



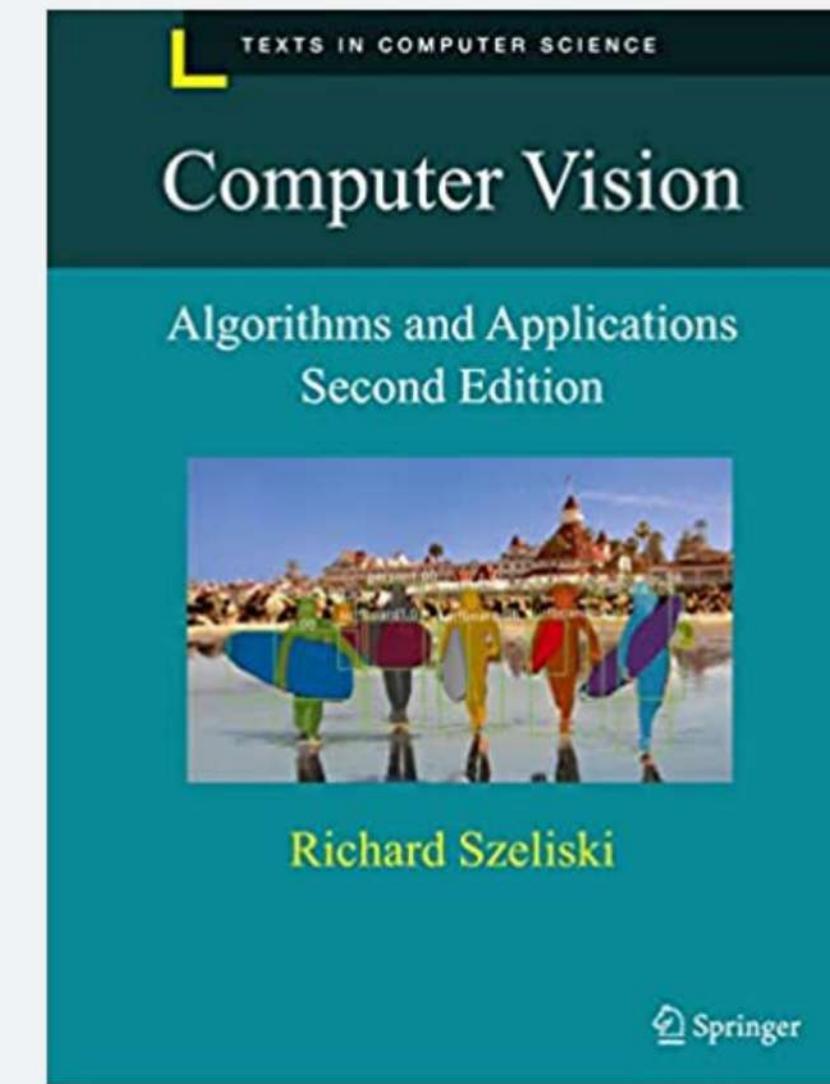
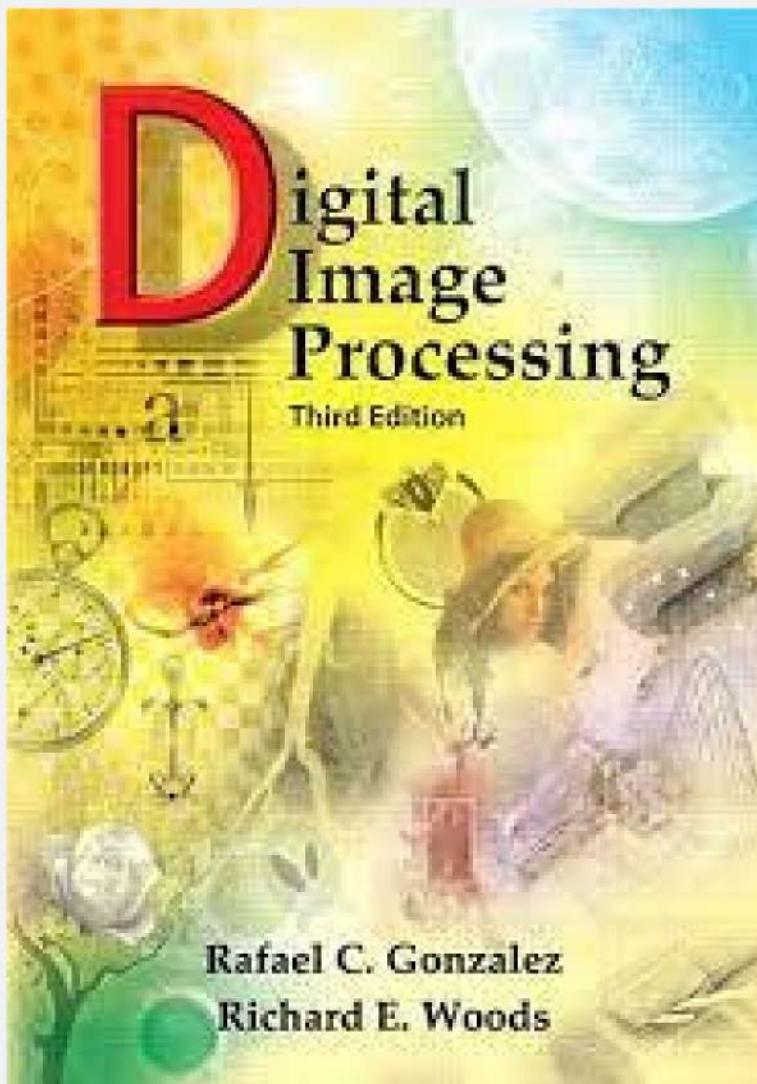
Digital Image Processing

Computer Vision School
March 2023



@AminAlipour_It

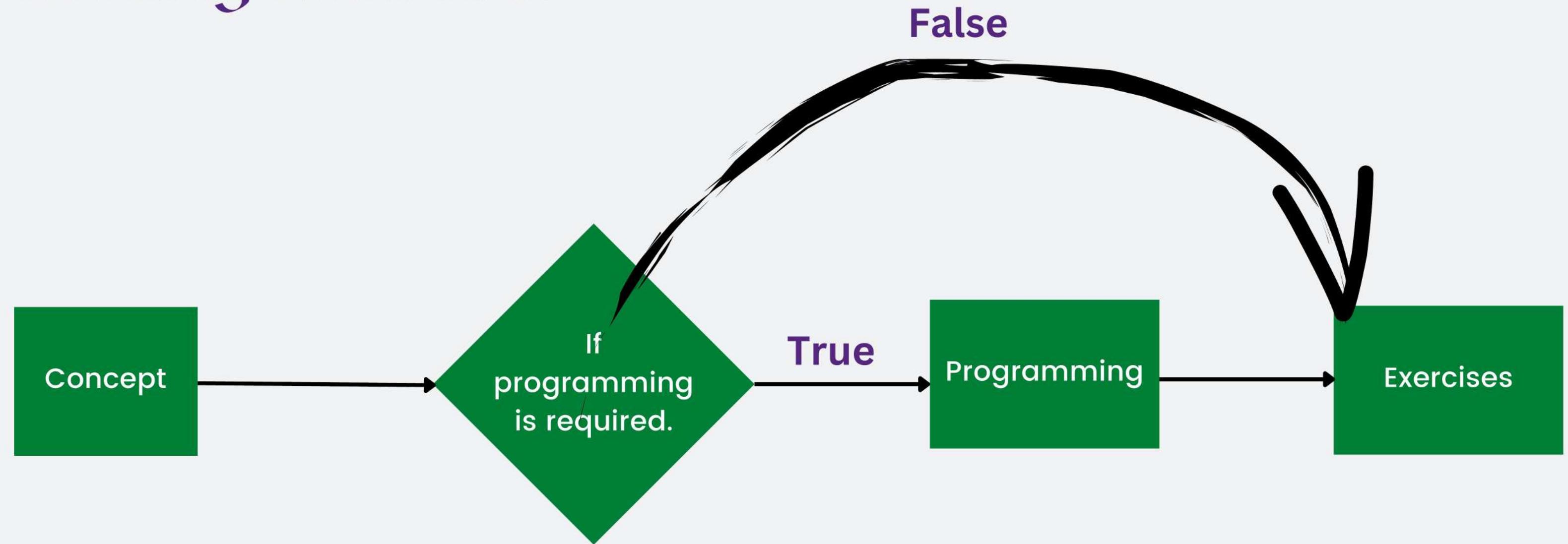
Ref.



Syllabus

- | | | |
|--|--------------------------------------|--|
| 1. Introduction & History | 11. Interpolation | 21. Pattern Matching |
| 2. Image | 12. 3D Images | 22. Shape Descriptors & Pattern |
| 3. Color | 13. Segmentation | Recognition |
| 4. Optics and Image formation | 14. Morphological Operators | 23. Image Classification |
| 5. Depth of Focus / Field | 15. Image Noise and Denoising | 24. Object Tracking |
| 6. Optical Aberrations | 16. Convolution Operators | |
| 7. CCD & CMOS | 17. Correlation | |
| 8. Bit depth | 18. Edge Detection | |
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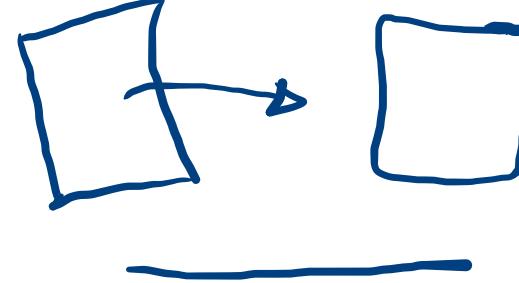
Teaching Method



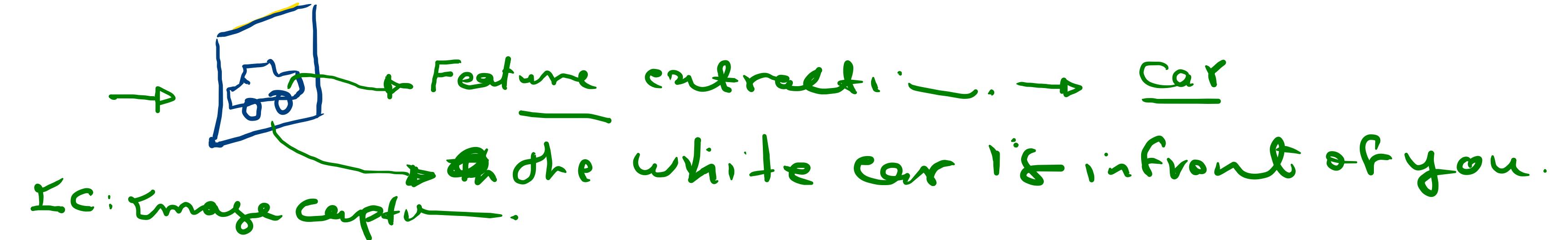
Introduction & History

What is Image Processing?

Digital Image Processing



Digital Image Processing consists of the various techniques and methods involving in the manipulation of images on a computer. Various types of operations are performed on images, which constitute Digital Image Processing.



What is Computer Vision?

