

Digital Image Processing

Lecture 1 - Introduction



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(Slides courtesy of Ha Dai Duong)

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2. What is Digital Image Processing (DIP)
3. The Origins of DIP
4. Examples of fields that use DIP
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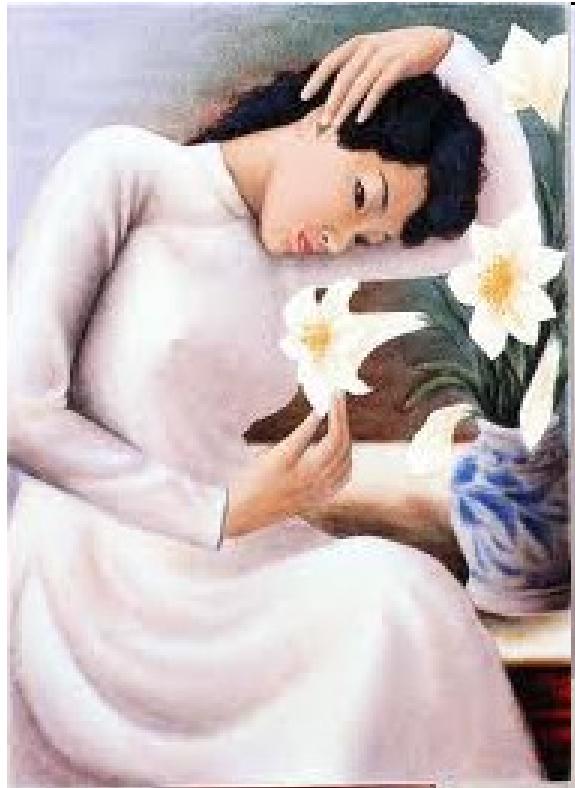


1. Introduction to the course

- The objectives of this course are to:
 - Cover the basic theory and algorithms that are widely used in digital image processing
 - Expose students to current technologies and issues that are specific to image processing systems
 - Develop hands-on experience in using computers to process images
 - Develop critical thinking about shortcomings of the state of the art in image processing



1. Introduction to the course



“One picture is worth more than ten thousand words”

Anonymous



1. Introduction to the course

- **Course website:**

- <http://fit.mta.edu.vn/~giangnv/coursesdetail-72-283.aspx>

- **Textbook:**

- Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing, 3rd edition", Prentice Hall, 2008.

- **References:**

- Linda Shapiro, "Computer Vision", The University of Washington, 2000;
 - *Luong Chi Mai*, "Introduction to Image processing and Computer Vision";
 - Lương Mạnh Bá, Nguyễn Thanh Thủy, "Nhập môn xử lý ảnh", NXB KHKT, 2003;
 - Nguyễn Kim Sách, "Xử lý ảnh và Video số", NXB KHKT, 1997;
 - Internet ...



1. Introduction to the course

■ Article Reading and Project

- Face recognition;
- Fingerprint recognition;
- Fire detection;
- Predesigned Form reader;
- Text and Number recognition;
- Image and/or video compression;
- Image segmentation and/or denoising;
- Medical image analysis;
- Whatever you're interested ...



1. Introduction to the course

■ Course content

Lecture 1	Introduction
Lecture 2	Fundamentals of Image
Lecture 3, 4, 5	Image Enhancement In spatial domain
Lecture 6, 7, 8	Image Segmentation
Lecture 9,10	Image Compression
Lecture 11, 12, 13	Representation & Description
Lecture 14, 15	Object Recognition



1. Introduction to the course

■ Grading:

- Article Reading and Presentation: 15%
- Homework: 20%
- Exam: 15%
- Project: 50%
- Total: 100%
- **Extra Credits: 50%.** If the method and experimental results of your project achieve the state of the art, you will earn the extra 50% credits



1. Introduction to the course

■ Evaluation of article reading and project

□ Report

- Article reading: Submit a survey of the articles you read and the list of the articles
- Project
 - Submit an article including introduction, methods, experiments, results, and conclusions
 - Submit the project code, the readme document, and some testing samples (images, videos, etc.) for validation

□ Presentation



2. What is Digital Image Processing

■ Digital Image

- ❑ A two-dimensional function $f(x, y)$
 x and y are spatial coordinates

The amplitude of f is called intensity or gray level at the point (x, y)

■ Pixel

- ❑ The elements of a digital image



2. What is Digital Image Processing

■ **Digital Image Processing**

- Process digital images by means of computer

■ Image processing is a subclass of signal processing concerned specifically with pictures;

■ Image processing quality for human perception and/or computer interpretation



2. What is Digital Image Processing

■ Two principal application areas

- Improvement of pictorial information for human interpretation
=> **Image enhancement**
- Processing of image data for storage, transmission and representation for autonomous machine perception
=> **Computer vision**



2. What is Digital Image Processing

- **Three types of computerized process**
 - Low - level: Input, output are Images
 - Primitive operations such as reduction of noise, contrast enhancement, image sharpening ...
 - Mid - Level: Outputs are attributes extracted from input image
 - Segmentation, Description, Classification
 - High - Level:
 - Image Analysis



3. The origins of DIP

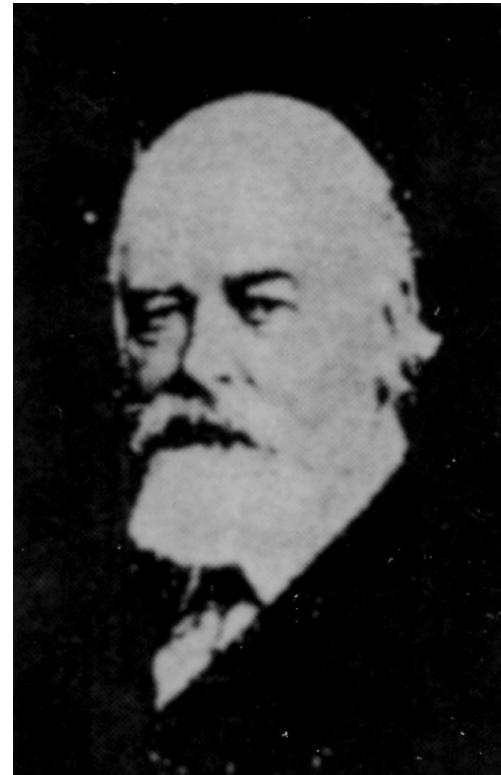


FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.[†])



3. The origins of DIP

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.)



