Image processing

Section 1

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What is image processing:

- Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it.

Image processing basically includes the following three steps:

- Importing the image via image acquisition tools;
- Analysing and manipulating the image;
- Output in which result can be altered image or report that is based on image analysis.

image – digital image

An image is a two-dimensional function **f(x,y)**, where x and y are the **spatial** (plane) coordinates, and the amplitude of **f** at any pair of coordinates (x,y) is called the intensity of the image at that level.

If x,y and the amplitude values of f are finite and discrete quantities, we call the image a digital image. A digital image is composed of a finite number of elements called pixels, each of which has a particular location and value.

Pixel intensity value

$f(1,1) = 103$

Pixel location

rows columns

$f(645{:}650,1323{:}1328) =$

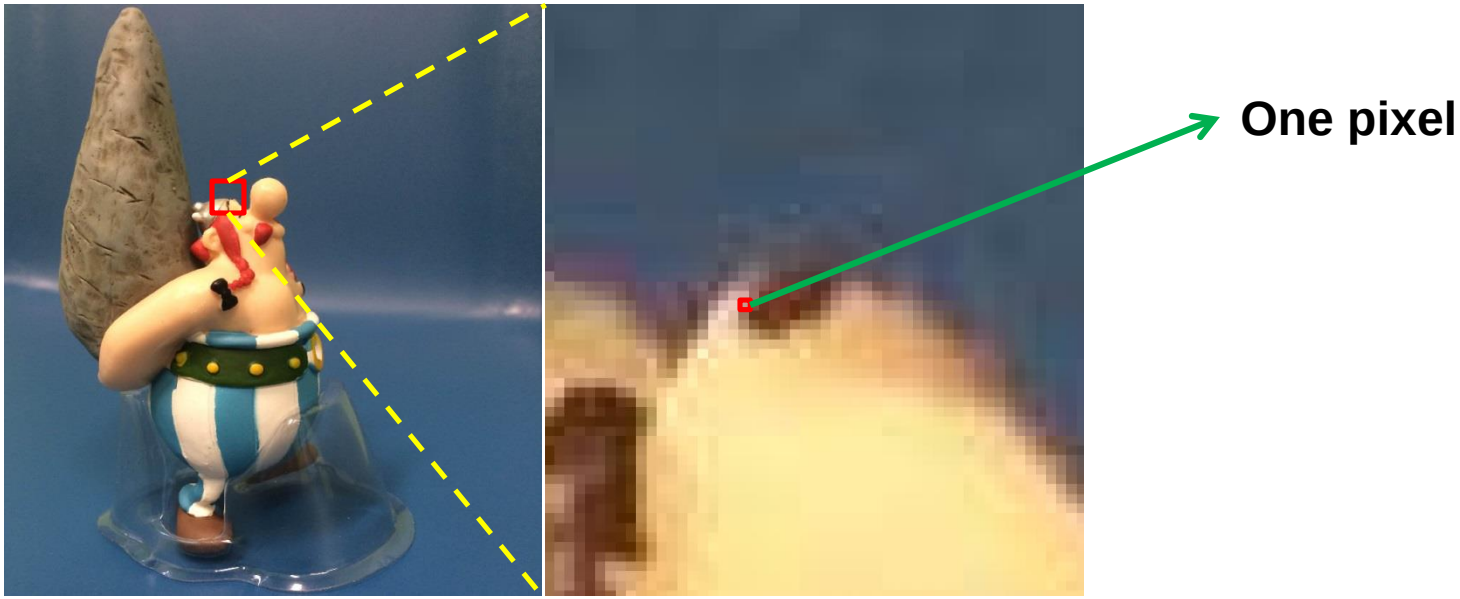
83	82	82	82	82	82
82	82	82	81	81	81
82	82	81	81	80	80
82	82	81	80	80	79
80	79	78	77	77	77
80	79	78	78	77	77

$f(2724,2336) = 88$

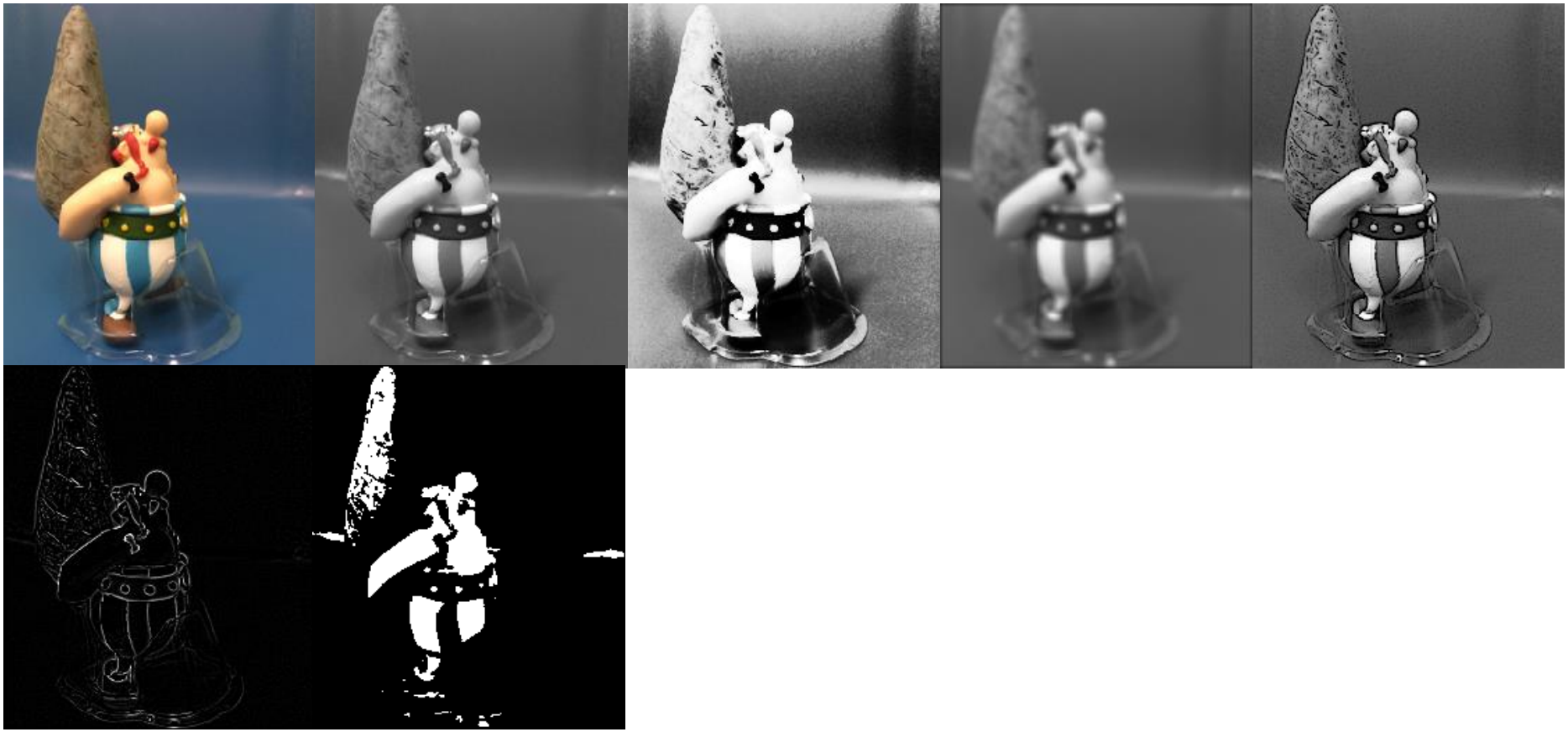
Consider the following image (2724x2336 pixels) to be 2D function or a **matrix** with **rows** and **columns**