→ I_P

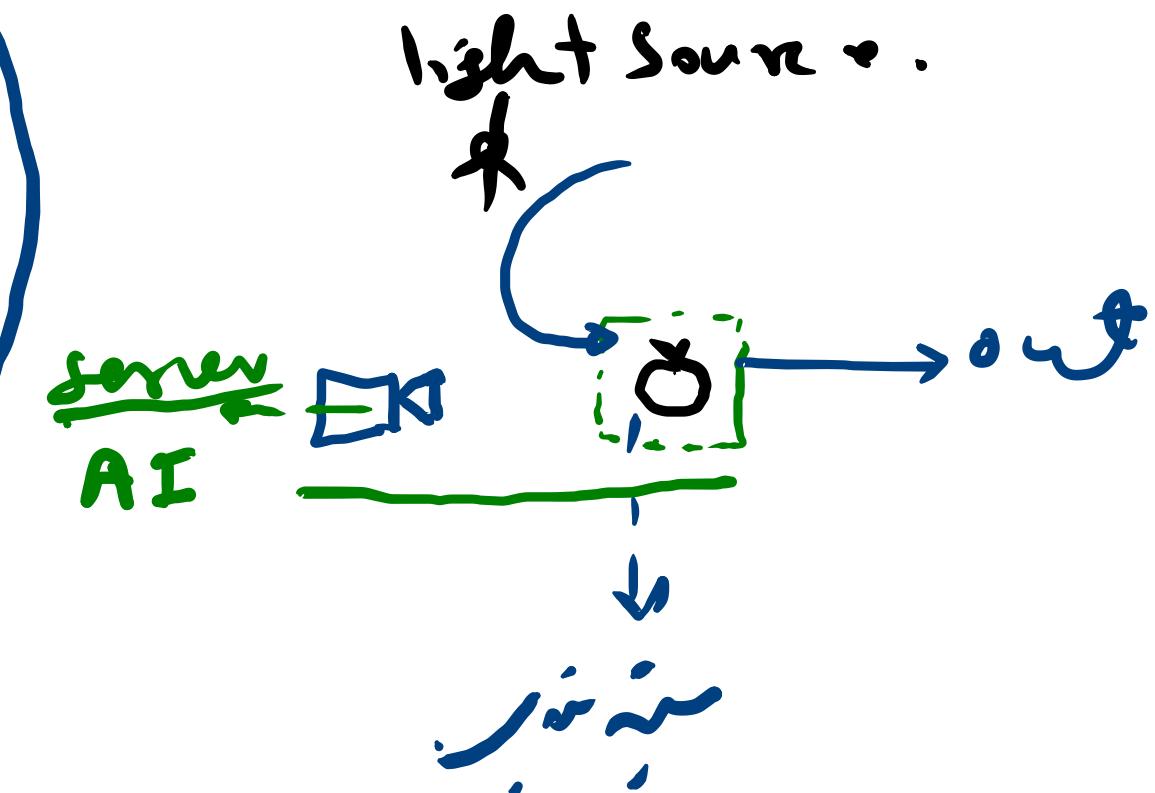
Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos, and other visual inputs – and take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand.

high-level
mid-level

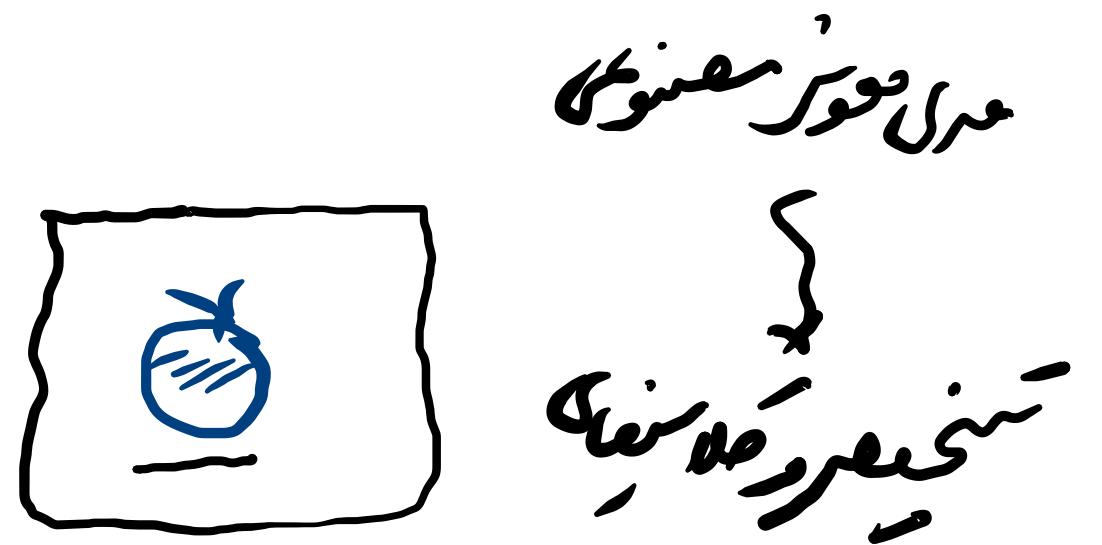
Computer vision

- نور حس بینی!
- صنعتی ام بینی!
- Object پرستی!

Machine vision



- نظریّہ نور حس بینی!
- نظریّہ Scene حس بینی!
- بررسی حس بینی!



apple

building

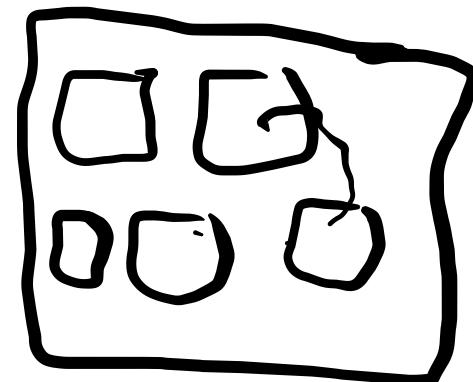
apple



apple



child

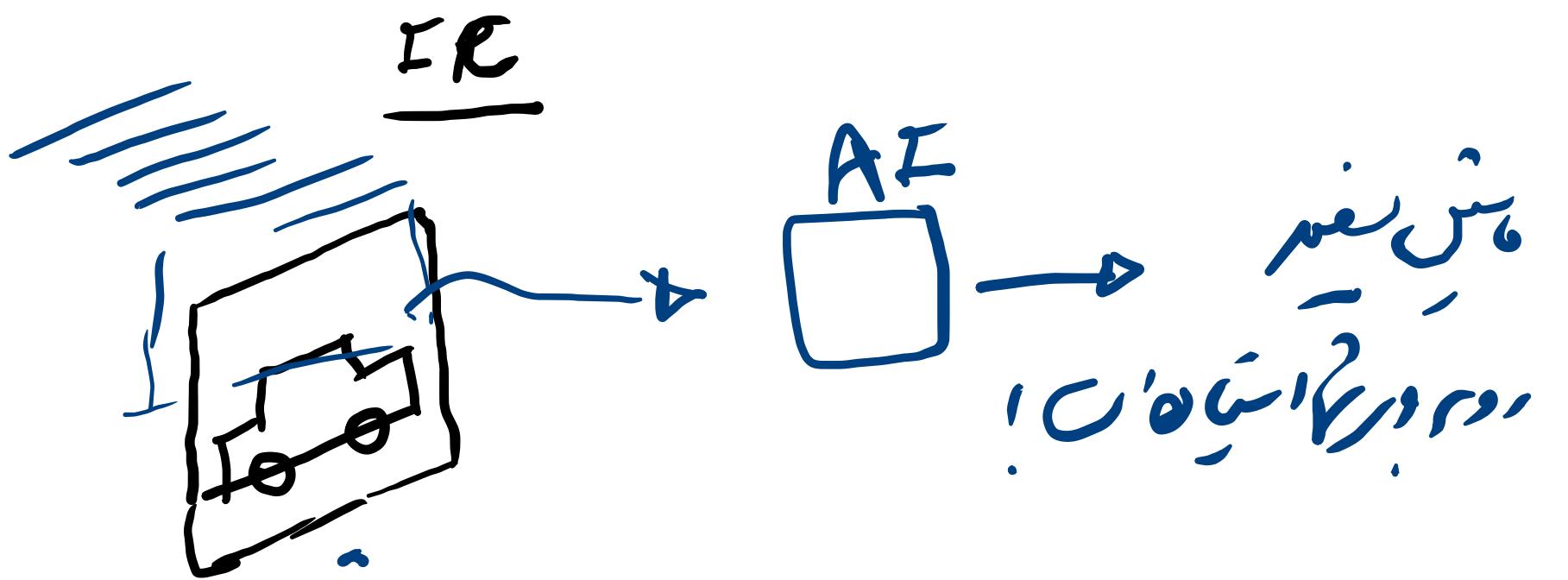


cv

object

Detection





CV + NLP

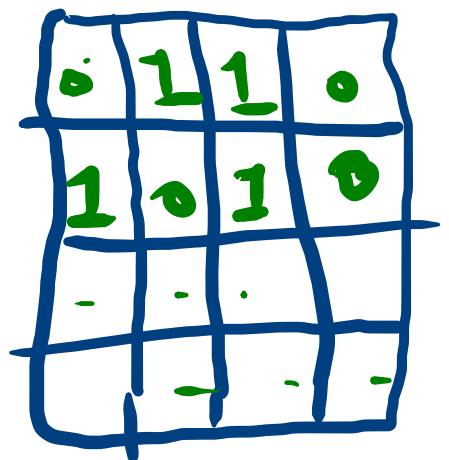
London → New York
2 weeks ✓
Submarine
telegraph.