3. The origins of DIP

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



3. The origins of DIP

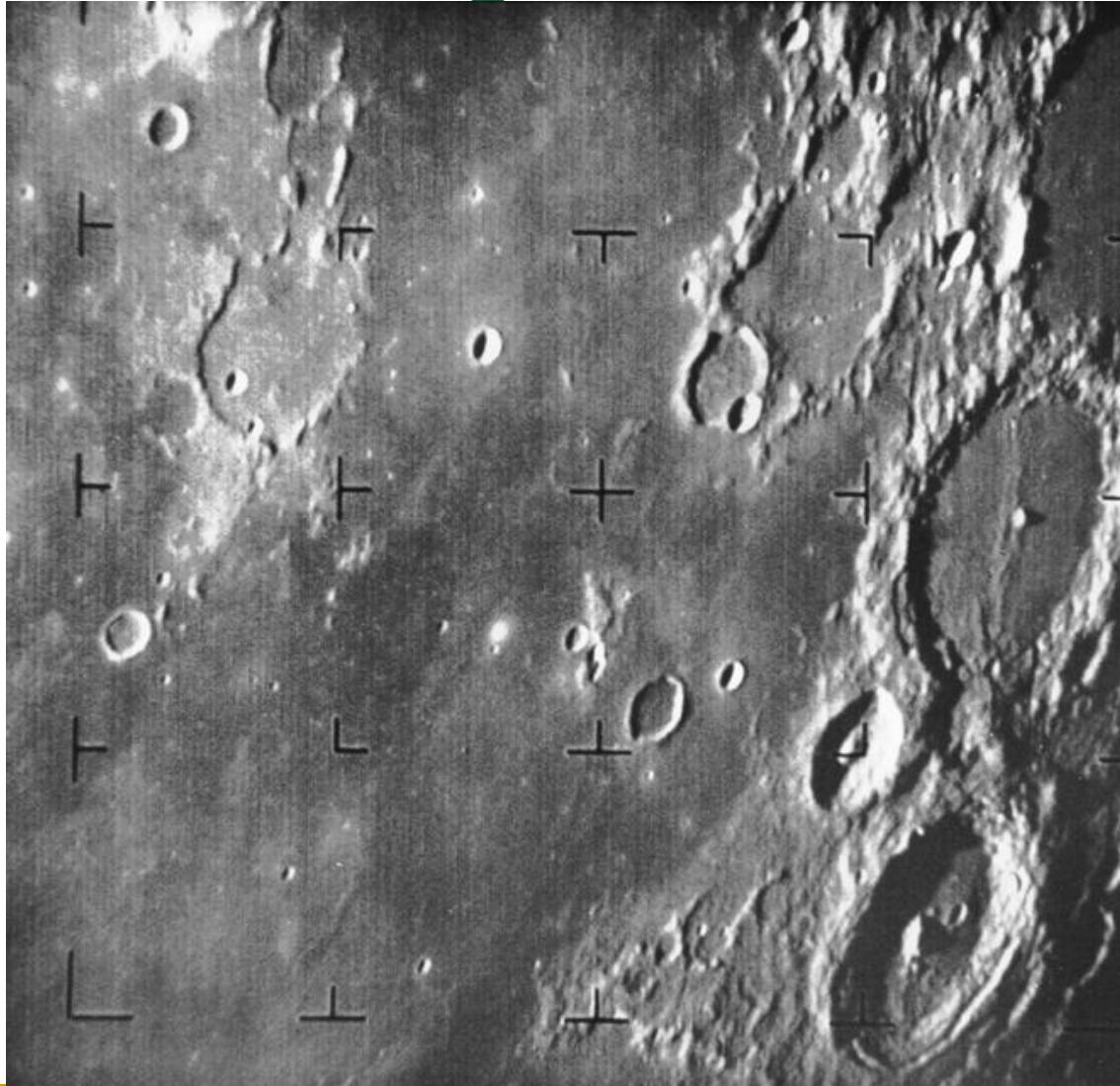


FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger* 7 took this image on July 31, 1964 at 9 : 09 A.M. EDT, about 17 minutes before impacting the lunar surface. (Courtesy of NASA.)



3. The origins of DIP

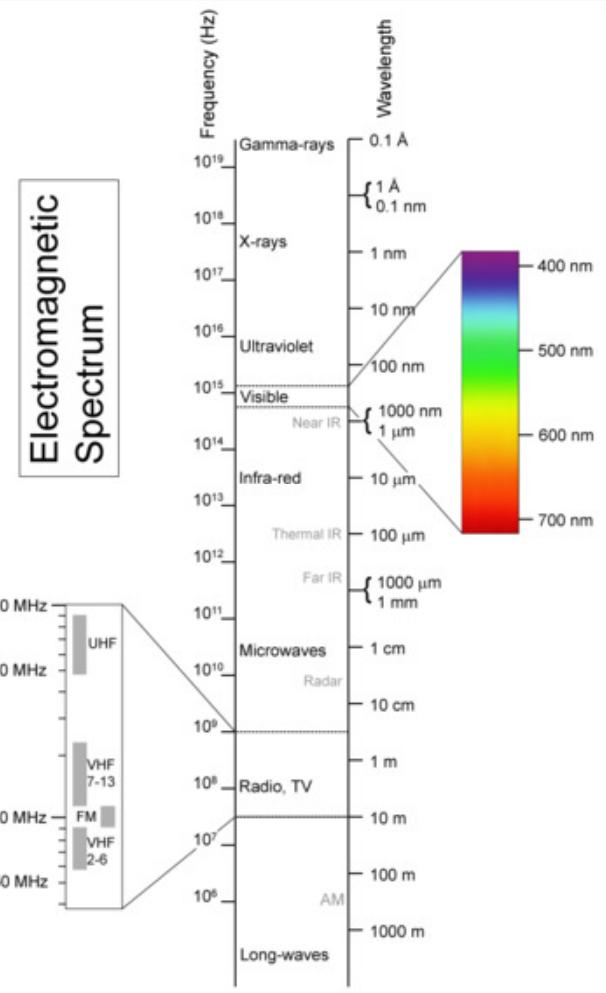
- Some important points in the development of computer
 - 1. The invention of the transistor by Bell Laboratories in 1948;
 - 2. The development in the 1950s and 1960s of the high-level programming languages COBOL and FORTRAN (Formula Translator);
 - 3. The invention of the integrated circuit (IC) at Texas Instruments in 1958;
 - 4. The development of operating systems in the early 1960s;
 - 5. The development of the microprocessor by Intel in the early 1970s;
 - 6. Introduction by IBM of the personal computer in 1981;
 - 7. And progressive miniaturization of components, starting with large scale integration (LSI) in the late 1970s, then very large scale integration (VLSI) in the 1980s, to the present use of ultra large scale integration (ULSI).



