SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

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Department of Biomedical Engineering

Course Name: 19BMB304 & Biomedical Image Processing

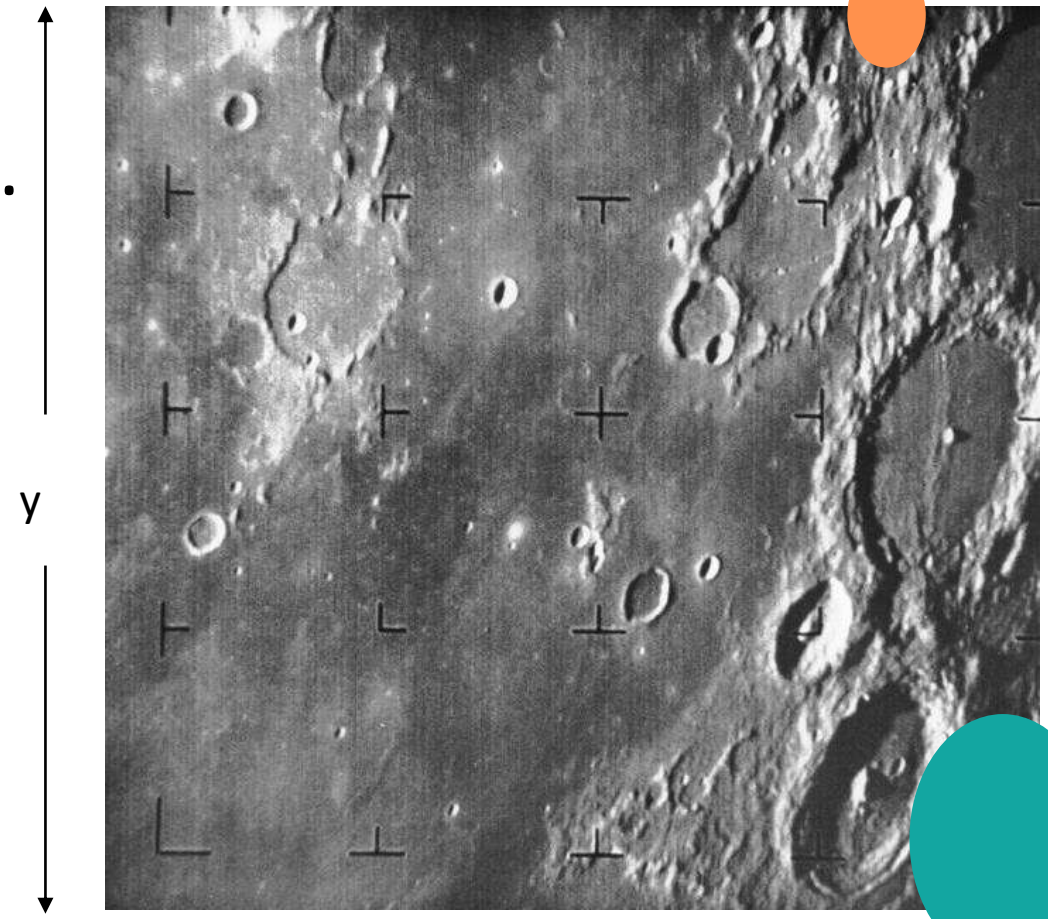
III Year : VI Semester

Unit I –DIGITAL IMAGE FUNDAMENTALS

Topic : Digital Image Processing - Fundamentals

What Is Digital Image Processing?

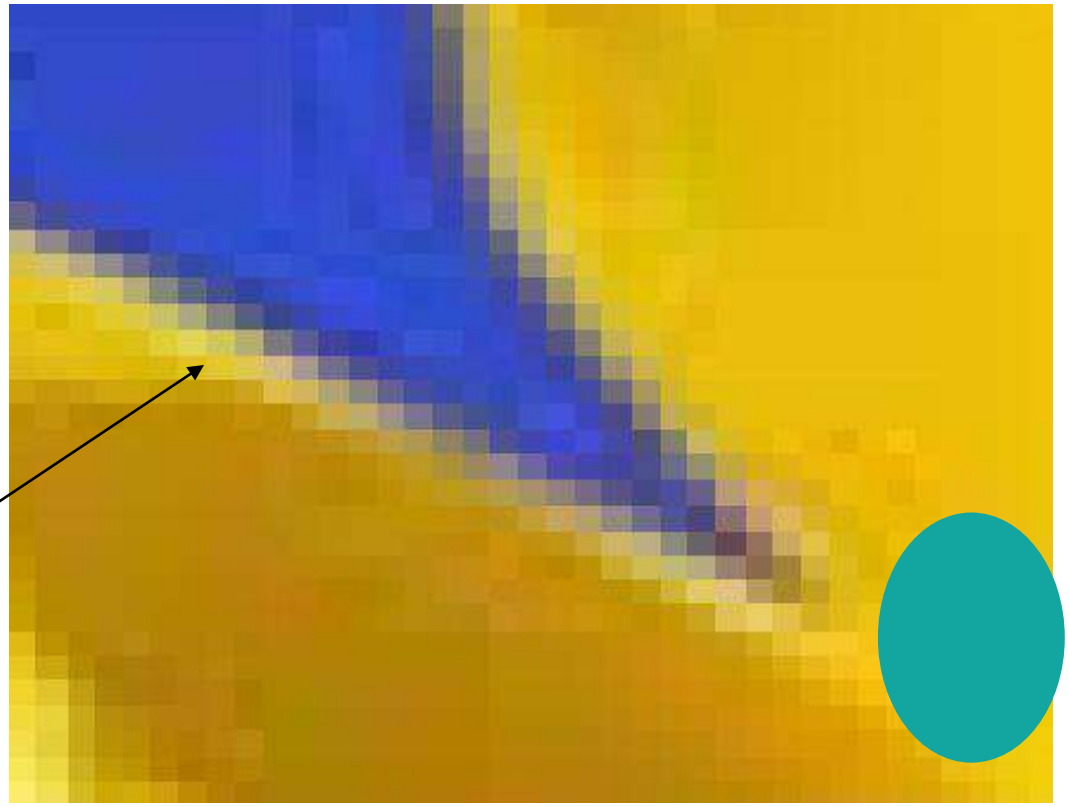
- A sample digital image. 662*640*256



- f(x,y): A two-dimensional function where x and y are spatial coordinates, and the amplitude of f at any pair of coordinates (x,y) is called the intensity or gray level of the image at that point.
- x size: 662, y size: 640, gray levels: 256
- Digital image: x, y, and the amplitude values of f are all finite, discrete quantities

- A sample color digital image, 800*600* 24 bits

- Pixel: The elements of a digital image.



- Some applications
  - **FUJIFILM**: Searching faces
  - License plates
  - Tracking people

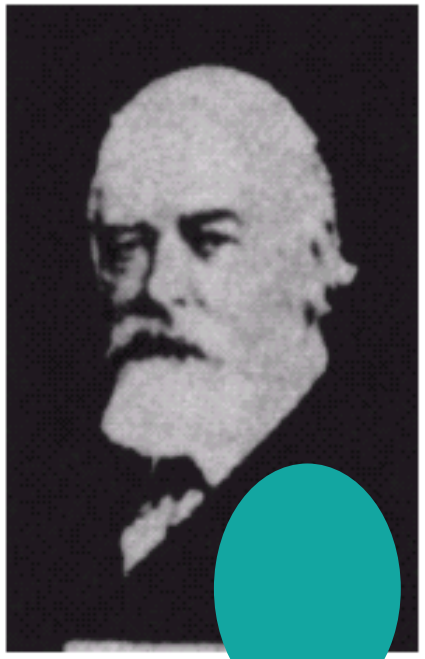
The Origins of Digital Image Processing

- One of the first applications of digital images was in the newspaper industry, when pictures were first sent by submarine cable between London and New York.

