ICT2403 – Graphics and Image Processing

Introduction to Computer Vision and Image Processing

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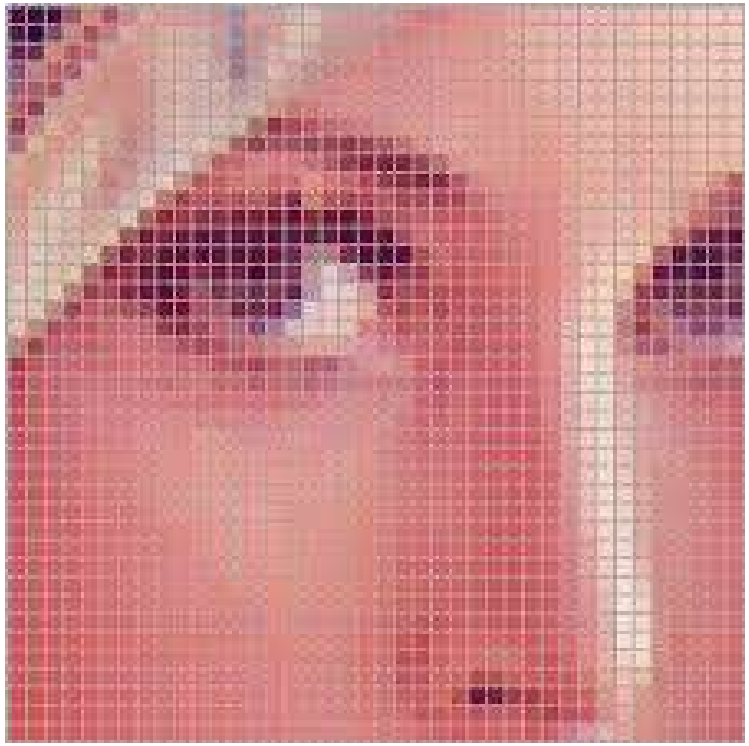
Learning Outcomes

- At the end of this lecture, you should be able to;
  - Describe image.
  - Describe digital image processing and computer vision.
  - Compare and Contrast image processing and computer vision.
  - Describe image sources.
  - Identify the array of imaging application under the EM Image source.
  - Describe the components of Image processing system and computer vision system.

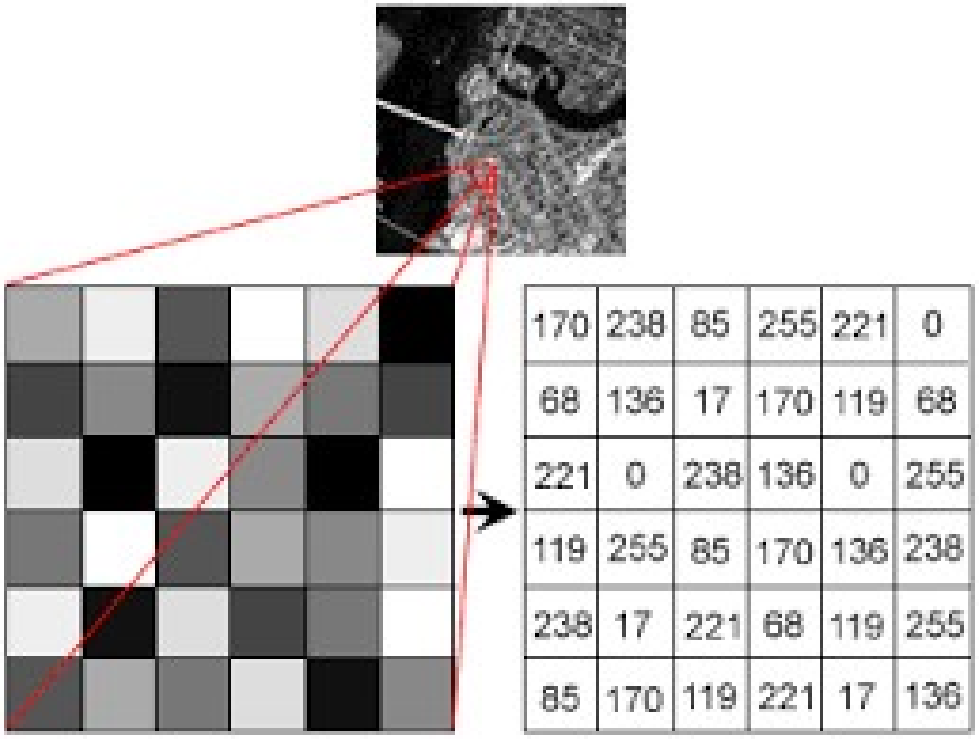
What is an Image?

- A rectangular grid of pixels.
- It has definite width and height counted in pixels
- Each pixel is a square and has a fixed size in given display.
- Each pixel has a color.

