



Introduction

Image Processing

(EE663 – Image Processing)

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*“One picture is worth
more than ten thousand
words”*
Anonymous



This lecture will cover:

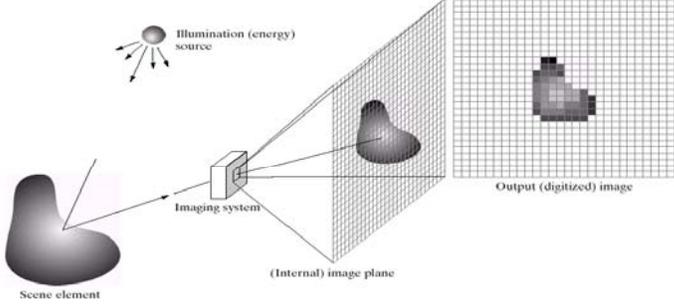
- What is a digital image?
- What is digital image processing?
- History of digital image processing
- State of the art examples of digital image processing
- Key stages in digital image processing

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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

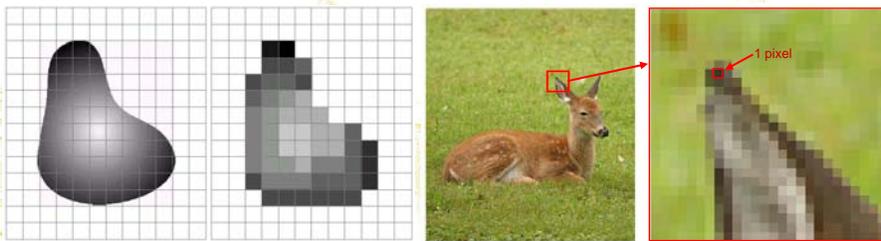


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What is a Digital Image? (cont...)



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



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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)



For most of this course we will focus on grey-scale images

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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

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What is DIP? (cont...)



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

Low Level Process	Mid Level Process	High Level Process
Input: Image Output: Image	Input: Image Output: Attributes	Input: Attributes Output: Understanding
Examples: Noise removal, image sharpening	Examples: Object recognition, segmentation	Examples: Scene understanding, autonomous navigation

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History of Digital Image Processing



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

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

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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



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



FIGURE 1.3 Unretouched cable picture of General Pershing and Fitch, transmitted in 1929 from London to New York by 15-tone equipment. (McFarlane.)

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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



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.)

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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

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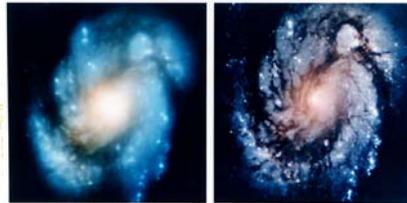
Examples: The Hubble Telescope



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



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Examples: Artistic Effects



Artistic effects are used to make images more visually appealing, to add special effects and to make composite images



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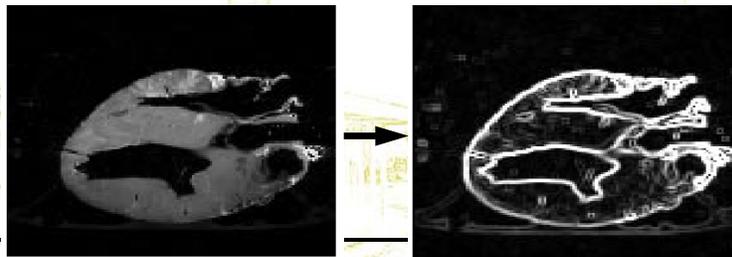
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Examples: Medicine



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



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Original MRI Image of a Dog Heart

