

Digital Image Processing

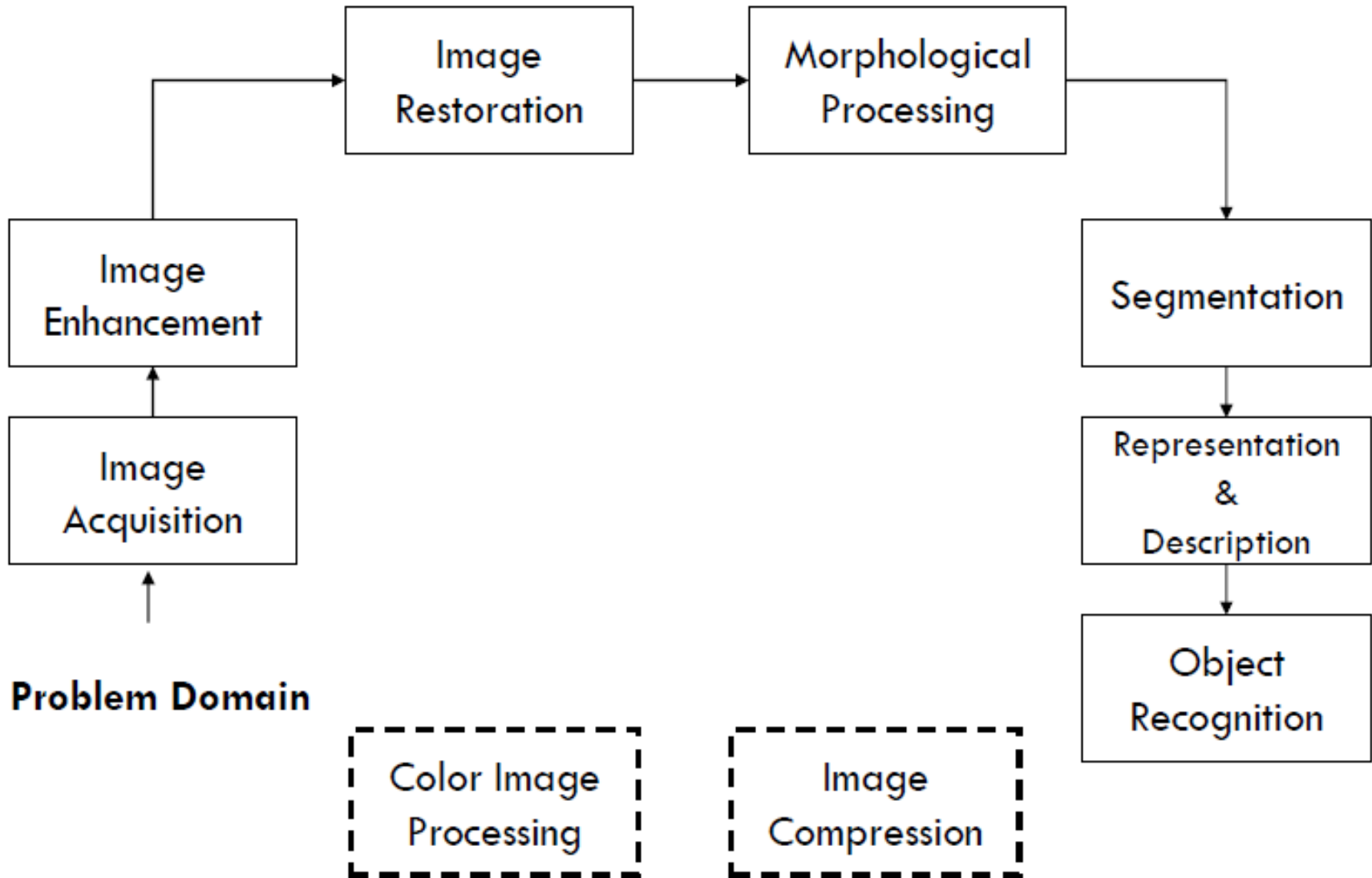
Lecture 3

Introduction

Key Stages in Digital Image Processing

- Image Acquisition
- Image Enhancement
- Image Restoration
- Image Compression
- Color Image Processing
- Morphological Image Processing
- Image Segmentation
- Representation & Description
- Image Recognition