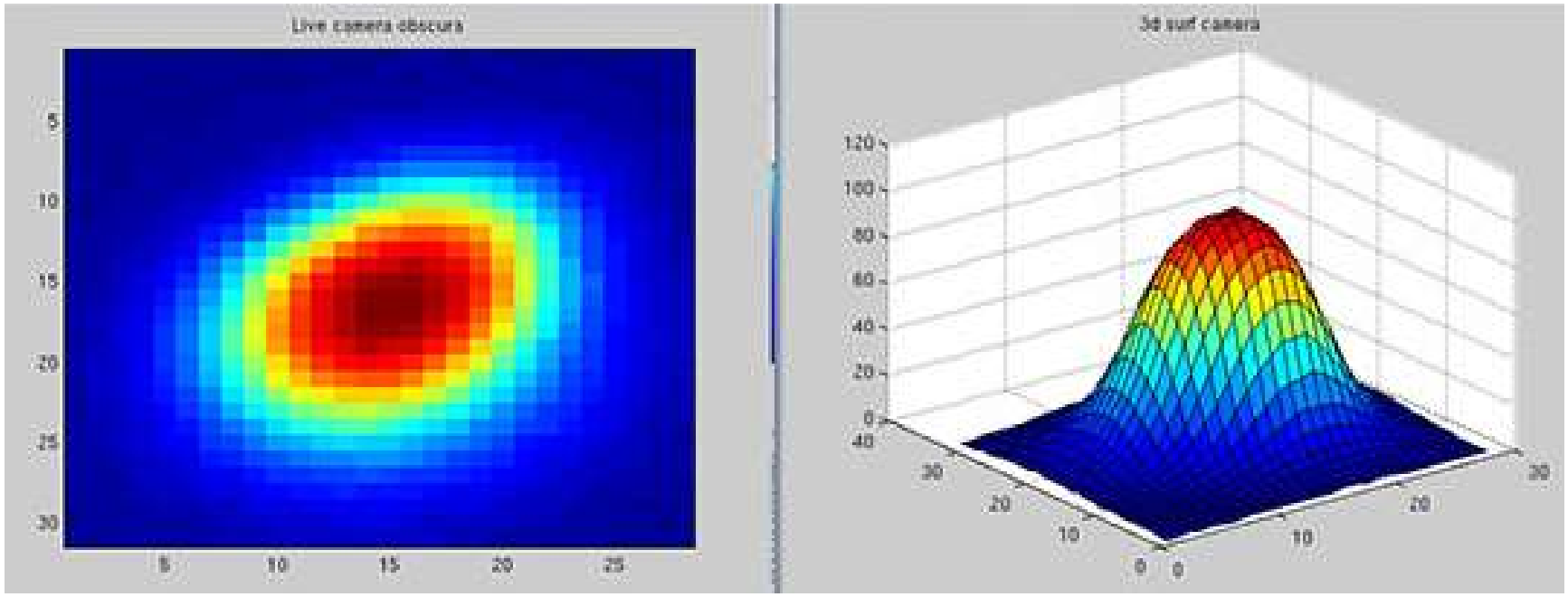


What is an Image? (Cont…)

- Image can be represented using a two-dimensional function *f(x,y)* where *x* and *y* are the spatial coordinates of each point in the image and the amplitude of *f* at any coordinate is known as the intensity or gray value of that point.

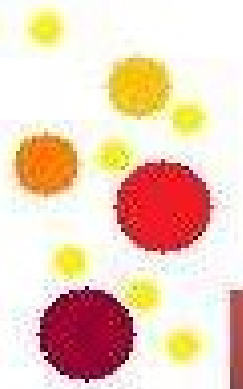


What is an Image? (Cont…)



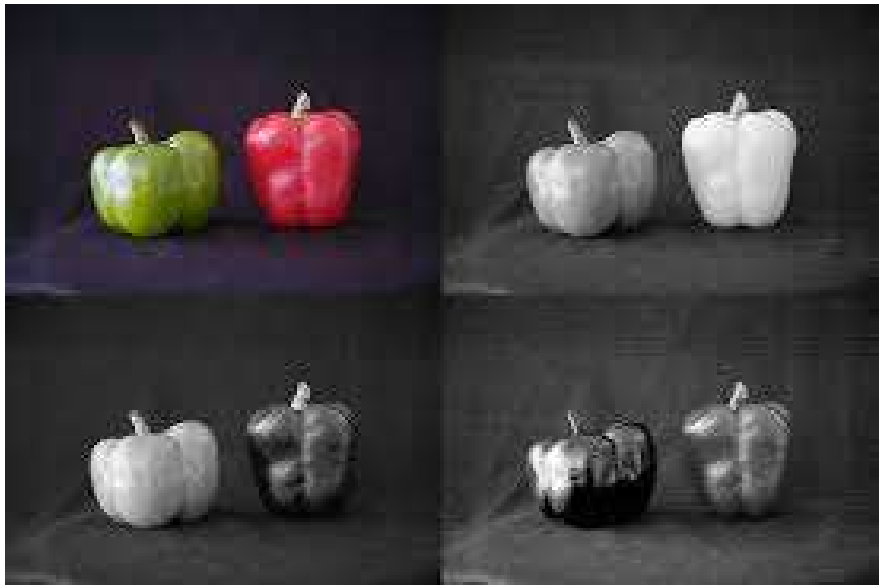
What is Digital Image Processing?

- If the image has discrete and finite quantities of coordinates and intensity, we call it as a **Digital Image**.
- Each image contains a finite number of elements each of which has a location and value. These elements are referred to as **Pixels** or **Picture elements**.
- **What is digital image processing?**
  - **Processing a digital image by means of computer is known as digital image processing.**
  - Basically we can identify two stems of image processing,
    - Processing pictorial information for the human interpretation and
    - Processing image data to store transmit and represent for autonomous machine perception.



What is Computer Vision?

- Computer vision is the transformation of data from a still or video camera into either a decision or a new representation.