In 8-bit representation Pixel intensity values change between 0 (Black) and 255 (White)

Remember *digitization* implies that a digital image is an *approximation* of a real scene

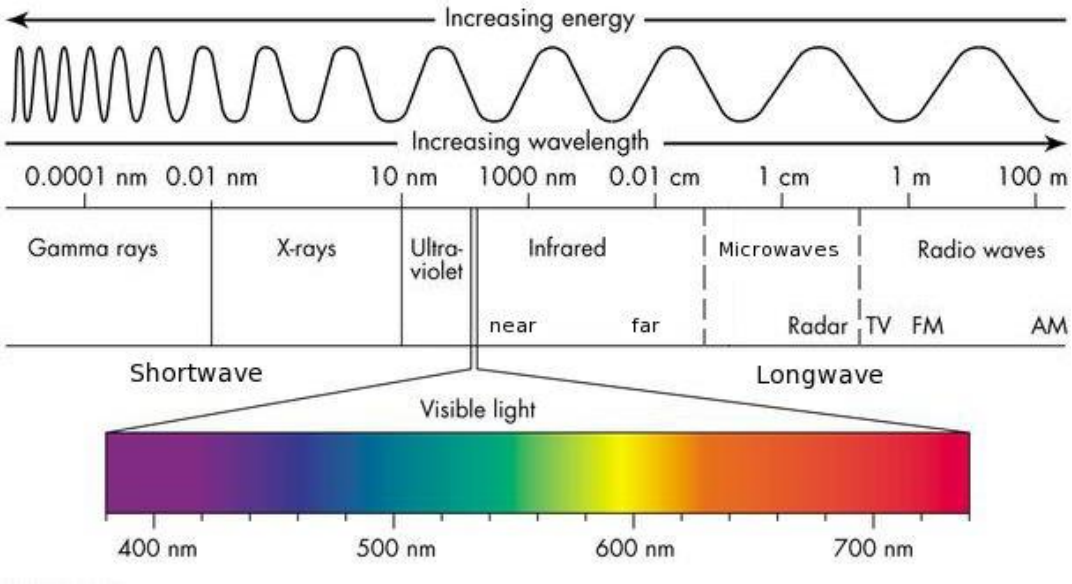


Digital Image Processing

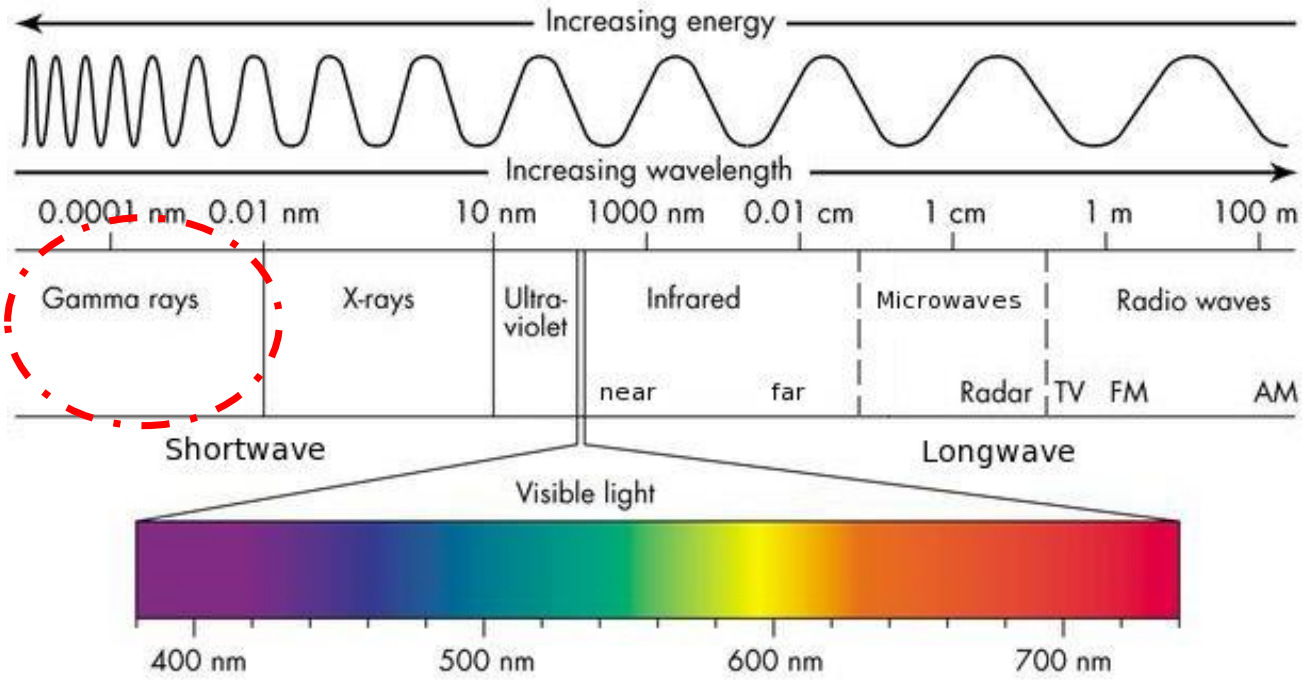


Sources of Digital Images

The principal source for the images is the electromagnetic (EM) energy spectrum.