Key Stages in Digital Image Processing



Key Stages in Digital Image Processing

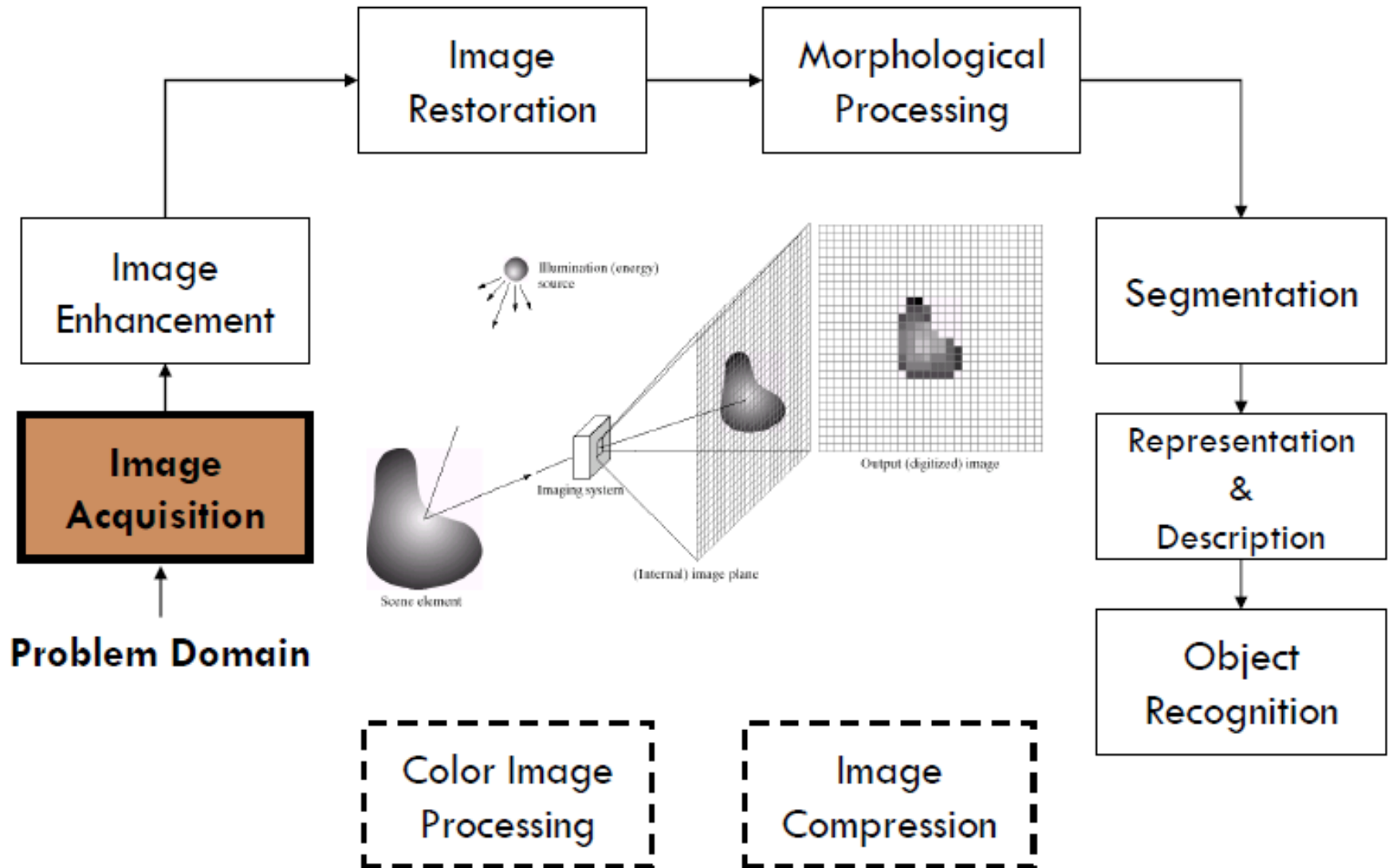


Image Acquisition

- ❑ The first stage of any vision system is the image acquisition stage.
- ❑ After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today.
- ❑ However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable



Key Stages in Digital Image Processing

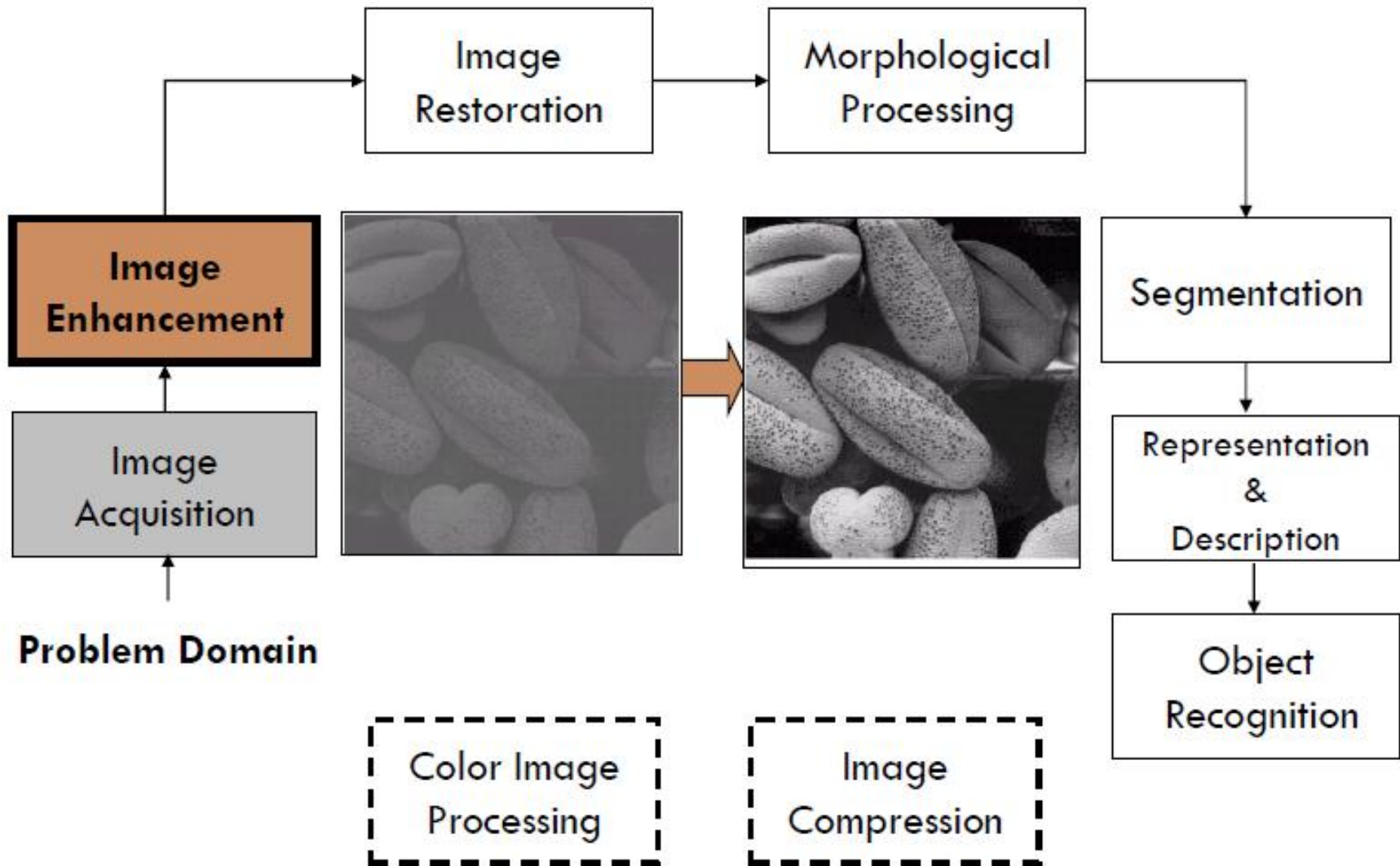


Image Enhancement

- ❑ The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide 'better' input for other automated image processing techniques.
- ❑ Image enhancement techniques can be divided into two broad categories:
 - ✓ Spatial domain methods, which operate directly on pixels, and
 - ✓ Frequency domain methods, which operate on the Fourier transform of an image.