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

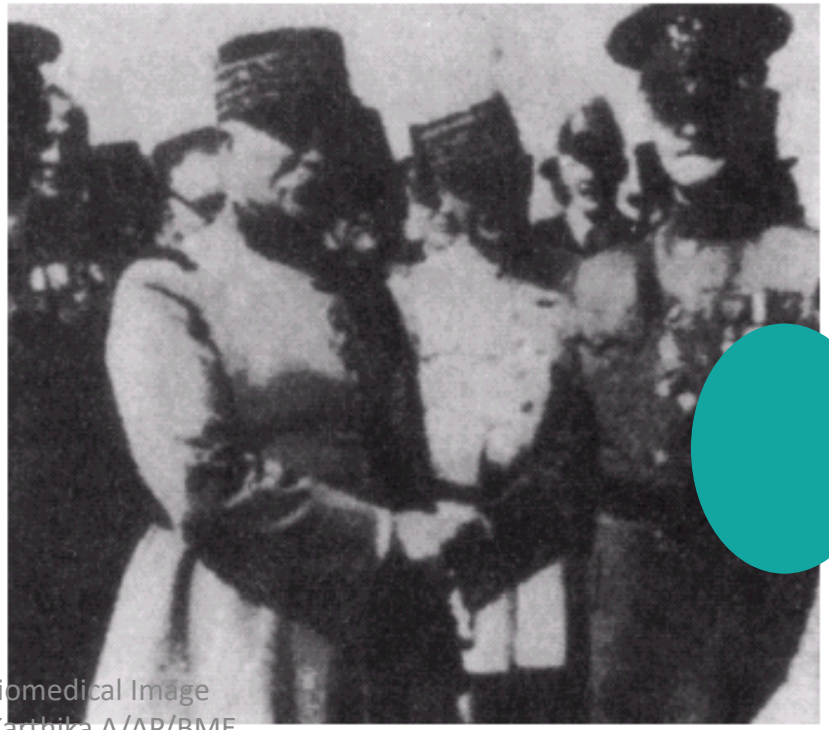
- Better quality

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.)



- 15-tone equipment

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



- From computers, meaningful image processing tasks appeared.

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.)

Applications

- Medical imaging
- Remote Earth resource observations
- Astronomy
- High-energy plasmas and electron microscopy

Examples of Fields that Use Digital Image Processing

- Electromagnetic energy spectrum

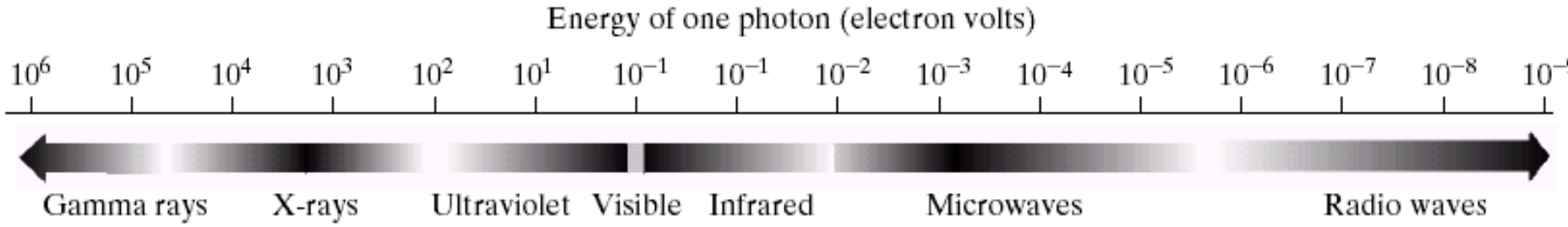
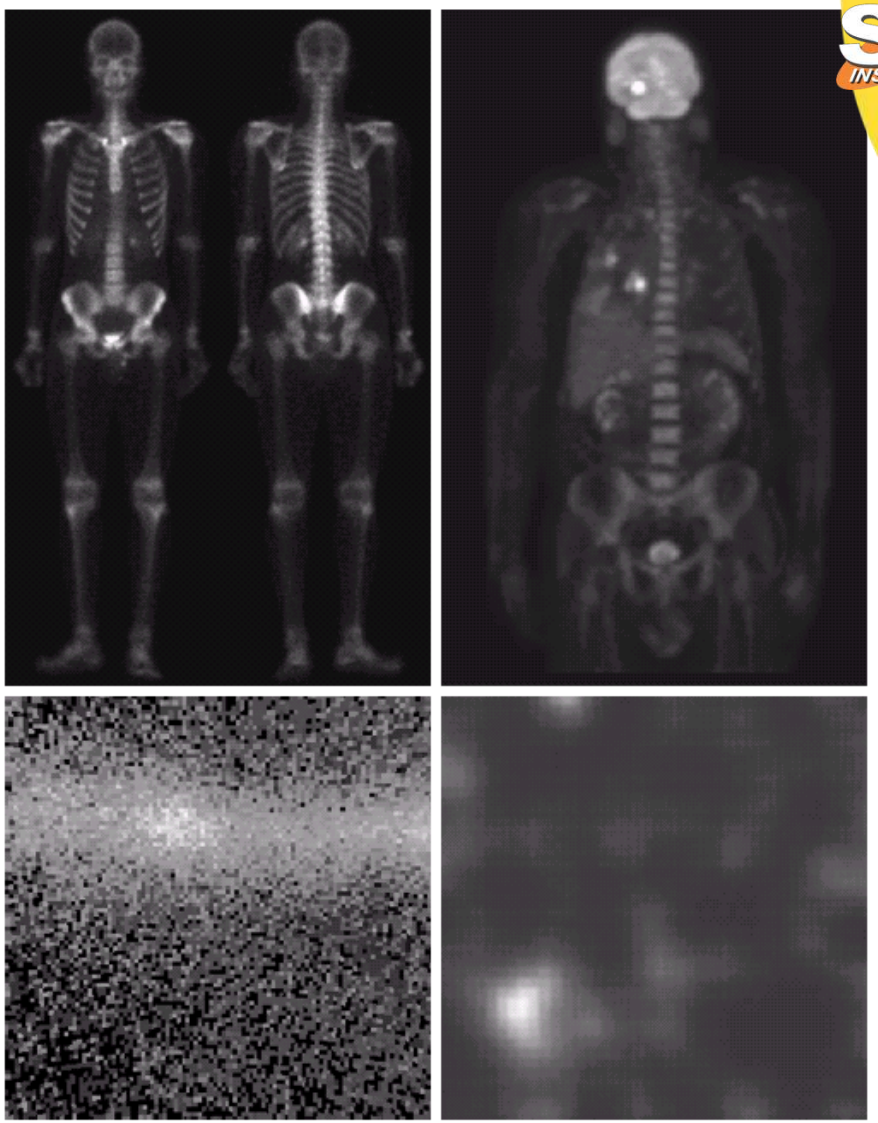