4. Examples of fields that use DIP

Categorize by image sources: Electromagnetic spectrum

- ❑ **Gamma-ray imaging:** nuclear medicine and astronomical observations
- ❑ **X-rays:** medical diagnostics, industry, and astronomy, etc.
- ❑ **Ultraviolet:** lithography, industrial inspection, microscopy, lasers, biological imaging, and astronomical observations
- ❑ **Visible and infrared bands:** light microscopy, astronomy, remote sensing, industry, and law enforcement
- ❑ **Microwave band:** radar
- ❑ **Radio band:** medicine (such as MRI) and astronomy



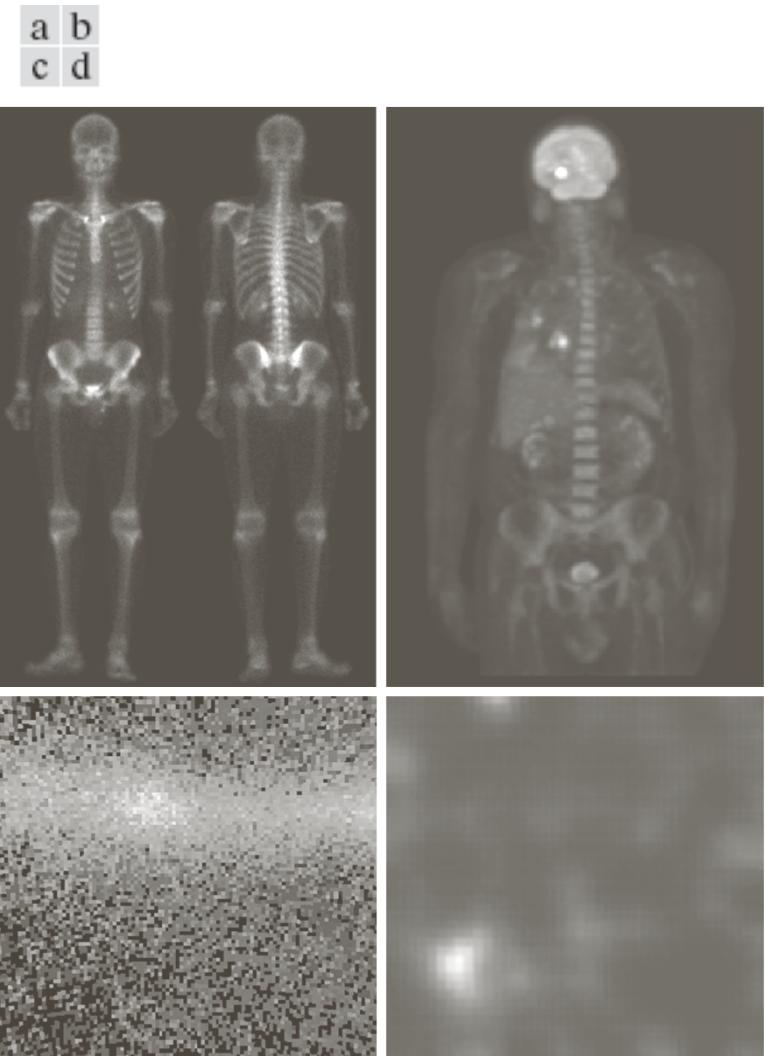
Louis E. Keiner - Coastal Carolina University



4. Examples of fields that use DIP

■ Gamma-Ray Image

- Nuclear medicine Images
 - (a) Bone scan
 - (b) PET image
- Astronomical Observations
 - (c) Cygnus Loop
- Nuclear Reaction
 - (d) Gamma radiation from a reactor valve

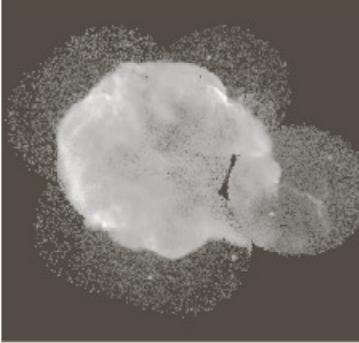
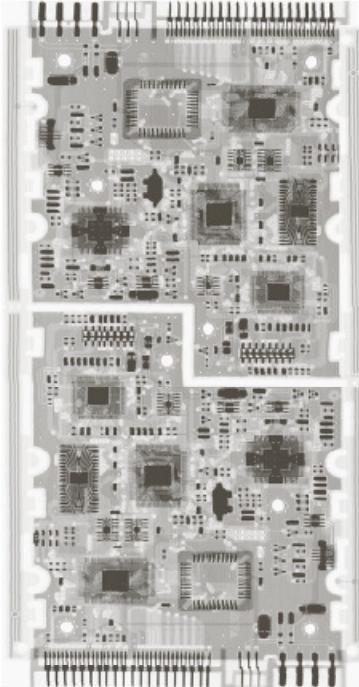


4. Examples of fields that use DIP

■ X-Ray Image

- Medical diagnostics
 - (a) Chest X-Ray
 - (b) Aortic image
 - (c) Head CT
- Industrial Image
 - (d) Circuit board
- Astronomy
 - (e) Cygnus Loop