Image Enhancement



Original Images

Enhanced Images

Key Stages in Digital Image Processing

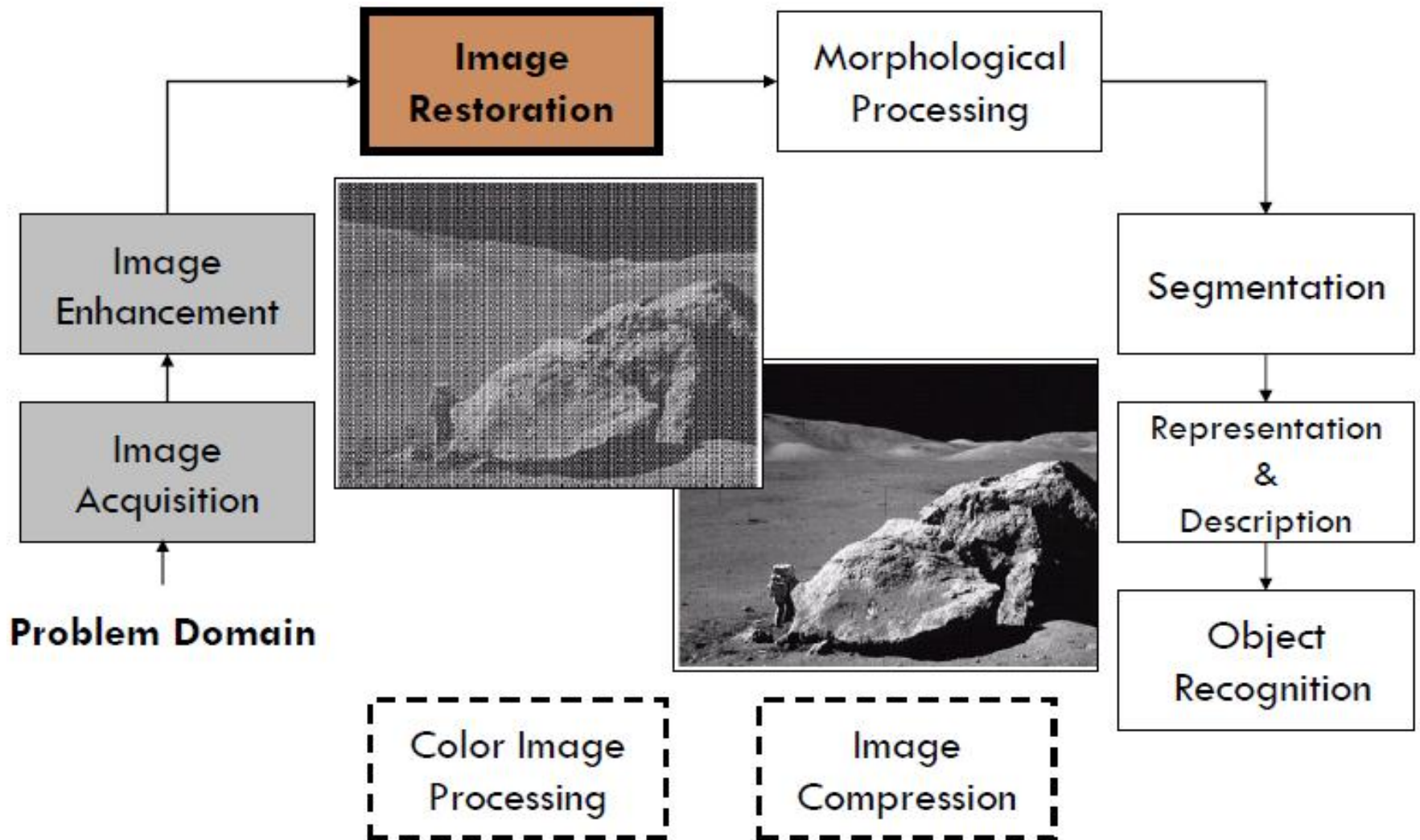


Image Restoration

- Image restoration refers to the recovery of an original signal from degraded observations.
- The purpose of image restoration is to "compensate for" or "undo" defects which degrade an image. Degradation comes in many forms such as motion blur, noise, and camera misfocus.