A 1920s Brief HISTORY

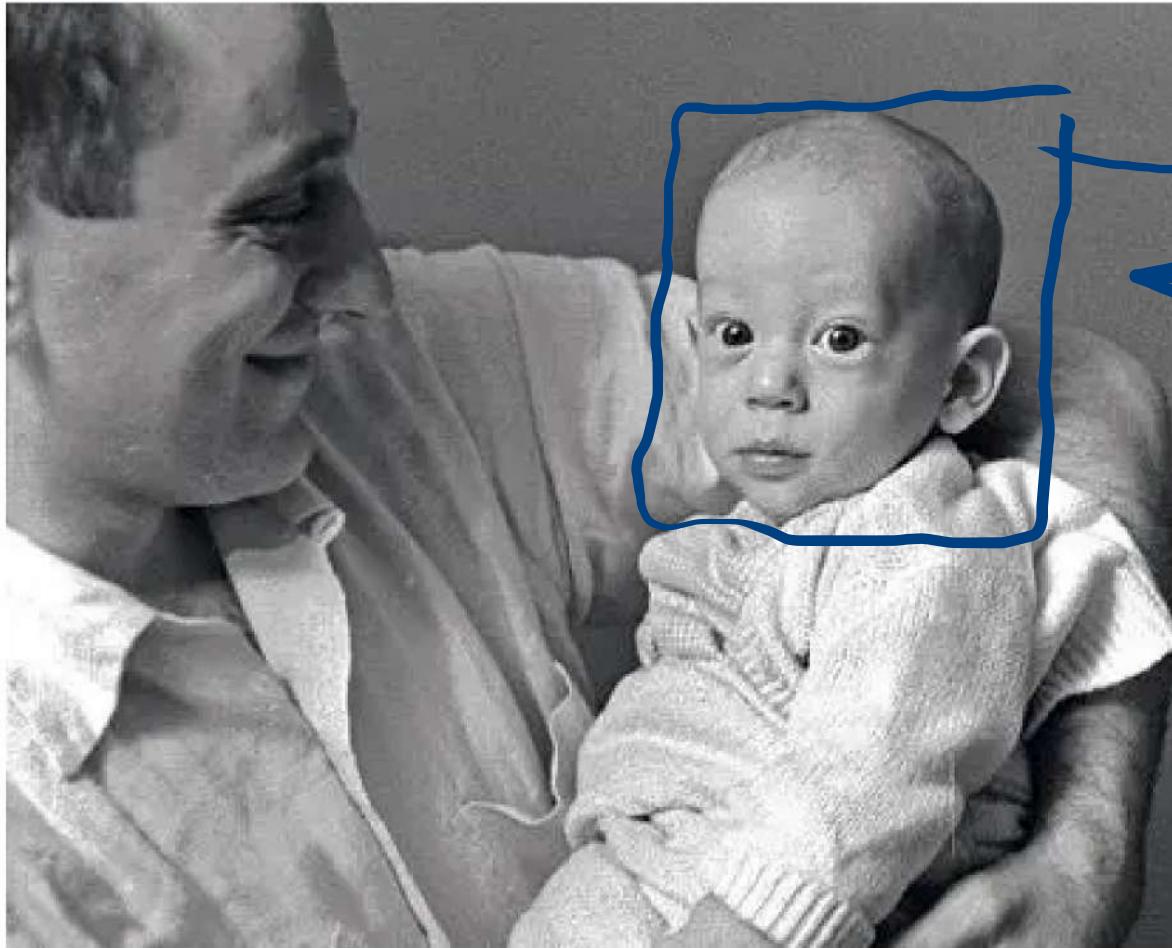
A Brief HISTORY

1950s



Scanner

0-294



A Brief HISTORY

1960s



A Brief HISTORY

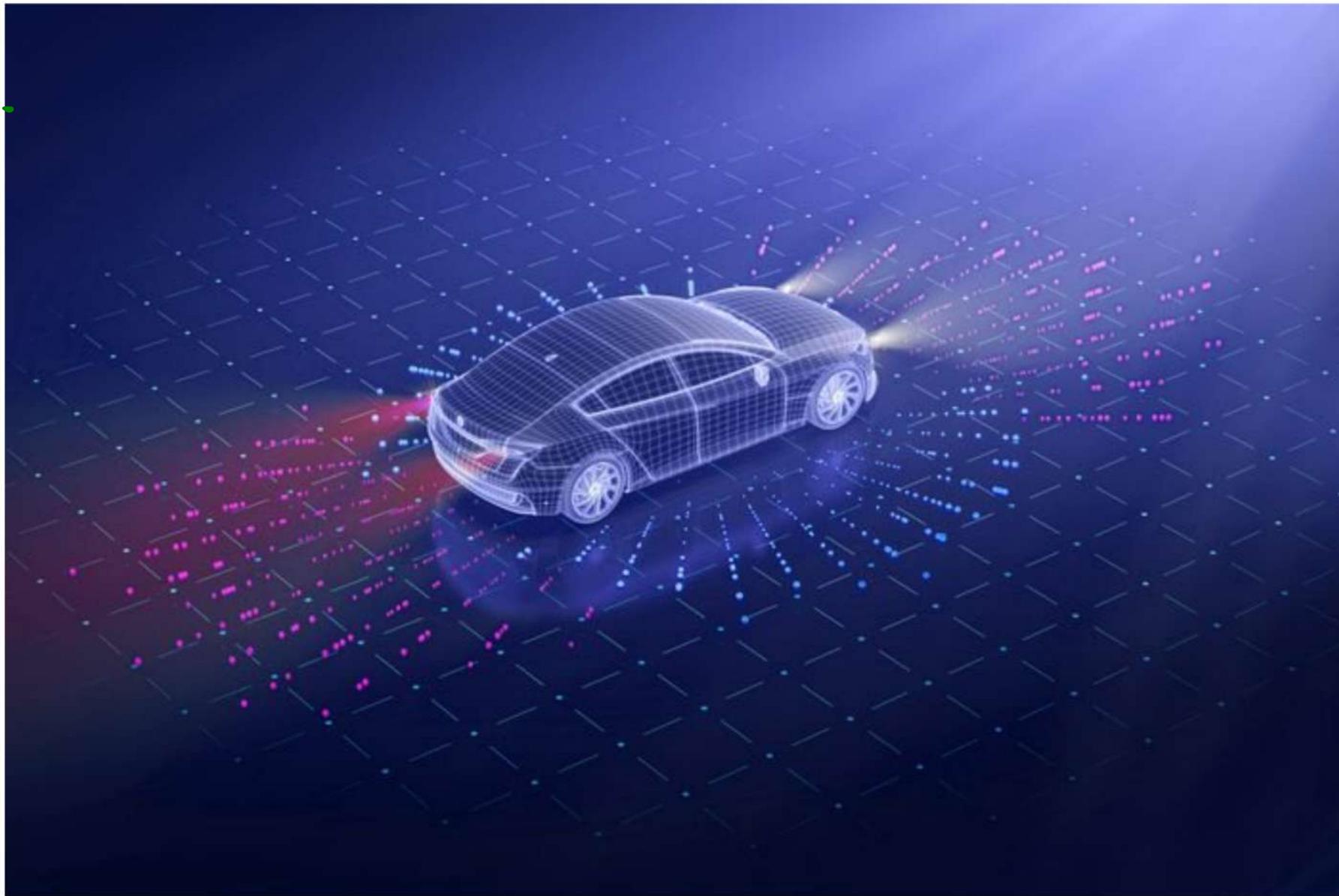
1970s



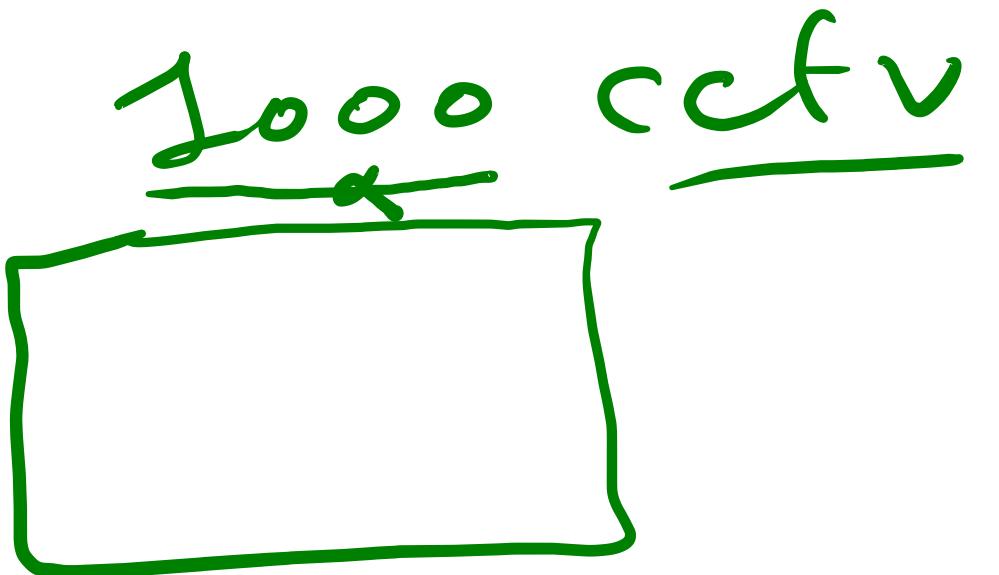
A Brief HISTORY

1980s -
Todays

mechanical
driver test cars



missiles
cetv

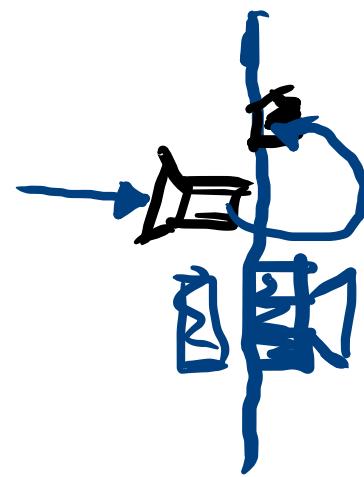


AI

daily report

→ see videos AI 1page.