a
b
c
d
e

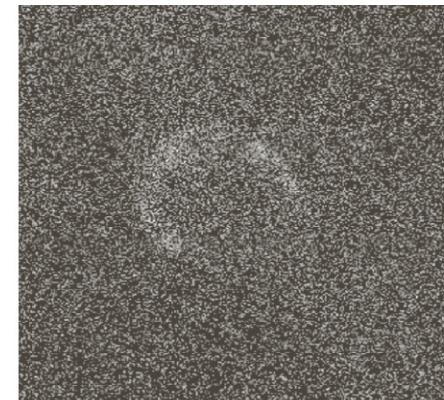
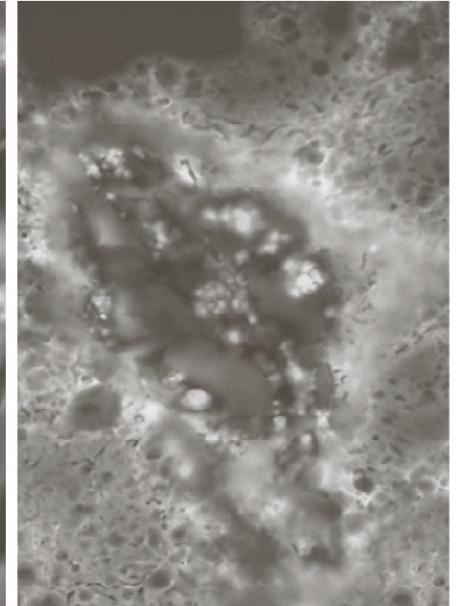
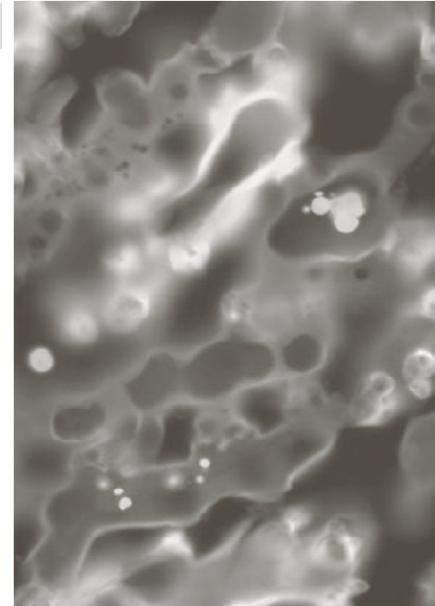


4. Examples of fields that use DIP

■ Imaging in Ultraviolet band

- ❑ Lithography
- ❑ Industrial Inspection
- ❑ Microcopy
 - (a) Normal corn
 - (b) Smut corn
- ❑ Lasers
- ❑ Biological Imaging
- ❑ Astronomical Observations
 - (c) Cygnus Loop

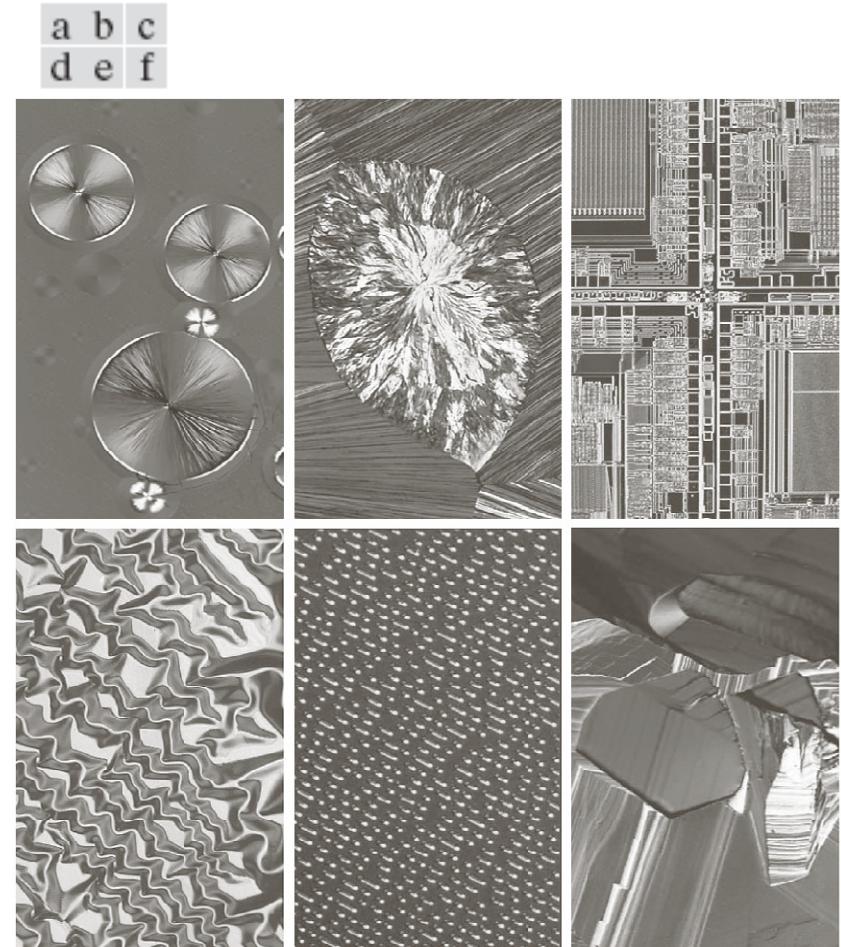
a
b
c



4. Examples of fields that use DIP

■ Imaging in visible and infrared band

- Astronomy
- Light Microcopy
 - Pharmaceuticals
 - (a) Taxol (anticancer agent)
 - (b) Cholesterol
 - Industrial
 - (c) Microprocessor
 - (d) Nikel Oxide thin film
 - (e) Surface of Audio CD
 - (f) Organic Superconductor

