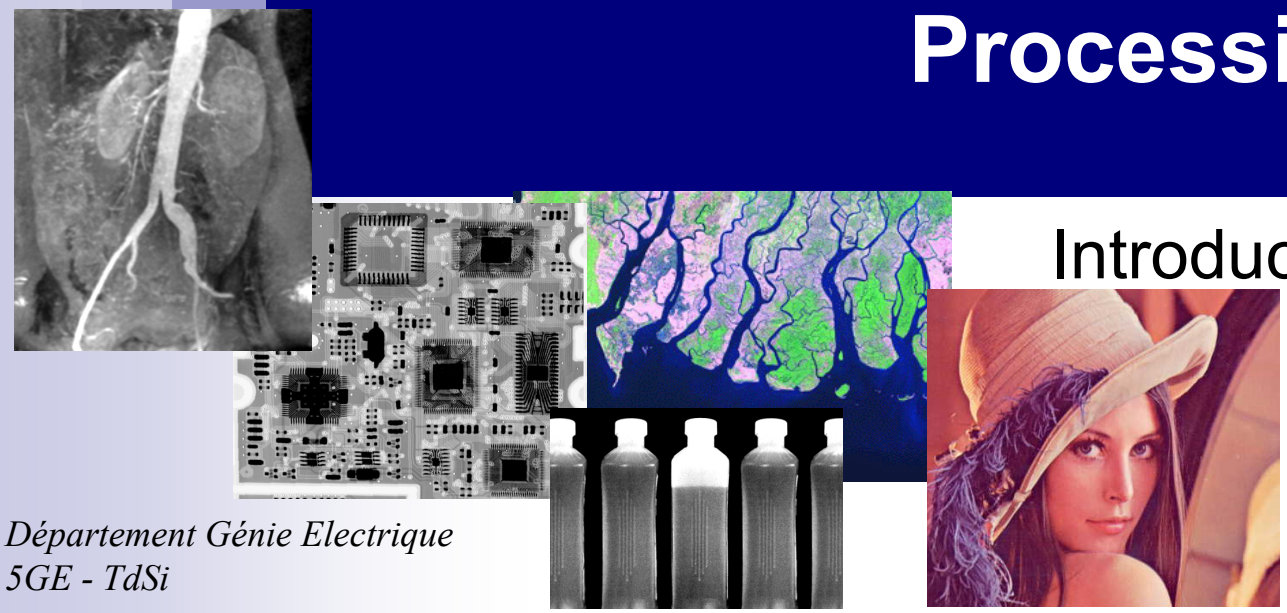
Thomas.Grenier@creatis.insa-lyon.fr

Digital Image Processing

Introduction



Département Génie Electrique
5GE - TdSi

Summary

Introduction

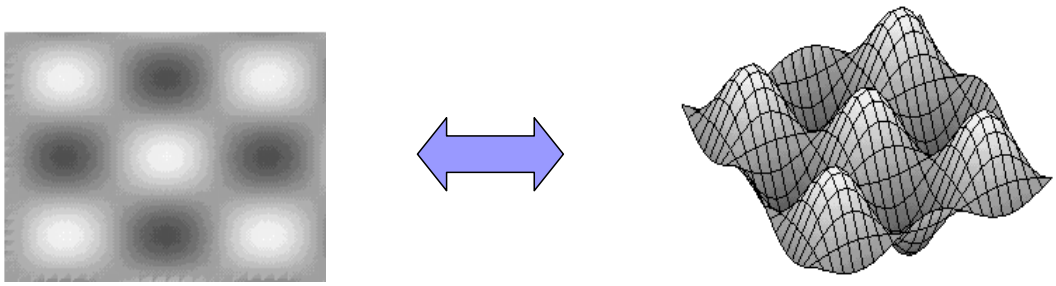
- What is Digital Image Processing?
- Examples of fields that use DIP
- Fundamental steps in DIP
- Components of an image processing system

→ Book

Digital Image Processing, Gonzales, *Prentice Hall (3Ed.)*

What is a *DIP* ?

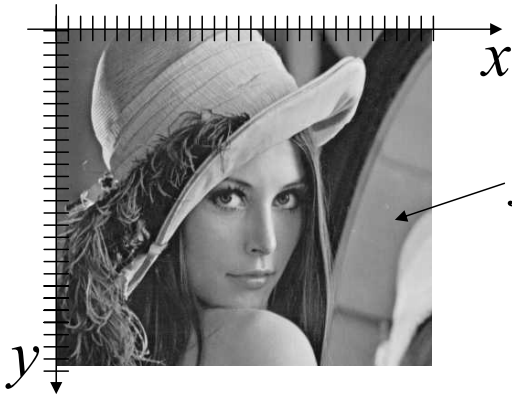
- Image definition
  - An image may be defined as a two-dimensional function, $f(x,y)$
    - x and y are spatial (plane) coordinates
    - the amplitude of f at any pair of coordinates (x,y) is called ***intensity*** or ***gray level*** of the image at that point



What is a *DIP* ?