What is Computer Vision? (cont…)

- Visual scene → extract → a task relevent information
- Examples
  - Optical character recognition
  - Analysis of medical, satellite and microscopic images
  - Surveillance
  - Identity verification
  - Quality control in manufacturing

What is Computer Vision? (cont…)

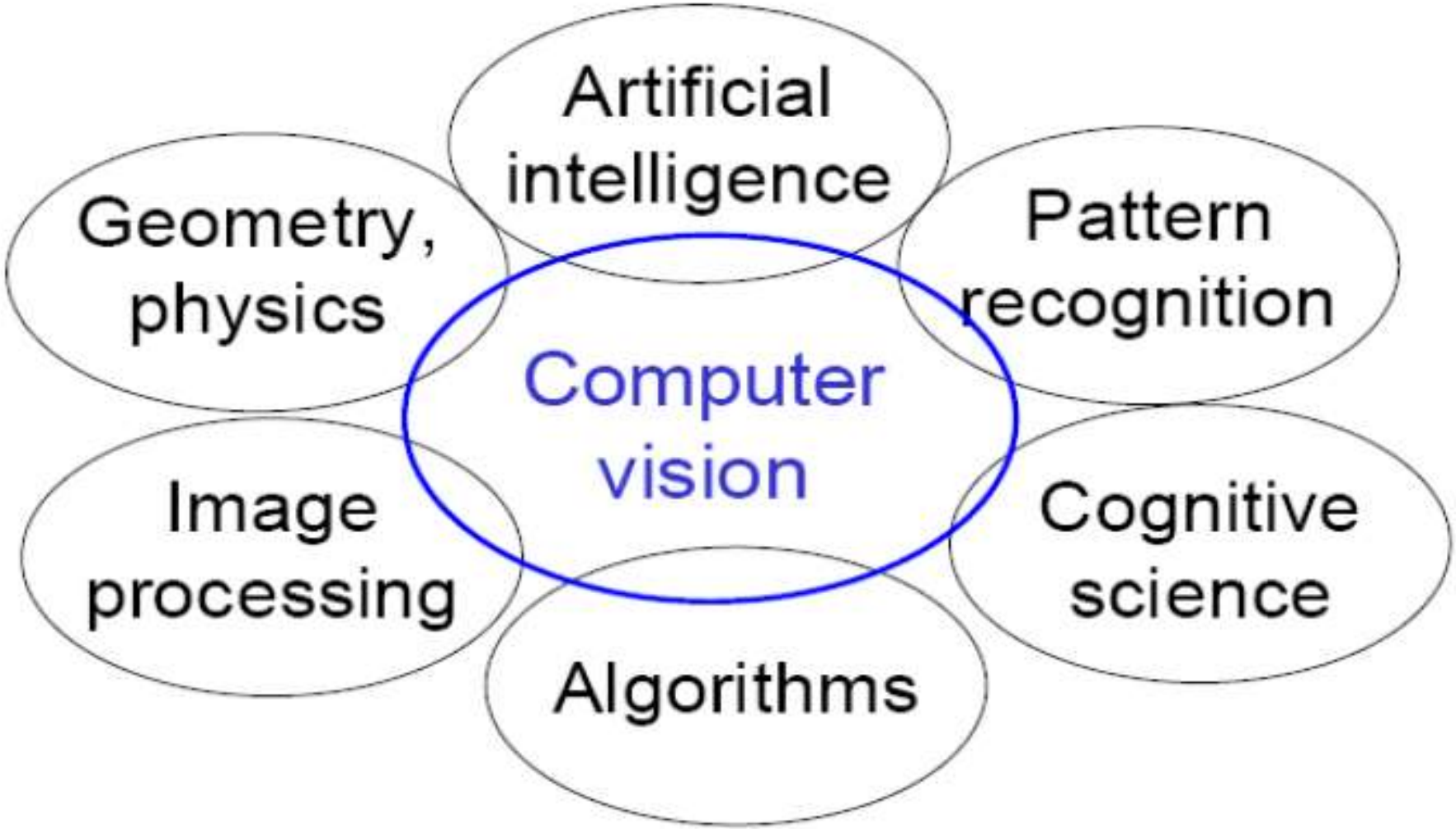
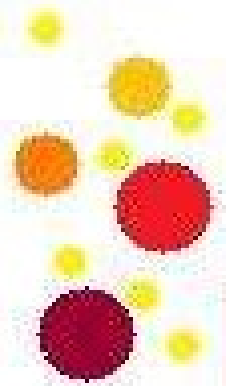