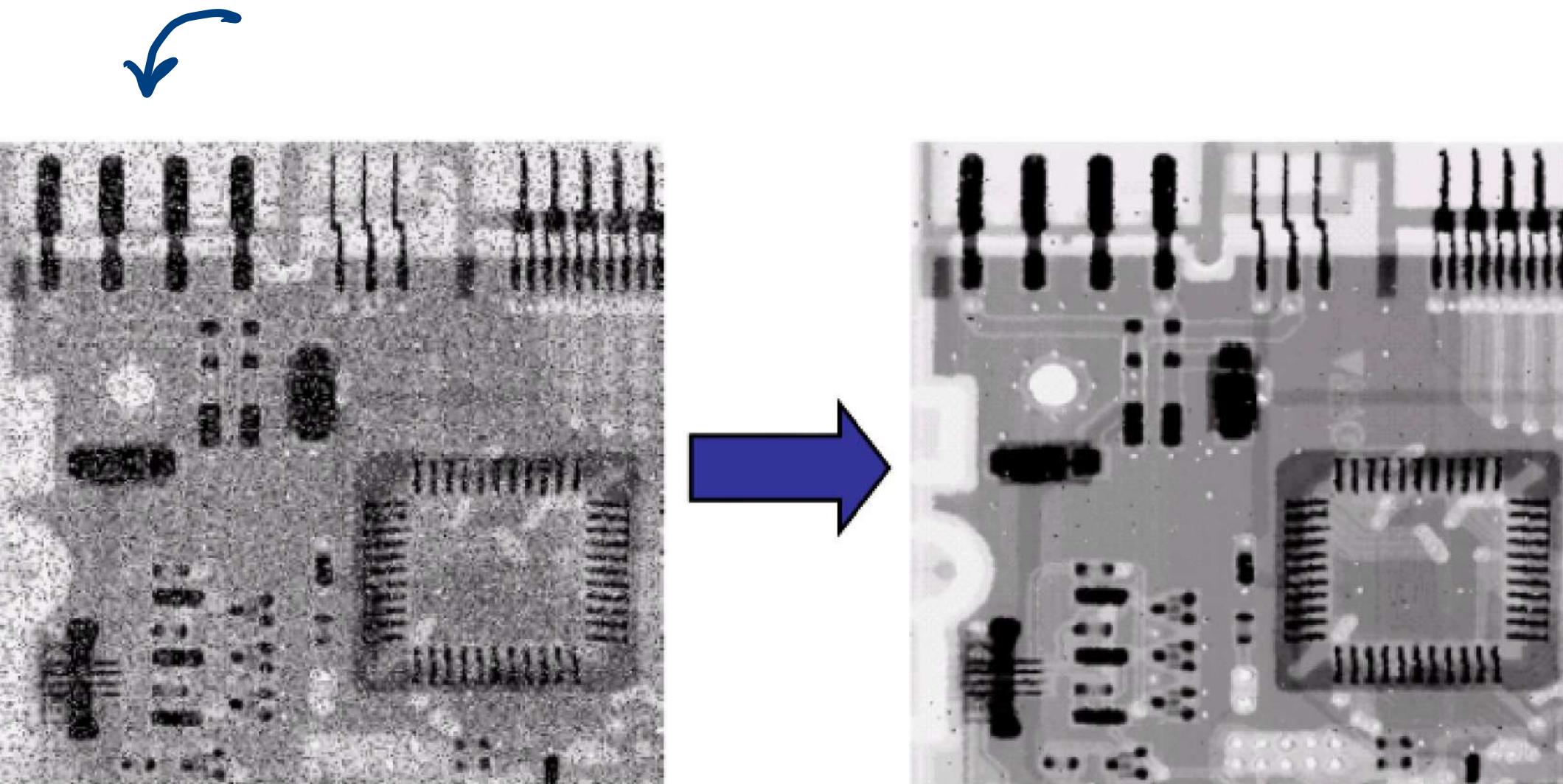




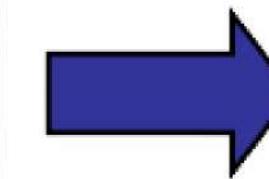
Applications



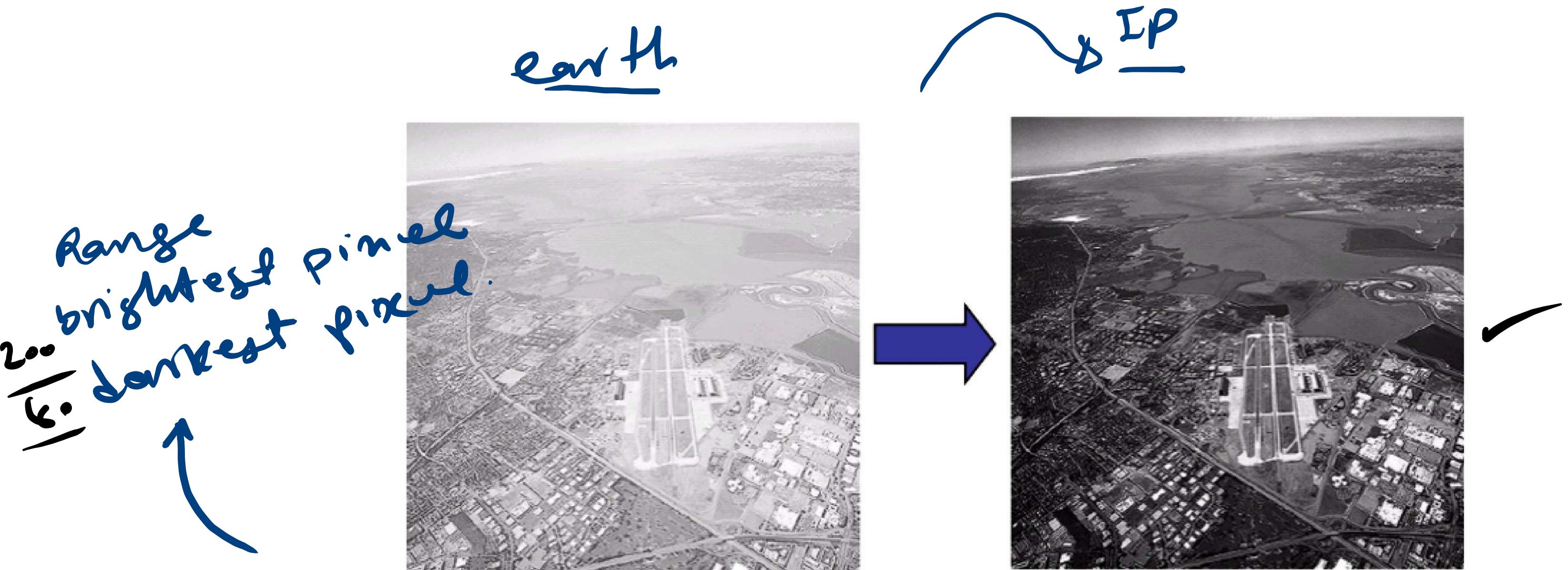
مسار



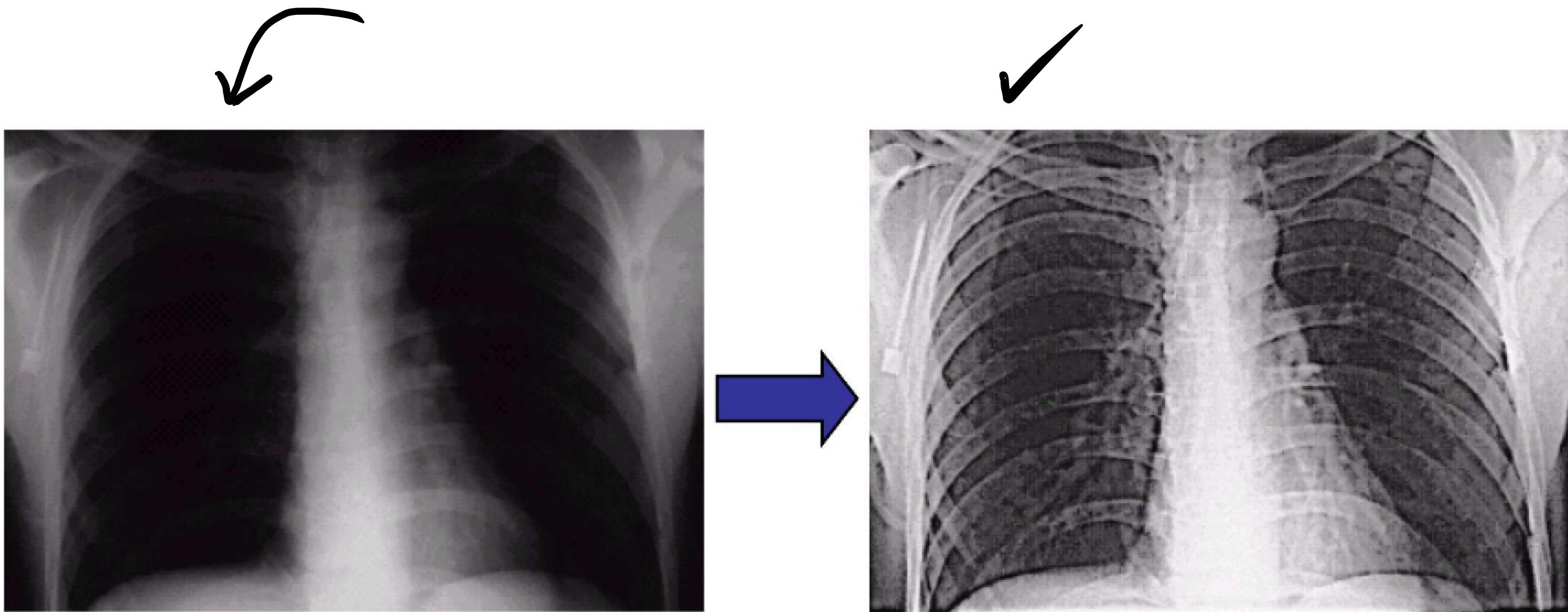
Noise Removal



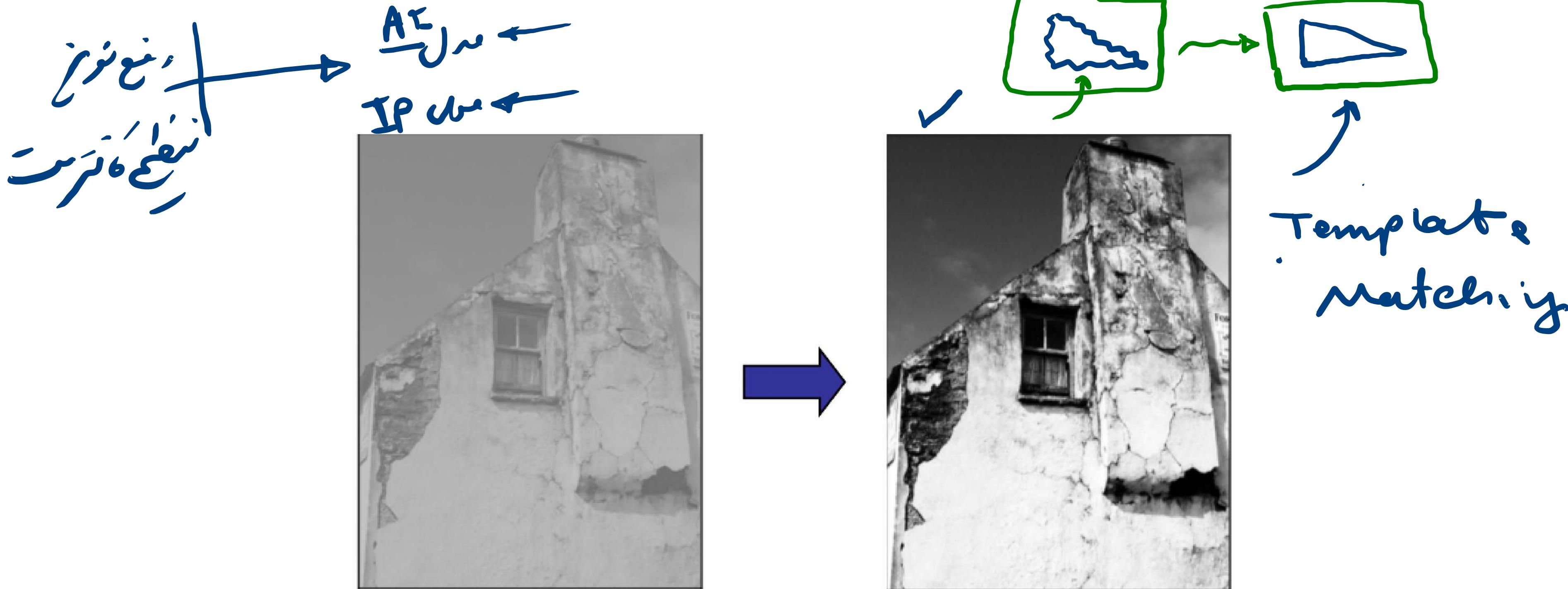
Noise Removal



Contrast Adjustment



Contrast
Adjustment



Contrast Adjustment

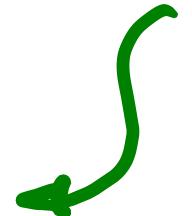


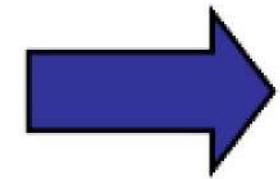
Launched in 1990 the Hubble telescope can take images of very distant objects. However, an incorrect mirror made many of Hubble's images useless. Image processing techniques were used to fix this.

Image Enhancement



Noise pattern





Edge Detection

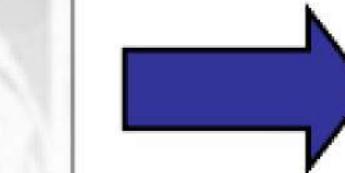


Compression

nearest neighbor.
kernel.



Damaged



Restored

Restoration



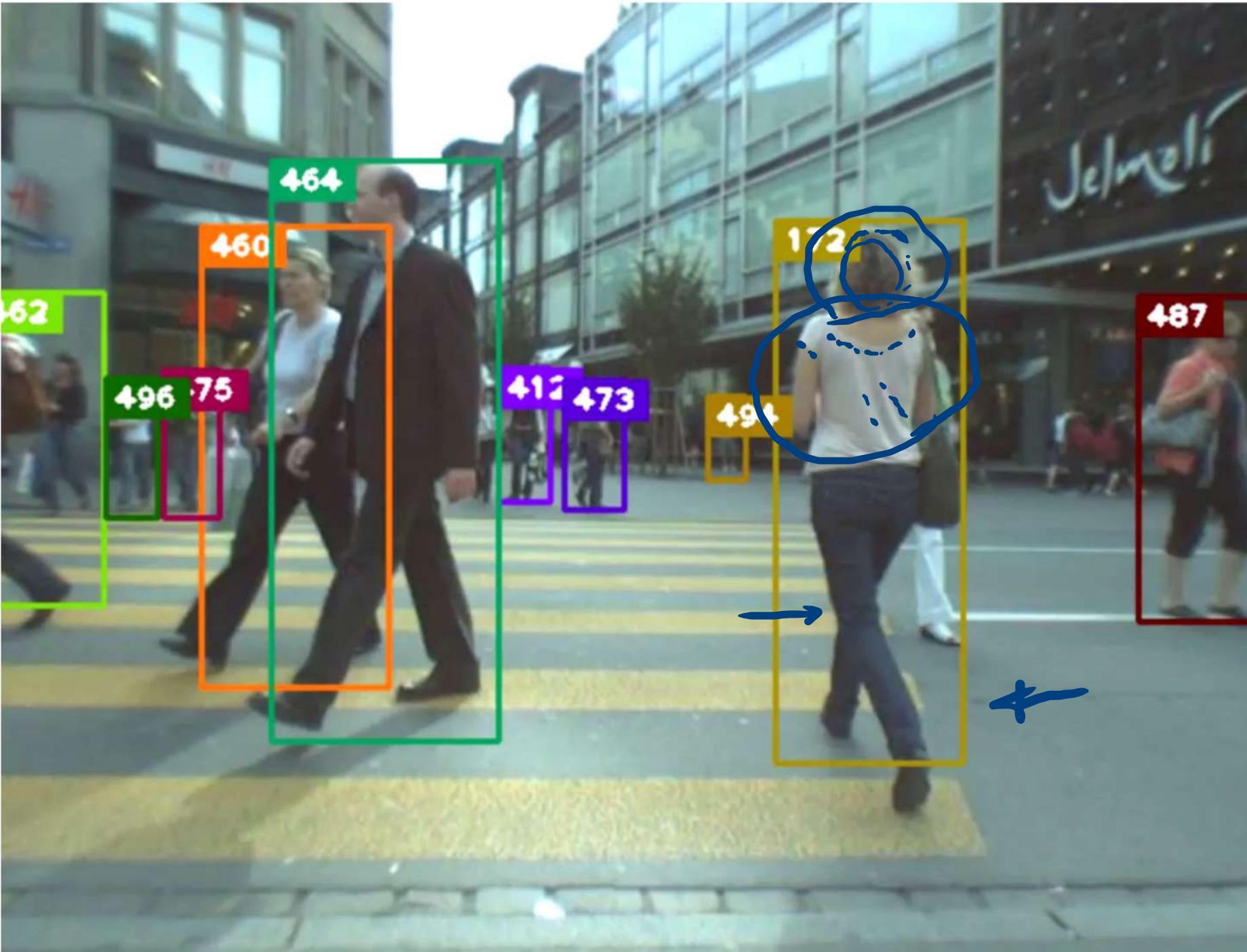
- Can you find the aircraft?

Object Detection



vimeo

Scene Understanding



- Tracking humans is a useful task but it is hard - why?

- Unconstrained shape, position
- Constant changing shape
- Lighting problems
- Clothing

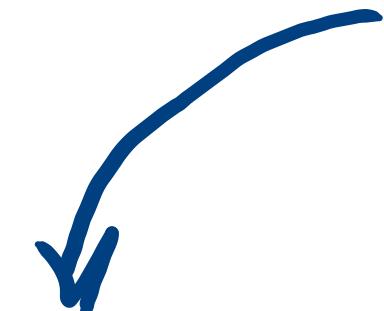
Youtube

Human Tracking

Thousands of hours of CCTV footage analysed by a computer.

