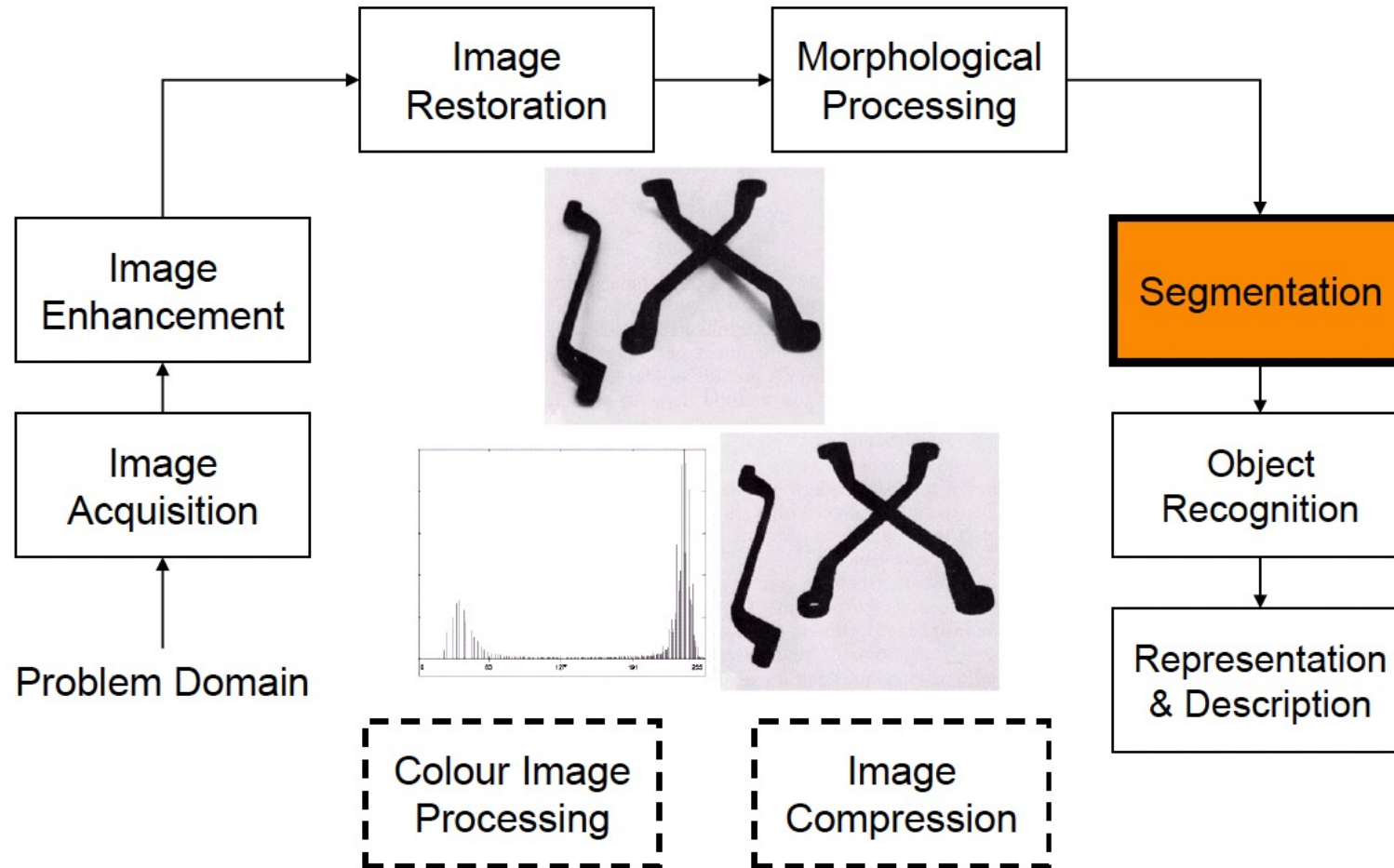