Image Sources

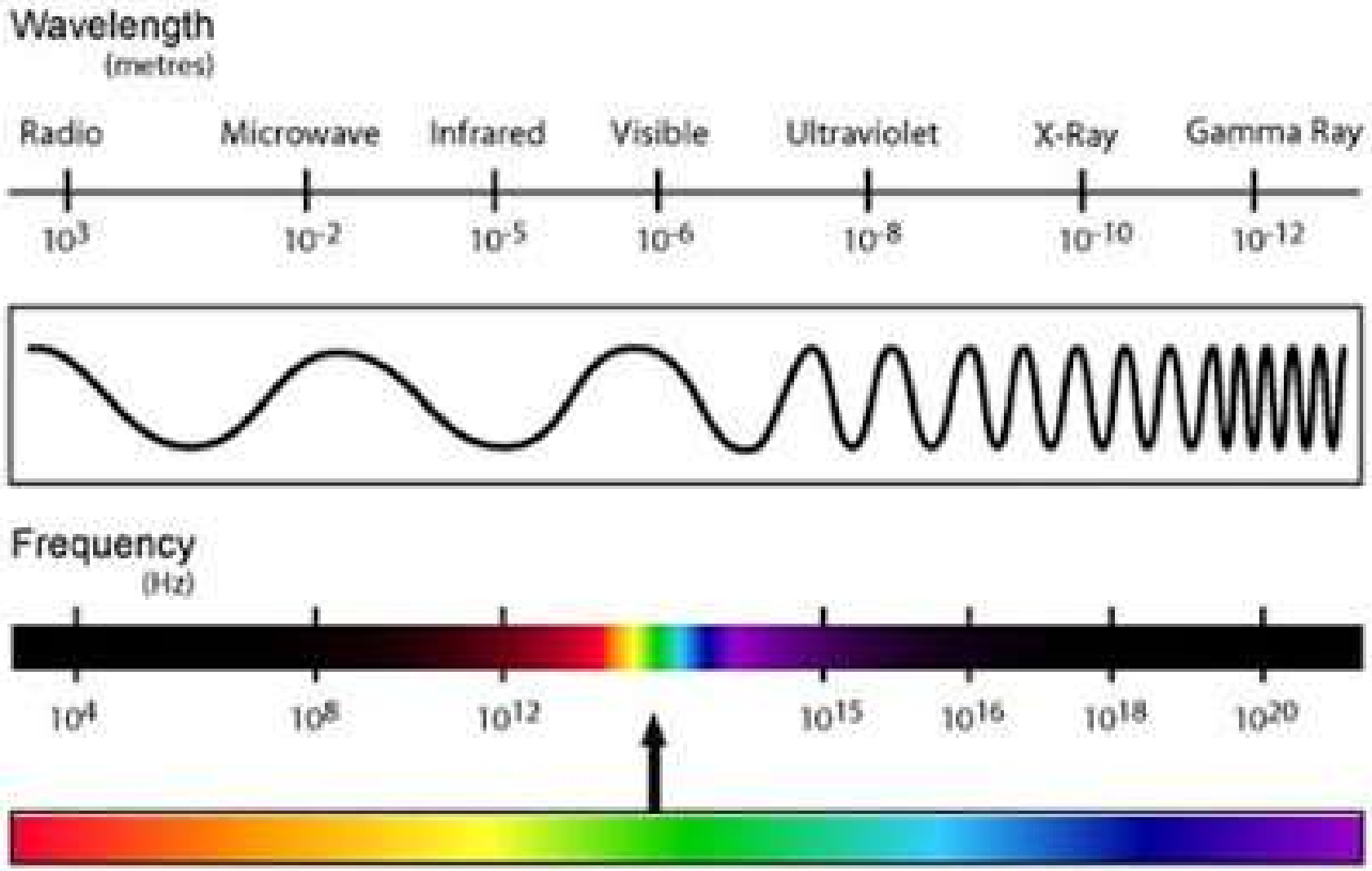
- There are various image sources available which can produce images.
  - Electro Magnetic (EM) energy spectrum.
  - Acoustic: medical ultrasound, underwater imaging, sonar mapping
  - Ultra sonic: medical ultrasonography, dental images, material characterizing
  - Electronics- Computer Generated Images (CGI)



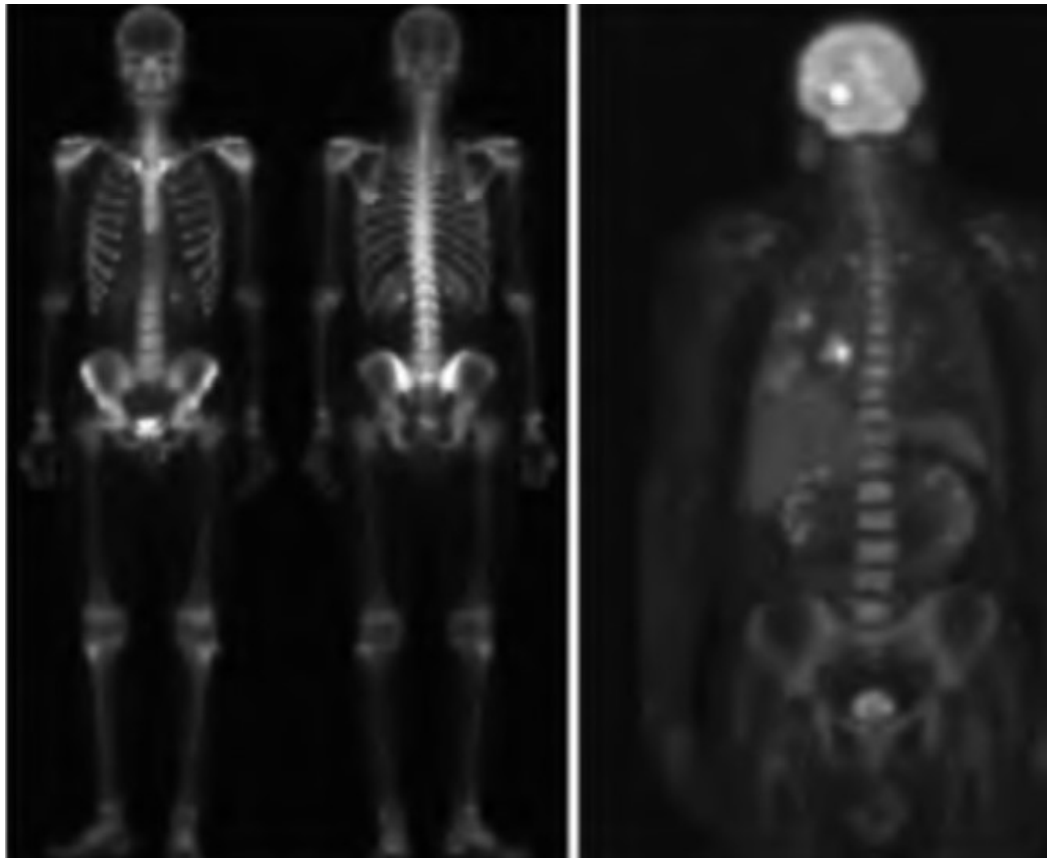
Imaging in Electro Magnetic (EM) Energy Spectrum

- Electromagnetic waves are conceptually sinusoidal and formation of different wave lengths.
- It can be thought of as a stream of massless particles, each travelling in a wave like pattern and moving at the speed of light.
- Each massless particle contains a certain amount of energy and a bundle of energy is known as photon.