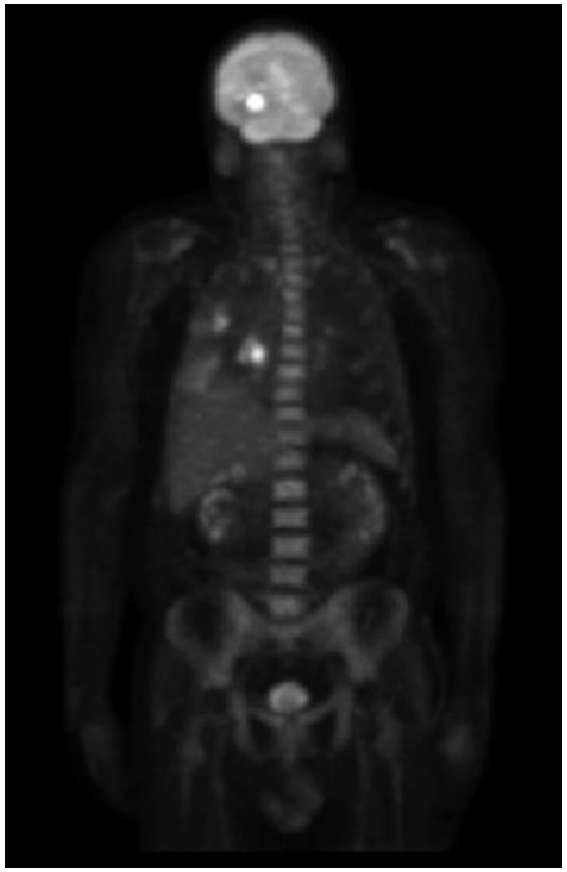


Gamma rays



Gamma rays

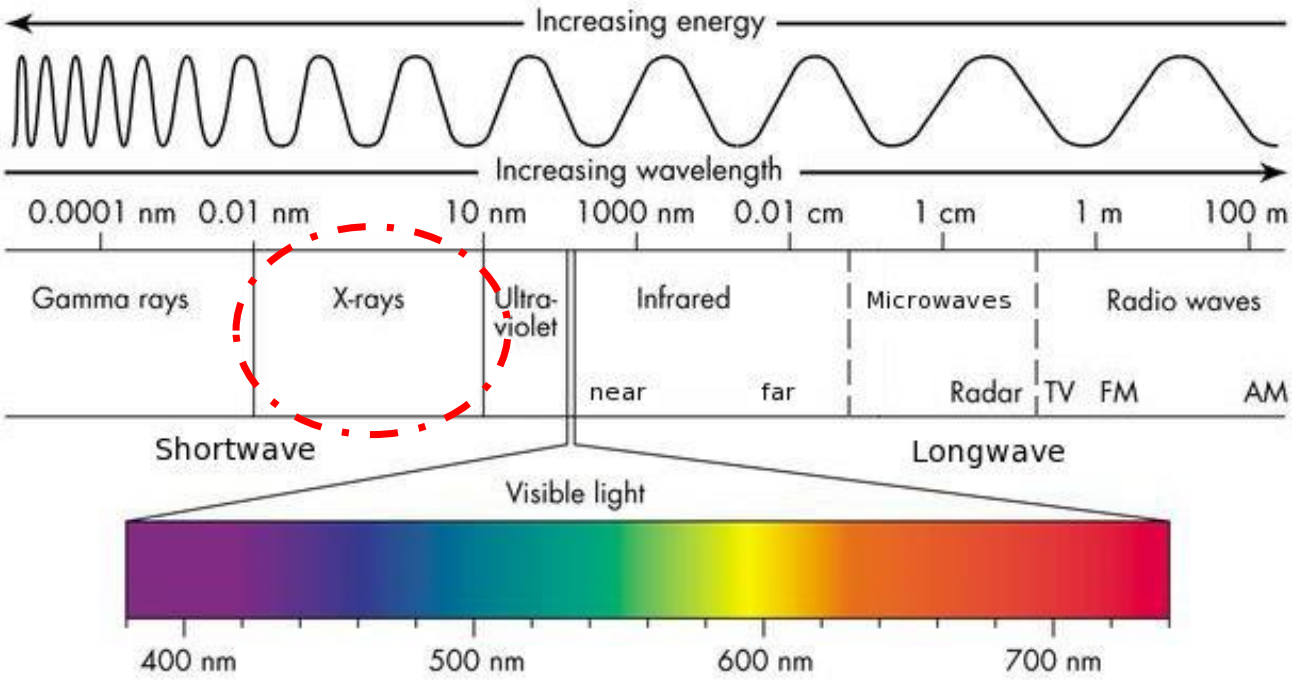
Gamma-Ray Imaging
Cherenkov Telescope



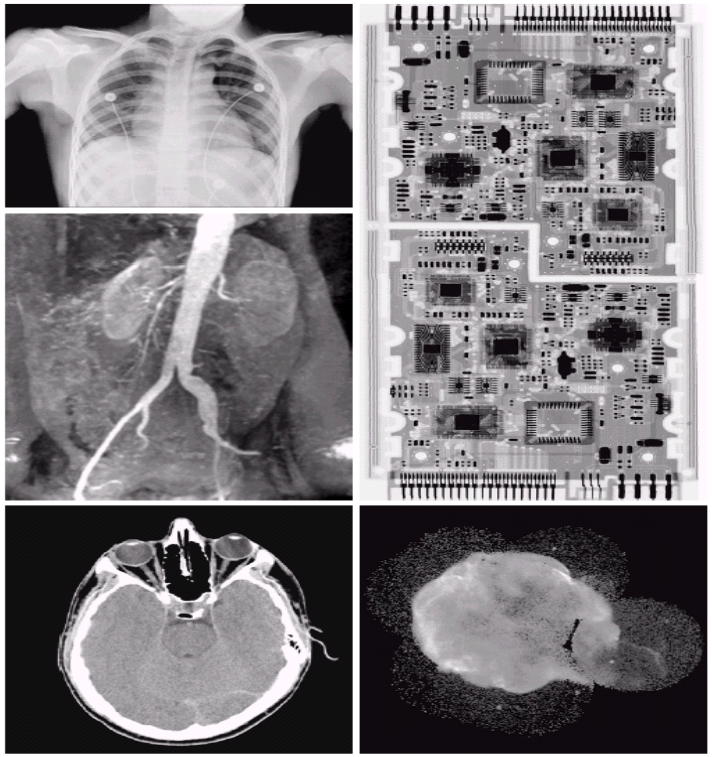
Gamma-Ray Imaging
İn nuclear medicine

Gamma-Ray imaging of
A starburst galaxy about 12
million light-years away

X- rays

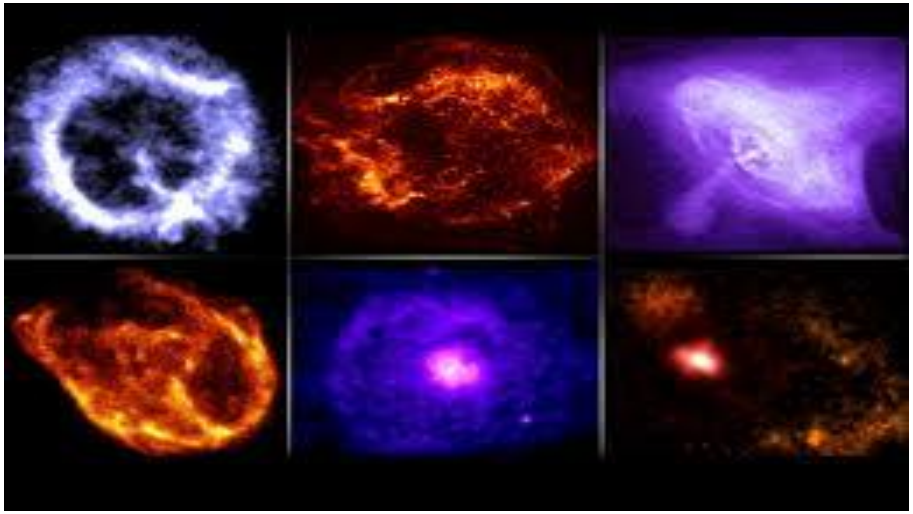


X- rays



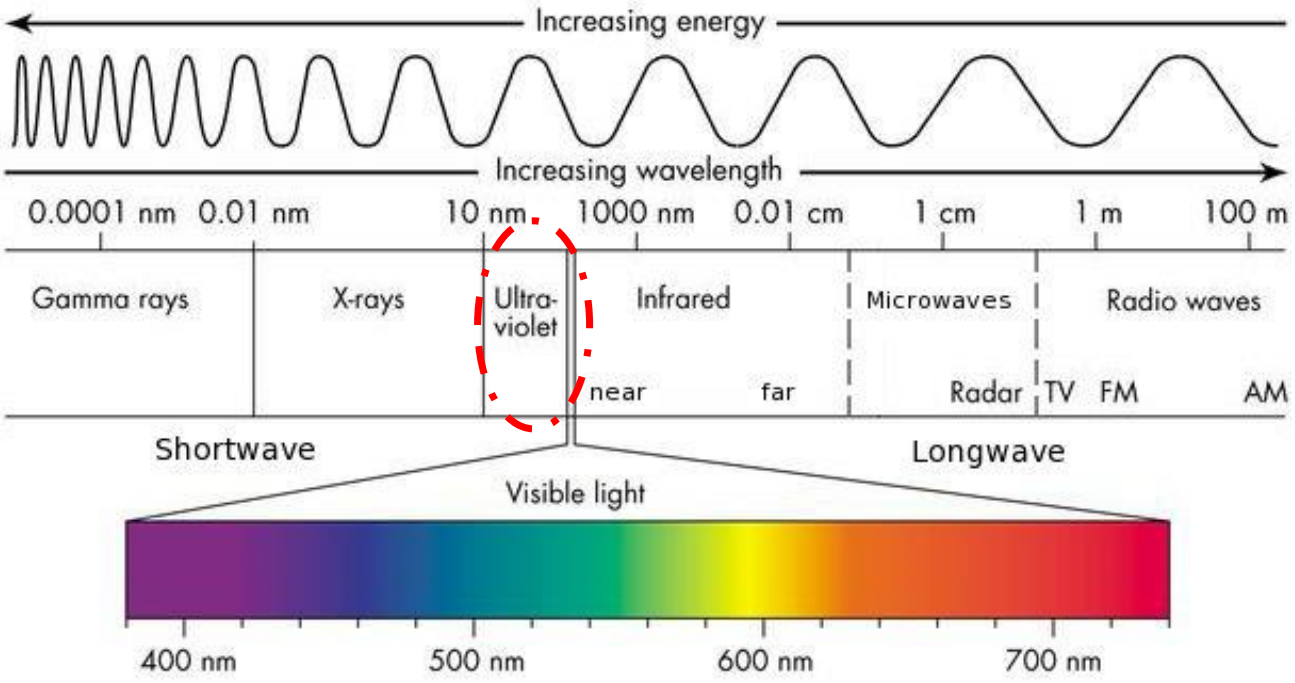
a d
b
c e

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.)