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing

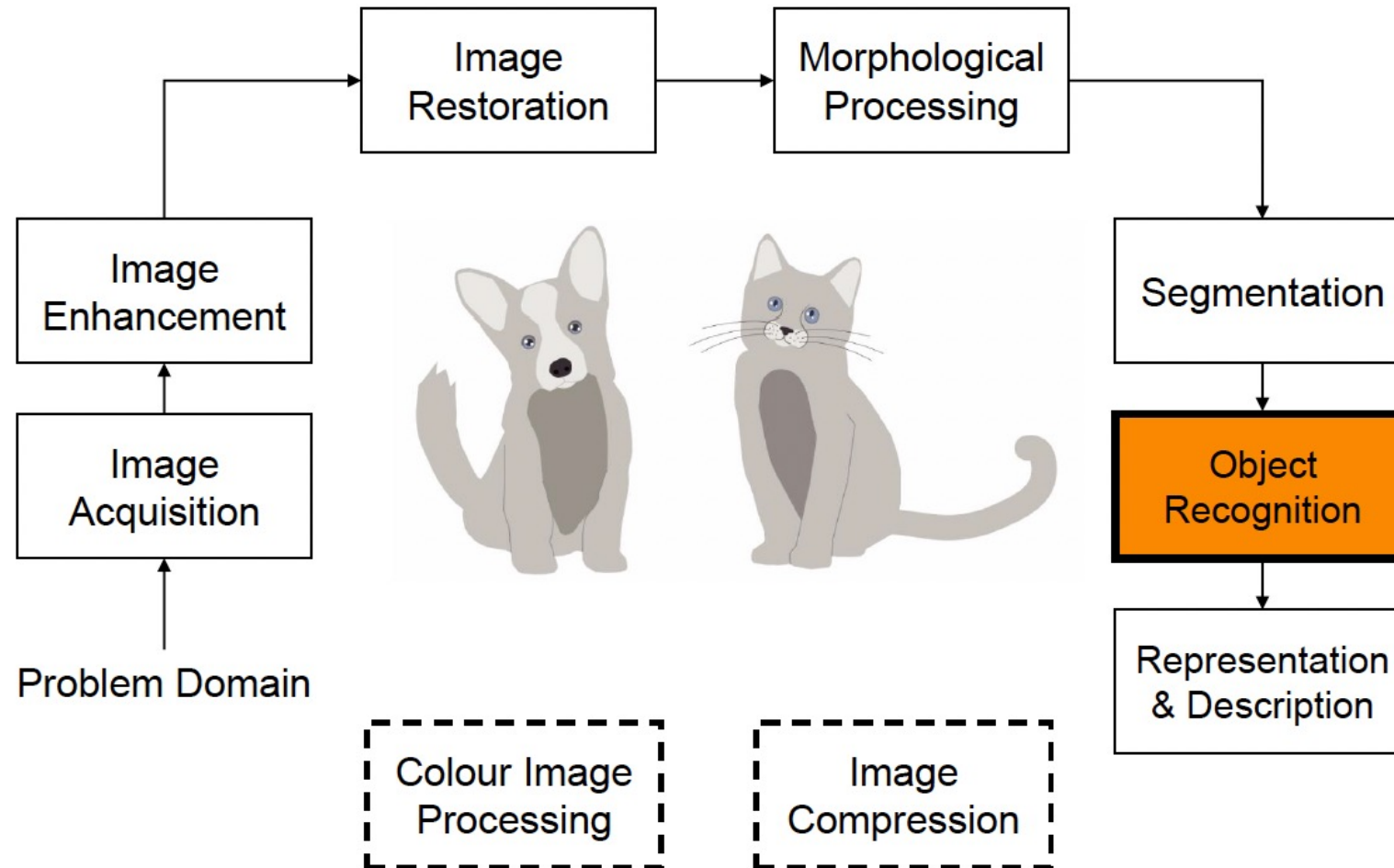
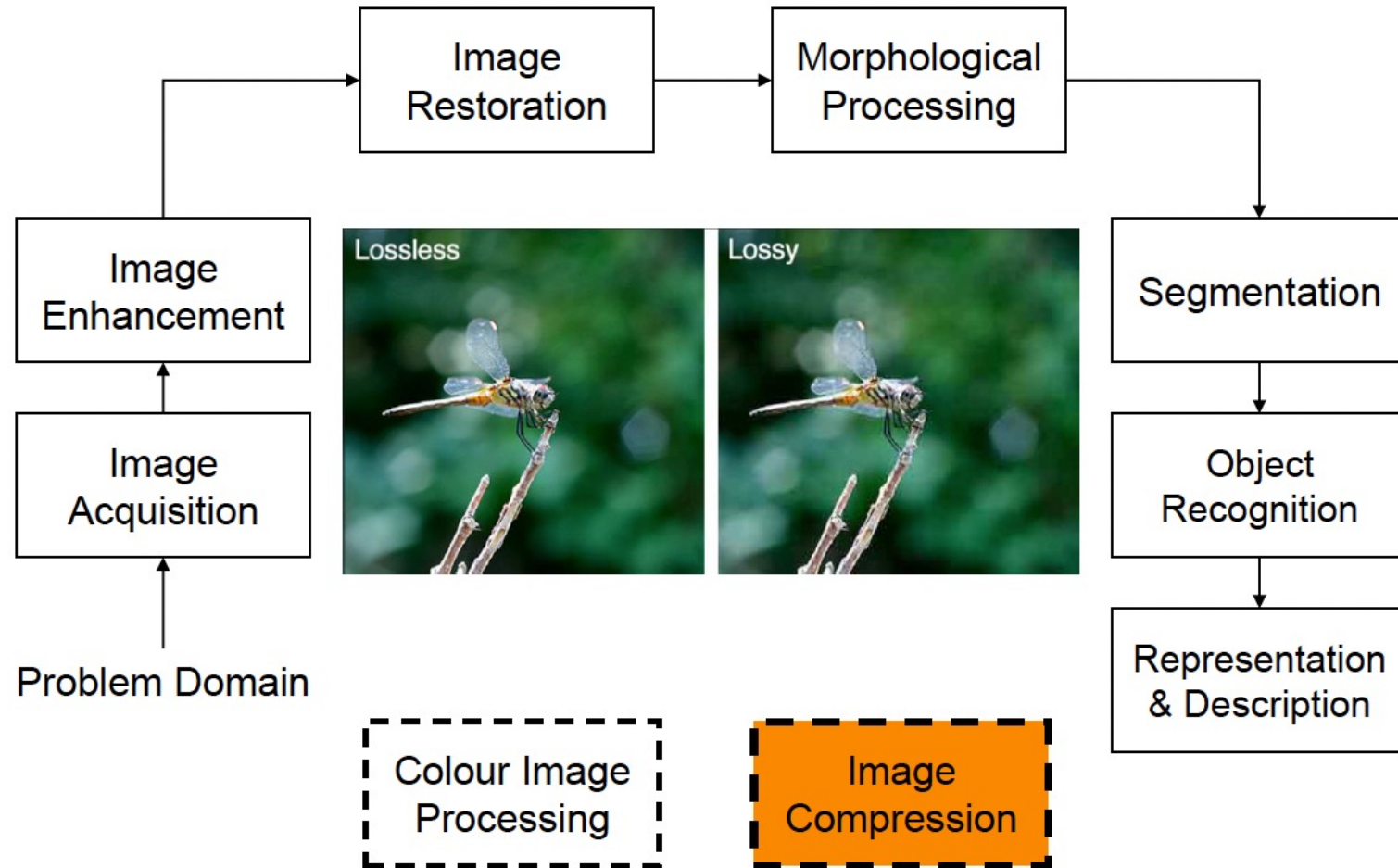