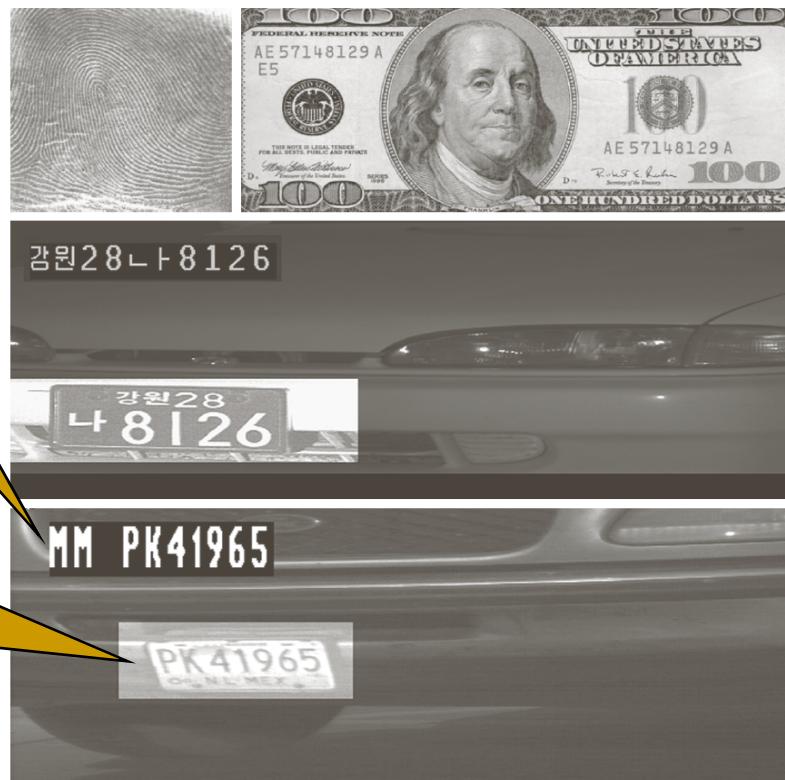


4. Examples of fields that use DIP

■ Imaging in visible and infrared band

Results of automated reading of the plate content by the system

The area in which the imaging system detected the plate



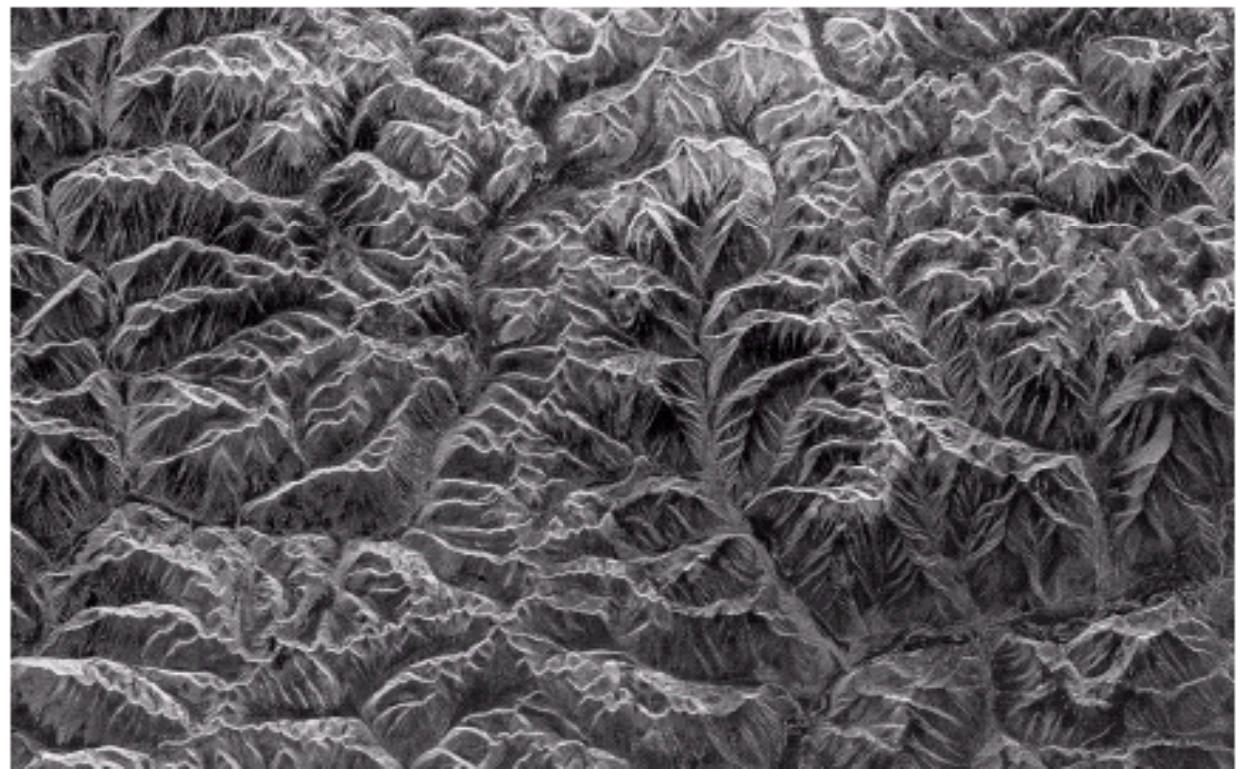
a
b
c
d

FIGURE 1.15
Some additional examples of imaging in the visual spectrum.
(a) Thumb print.
(b) Paper currency.
(c) and (d) Automated license plate reading.
(Figure (a) courtesy of the National Institute of Standards and Technology.
Figures (c) and (d) courtesy of Dr. Juan Herrera, Perceptics Corporation.)

4. Examples of fields that use DIP

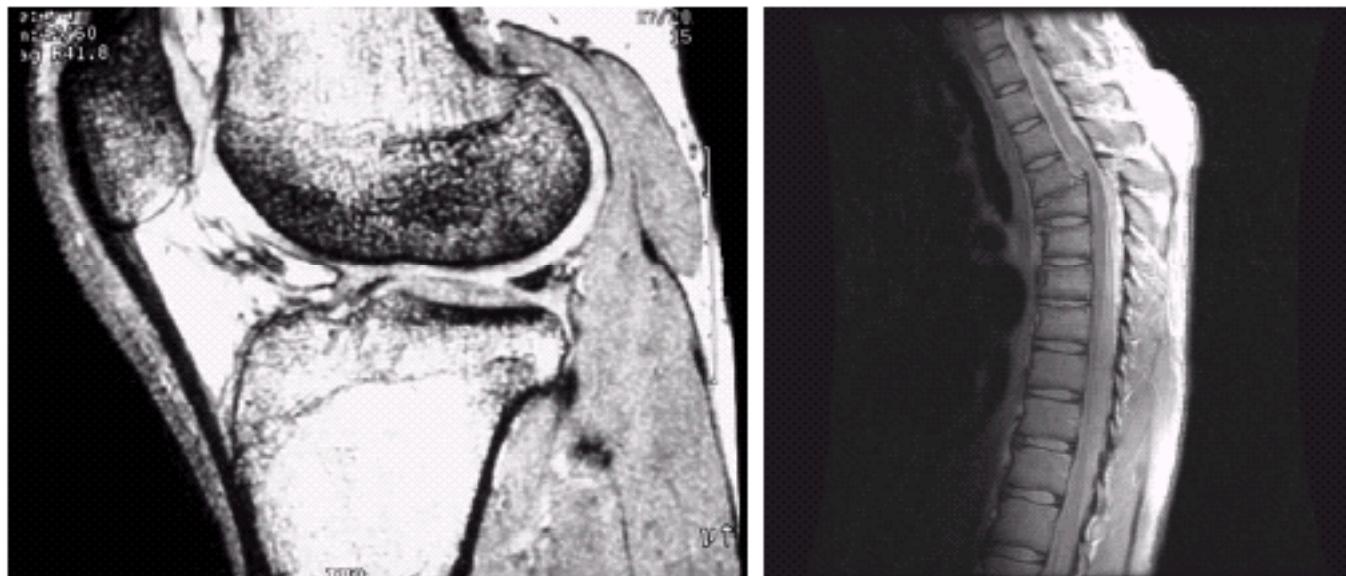
■ Imaging in Microwave band

FIGURE 1.16
Spaceborne radar
image of
mountains in
southeast Tibet.
(Courtesy of
NASA.)