X-ray images from the space
The Chandra X-Ray Observatory

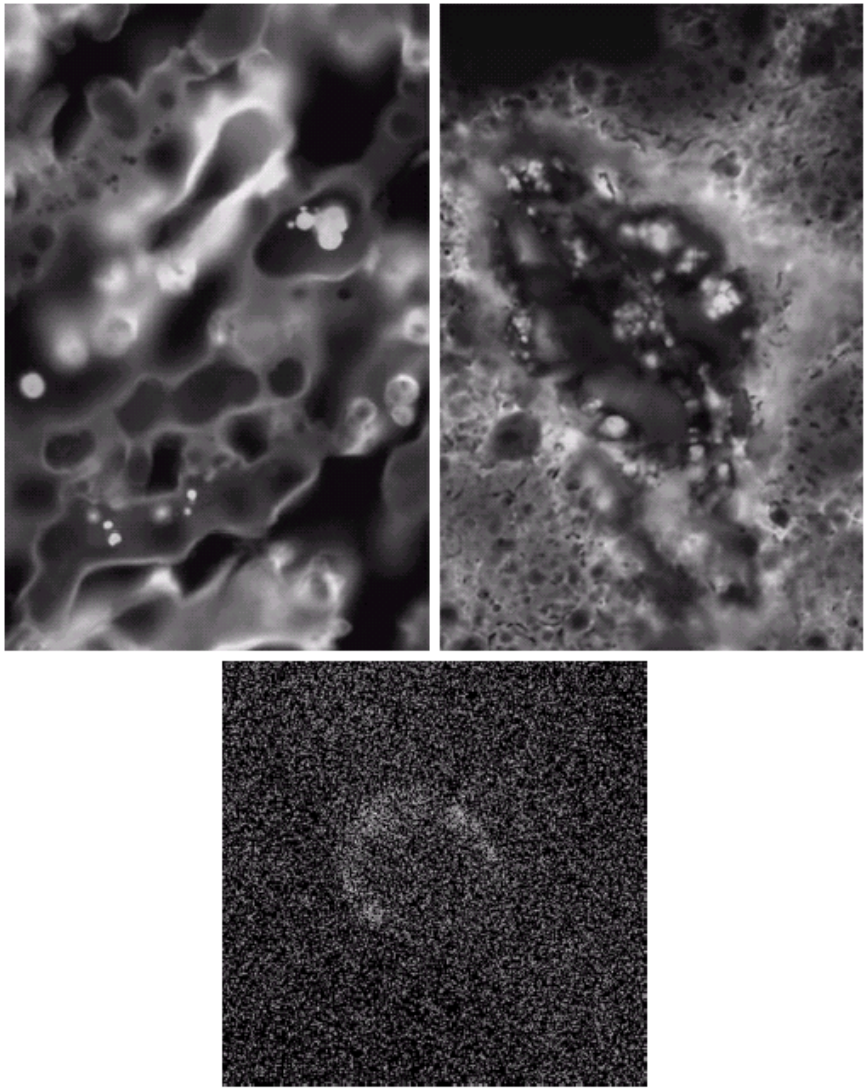
Ultra-violet



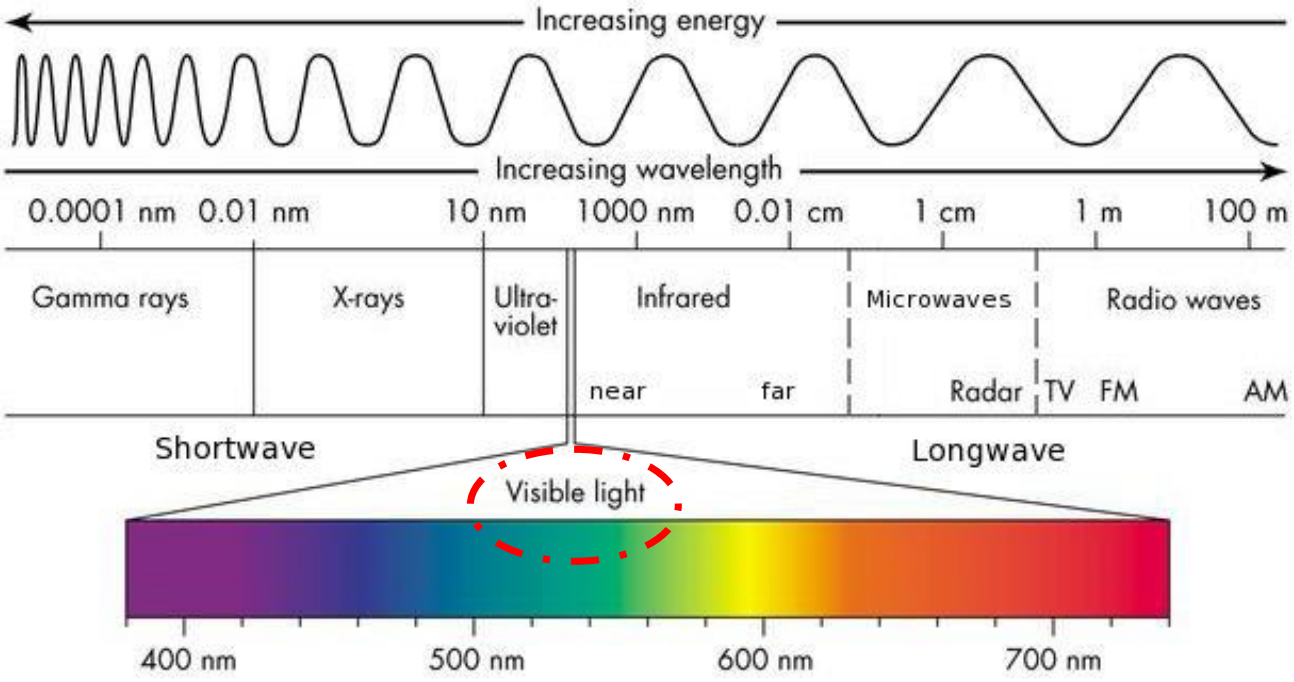
Ultra-violet

a b
c

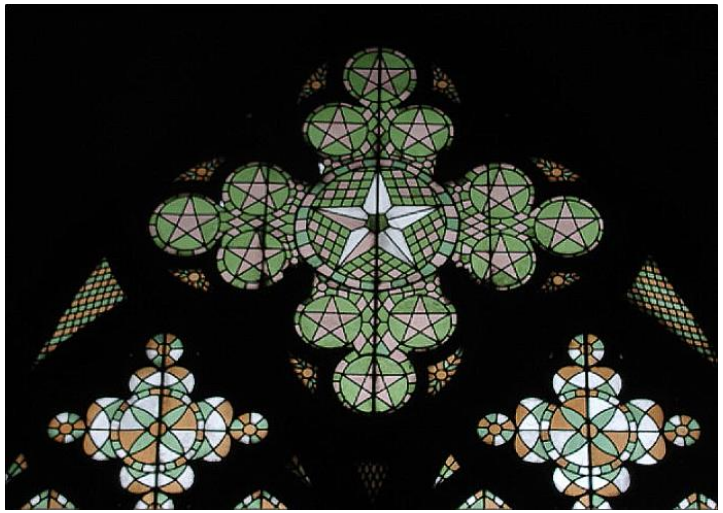
FIGURE 1.8
Examples of ultraviolet imaging.
(a) Normal corn.
(b) Smut corn.
(c) Cygnus Loop.
(Images courtesy of (a) and (b) Dr. Michael W. Davidson, Florida State University, (c) NASA.)