How many people were arrested because of it? (4000!)

One – from Logo recognition on his clothing



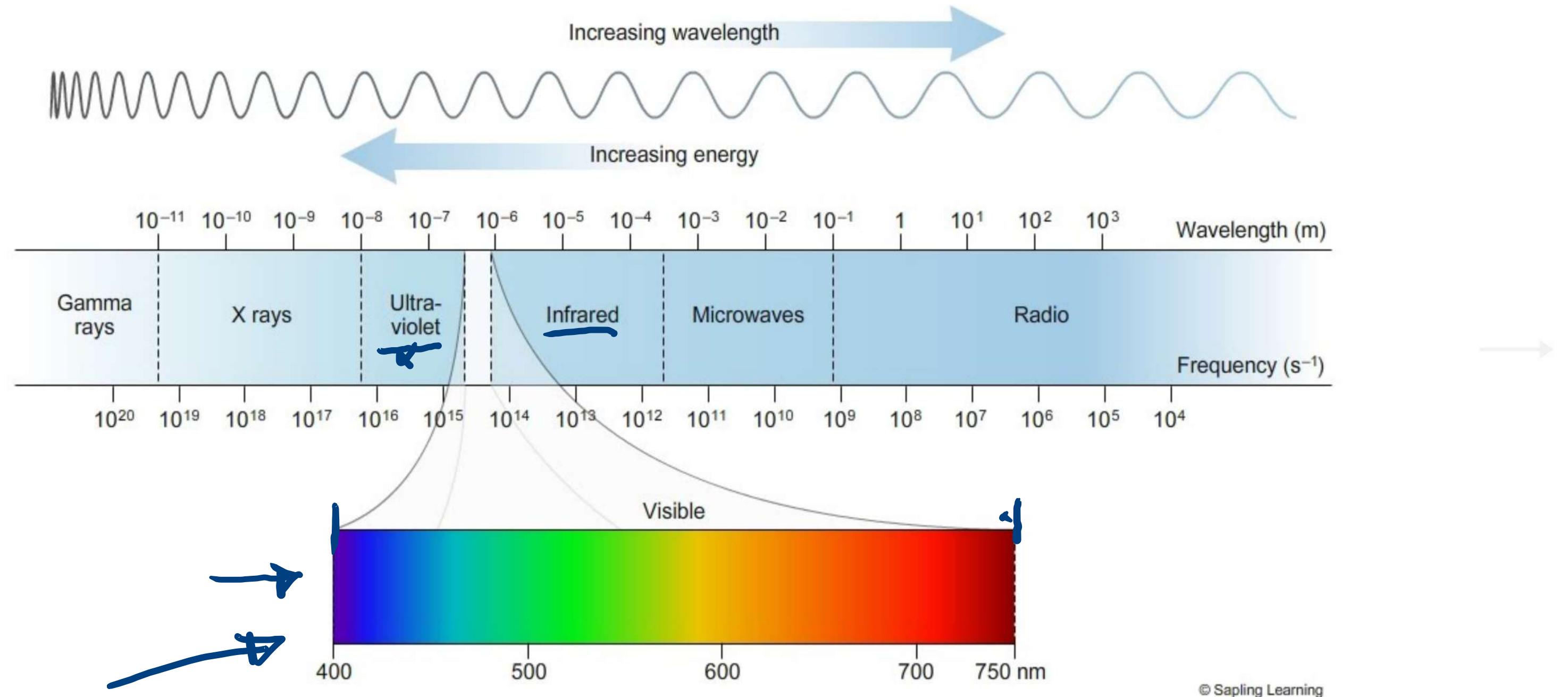
UseCase : London Riots 2011

✓

- 2004 - 142 miles of desert road, 15 entries
- None finished
- Today cars can safely self drive on urban roads!
- [2007 Entry \(Link\)](#)
✓



UseCase : DARPA Grand Challenge



Electromagnetic (EM) energy spectrum

Gamma-ray imaging:
nuclear medicine and
astronomical observations

X-rays:
medical diagnostics, industry,
astronomy, etc.

Ultraviolet:
lithography, industrial inspection,
microscopy, lasers, biological
imaging, and astronomical
observations

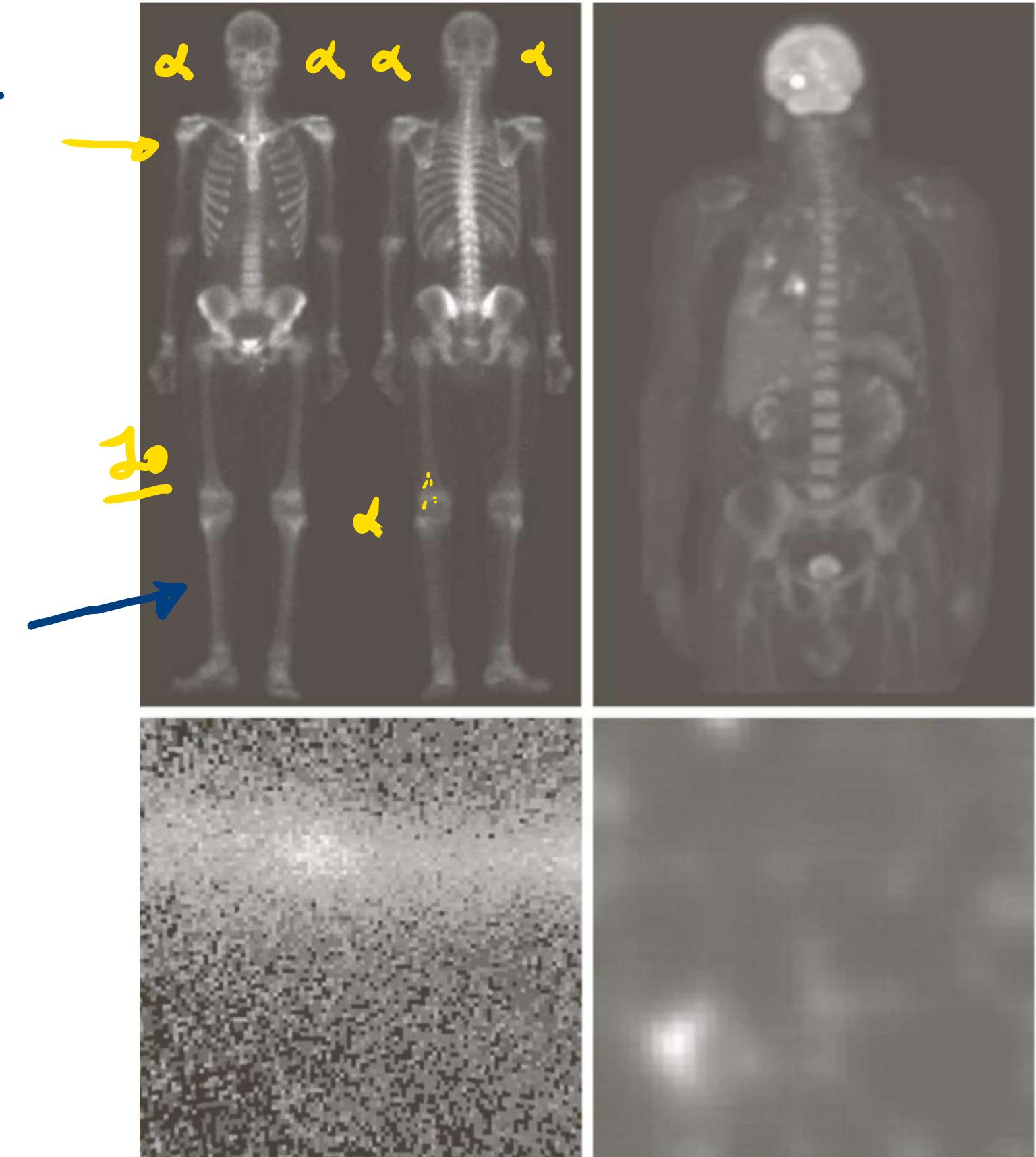
Visible and infrared bands:
light microscopy, astronomy,
remote sensing, industry,
and law enforcement

Microwave band:
radar

Radio band:
medicine (such as MRI) and
astronomy

Major Uses

Gamma
X-ray



a
b
c
d

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.)

Gamma-Ray Imaging

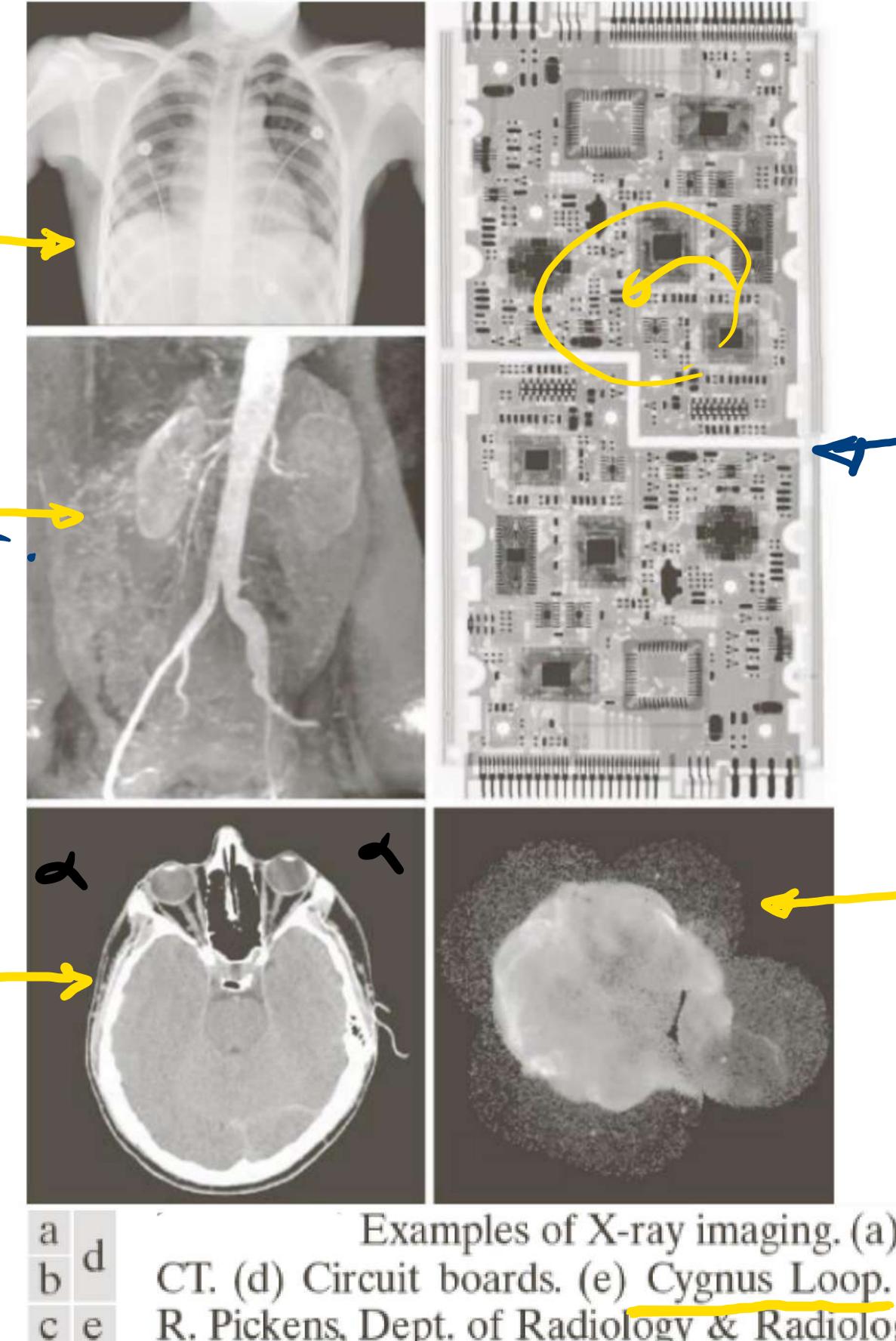
X-Ray Imaging

α -Ray

1. medical
2. crystography
- α -Ray 3. broken product.