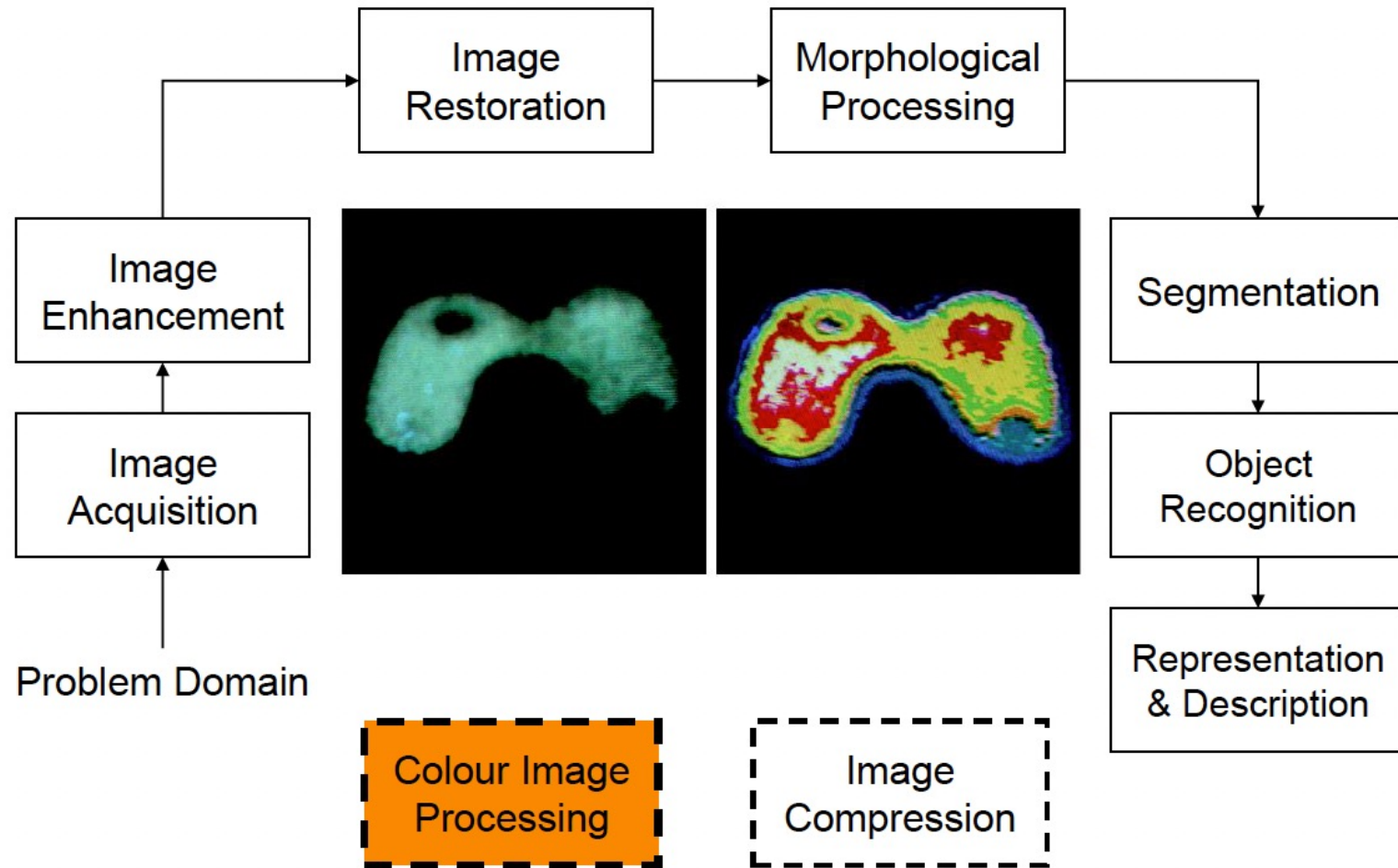