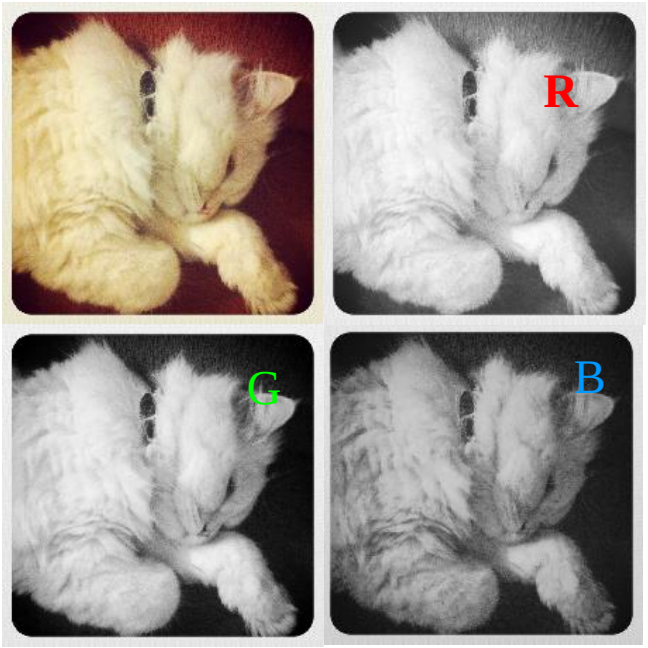


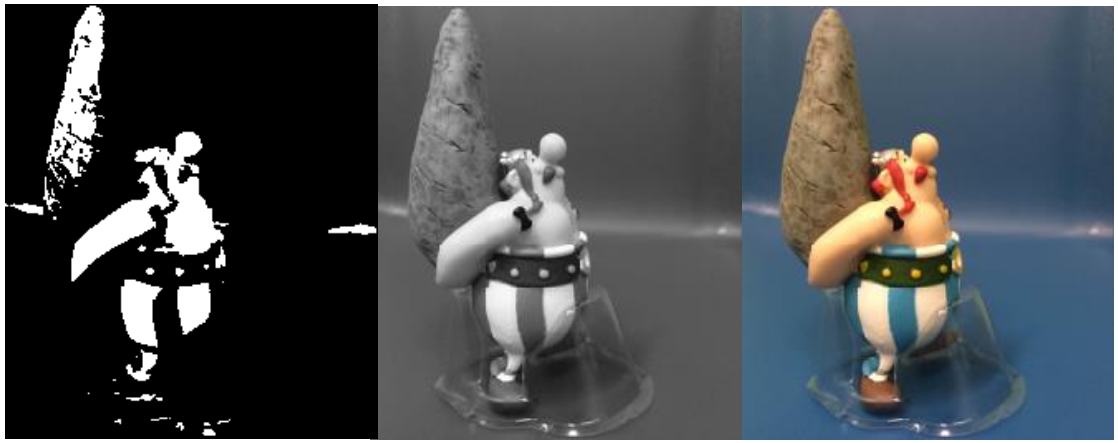
Visible light



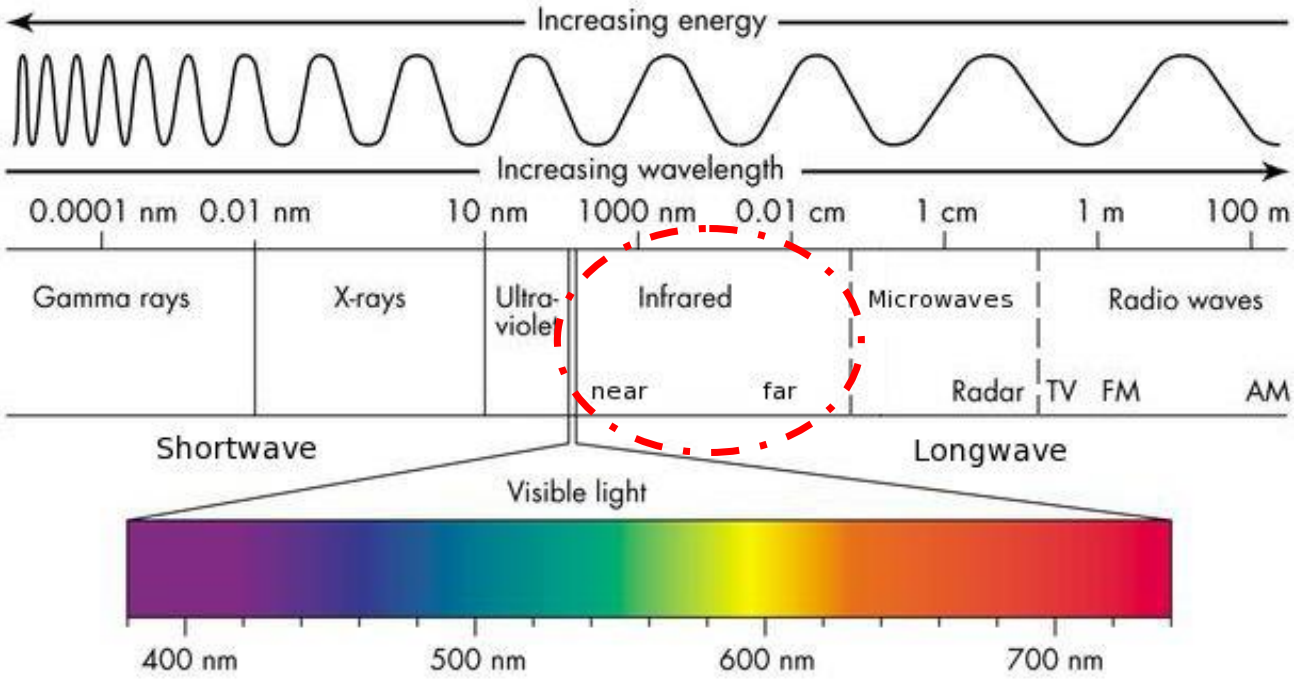
Visible light



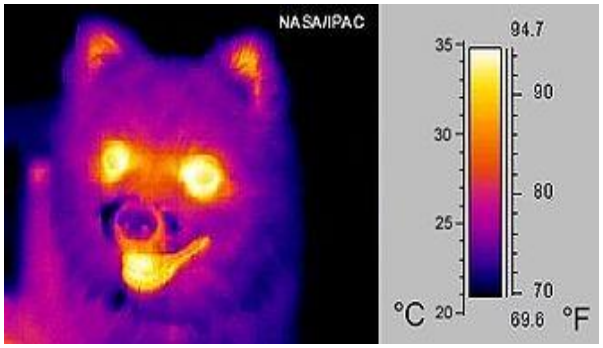




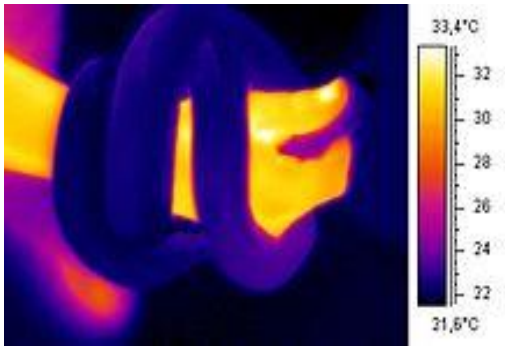
Infrared