Edge Detection Image

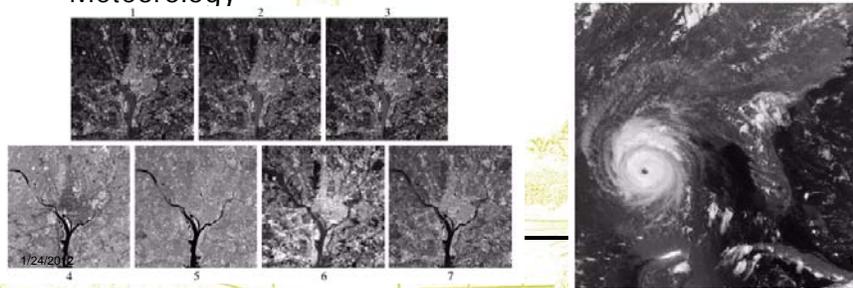
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Examples: GIS



Geographic Information Systems

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



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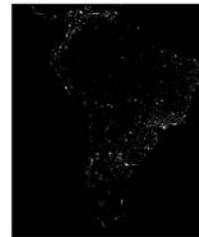
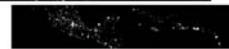
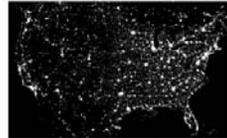
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Examples: GIS (cont...)



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



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Examples: Industrial Inspection

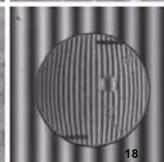
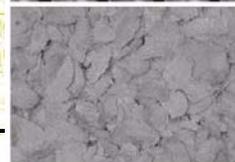
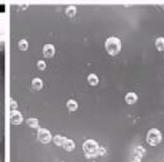
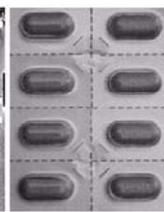
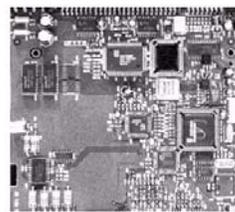


Human operators are expensive, slow and unreliable

Make machines do the job instead

Industrial vision systems are used in all kinds of industries

Can we trust them?



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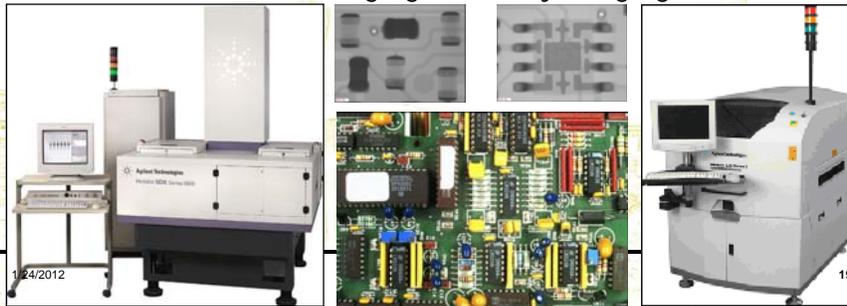
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Examples: PCB Inspection