Image Source: Gonzalez & Woods, Digital Image Processing (2022)

Key stages in Digital Image Processing



Key stages in Digital Image Processing

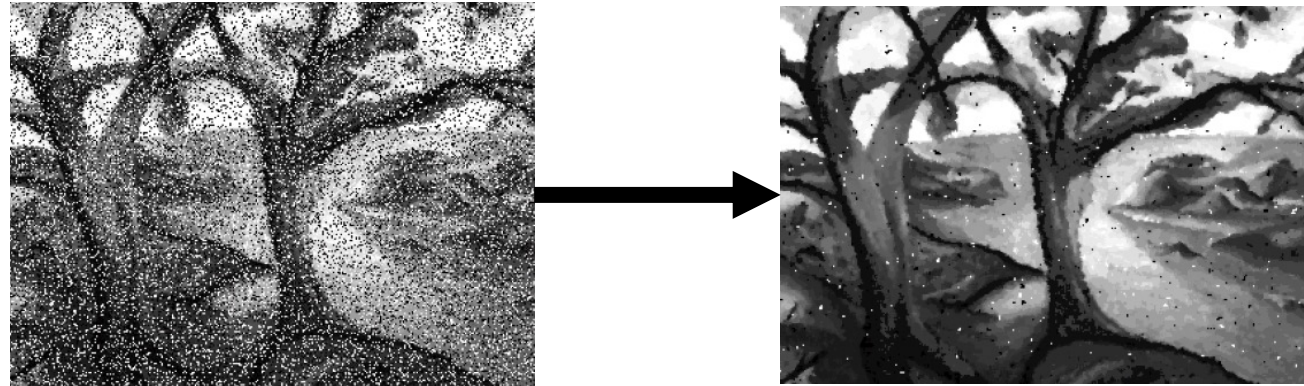


Reasons of Image Distortion

- Environmental noise.
- Motion/Movement.
- Vibration.
- Extreme Angle of Camera.
- Bad illumination.
- Lost pixels.
- ...

Examples of Image Enhancement

Salt & Pepper Noise cancellation



Motion Blur cancellation



Image Feature Extraction

Pixel Count

- The number of pixels in an image.

Edges

- Edges in an image are the corners where the pixel change drastically.

Corners

- A corner is an area of an image that has a large variation in pixel color intensity values in all directions.

SIFT

- Features in an image regardless of changes to its size or orientation.

SURF

- SURF is a faster version of SIFT.

Video Processing

- Video: the recording, reproducing, or broadcasting of moving visual images. Therefore, Video is a summation of image sequences.
- Frame: each image of a video is called a Frame
- Frame Rate: Frames record or display in one second
- Unit : fps (frame per second)
- Video processing is done by applying image processing tasks on each frame.

Library for Image Processing :: OpenCV

- It stands for Open Source Computer Vision Library.
- This library consists of around 2000+ optimized algorithms that are useful for computer vision and machine learning.
- OpenCV is an Image Processing library created by Intel and maintained by Willow Garage.
- Available for different programming languages.
- Open Source and free.
- Easy to use and install.
- Details: <http://opencv.willowgarage.com/wiki/InstallGuide>.

Library for Image Processing :: scikit-image

- It is an open-source library used for image pre-processing.
- It makes use of machine learning with built-in functions and can perform complex operations on images with just a few functions.
- It works with numpy arrays and is fairly simple to use. For example,
 - To rotate the image use, **rotate()** method under the **transform** module.
 - To rescale the image use, **rescale()** method from the **transform** module.

Library for Image Processing :: PIL/pillow

- PIL stands for Python Image Library and pillow is the friendly PIL fork by Alex Clark and contributors.
- It's one of the powerful libraries. It supports a wide range of image formats like PPM, JPEG, TIFF, GIF, PNG, and BMP.
- It can help you perform several operations on images like rotating, resizing, cropping, grayscaling, etc.
- Let's go through some of those operations. To carry out manipulation operations there is a module in this library called **Image**.
 - To load an image, use the **open()** method.
 - To display an image, use **show()** method.
 - To know the file format, use **format** attribute
 - To know the size of the image use **size** attribute
 - To know about the pixel format, use **mode** attribute.
 - To save the image file after desired processing, use **save()** method.
 - To resize the image, use **resize()** method that takes two arguments as width and height.
 - To crop the image, use **crop()** method that takes one argument as a box tuple that defines position and size of the cropped region.
 - To rotate the image, use **rotate()** method that takes one argument as an integer or float number representing the degree of rotation.