Downgraded Image

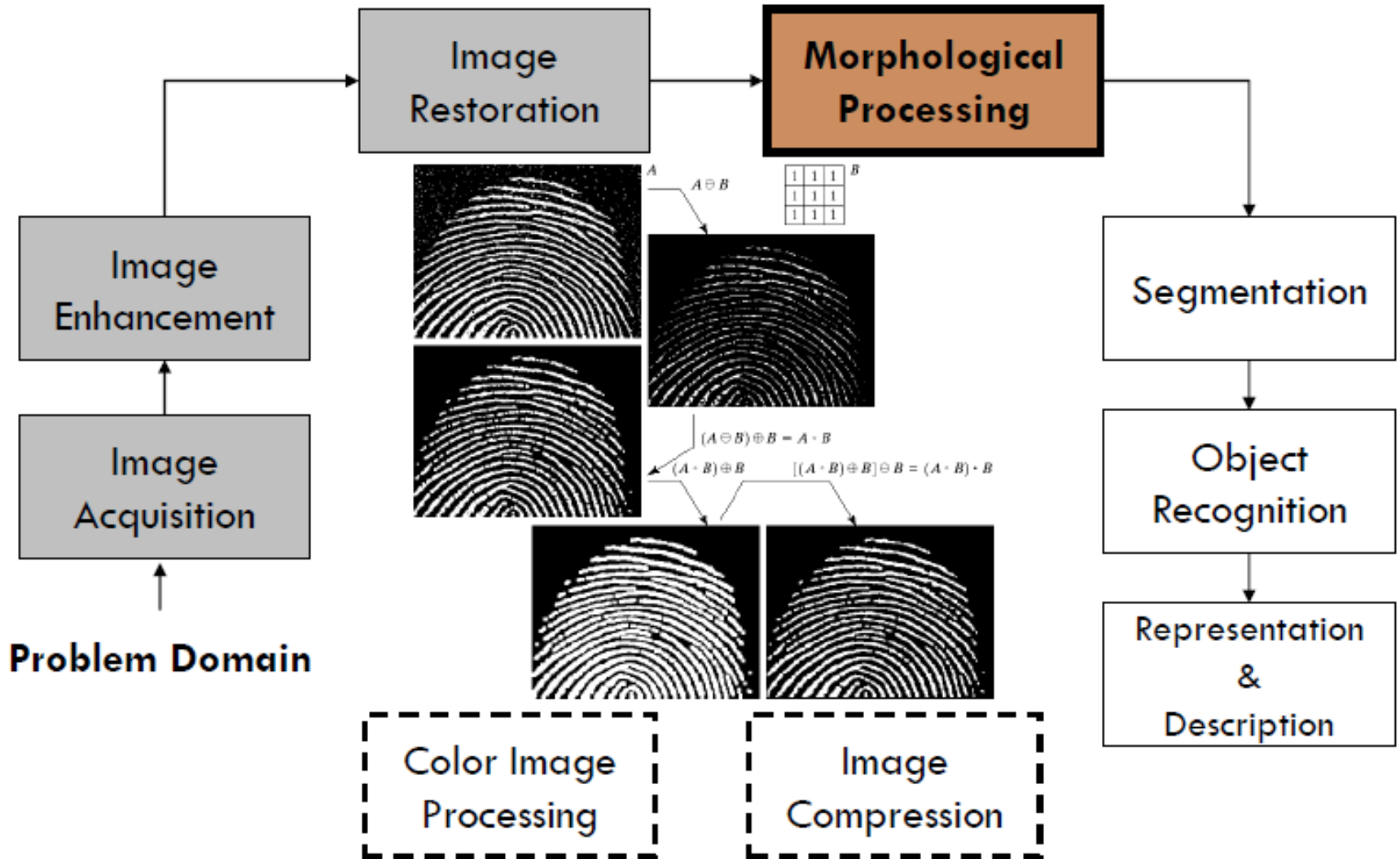


Restored Image

Image Enhancement vs Image Restoration

- Image enhancement : process image to emphasize features of the image that make the image more pleasing to the observer or to process image so that the result is more suitable for a specific application, is largely a **subjective process**.
- Image restoration : recover image from distortions to its original image, is largely an **objective process**.
- Image enhancement is the improvement of digital image quality without knowledge about the source of degradation. If the source of degradation is known, one calls the process image restoration

Key Stages in Digital Image Processing



Key Stages in Digital Image Processing

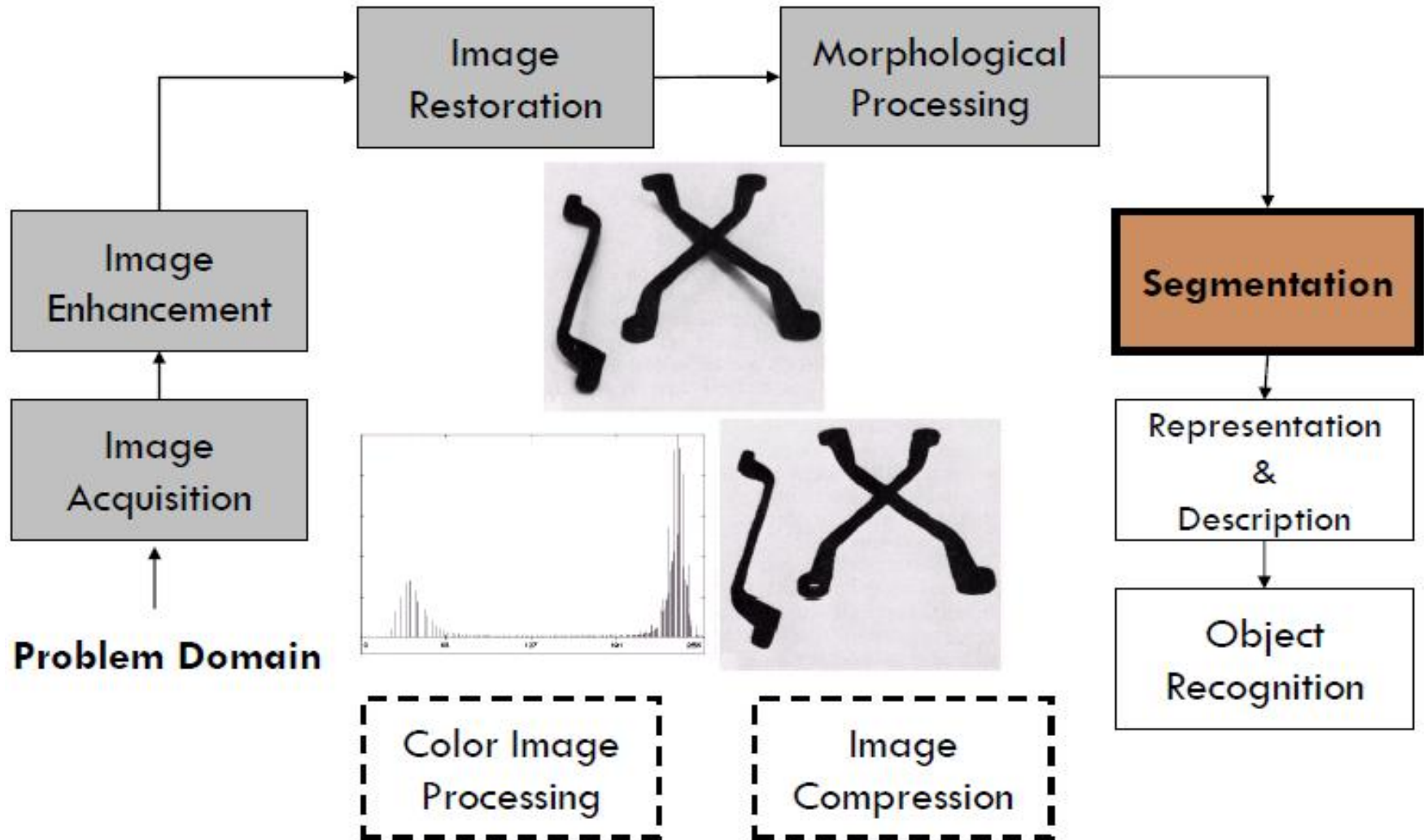


Image Segmentation

- Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze
- Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images