medical

→ عکس‌برداری از
عکس‌برداری از
عکس‌برداری از

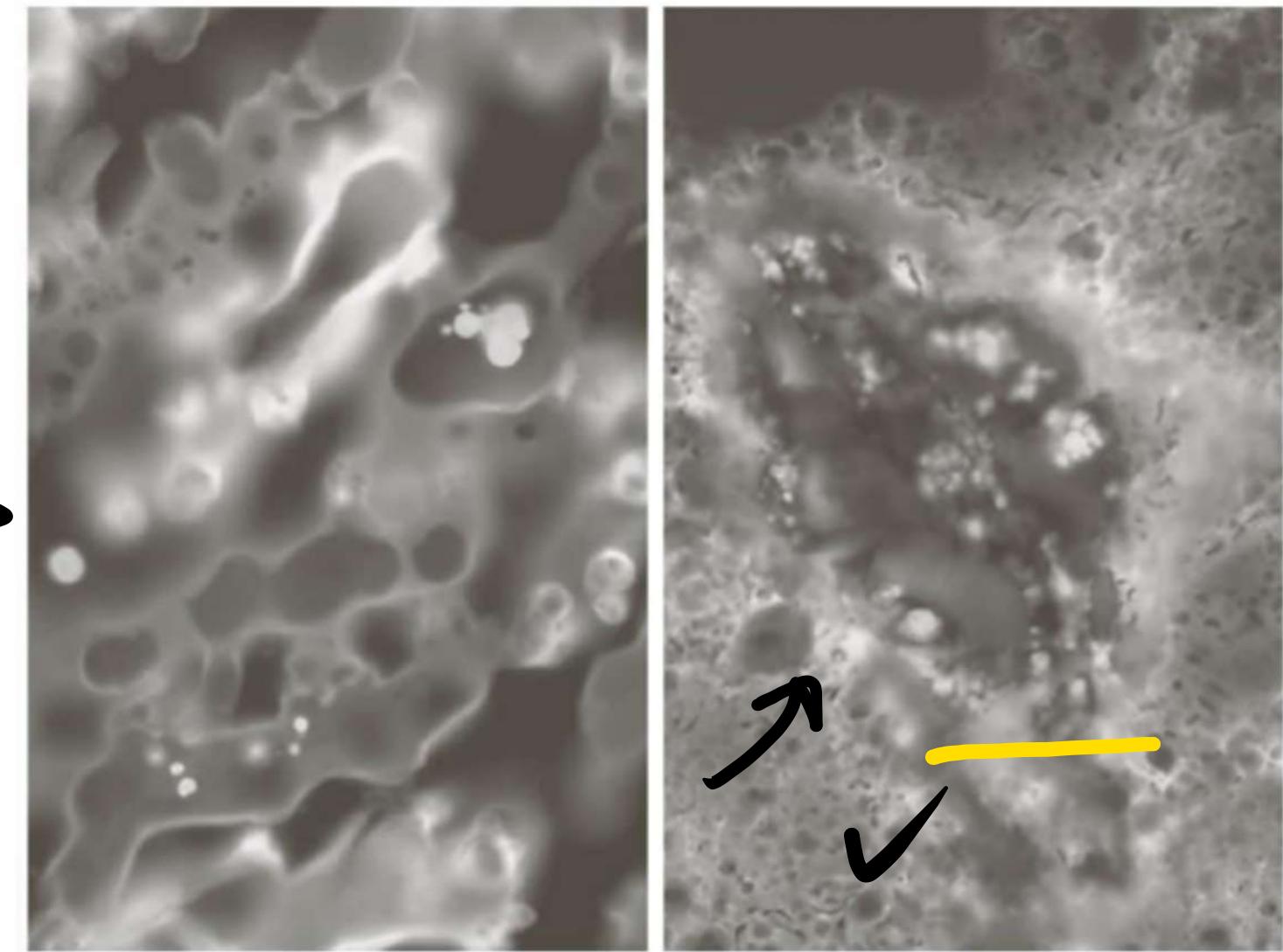


Examples of X-ray imaging. (a) Chest X-ray. (b) Aortic angiogram. (c) Head CT. (d) Circuit boards. (e) Cygnus Loop. (Images courtesy of (a) and (c) Dr. David R. Pickens, Dept. of Radiology & Radiological Sciences, Vanderbilt University Medical Center; (b) Dr. Thomas R. Gest, Division of Anatomical Sciences,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

X -Ray

2D - Gray Scale.
 α -Ray : color

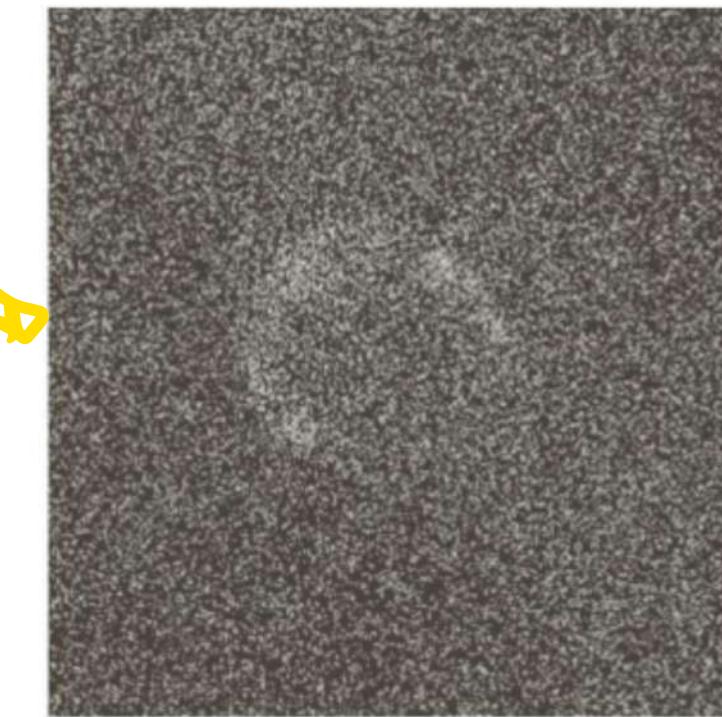
α -Ray : 3D



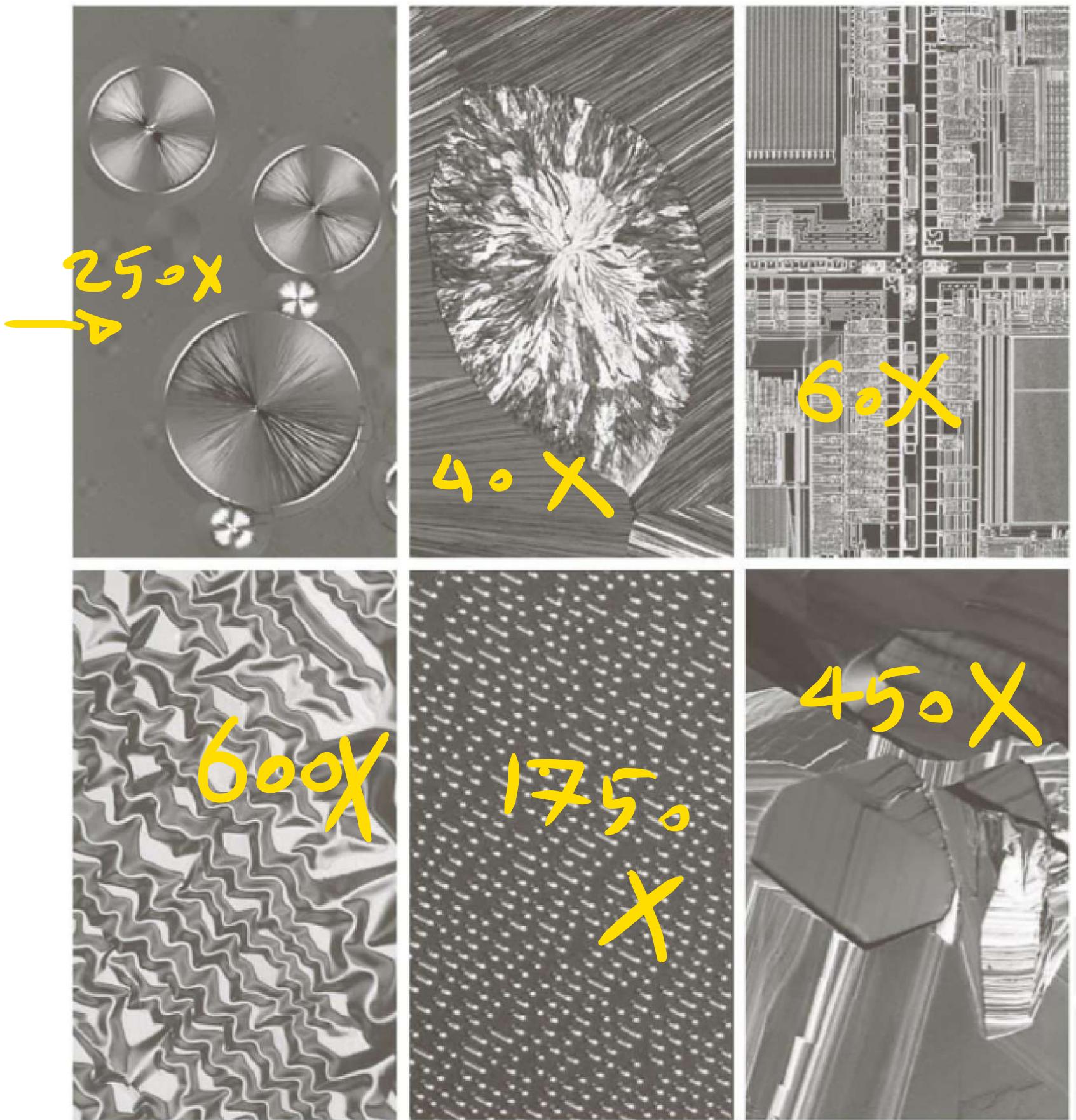
a b
c

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.)



Ultraviolet Imaging



a b c
d e f

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

Light Microscopy Imaging

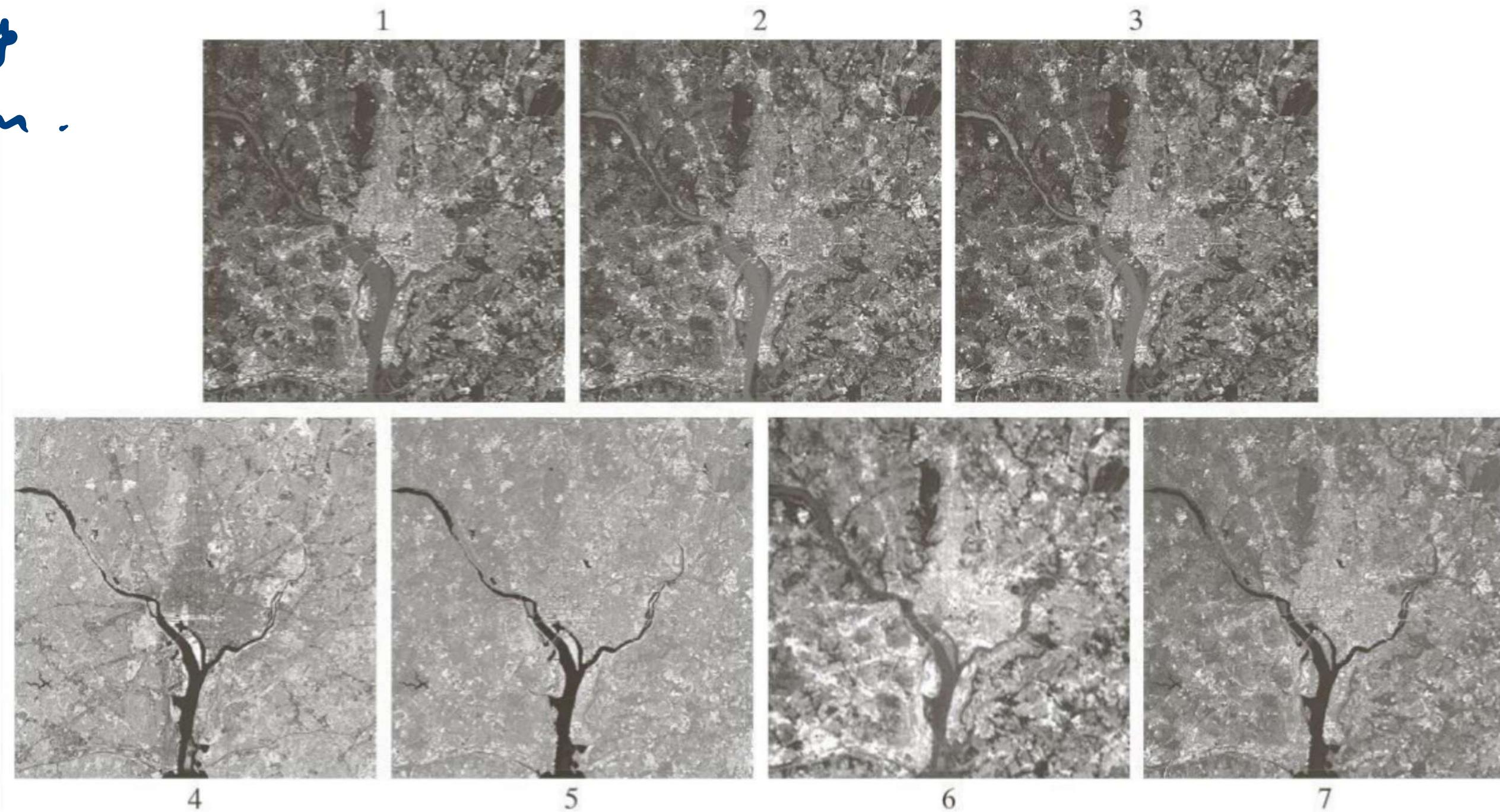
visual +
green.