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

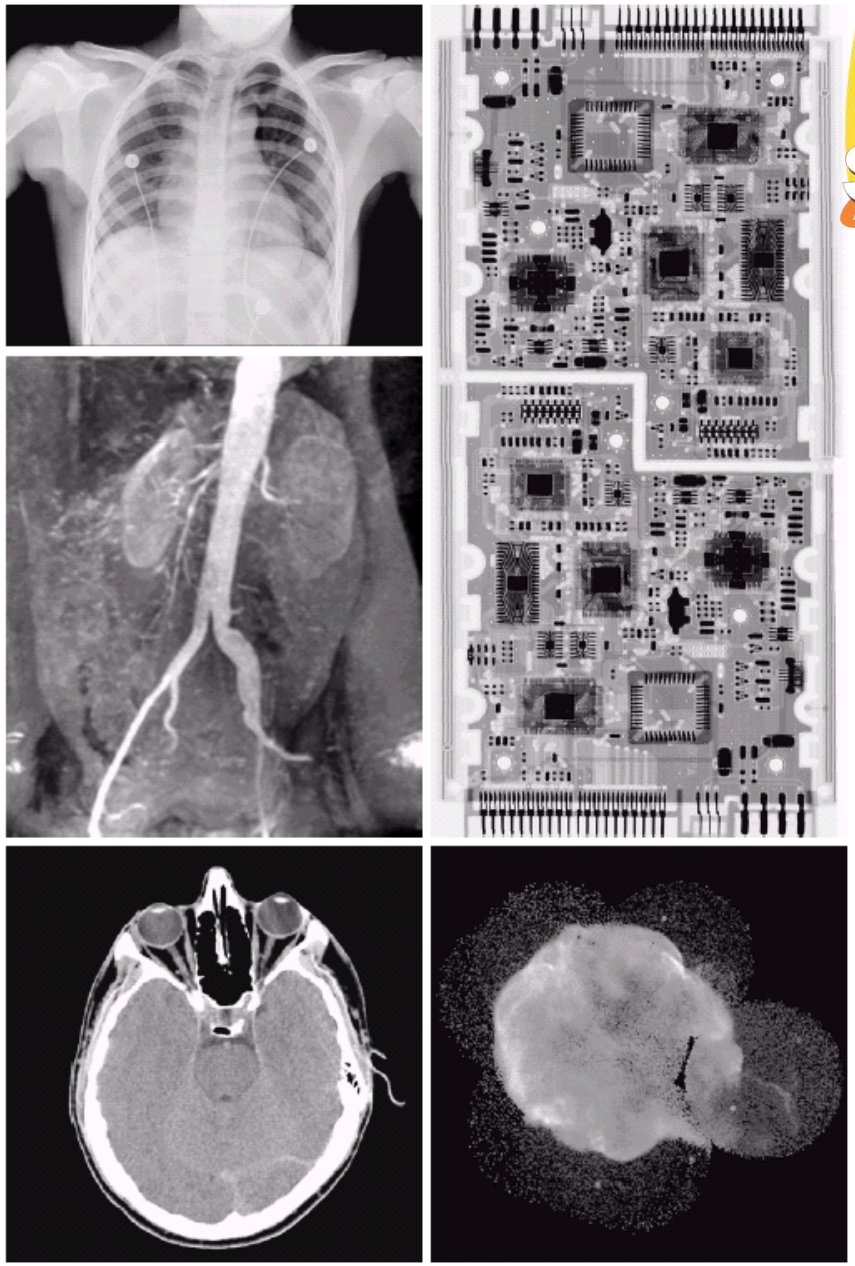
Gamma Ray Imaging

a b
c d

FIGURE 1.6 Examples of gamma-ray imaging. (a) Bone scan. (b) PET image. (c) Cygnus Loop. (d) Gamma radiation (bright spot) from a reactor valve. (Images courtesy of (a) G.E. Medical Systems, (b) Dr. Michael E. Casey, CTI PET Systems, (c) NASA, (d) Professors Zhong He and David K. Wehe, University of Michigan.)



X-ray Imaging



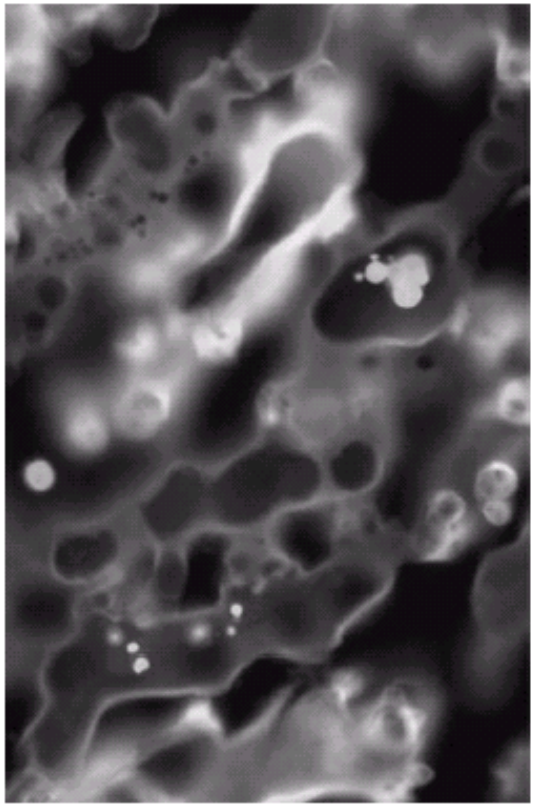
a b c d e

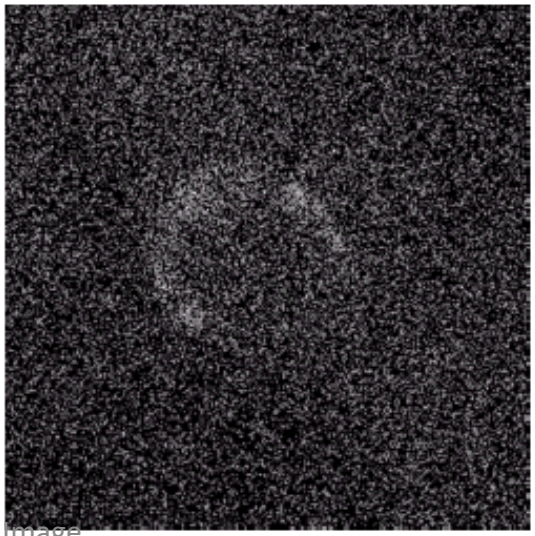
FIGURE 1.7 Examples of X-ray imaging. (a) Chest X-ray. (b) Aortic angiogram. (c) Head CT. (d) Circuit boards. (e) Cygnus Loop. (Images courtesy of (a) and (c) Dr. David R. Pickens, Dept. of Radiology & Radiological Sciences, Vanderbilt University Medical Center. (b) Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School. (d) Mr. Joseph E. Pascente, Lixi, Inc., and (e) NASA.)

Imaging in the Ultraviolet Band

a b
c

FIGURE 1.8 Examples of ultraviolet imaging. (a) Normal corn. (b) Smut corn. (c) Cygnus Loop. (Images courtesy of (a) and (b) Dr. Michael W. Davidson, Florida State University, (c) NASA.)





Imaging in the Visible and Infrared Bands

a b c
d e f

FIGURE 1.9 Examples of light microscopy images. (a) Taxol (anticancer agent), magnified 250×. (b) Cholesterol—40×. (c) Microprocessor—60×. (d) Nickel oxide thin film—600×. (e) Surface of audio CD—1750×. (f) Organic superconductor—450×. (Images courtesy of Dr. Michael W. Davidson, Florida State University.)

- Remote sensing

TABLE 1.1
Thematic bands in NASA's LANDSAT satellite.