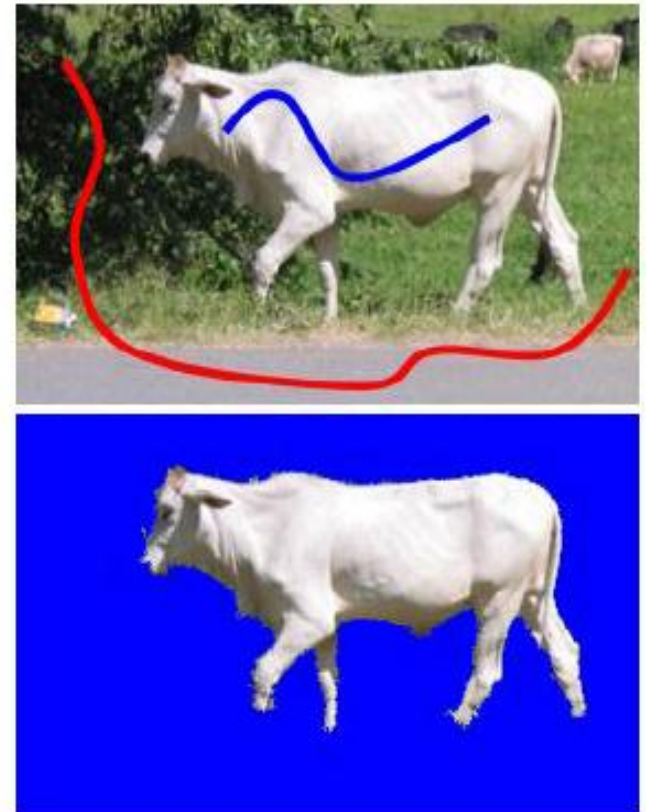
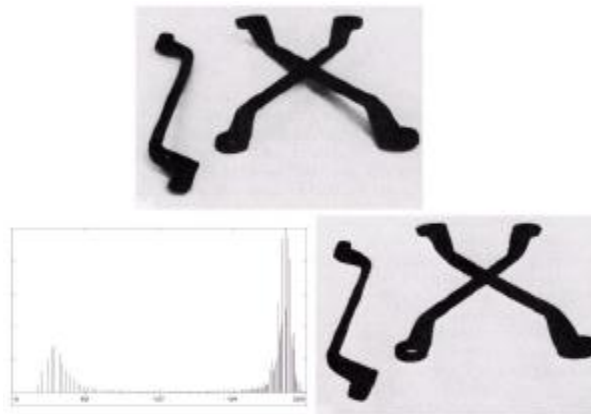
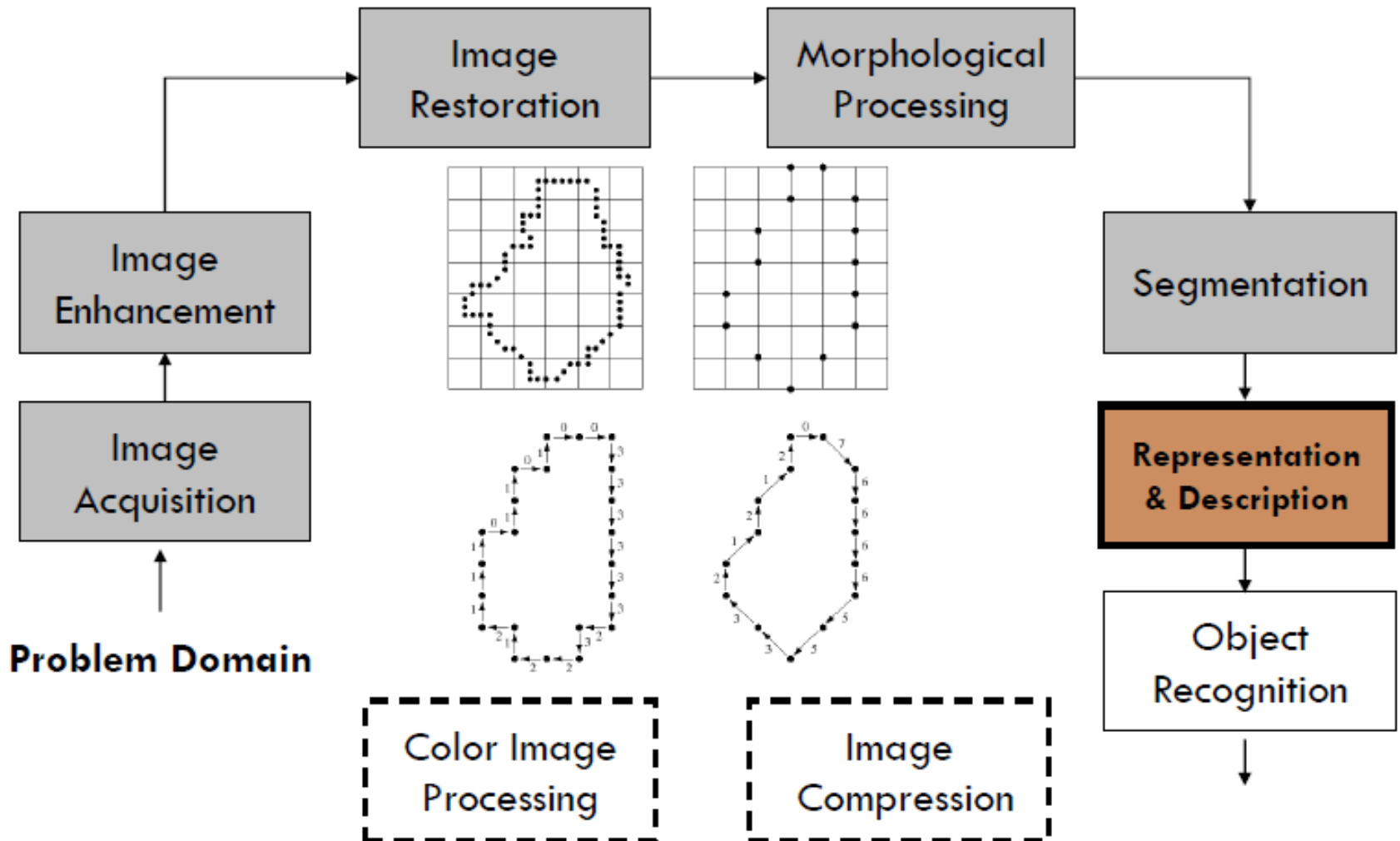


Image Segmentation

- Image Segmentation algorithms generally are based on one of two basic properties of intensity values:: **Discontinuity and Similarity**
- Through Discontinuity the approach is to partition an image based on abrupt changes in intensity, such as edges in an image
- Through Similarity the approach is based on partitioning an image into regions that are similar according to a set of predefined criteria. Thresholding, region growing, region splitting and merging are examples of methods in this category