4. Examples of fields that use DIP

■ Imaging in Radio band



a b

FIGURE 1.17 MRI images of a human (a) knee, and (b) spine. (Image (a) courtesy of Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School, and (b) Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)



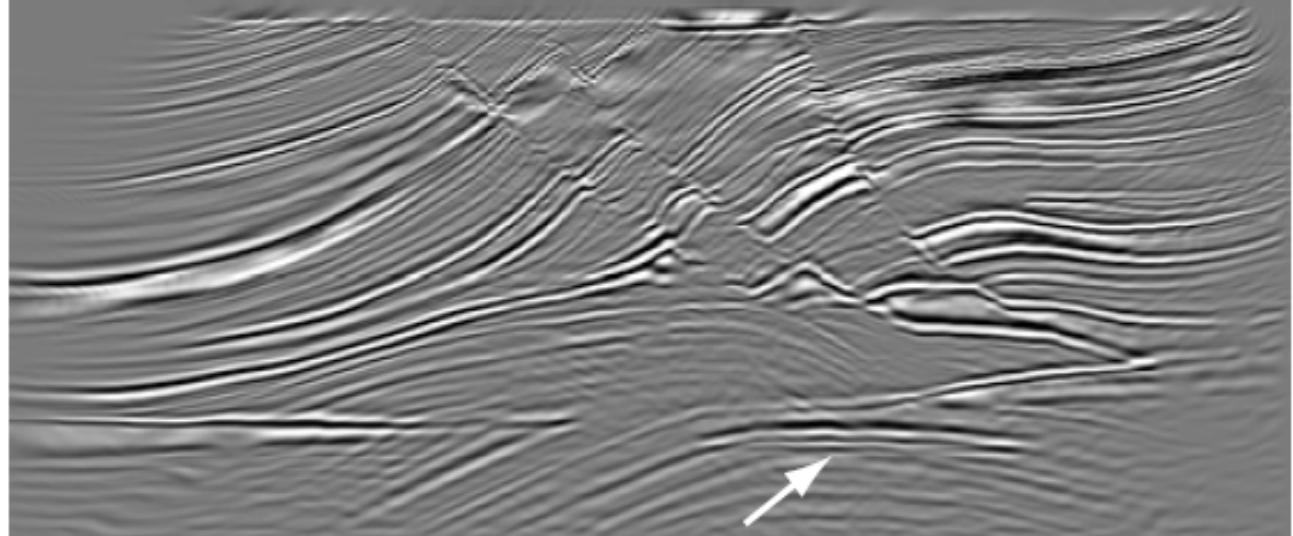
4. Examples of fields that use DIP

■ Acoustic Imaging

- Geological application: Mineral and oil exploration

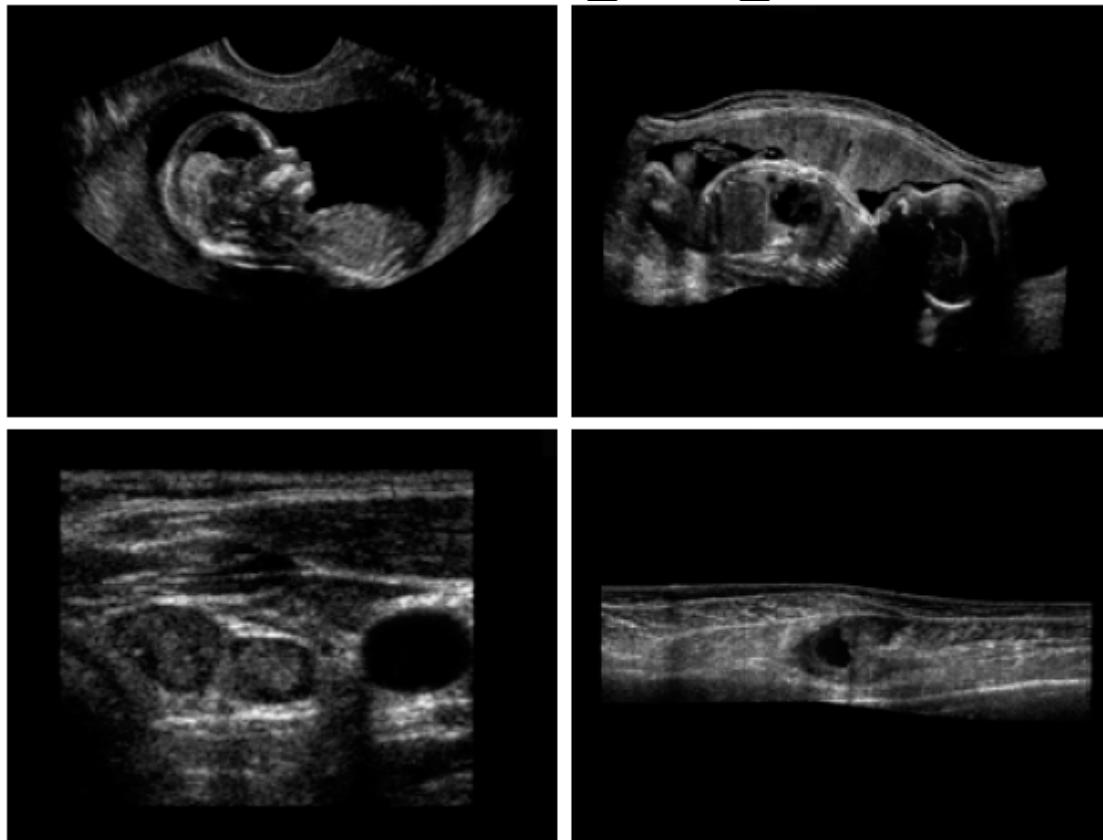
FIGURE 1.19

Cross-sectional image of a seismic model. The arrow points to a hydrocarbon (oil and/or gas) trap. (Courtesy of Dr. Curtis Ober, Sandia National Laboratories.)