Band No.	Name	Wavelength (μm)	Characteristics and Uses
1	Visible blue	0.45–0.52	Maximum water penetration
2	Visible green	0.52–0.60	Good for measuring plant vigor
3	Visible red	0.63–0.69	Vegetation discrimination
4	Near infrared	0.76–0.90	Biomass and shoreline mapping
5	Middle infrared	1.55–1.75	Moisture conte and vegetatio
6	Thermal infrared	10.4–12.5	Soil moisture; t mapping
7	Middle infrared	2.08–2.35	Mineral mapping

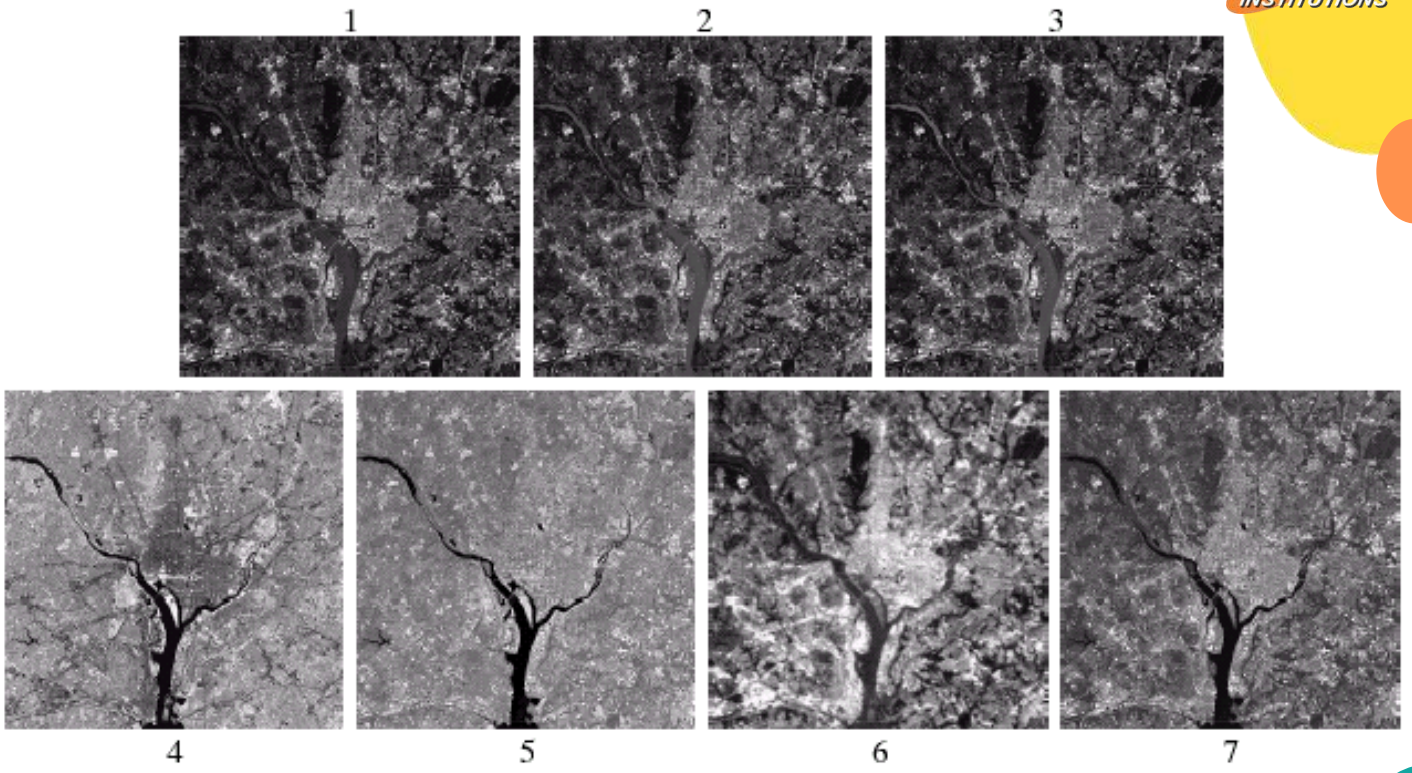
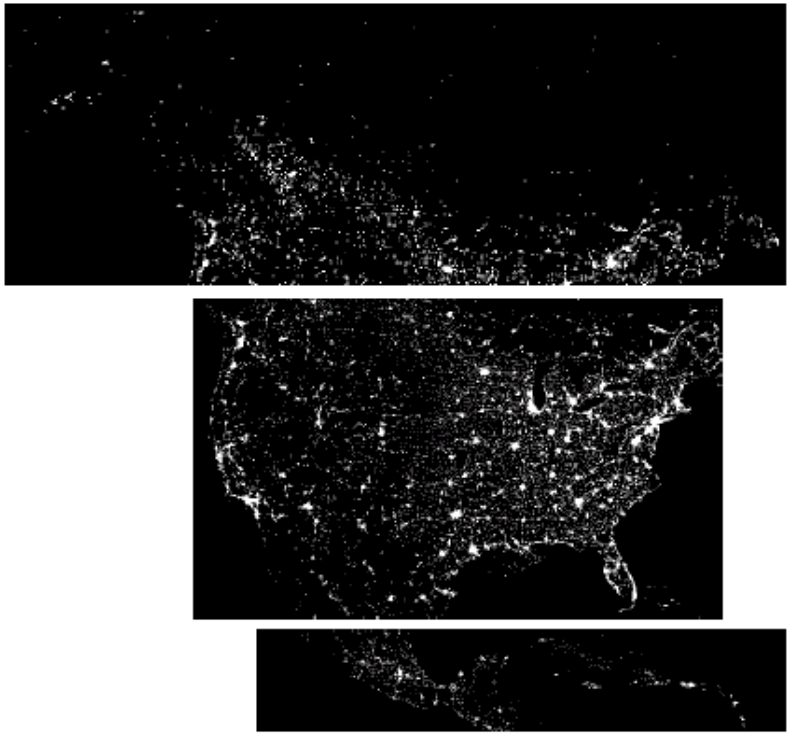


FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thema
bands in Table 1.1. (Images courtesy of NASA.)

- Weather Observation, visible and infrared bands

FIGURE 1
Satellite image of Hurricane Katrina taken on August 29, 2005. (Courtesy of NOAA.)

FIGURE 1.12
Infrared satellite images of the Americas. The small gray map is provided for reference. (Courtesy of NOAA.)