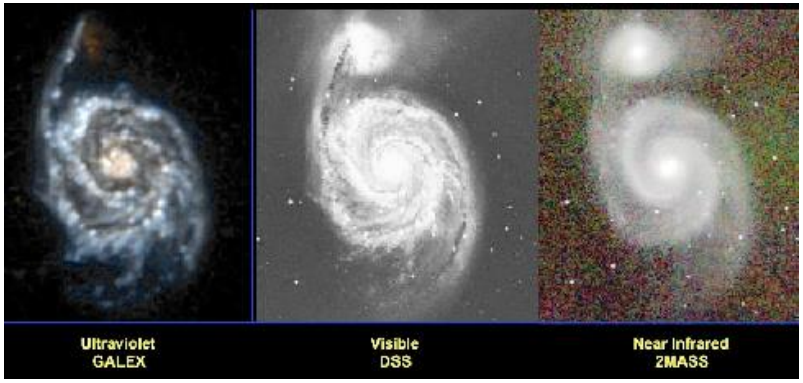
Infrared



infrared ("thermal") image

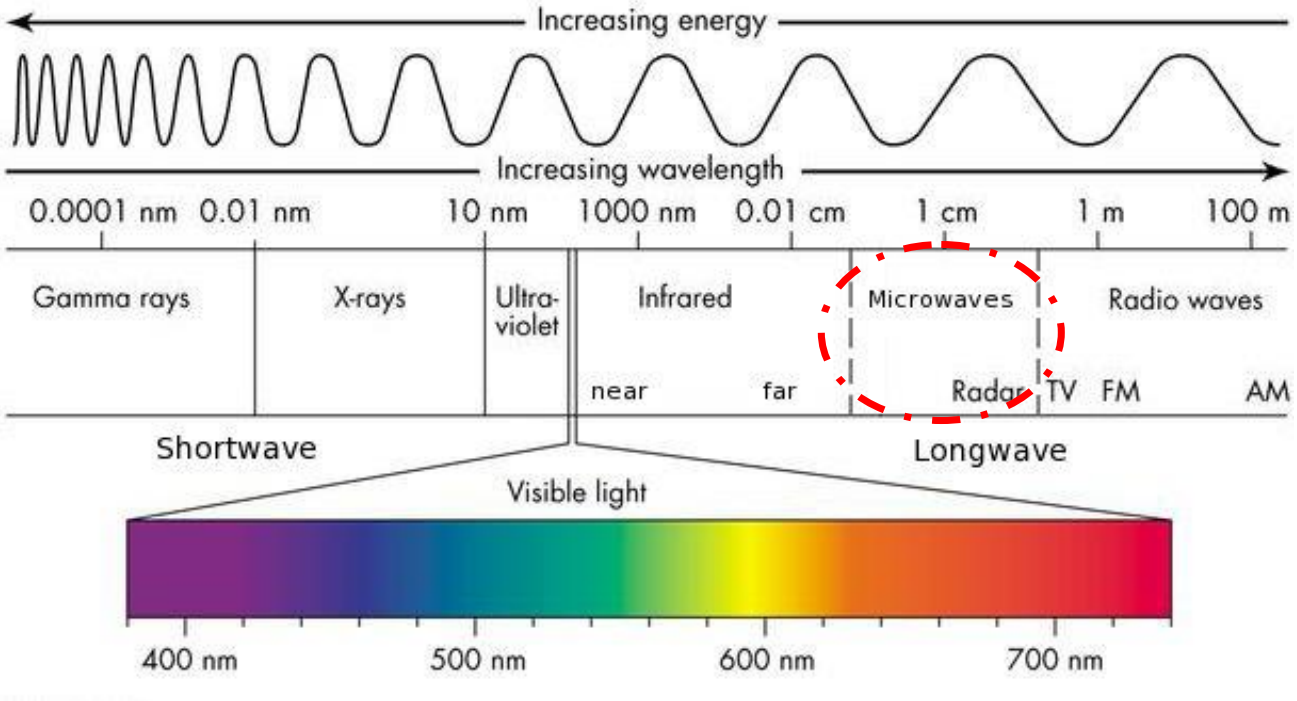


Snake around the arm



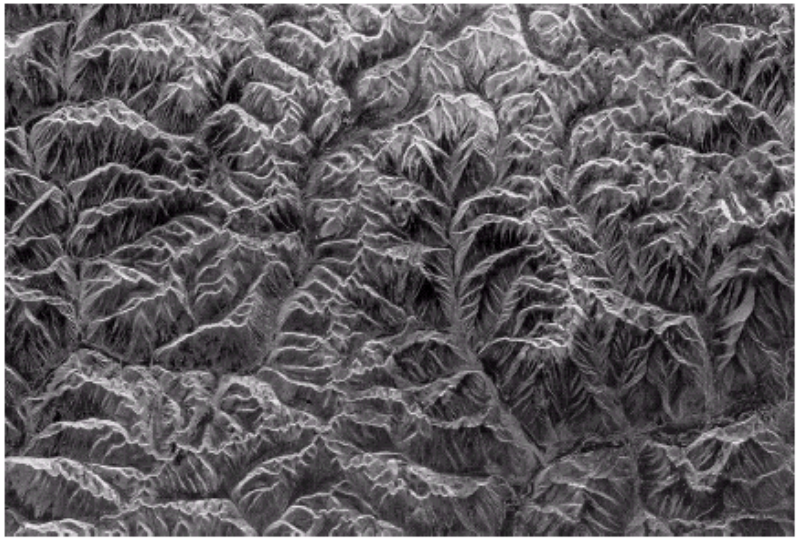
Messier 51 in ultraviolet (GALEX), visible (DSS), and near infrared (2MASS). *Courtesy of James Fanson.*