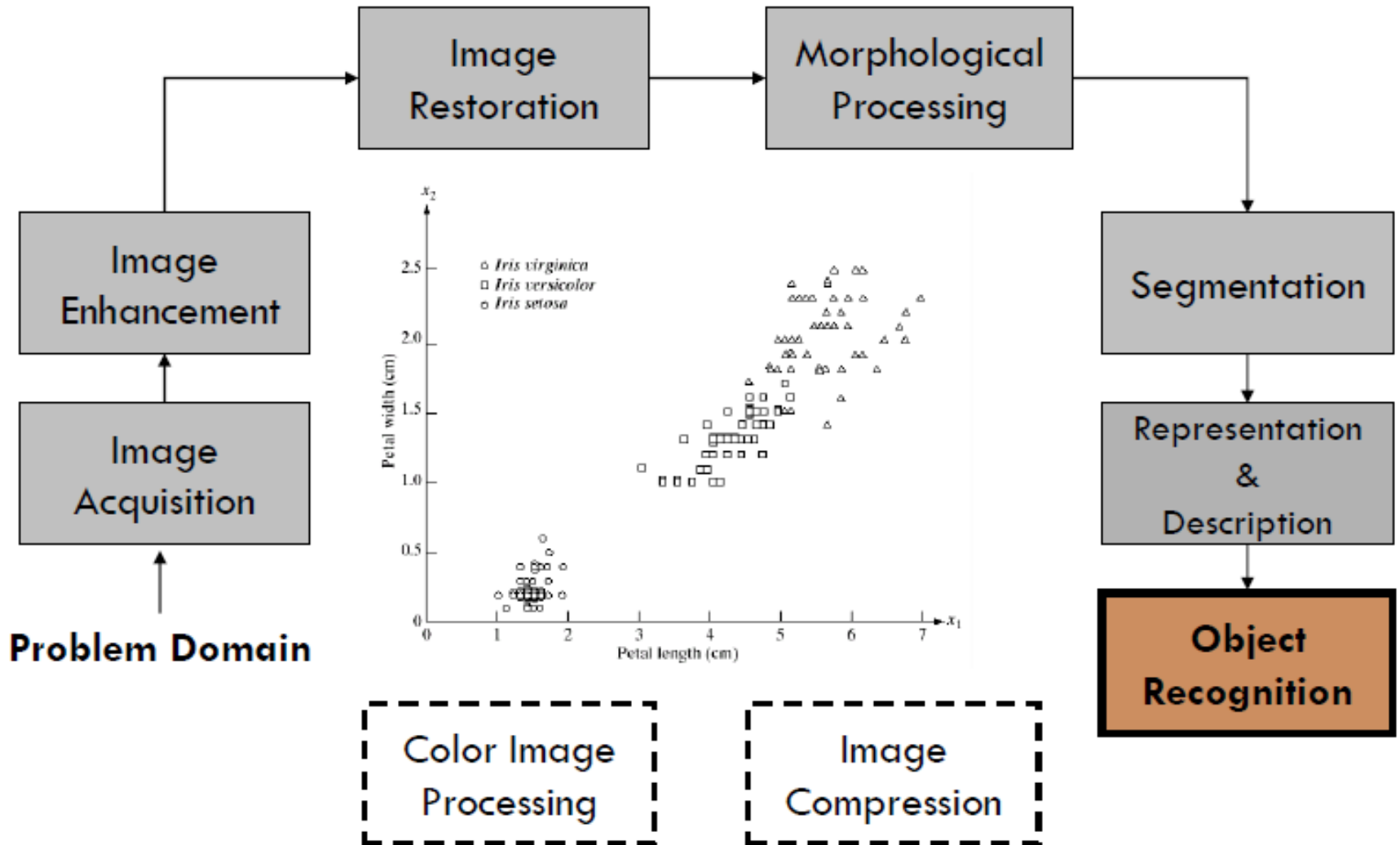
Key Stages in Digital Image Processing



Representation & Description

- A segmented region can be represented by boundary pixels or by internal pixels
- Representing region in 2 ways
 - in terms of its external characteristics (its boundary)
 - focus on shape characteristics
 - in terms of its internal characteristics (its region)
 - focus on regional properties, e.g., color, texture
- sometimes, we may need to use both ways
- The description of a region is based on its representation,
 - for example a boundary can be described by its length

Key Stages in Digital Image Processing



Object Recognition

- Recognition is the process that assigns a label to an object based on its descriptors
- A pattern is an arrangement of descriptors also known as features
- A pattern class is a family of patterns that share some common properties
- Pattern recognition by machine involves techniques for assigning patterns to their respective classes automatically and with as little human intervention as possible