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



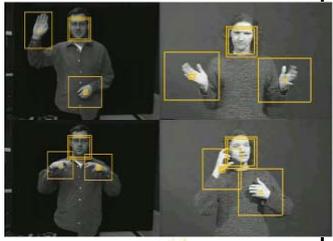
Examples: HCI

Try to make human computer interfaces more natural

- Face recognition
- Gesture recognition

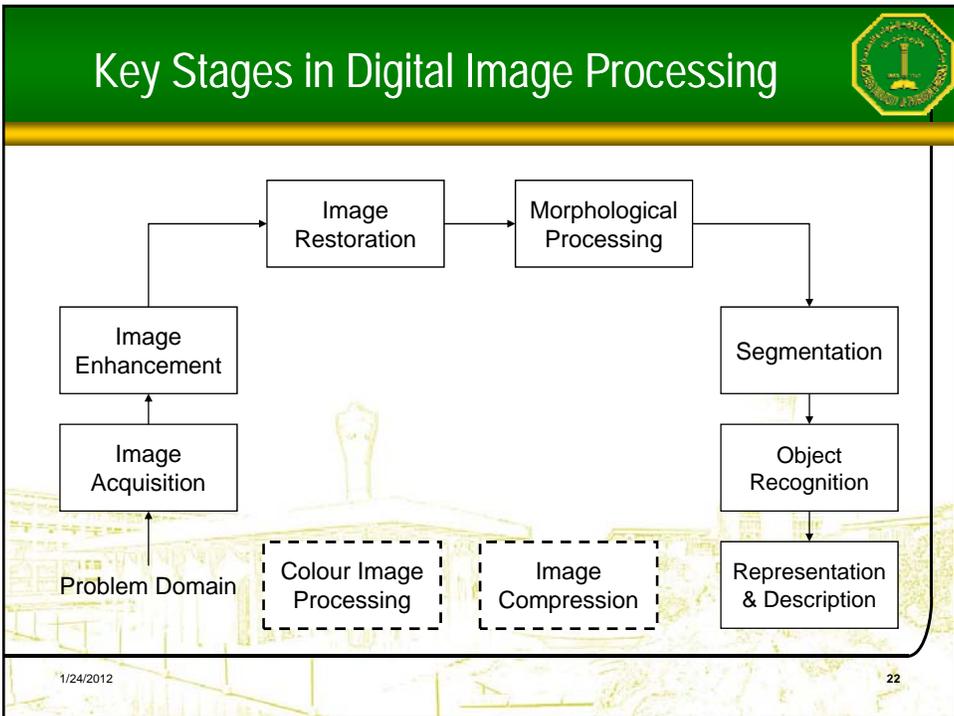
Does anyone remember the user interface from "Minority Report"?

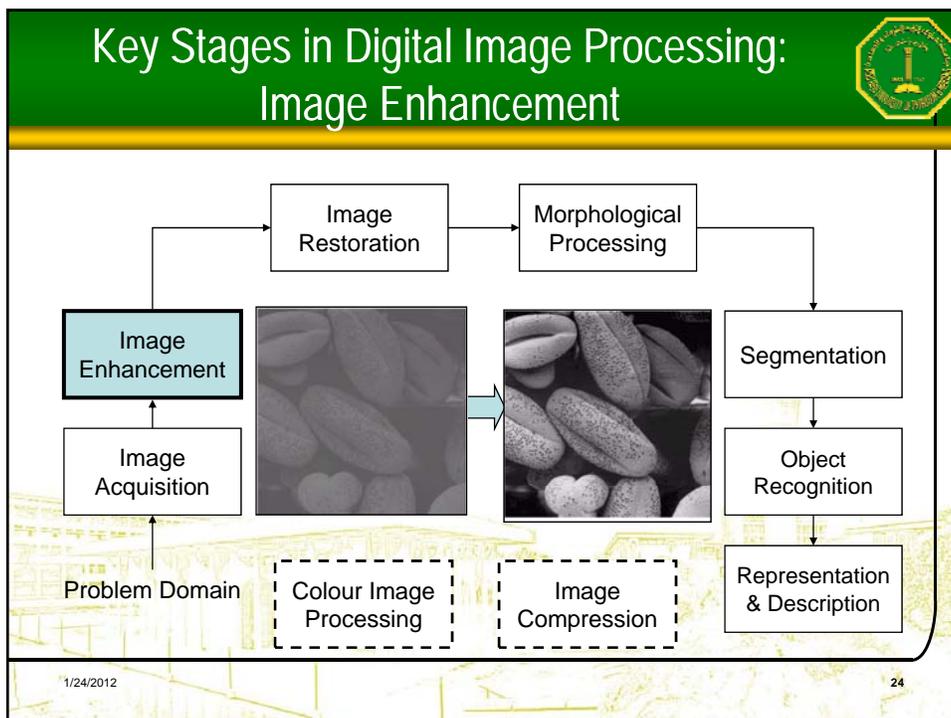
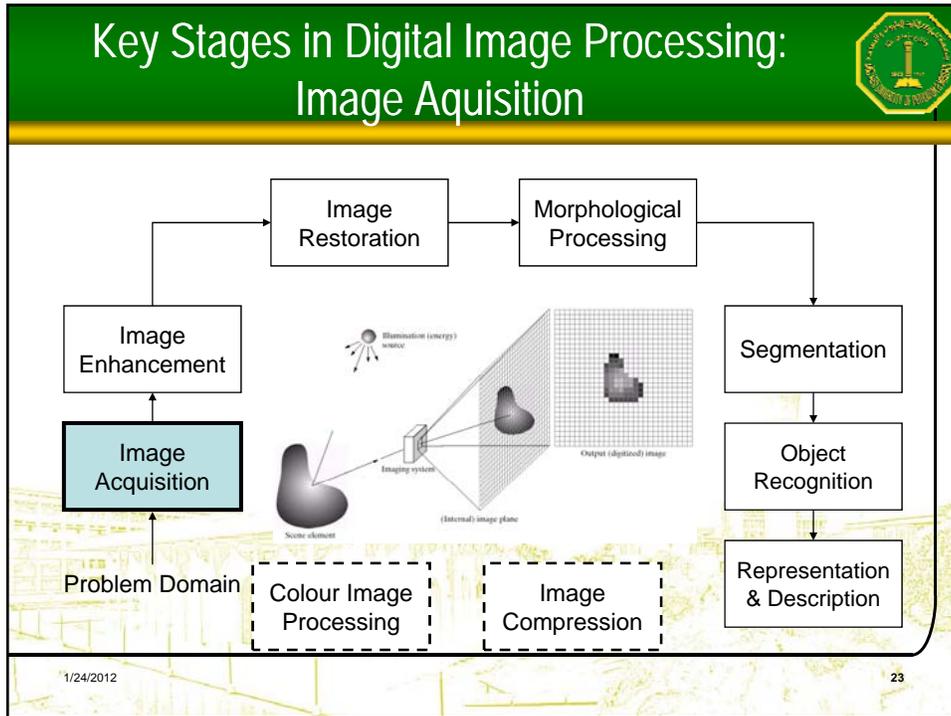
These tasks can be extremely difficult