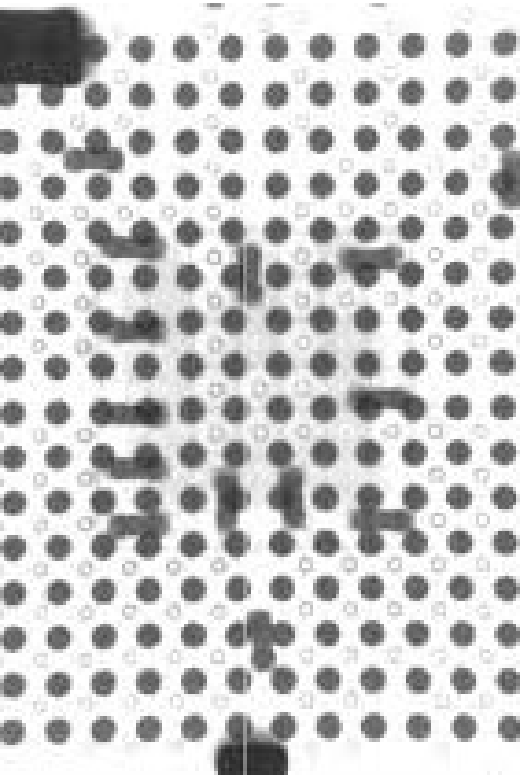
Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

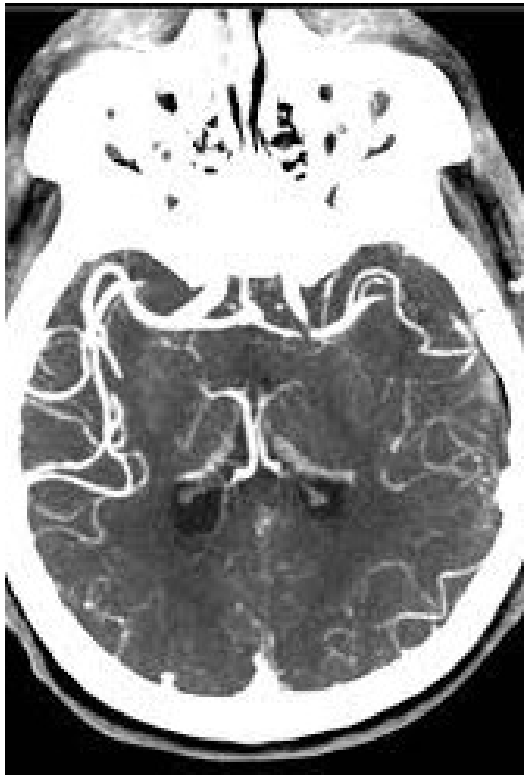


Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)



- **Gamma Ray Band**
  - Gamma rays are used in nuclear medicine and astronomical observations.
    - X-ray Tomography
    - Positron Emmition Tomography (PET)



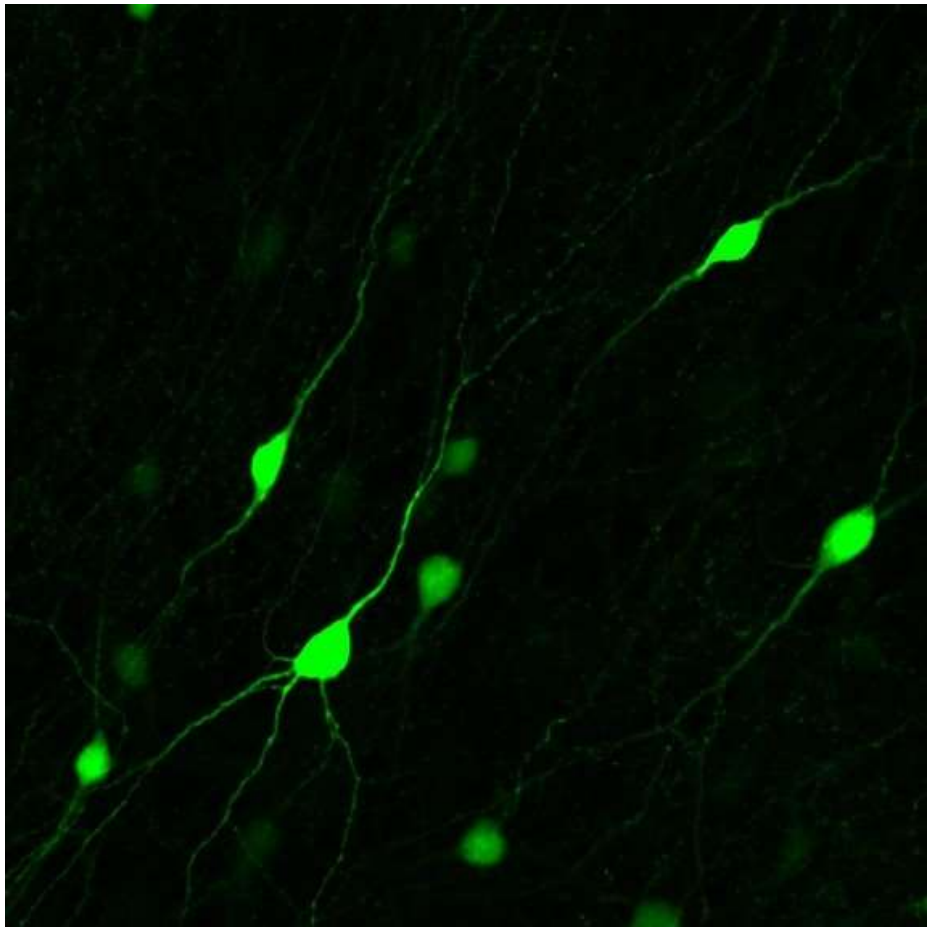


Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

- **X-ray**
  - X-ray is used in medical diagnostics, industry and astronomy.
  - Bone structure visualization, angiogram and Computed Axial Tomography (CAT) are common examples of the X-rays in medical domain.