Key Stages in Digital Image Processing

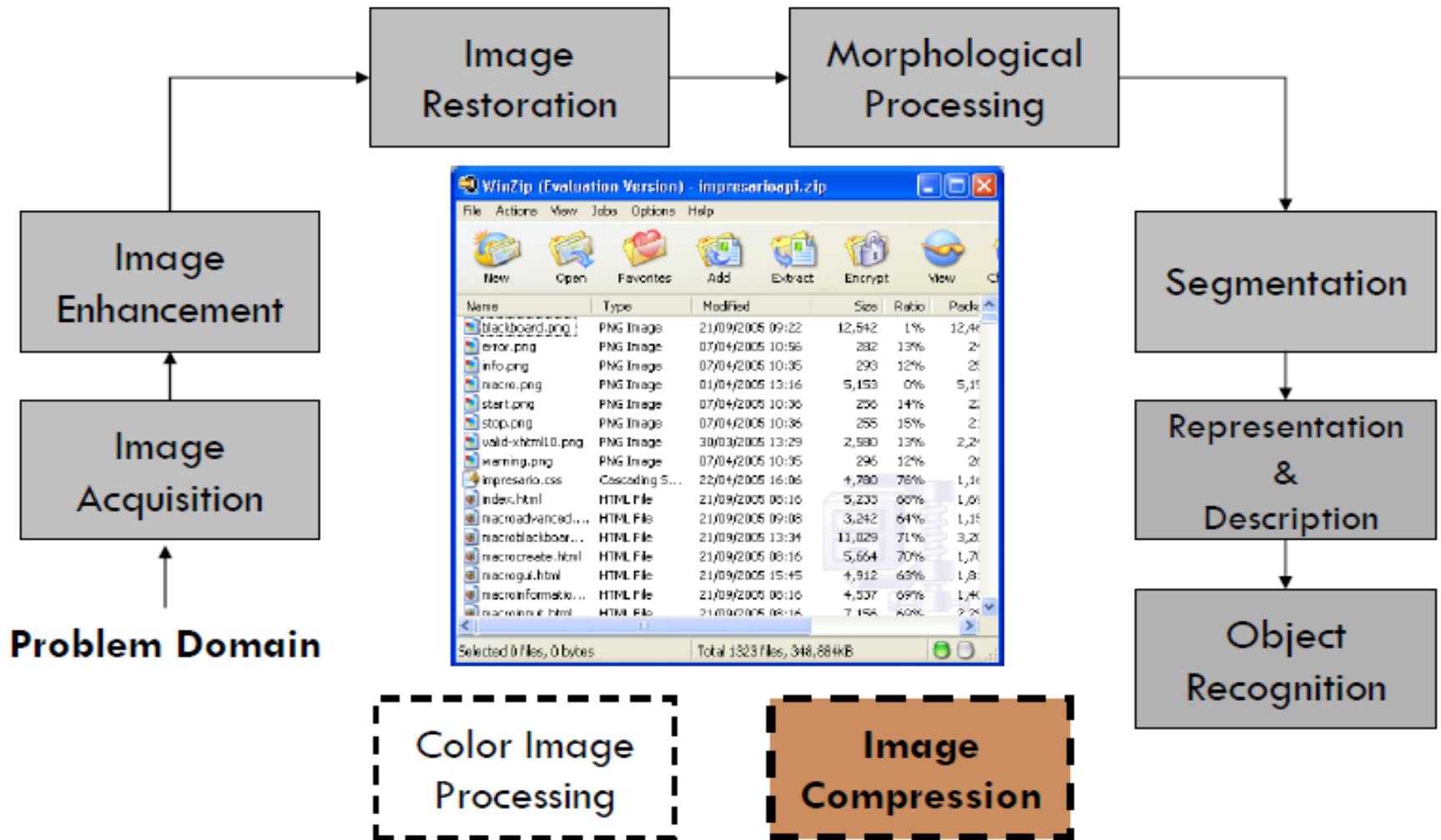


Image Compression

- Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level.
- The reduction in file size allows more images to be stored in a given amount of disk or memory space. It also reduces the time required for images to be sent over the Internet or downloaded from Web pages.
- Image Compression methods can be based on either:
 - Lossy Compression methods
 - Lossless Compression methods

Image Compression



Original Image (lossless PNG, 60.1 KiB size) — uncompressed is 108.5 KiB



Medium compression (92% less information than uncompressed PNG, 4.82 KiB)



Low compression (84% less information than uncompressed PNG, 9.37 KiB)



High compression (98% less information than uncompressed PNG, 1.14 KiB)

Key Stages in Digital Image Processing

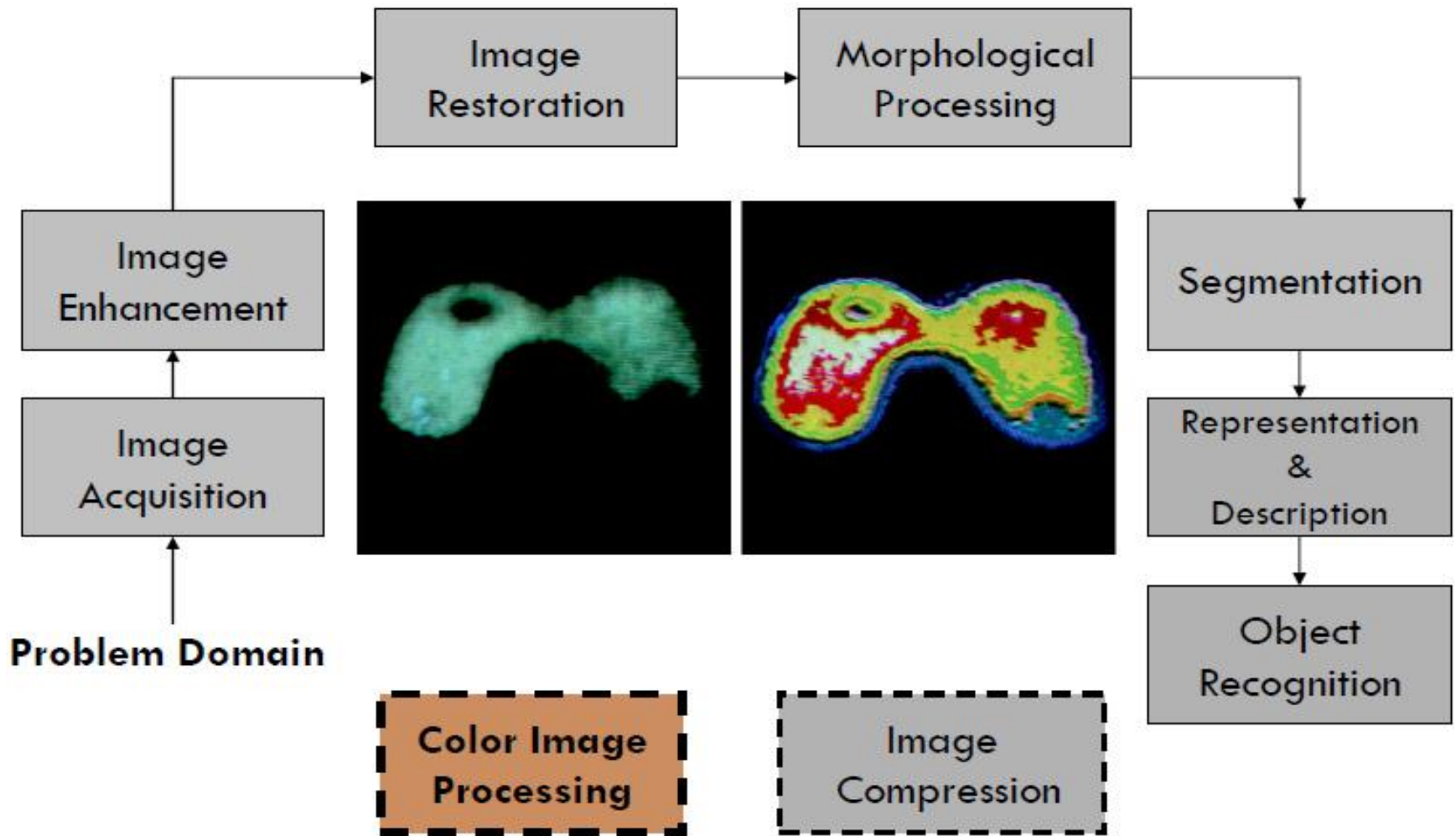
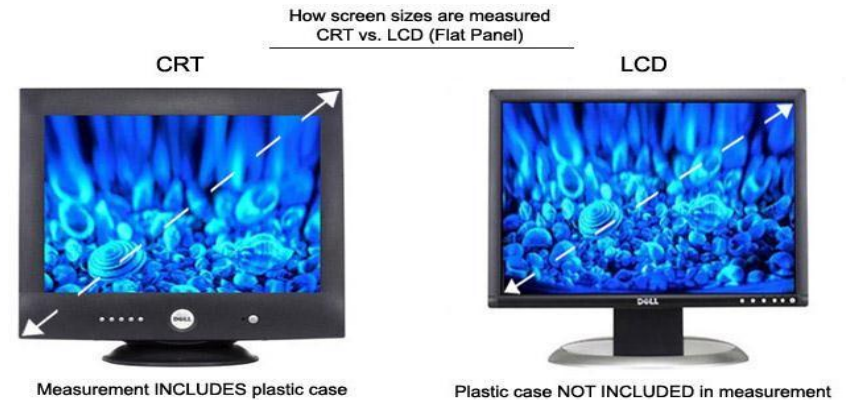