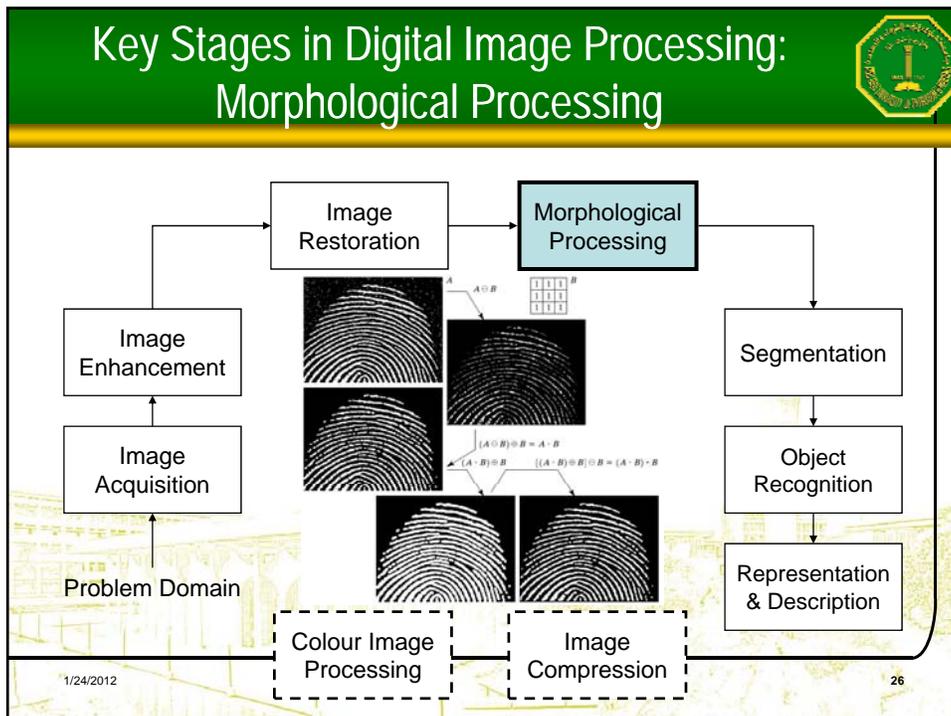
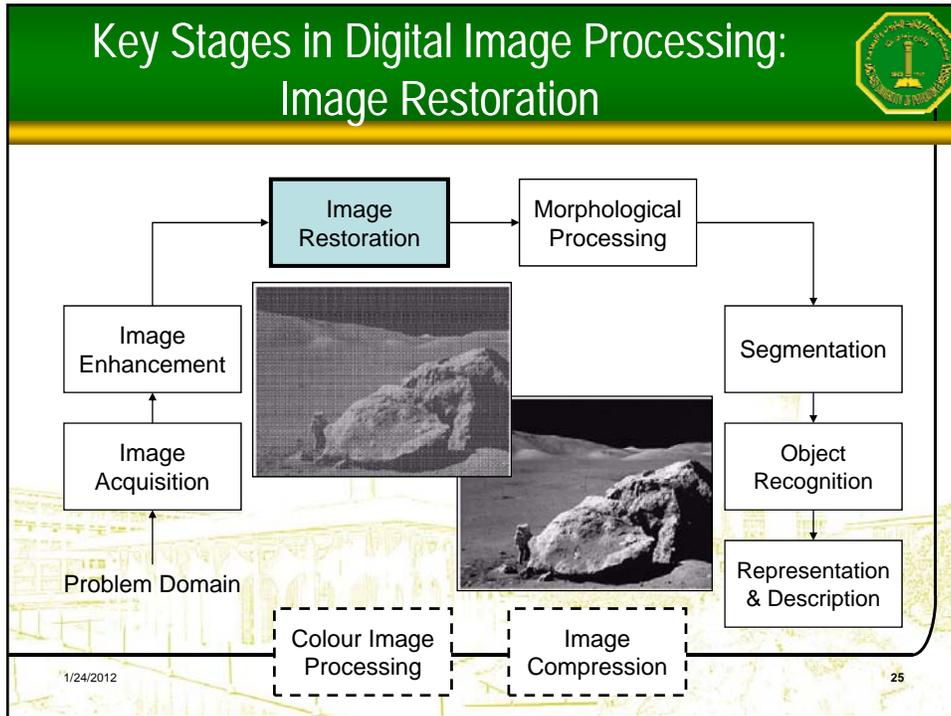