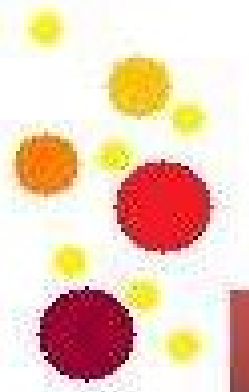
Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

- **Ultra Violet Band**
  - Imaging in Ultra Violet band includes lithography, industrial inspections, microscopy, lacers, biological imaging and astronomical observations.
  - One good example of Ultra Violet imaging is Fluorescence Microscopy.

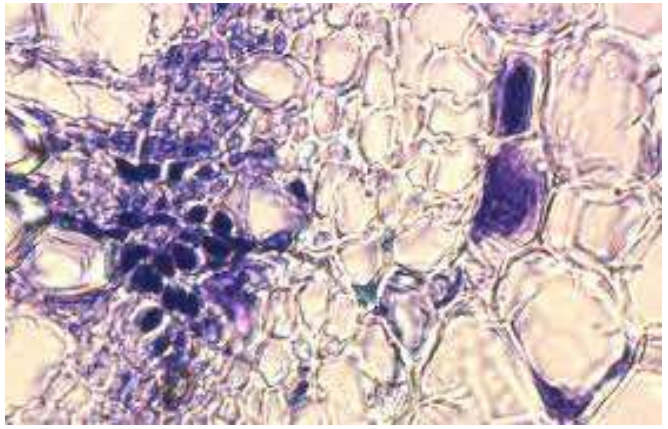


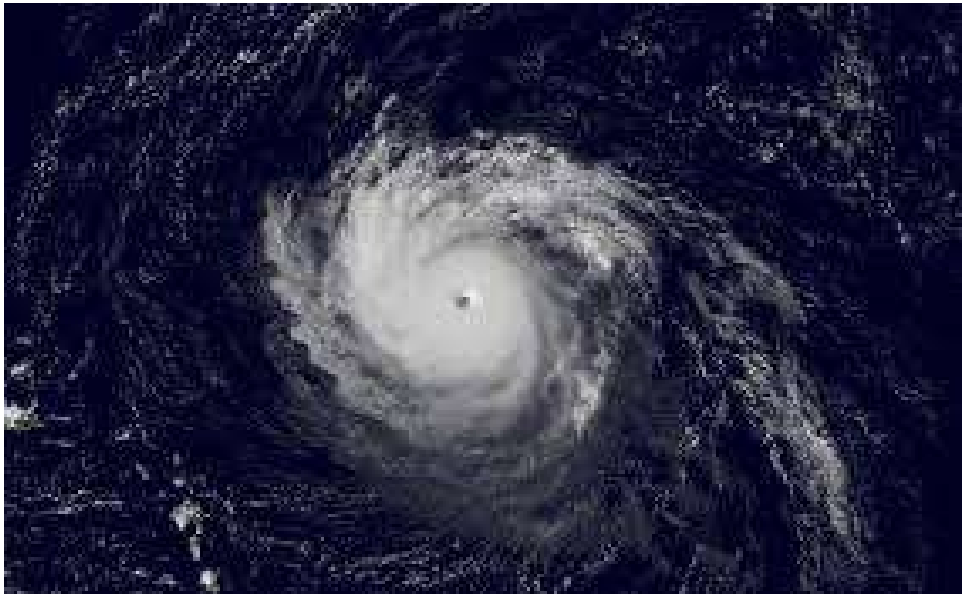
Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

- **Visible and Infrared Bands**
  - Infrared band is often use in conjunction with visible band.
  - Basically it is used in numerous applications like law enforcement (figner print reading, reading the number plate of the vehicles), industrial verifications, remote sensing, astronomy, light microscopy and many more.
  - Remote sensing, weather observation and predication are utilizing some energy bands in both visible and infrared regions.



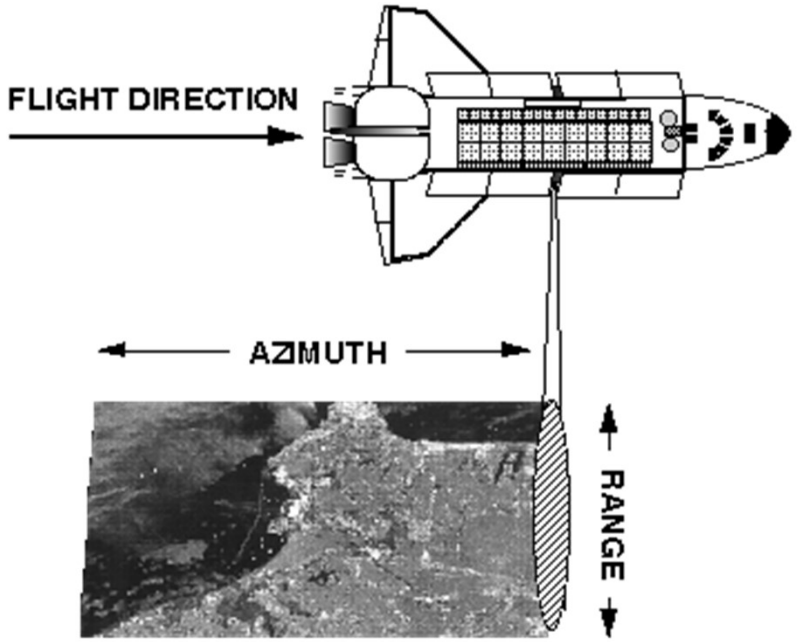
Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)




Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

- **Microwave Band**
  - The common utilization of Microwave is radar.
  - Radar can form images virtually any region at any time.
  - It does not care about the lighting conditions and the weather conditions.