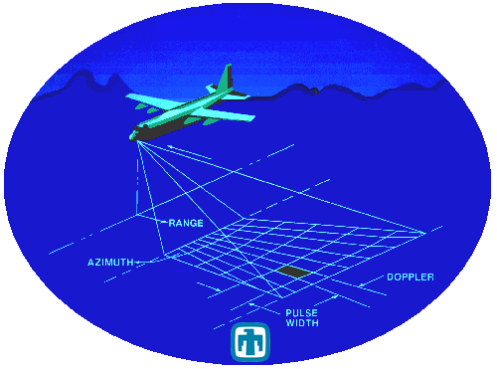
Microwaves



Microwaves

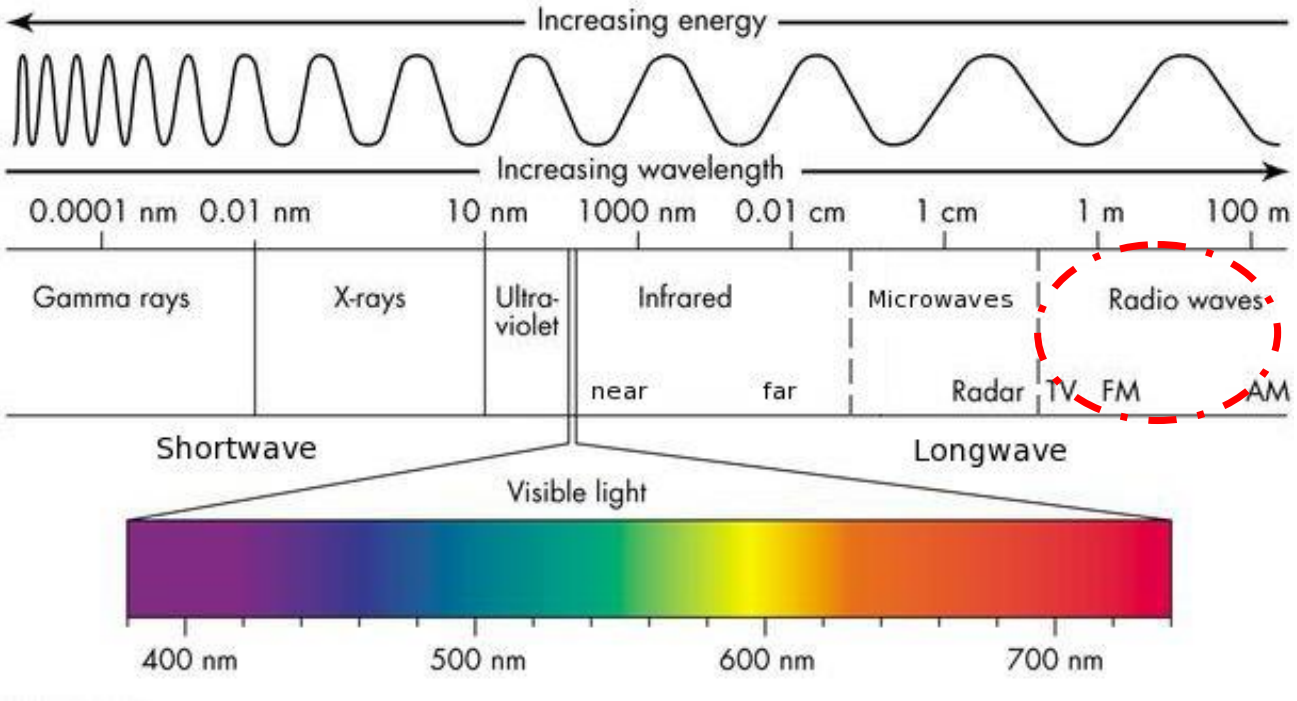
FIGURE 1.16 Spaceborne radar image of mountains in southeast Tibet. (Courtesy of NASA.)