infrared

1380

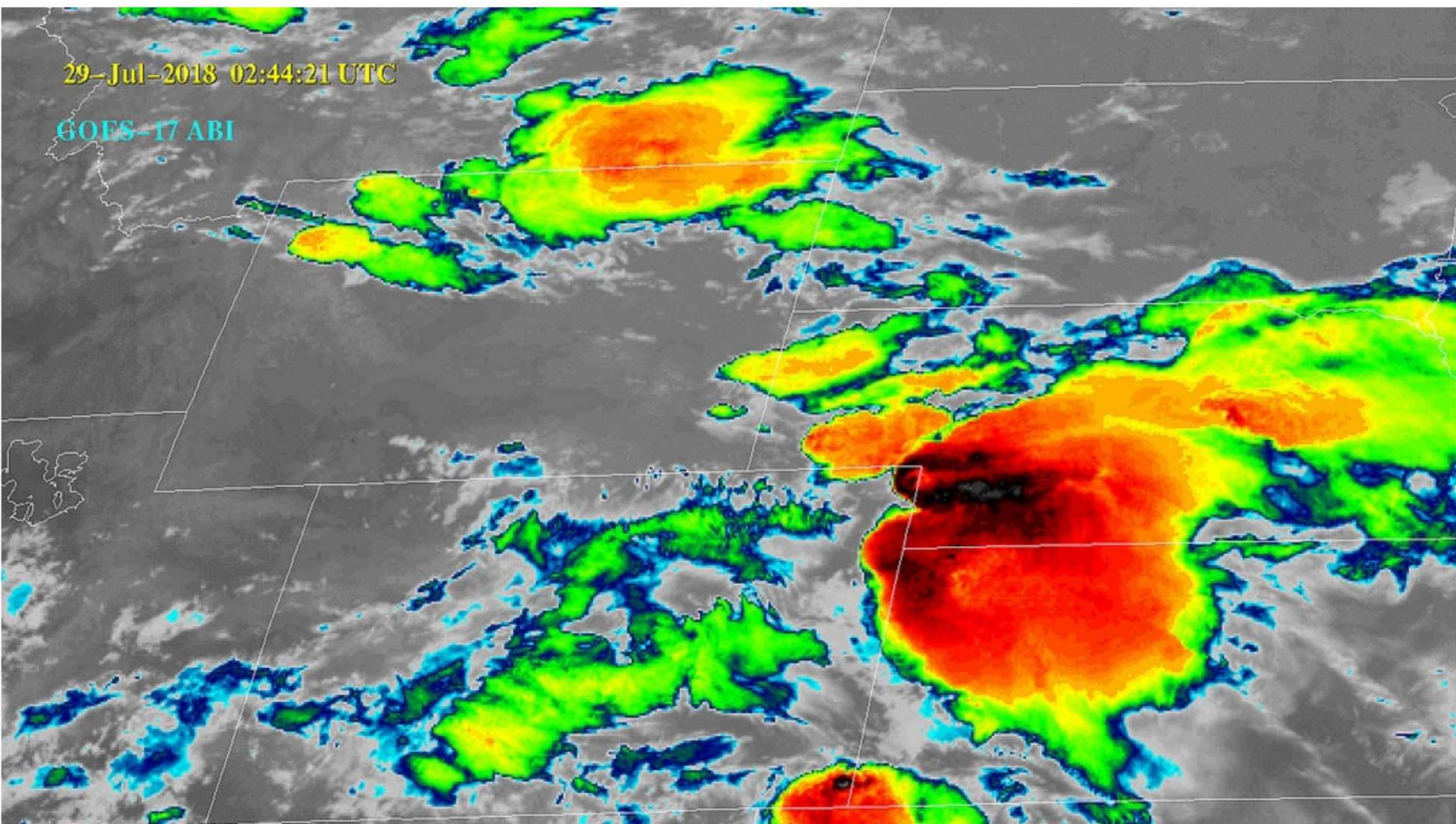
4 %.

infrared

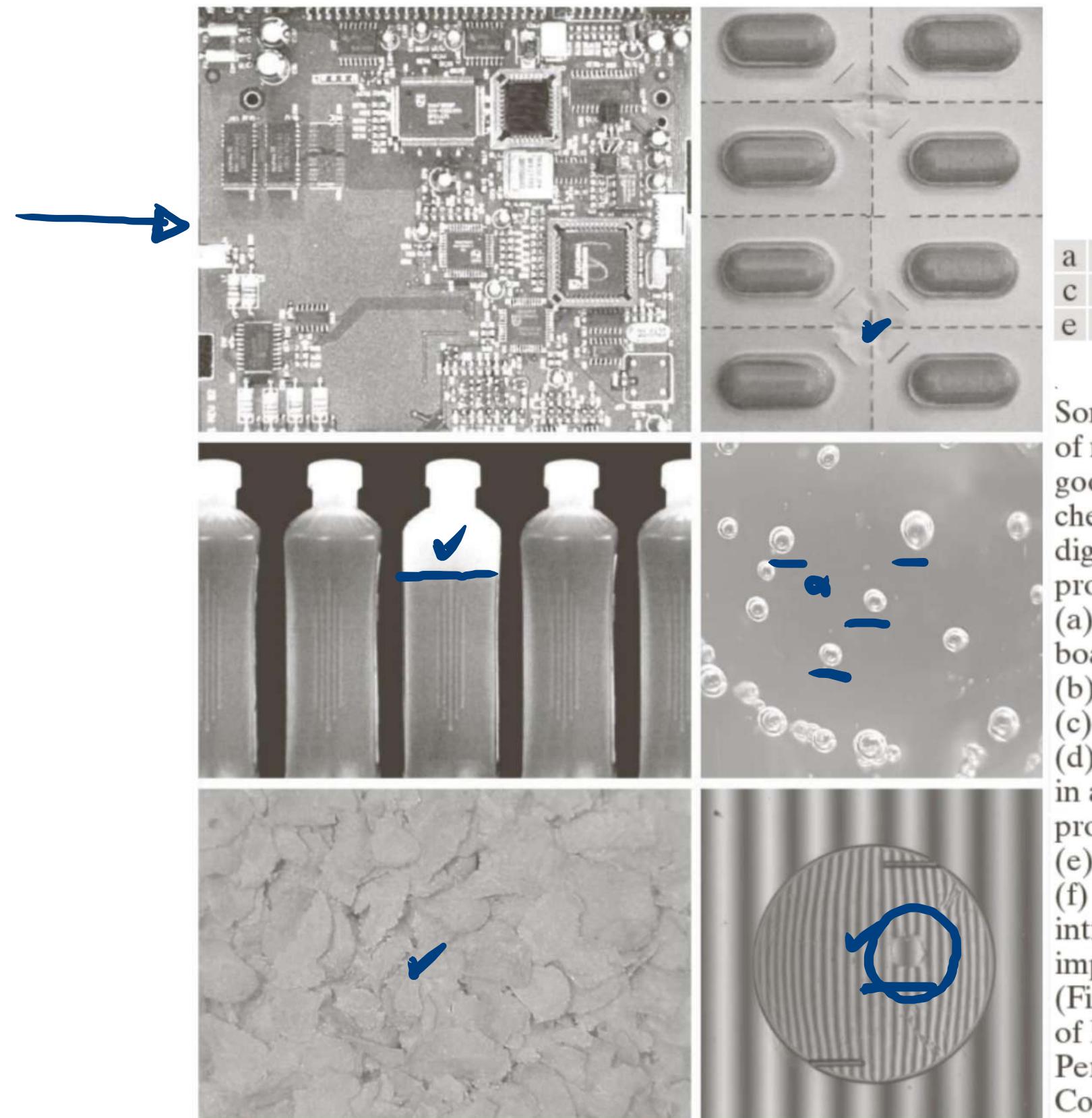


LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

Visual and Infrared Imaging



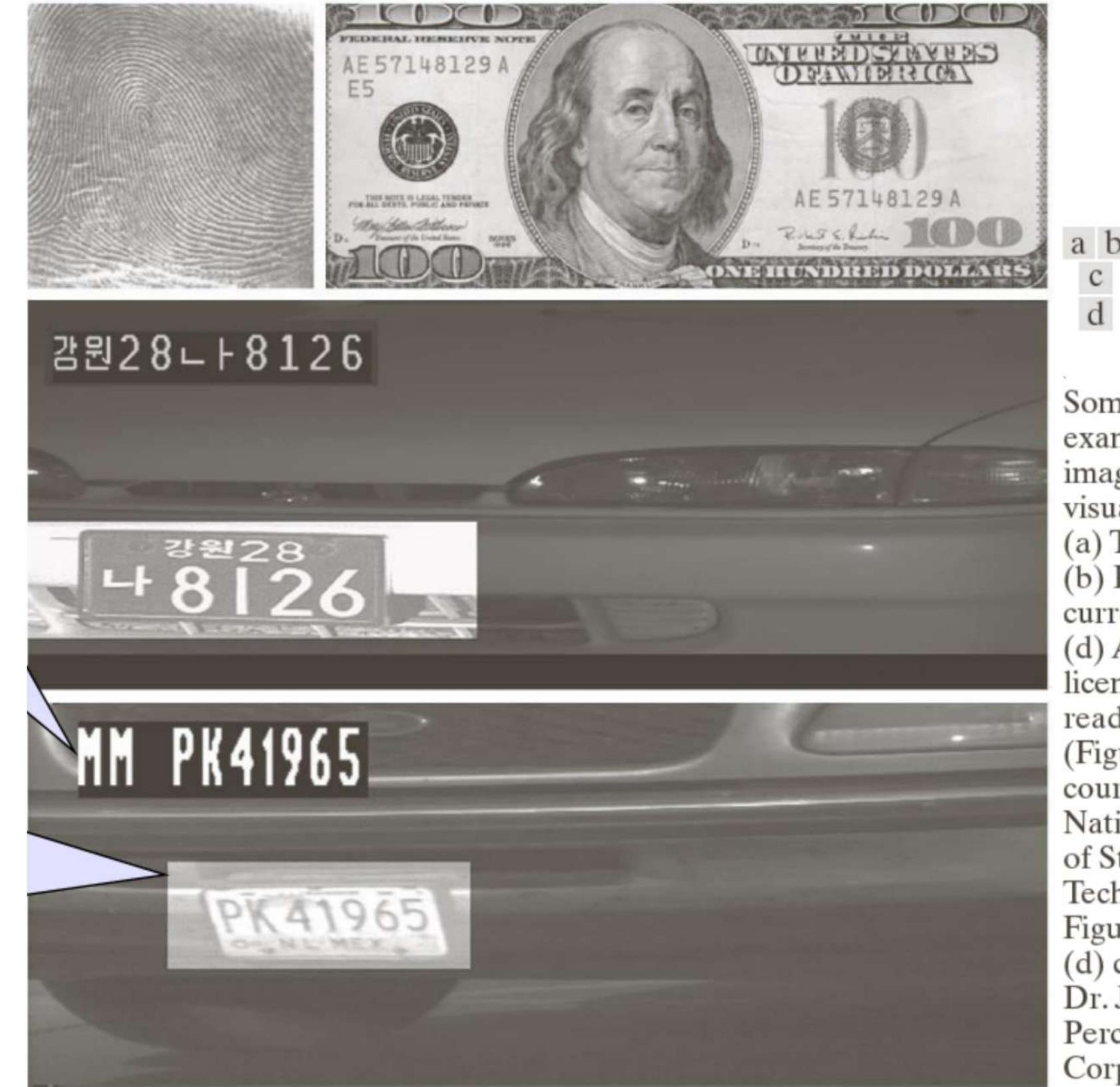
Infrared Satellite Imaging



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



Automated Visual Inspection(1)