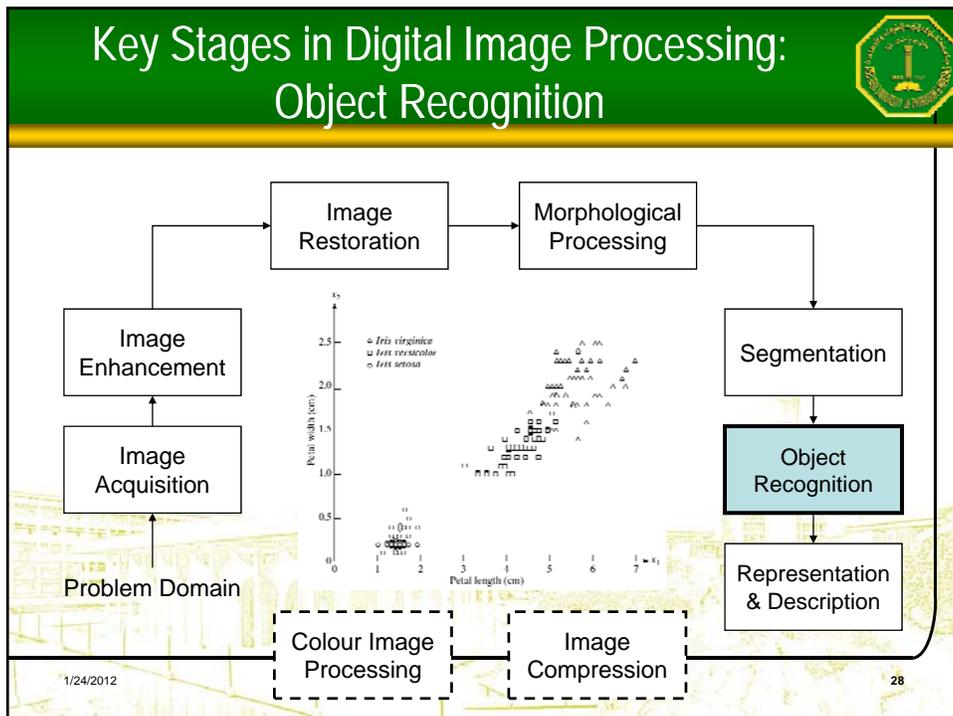
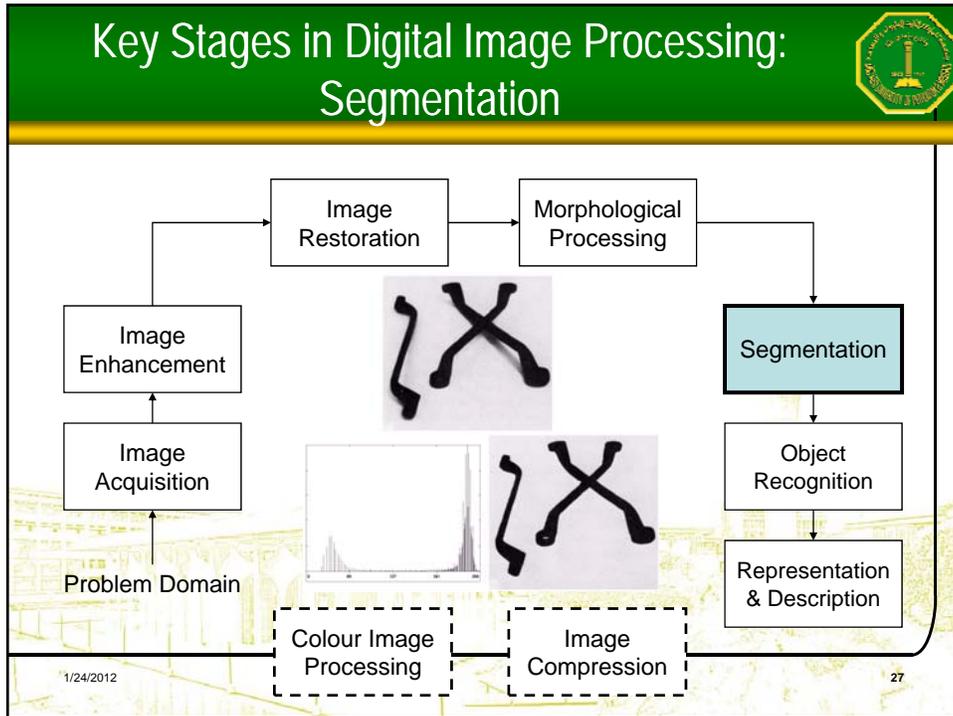