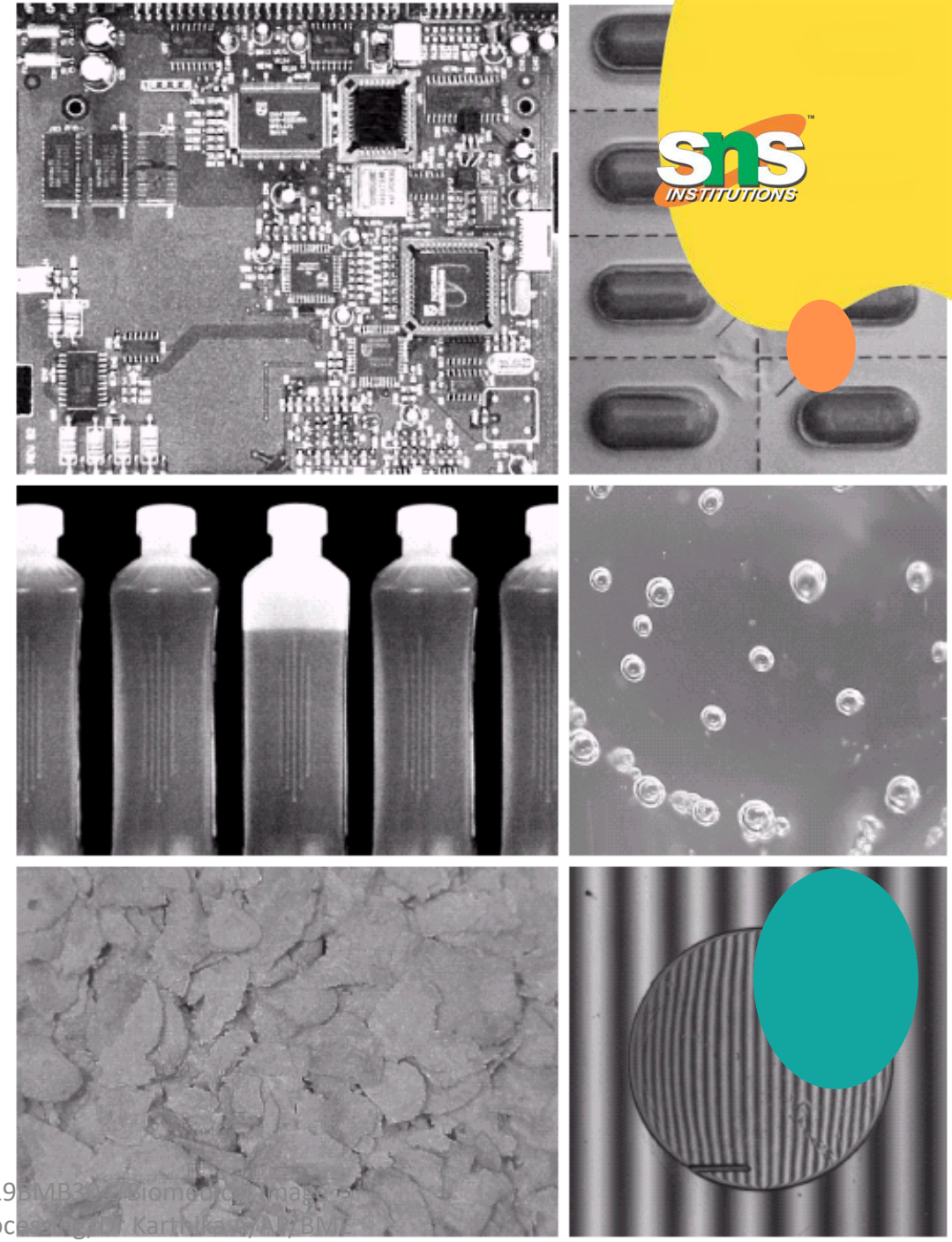
- **Infrared imaging**

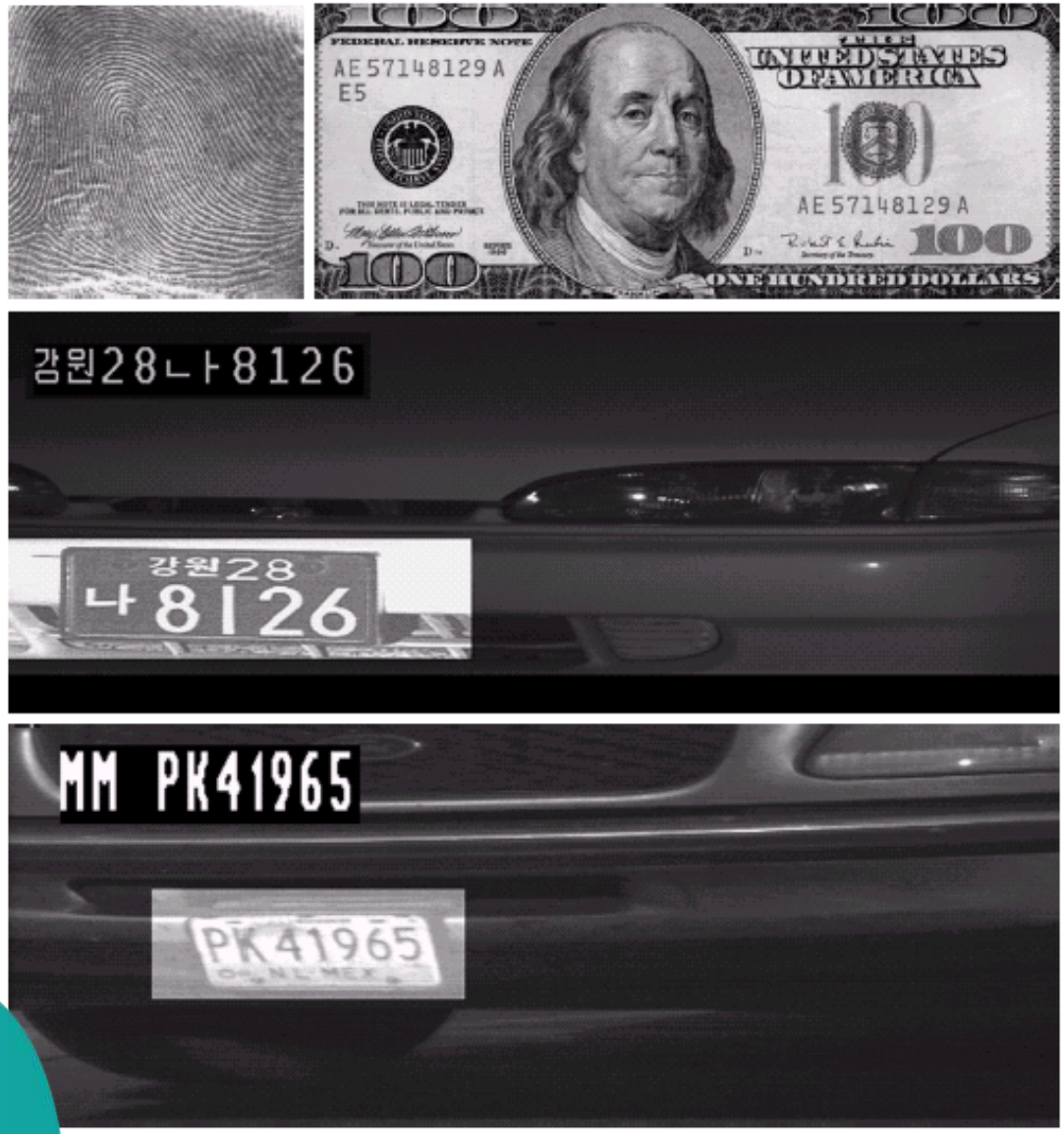
FIGURE 1.13
Infrared satellite images of the remaining populated part of the world. The small gray map is provided for reference. (Courtesy of NOAA.)

- Automated visual inspection

a b
c d
e f

FIGURE 1.14
Some examples of manufactured goods often checked using digital image processing. (a) A circuit board controller. (b) Packaged pills. (c) Bottles. (d) Bubbles in clear-plastic product. (e) Cereal. (f) Image of intraocular implant. (Fig. (f) courtesy of Mr. Pete Sites, Perceptics Corporation.)