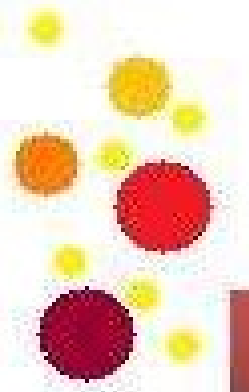
https://airsar.jpl.nasa.gov/documents/genairsar/radar.html

Imaging in Electro Magnetic (EM) Energy Spectrum (Cont…)

- **Radio Band**
  - Radio signals are used in medicine for diagnosis and astronomy.
  - Magnetic Resonance Imaging (MRI)

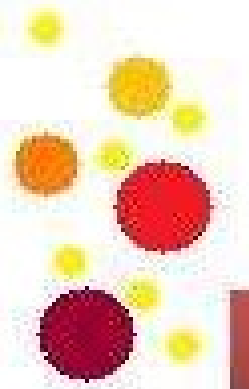
Components of an Image Processing System

- With reference to sensing, two devices 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 the digitizer, is the device for converting the output of the physical sensing device into digital form.
  - For instance, in a digital video camera the sensors produce electrical output proportional to the light intensity and the digitizer converts these outputs to digital data.



Components of an Image Processing System (Cont…)

- Digitizer and Arithmetic and Logical Unit (ALU) can be considered as specialized image processing hardware.
- In the image processing applications, the computers can be scaling from general purpose computer to supercomputer depending on the nature of the application.

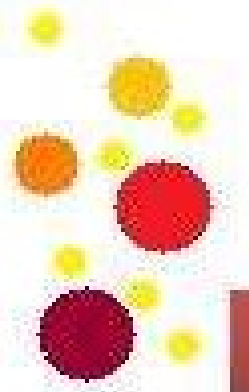


Components of an Image Processing System (Cont…)

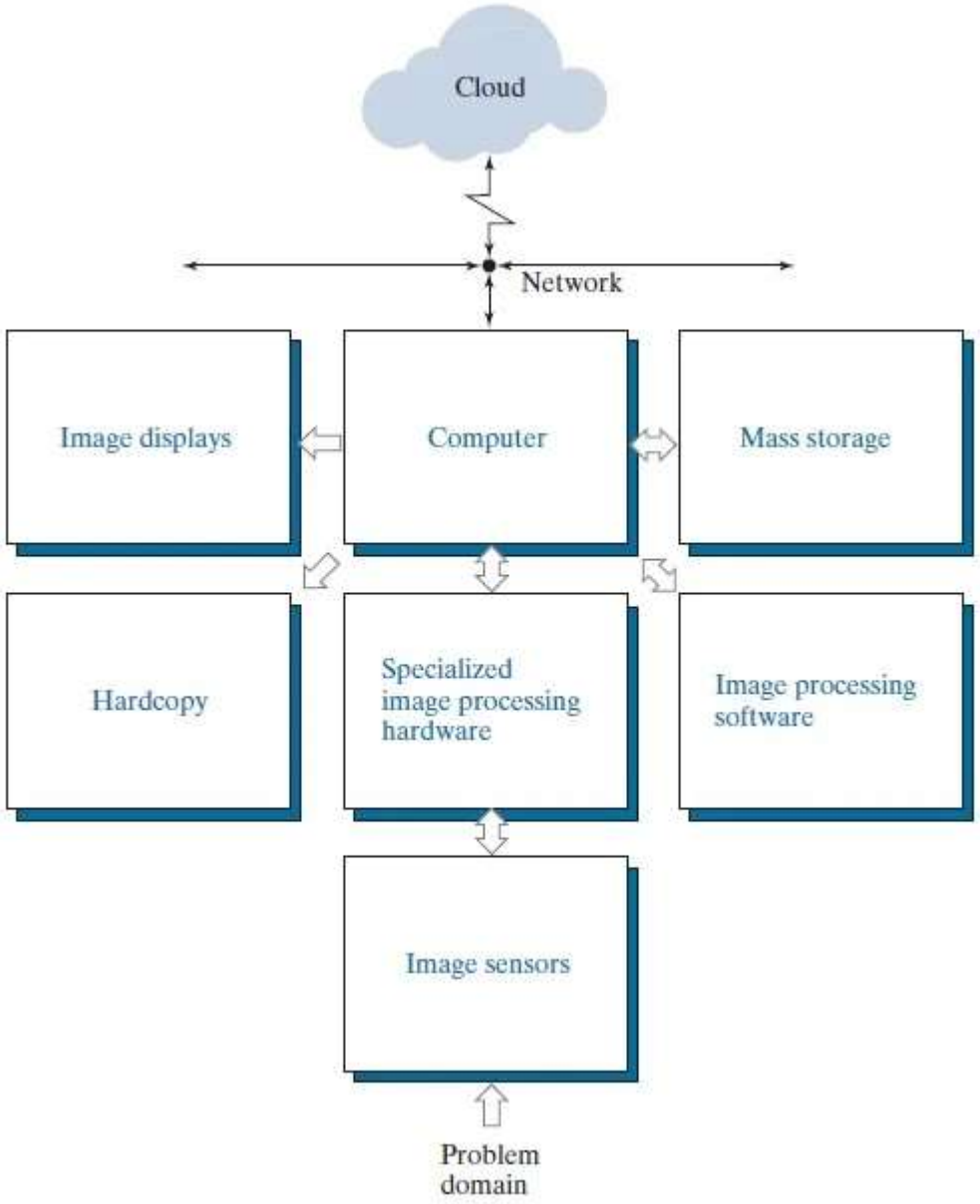
- Software for image processing applications indicates the specific software modules that help to the programmer to write efficient programs easily.
- Storage is required to store the image temporarily, online storage for fast recall and archival storage for rarely access.
- Displays are the units which visualize the output of the image processing application.
- It may be color monitor or graphic card.