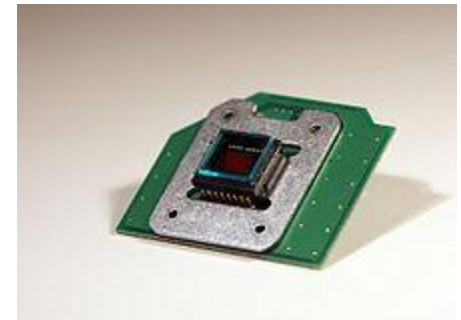
Image Processing Components

- ❑ Image Sensing device
- ❑ Storage Media
- ❑ Processing Systems
- ❑ Displays [5]
- ❑ Communication Media
- ❑ Hardcopy devices (e.g Printer)
- ❑ Frame Grabber



Camera

- ❑ Lens (CMount, CSMount) [3,4]
- ❑ Optical Filter (Selectivity in EM waves)
- ❑ Imaging Sensor (CCD Sensor ,CMOS Sensor)[6]
- ❑ Flash (Used for lighting/Illumination)
 - ✓ Front Illumination
 - ✓ Back Illumination



Camera

- ❑ The function of the lens in the camera is to direct the light source to the camera sensor to help focusing the image.
- ❑ The main difference of the different lens brands will be the coating that they use.
- ❑ Different lens coating will give varying results from sharpness to color reproduction.
- ❑ Some "legendary" brands of camera/lens are **Carl Zeiss, Leica, Schneider Kreuchnach**, etc



Camera Filter/Optical Filter

- ❑ Camera filters alter the properties of light entering the camera lens for the purpose of improving the image being recorded.
- ❑ The filter can be a square or oblong shape mounted in a holder accessory, or, more commonly, a glass or plastic disk with a metal or plastic ring frame, which can be placed in front of the lens
- ❑ Filters can affect contrast, sharpness, color, and light intensity, either individually, or in various combinations.
- ❑ The negative aspects of using filters, though often negligible, include the possibility of loss of image definition if using dirty or scratched filters



Processing Systems

▣ PC based

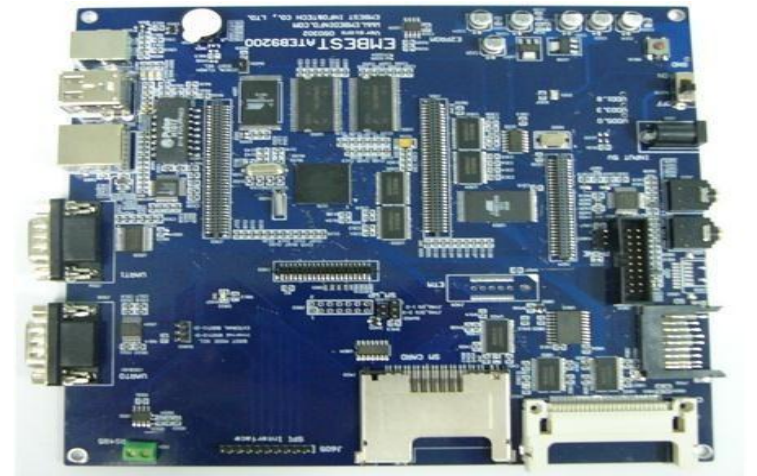
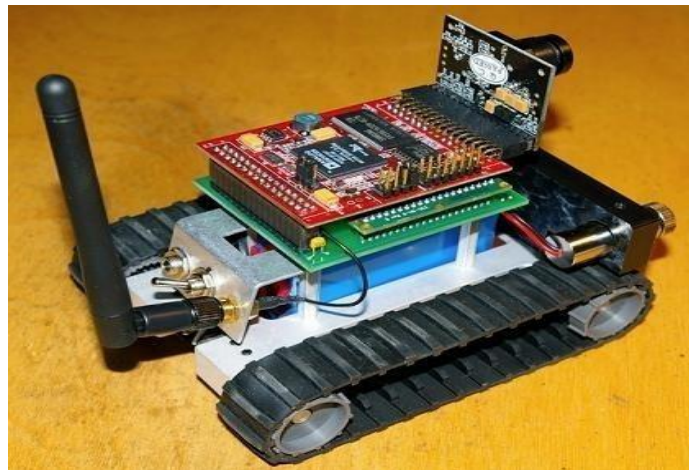
- ✓ General purpose PCs
- ✓ Servers
- ✓ Industrial PCs



Processing Systems

Embedded System based

- ✓ DSP processor based
- ✓ FPGA based
- ✓ System on chip (SoC)



Frame Grabber

- ❑ A component of a computer vision system, in which video frames are captured in digital form and then displayed, stored or transmitted in raw or compressed digital form.
- ❑ Frame Grabber can be Analog as well as Digital
- ❑ Early frame grabbers had only enough memory to acquire (i.e., "grab") and store a single digitized video frame
- ❑ Modern frame grabbers are typically able to store multiple frames and compress the frames in real time using algorithms such as MPEG2 & JPEG
- ❑ Frame Grabber Types
 - ✓ **Active Frame Grabber**
 - Frame grabbers that perform compression on the video frames are referred to as "Active Frame Grabbers".
 - ✓ **Passive Frame Grabber**
 - Frame grabbers that simply capture the raw video data are referred to as "Passive Frame Grabbers."

References

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3. <http://www.ikegami.com/cb/products/pdf/tech/lensmount.pdf>
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