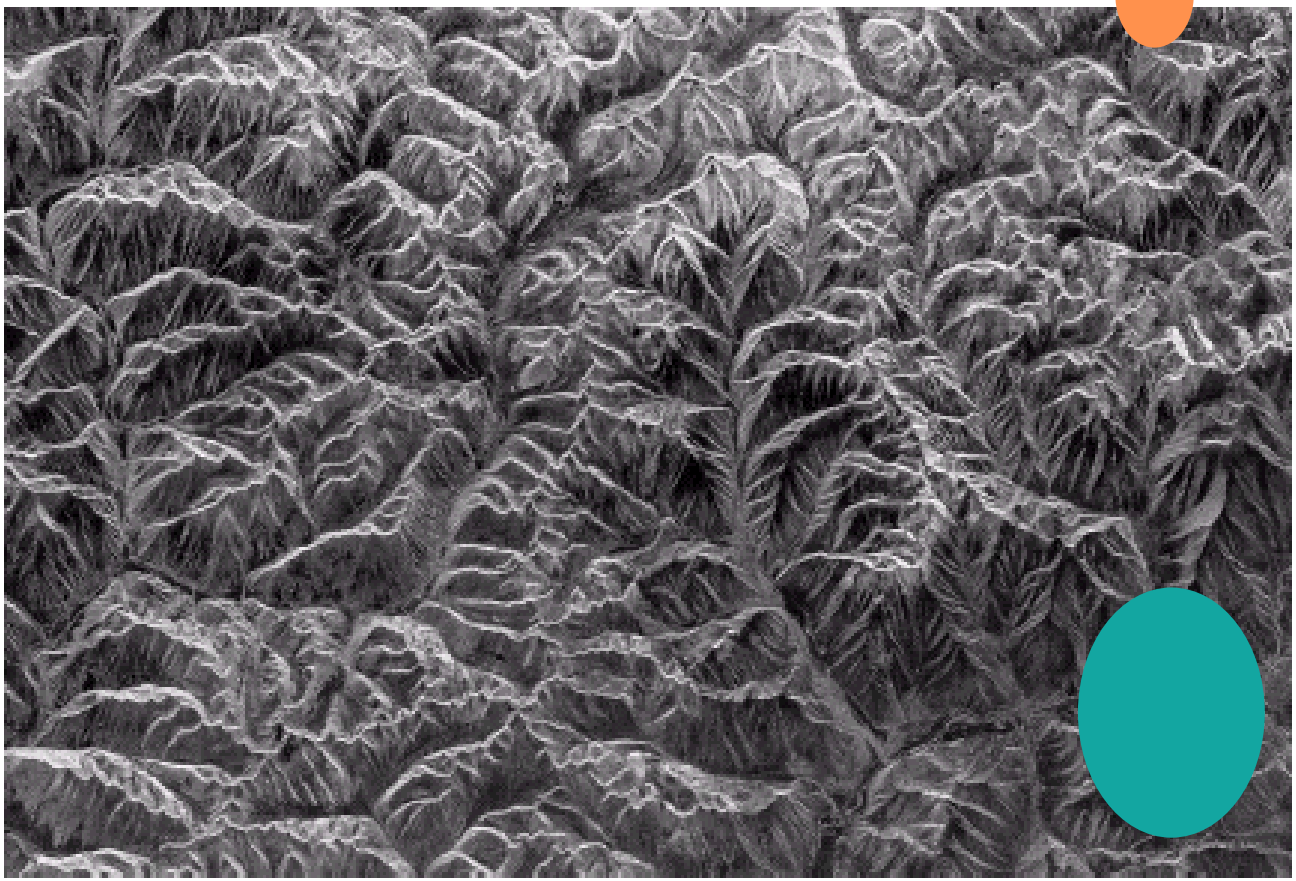


a b
c
d

FIGURE 1.15 Some additio 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.)