4. Examples of fields that use DIP

■ Ultrasound Imaging



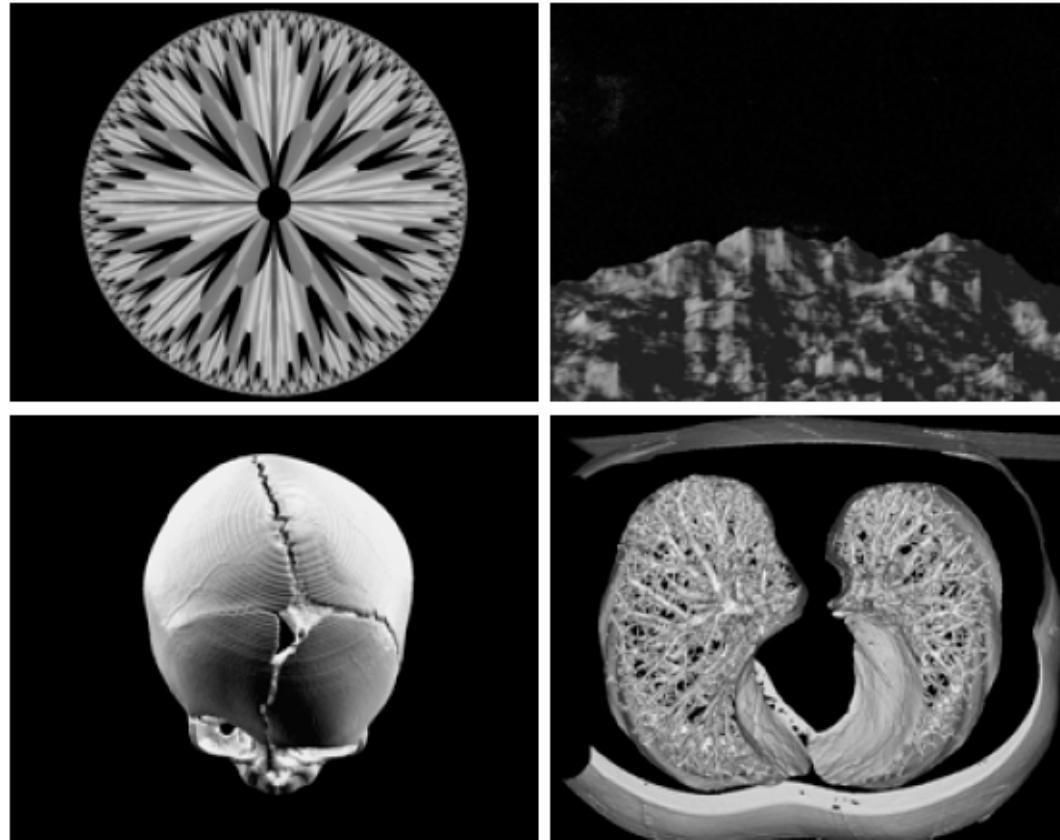
a
b
c
d

FIGURE 1.20
Examples of ultrasound imaging. (a) Baby.
(b) Another view of baby.
(c) Thyroids.
(d) Muscle layers showing lesion.
(Courtesy of Siemens Medical Systems, Inc., Ultrasound Group.)



4. Examples of fields that use DIP

■ Generated Images by computer



a b
c d

FIGURE 1.22
(a) and (b) Fractal images. (c) and (d) Images generated from 3-D computer models of the objects shown. (Figures (a) and (b) courtesy of Ms. Melissa D. Binde, Swarthmore College, (c) and (d) courtesy of NASA.)



4. Examples of fields that use DIP

■ Others



a)



b)



c)



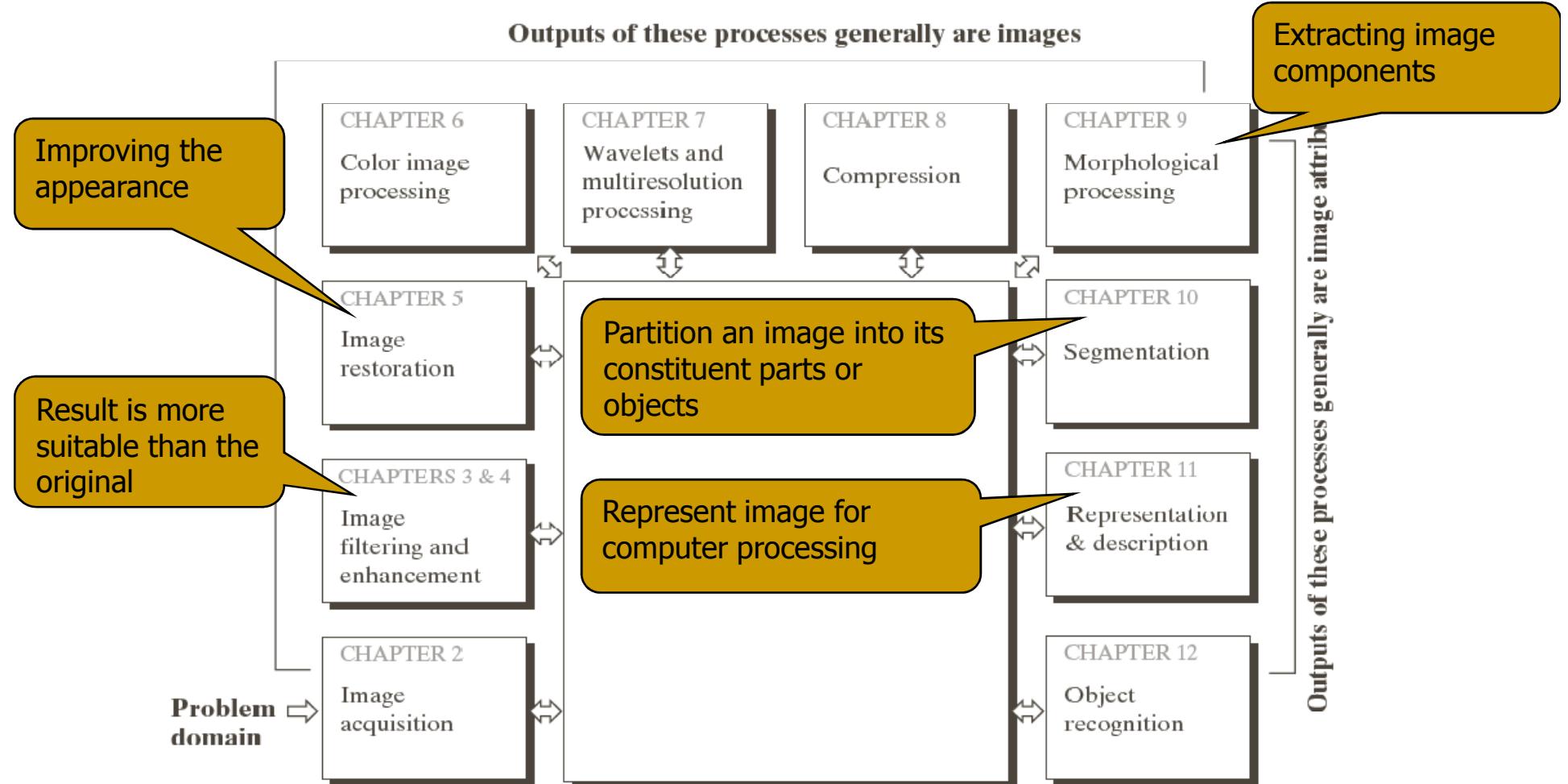
d)