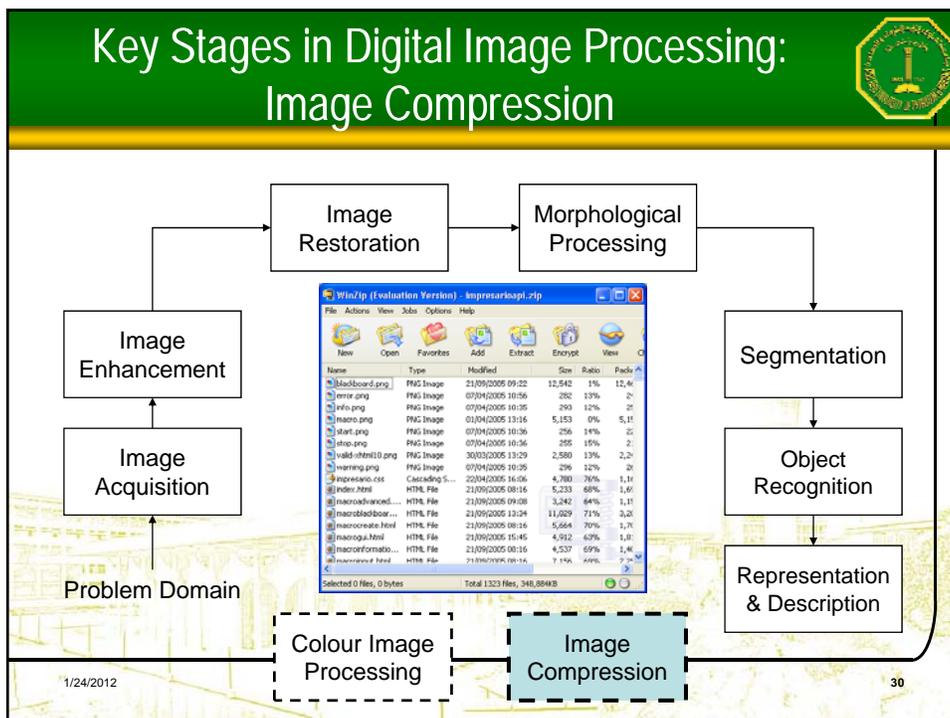
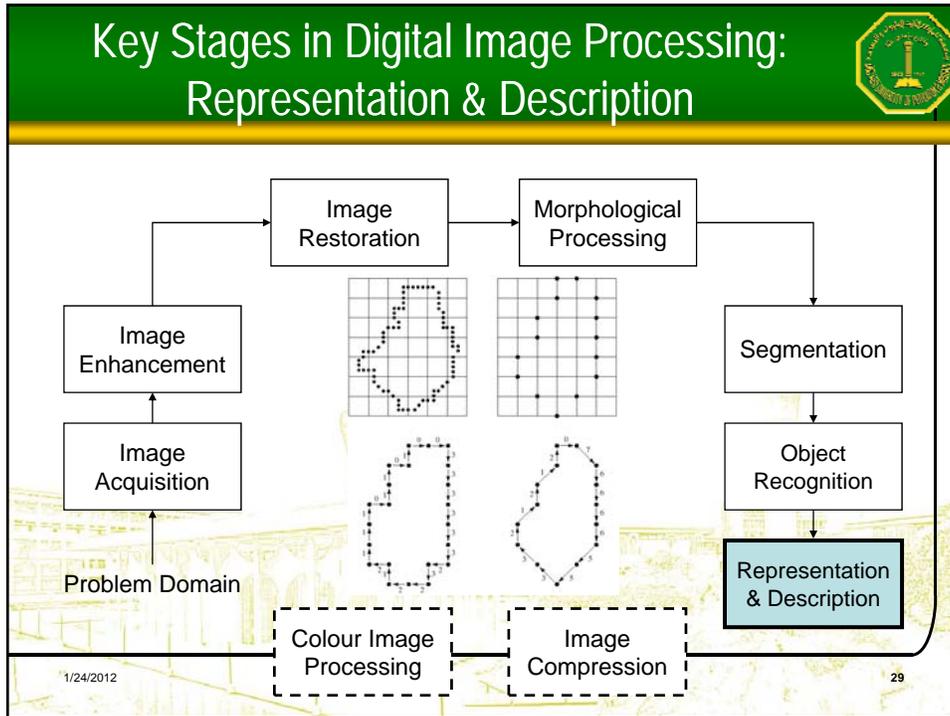
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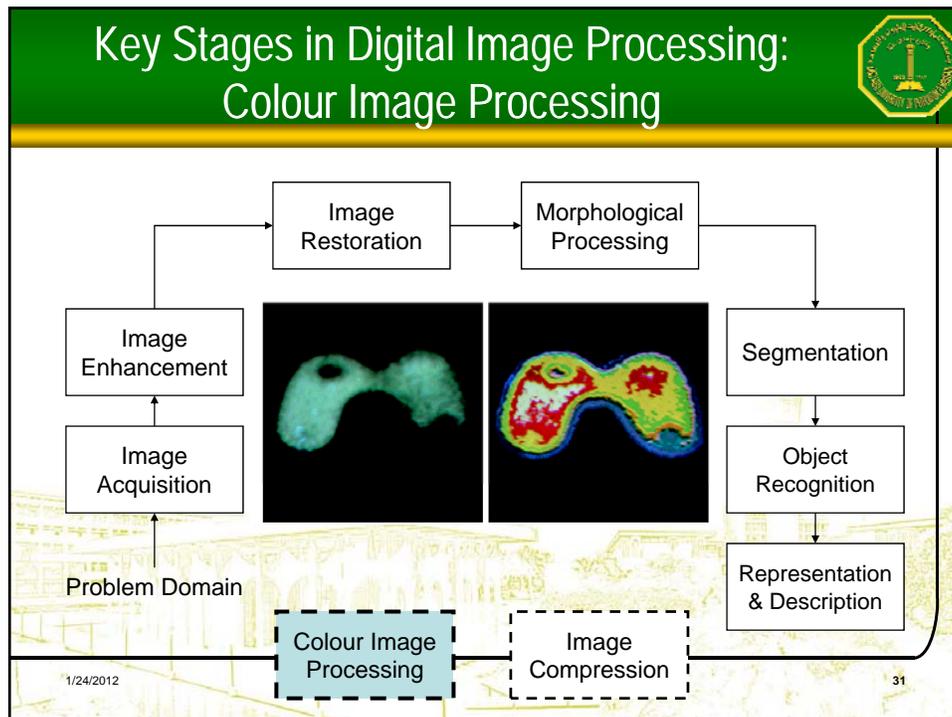