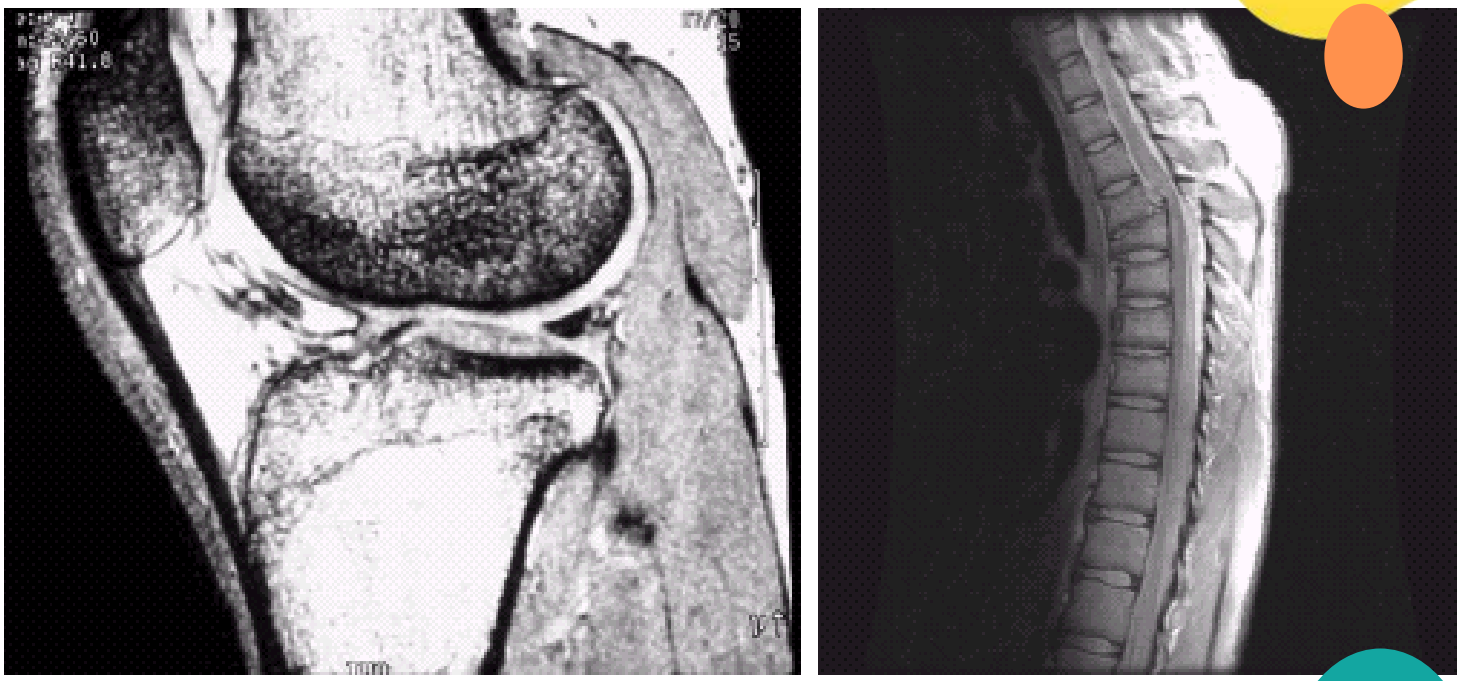
Imaging in the Microwave Band

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



Imaging in the Radio Ban

- MRI



a b

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

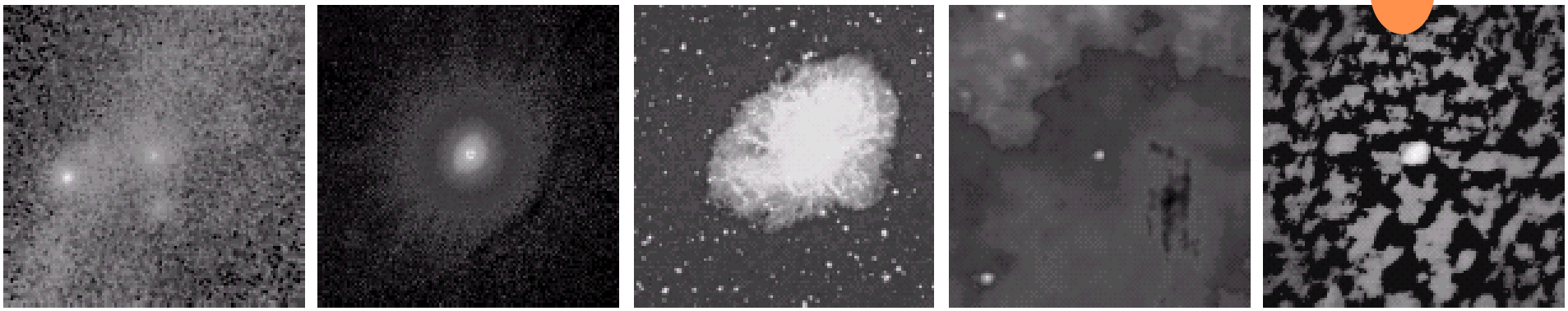
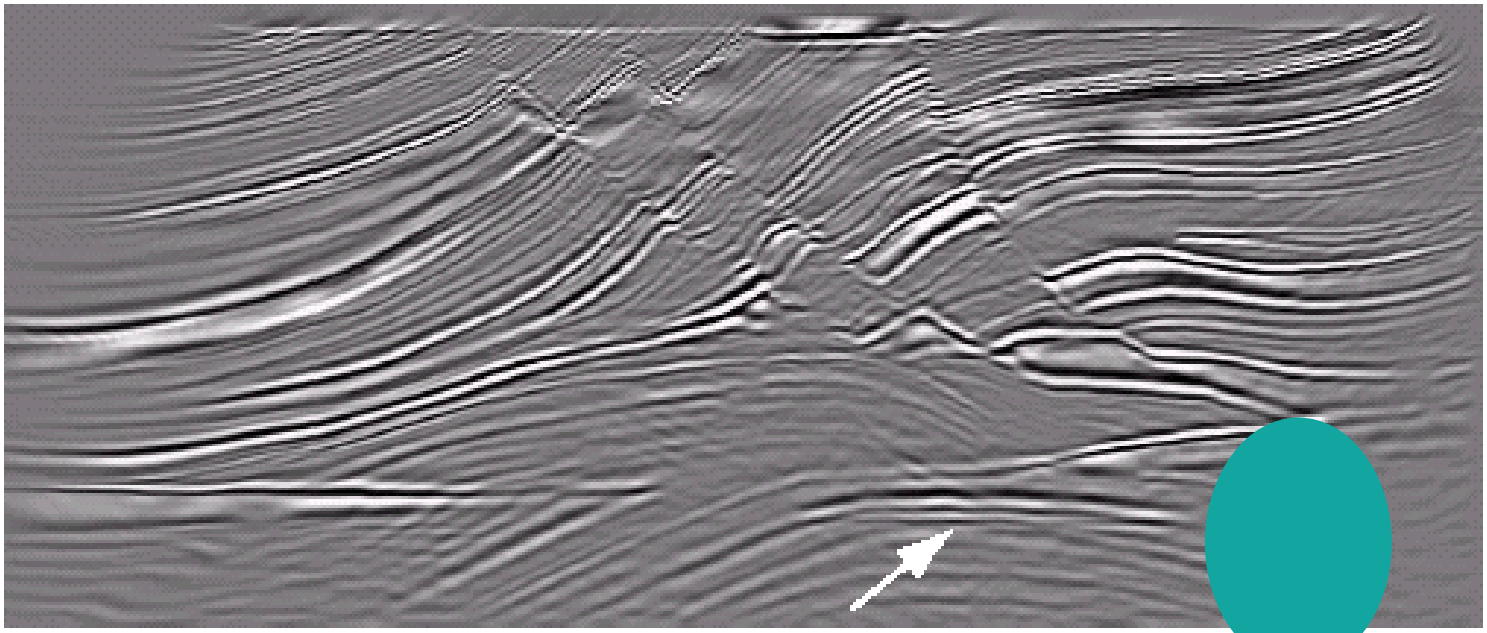


FIGURE 1.18 Images of the Crab Pulsar (in the center of images) covering the electromagnetic spectrum. (Courtesy of NASA.)

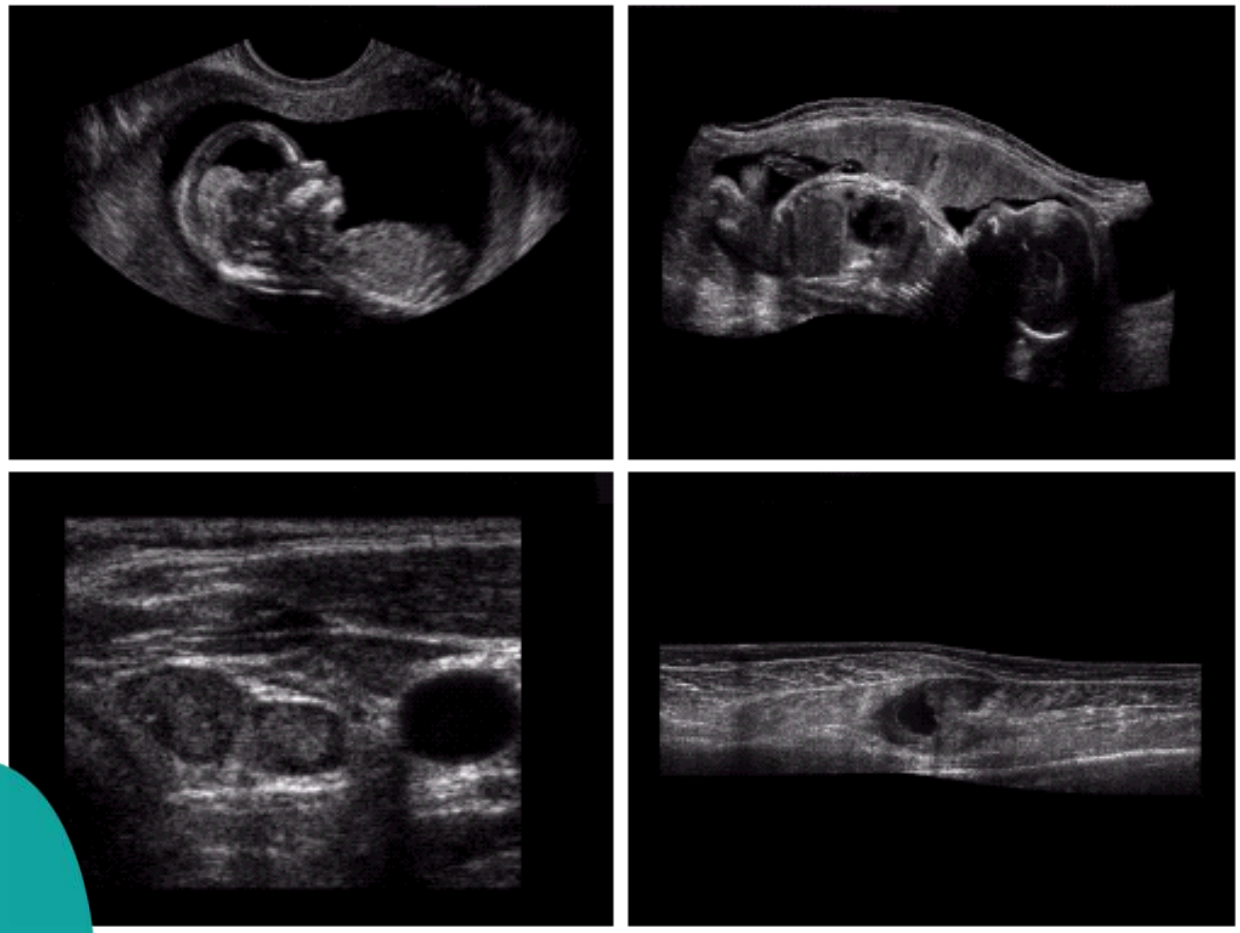
Examples in which Other Imaging Modalities Are Used

- Sound

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.)