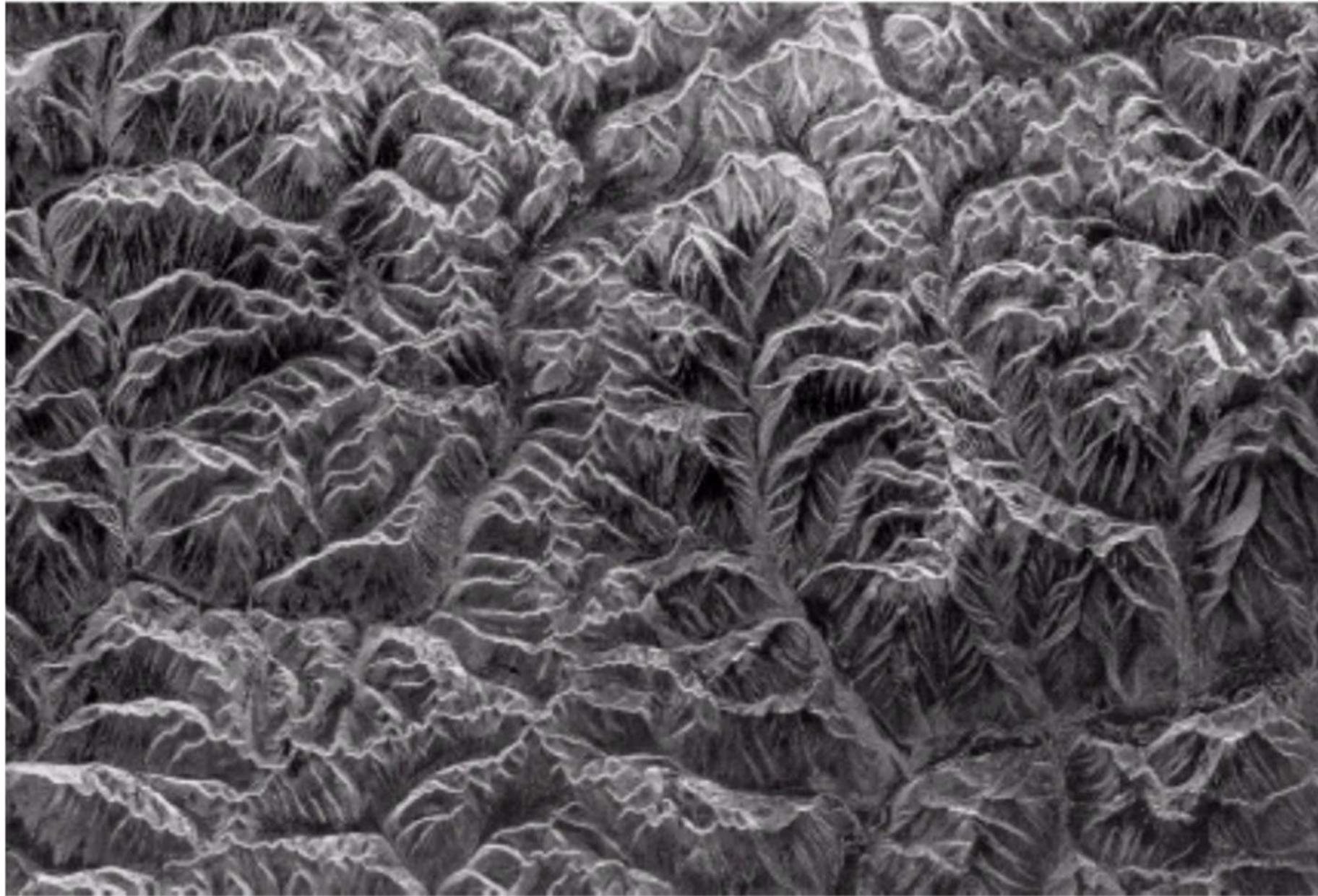


a b
c
d

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.)

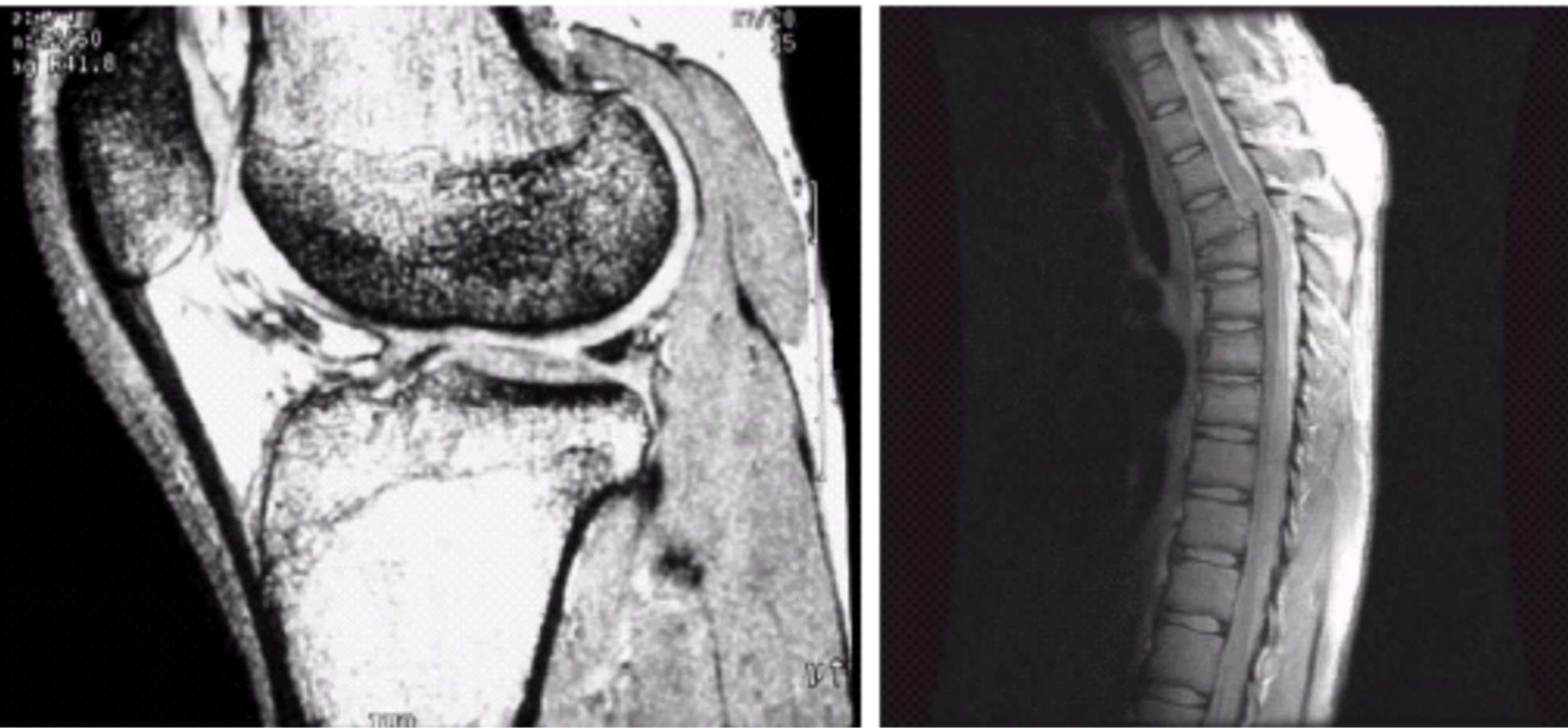
Automated Visual Inspection(2)

Example of Radar Image



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

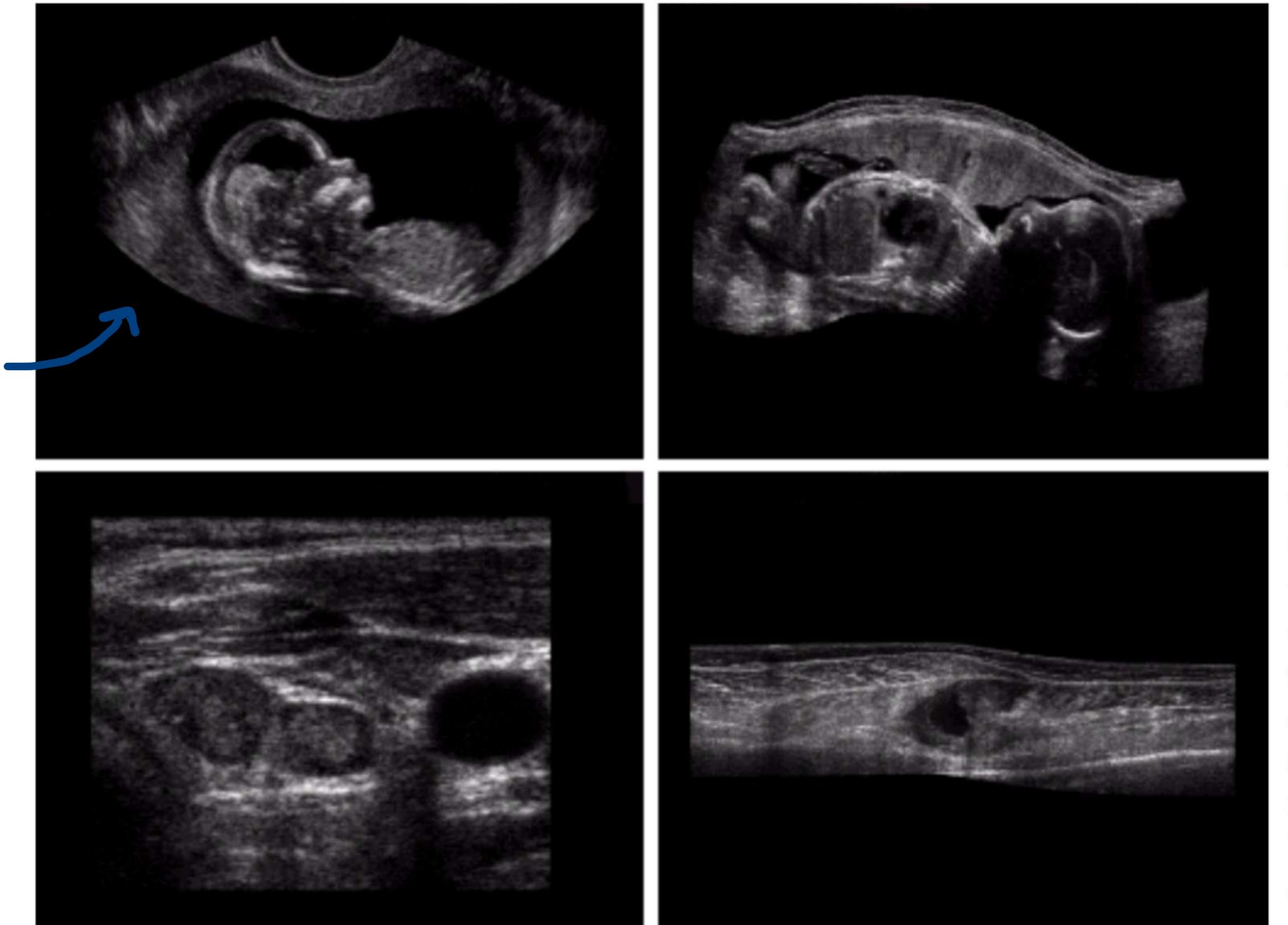




a b

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.)

MRI (Radio Band)



Ultrasound Imaging

a
b
c
d

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.)



Thank You

End of the Session 01