Summary

We have looked at:

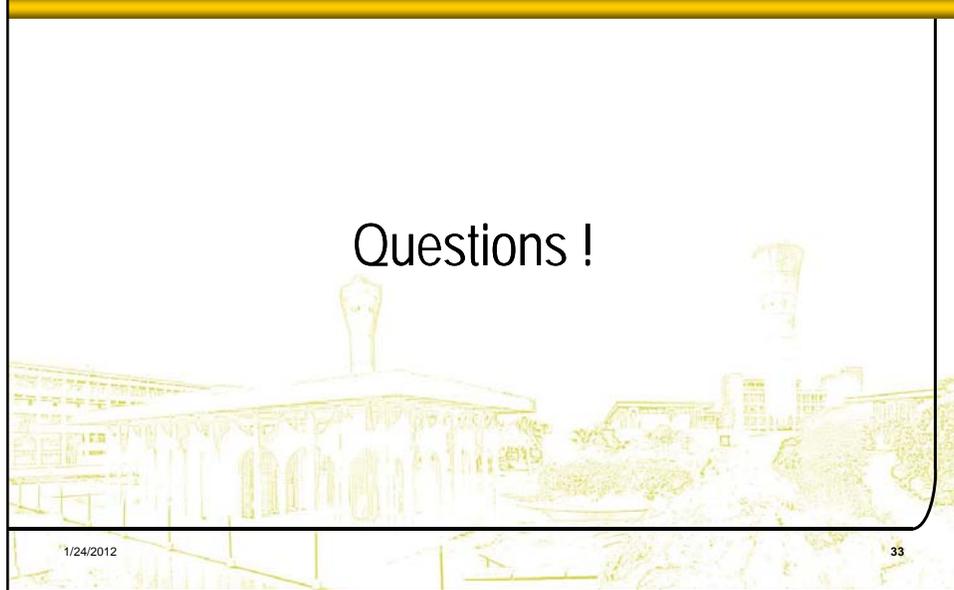
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Next time we will start to see how it all works...

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Questions !



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