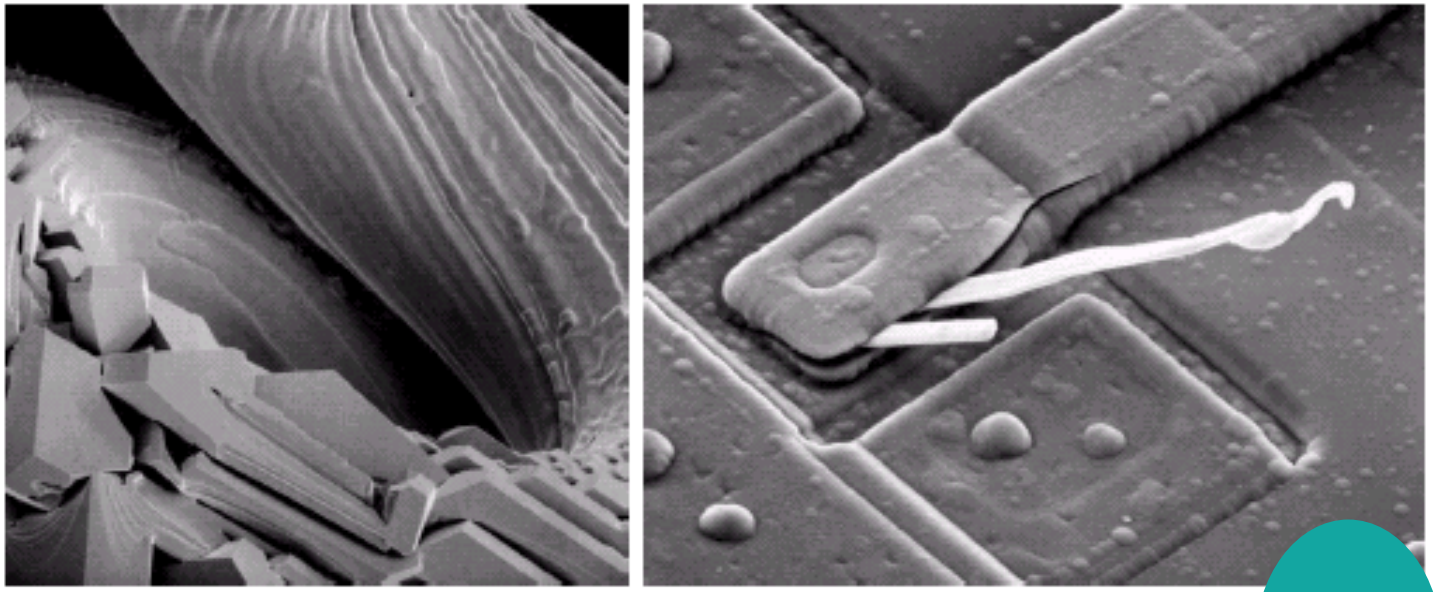
Ultrasound



a b
c d

FIGURE 1.20 Examples of ultrasound imaging. (a) Baby. (2) Another view of baby. (c) Thyroids. (d) Muscle layers showing lesion. (Courtesy of Siemens Medical Systems, Inc., Ultrasound Group.)

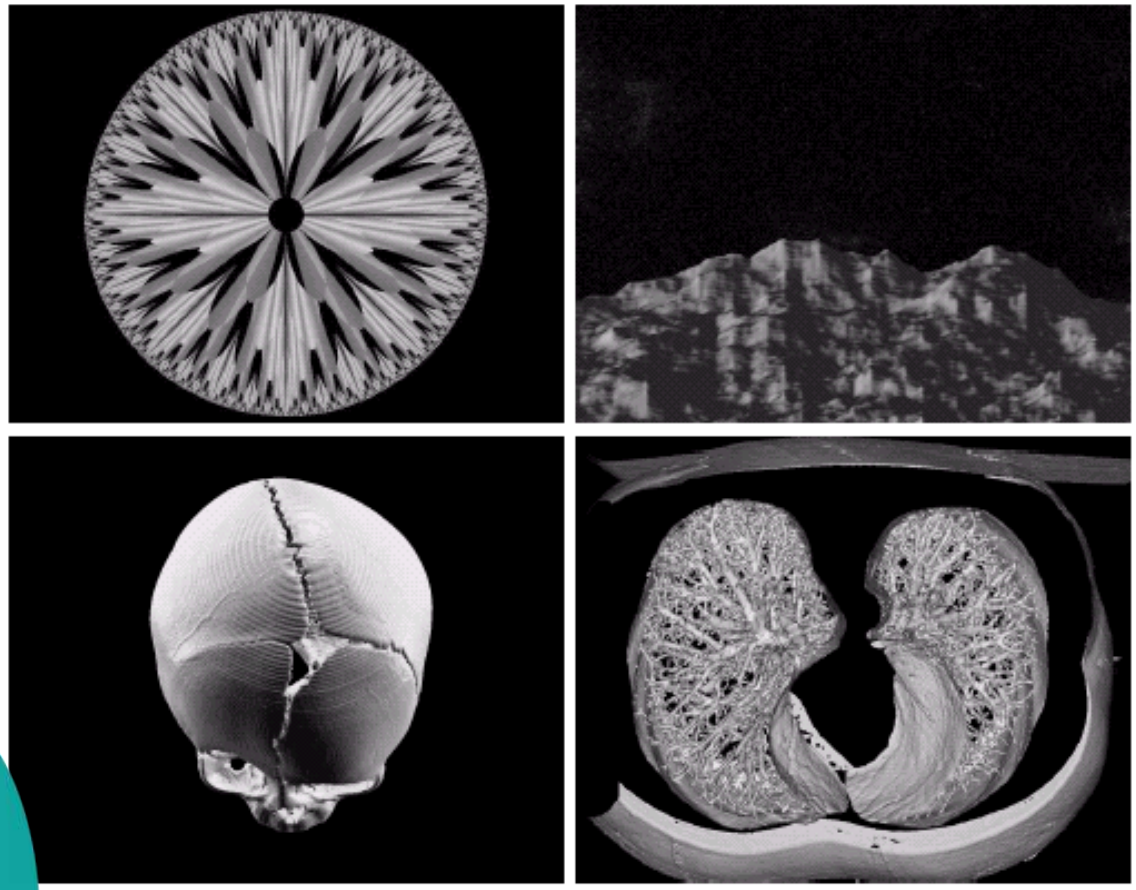
- Electron Microscope



a b

FIGURE 1.21 (a) 250× SEM image of a tungsten filament following therma
(b) 2500× SEM image of damaged integrated circuit. The white fibers are oxi e-
sulting from thermal destruction. (Figure (a) courtesy of Mr. Michael Shaffer, Depart-
ment of Geological Sciences, University of Oregon, Eugene; (b) courtesy of Dr.
J. M. Hudak, McMaster University, Hamilton, Ontario, Canada.)

Images generated by computers



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.)

Thank You