Components of an Image Processing System (Cont…)

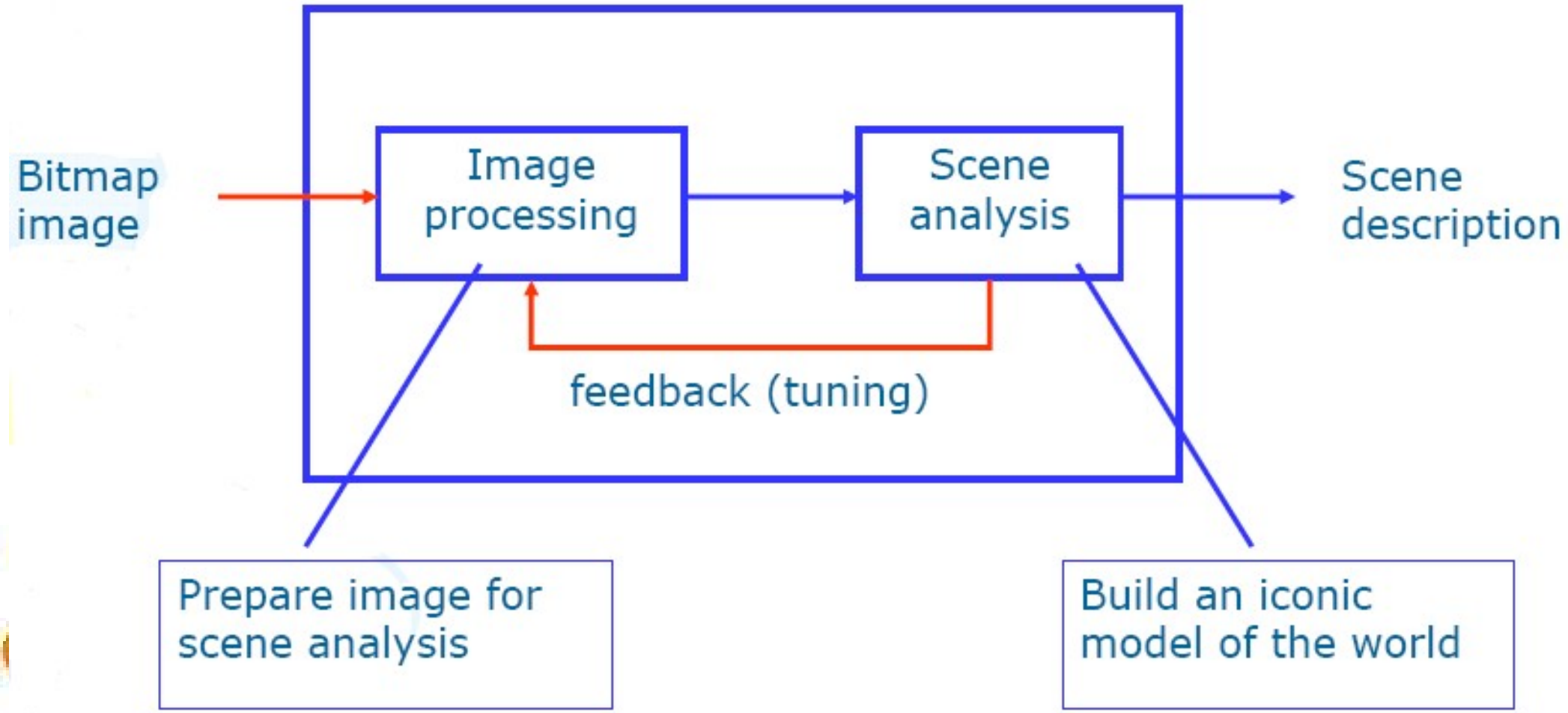
- Hardcopy devices are important to recording images includes laser printers, film cameras, heat sensitive devices, inkjet units or digital units such as optical disk or CD-ROM.
- Network provides the media to interchange the image processing outputs.



Components of an Image Processing System (Cont…)



Computer Vision System



Your Reflection

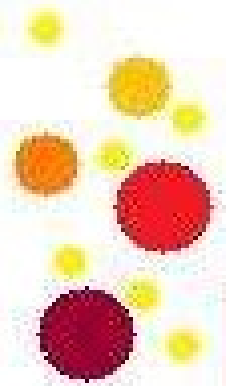
- Your reflection on “Imaging with different Image sources”?
  - Continue this Forum in LMS

Reference

- Chapter 01 and 02 of Gonzalez, R.C., Woods, R.E., Digital Image Processing, 3rd ed. Addison-Wesley Pub.

Learning Outcomes Revisit

- Now, you should be able to;
  - Describe image.
  - Describe digital image processing and computer vision.
  - Compare and Contrast image processing and computer vision.
  - Describe image sources.
  - Identify the array of imaging application under the EM Image source.
  - Describe the components of Image processing system and computer vision system.



Next Lecture – Digital Image Fundamentals

QUESTIONS ?