e)



5. Fundamental steps



6. Components of An IP System

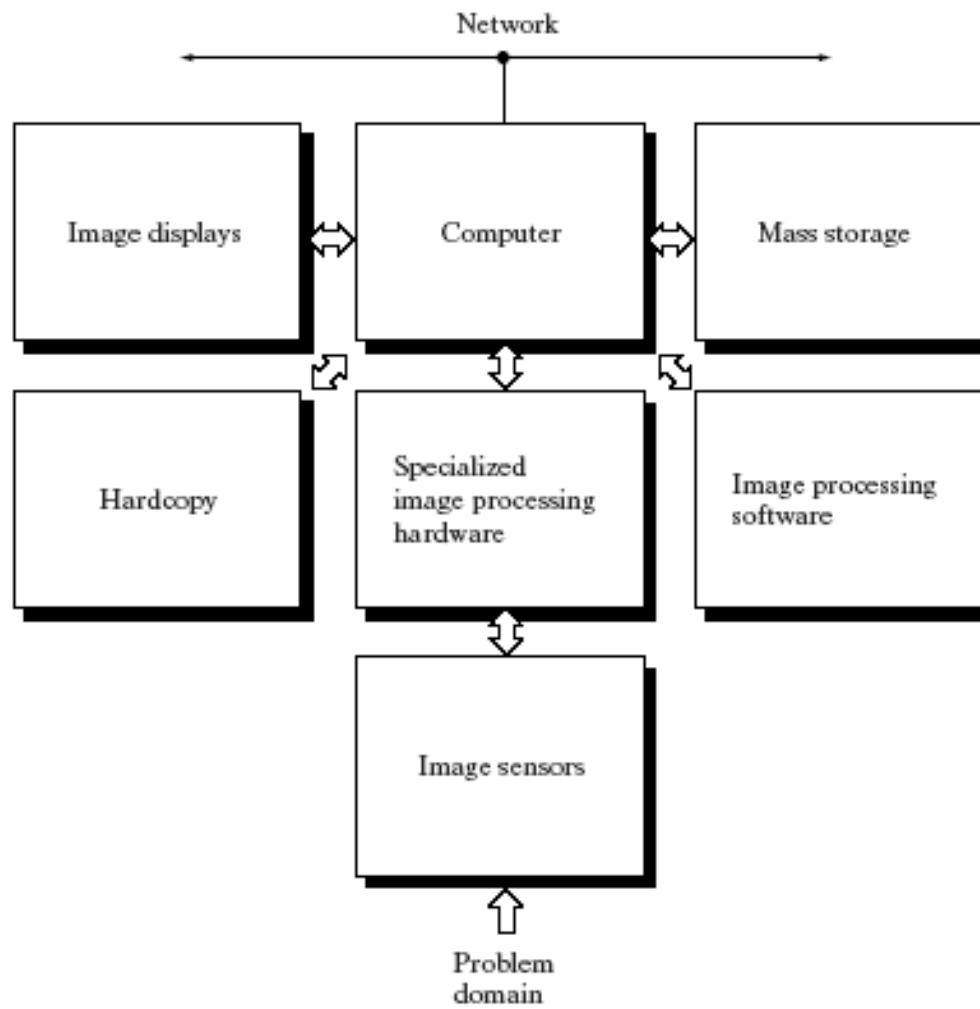


FIGURE 1.24
Components of a
general-purpose
image processing
system.



6. Components of an IP System

■ Image Sensors

- Two elements are required to acquire digital images.
 - The first is a physical device that is sensitive to the energy radiated by the object we wish to image.
 - The second, called a *digitizer*, is a device for converting the output of the physical sensing device into digital form.

■ Specialized image processing hardware

- Digitizer just mentioned;
- Hardware that performs other primitive operations



6. Components of An IP System

■ The Computer

- The *computer* in an image processing system is a general-purpose computer and can range from a PC to a supercomputer. In dedicated applications, sometimes specially designed computers are used to achieve a required level of performance, but our interest here is on general-purpose image processing systems. In these systems, almost any well-equipped PC-type machine is suitable for offline image processing tasks. Digitizer just mentioned;



6. Components of An IP System

- **Software**
 - *Software* for image processing consists of specialized modules that perform specific tasks. A well-designed package also includes the capability for the user to write code that, as a minimum, utilizes the specialized modules. More sophisticated software packages allow the integration of those modules and general-purpose software commands from at least one computer language
- **Mass storage**
- **Image display**
- **Other peripheral device**



7. Homework and Discussion

- 1. How to code in C# for Image processing?**
- 2. Which color model that beeing used in computer for storage and display?**
- 3. How to convert color image to gray image?**

Have anything else?



Summary

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2. What is Digital Image Processing (DIP)
3. The Origins of DIP
4. Examples of fields that use DIP
5. Fundamental steps
6. Components of An DIP System