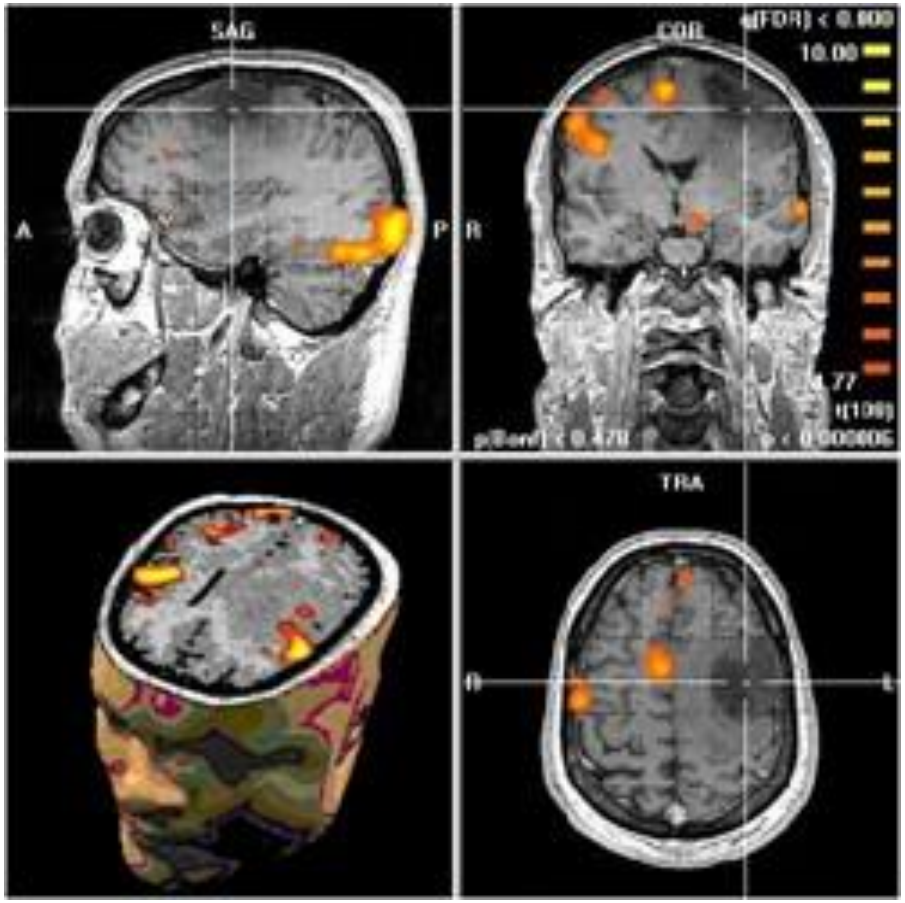


Synthetic Aperture Radar System

Radio Waves

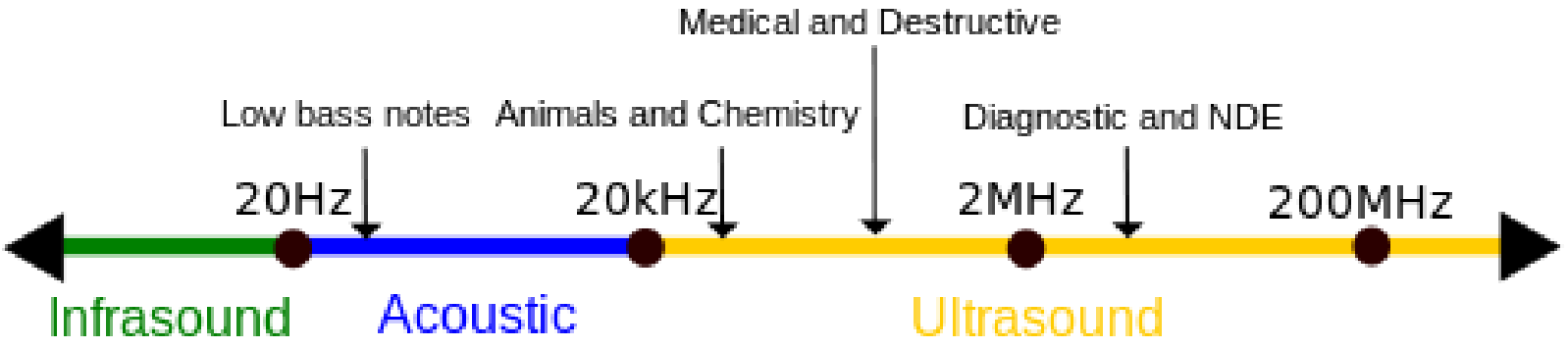


Radio Waves



MRI image slices from the brain

Ultrasound Imaging

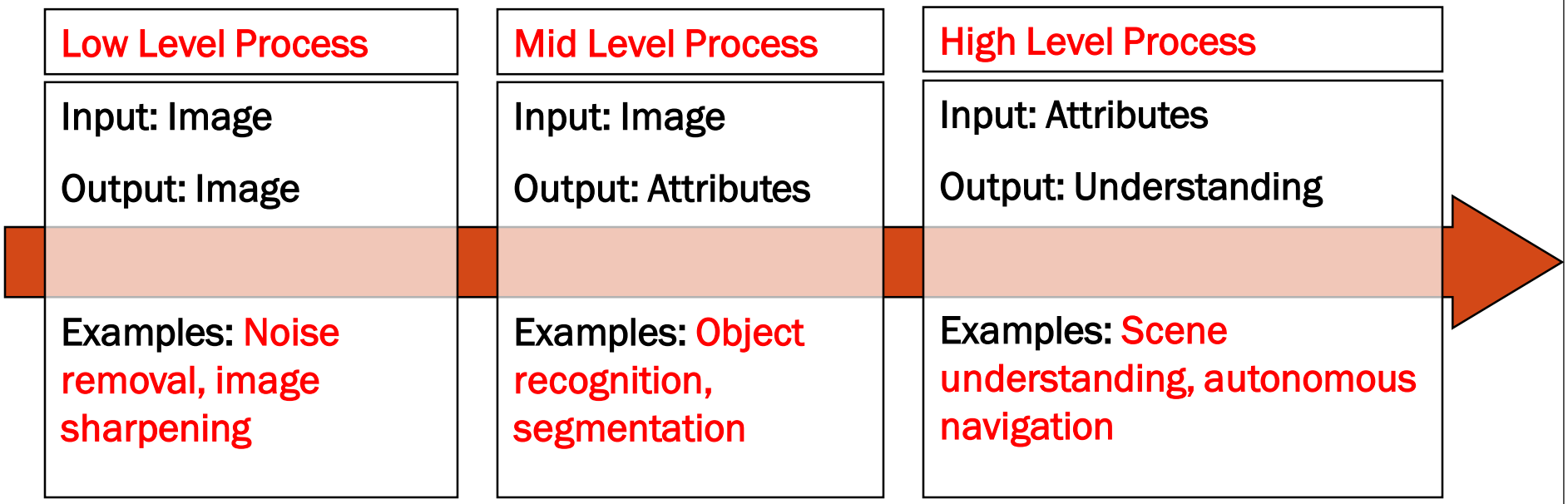


Ultrasonic spectrum

Ultrasonic Baby image during pragnancy

Ultrasound image acquisition device

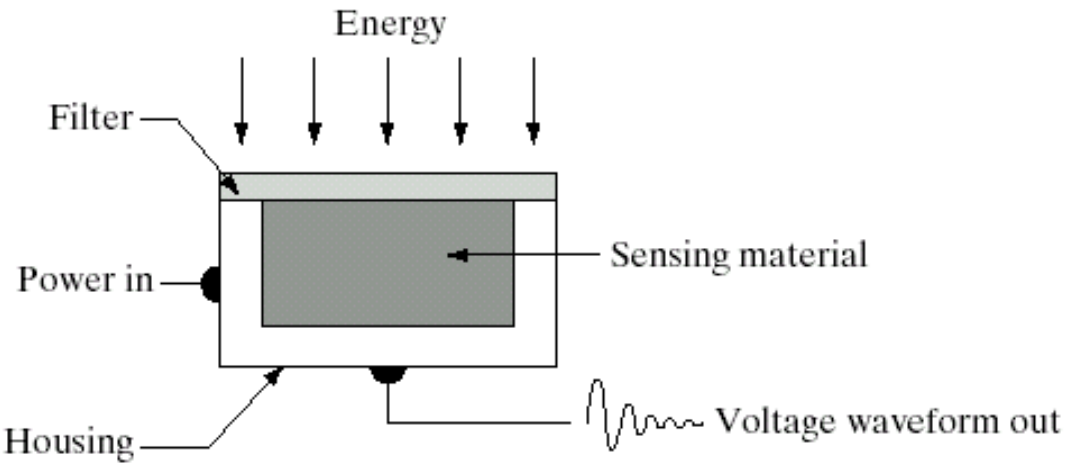
The continuum from image processing to computer vision can be broken up into low-, mid- and high-level processes



Acquisition of Images

The images are generated by the combination of an *illumination source* and the reflection or absorption of energy from that source by the elements of the *scene* being imaged.

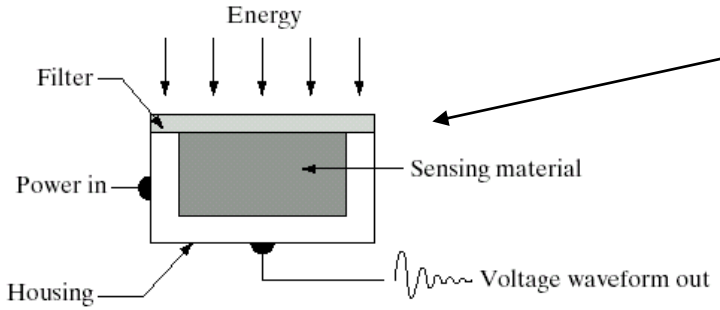
Imaging sensors are used to transform the *illumination energy* into digital images.



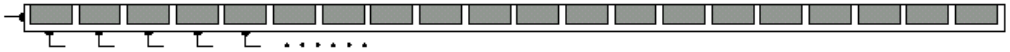
Types of Image Sensors

a
b
c

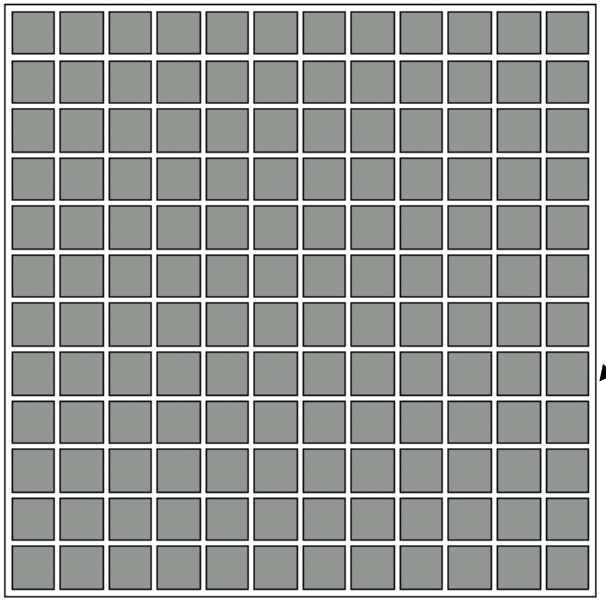
FIGURE 2.12
(a) Single imaging sensor.
(b) Line sensor.
(c) Array sensor.



Single Sensor



Line Sensor



Array Sensor

Quistions ?