- Image definition
  - When f, x and y are all finite and discrete quantities, the image is called a ***digital image***

Gray level digital image



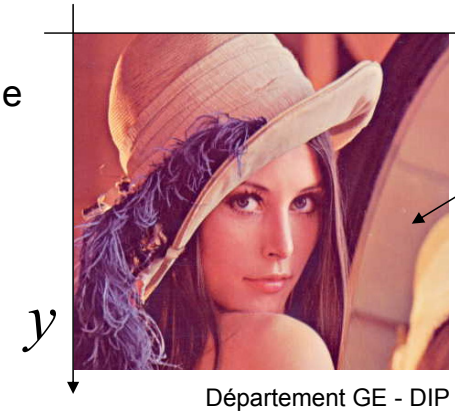
$f(x_1,y_1)= 179 =$ ■

What is a *DIP* ?

- Image definition
  - The definition of f may be extended:
    - as a ***n***-dimensional function,
      - i.e. 3D: $f(x,y,z)$ or image sequence $f(x,y,\boldsymbol{t})$
    - with amplitudes composed as a vector of data,

      i.e. Color image: 3 components at each point, Complex number

RBG image



$f(x_1,y_1)= \{217, 182, 167\}$

$= \{$ ■ , ■ , ■ $\}$

$= \{$ ■ , ■ , ■ $\}_{RGB}$

$=$ ■

What is a *DIP* ?

- Pixel
  - A digital image is composed of a finite number of elements, each of which has a particular location and value
  - These elements are referred to as *picture elements*, *image elements*, *pels*, and ***pixels***
  - *Pixel* is the term most widely used to denote the elements of a digital image

What is a *DIP* ?

- Digital Image Processing & related areas
  - Image processing
    - Low-level processes
      - noise reducing, contrast enhancement, …
  - Image analysis
    - Mid-level processes
      - segmentation (partitioning an image into regions or objects)
      - classification (recognition) of objects, …
  - Computer vision
    - Ultimate goal: emulate human vision
    - High-level processes
      - learning, inferences making, actions taking
      - giving a sense to a set of recognized objects
      - perform the cognitive functions normally associated with vision
  - no clear-cut boundaries…

What is a *DIP* ?

- Digital Image Processing and human vision
  - The field of DIP refers to processing digital images by means of a digital computer

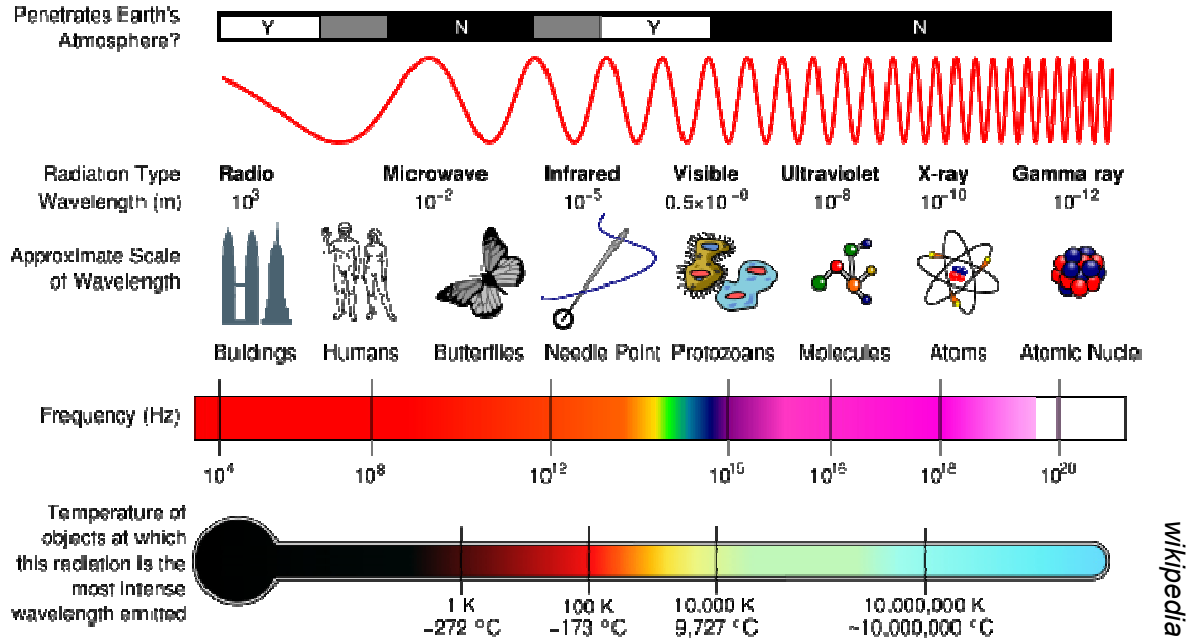
	humans	**imaging machines & DIP +CV**
electromagnetic spectrum of images	visible band	Full spectrum
sources of images	accustomed to be associated with image	all (Ultrasound, electron microscopy, …)
processing by	*brain*	computer(s)
analysis	*hand (manually)*	computer(s)

Examples of fields that use DIP

- Many applications…
  - **Industrial inspection** (anomalies detection, measuring (bench), tracking, monitoring…)
  - Medical imaging (visualization, tumor detection, reconstruction, artifact correction, diseases quantification, …)
  - Satellite Imaging (weather, environmental conditions monitoring,..)
  - microscopy (pharmaceutical, micro inspection, materials characterization,...)
  - Telecommunication (transmission, compression,...)
  - Cinema, image synthesis, scientific visualization
  - Law enforcement (license plate reading, speed, finger print…)
  - ...

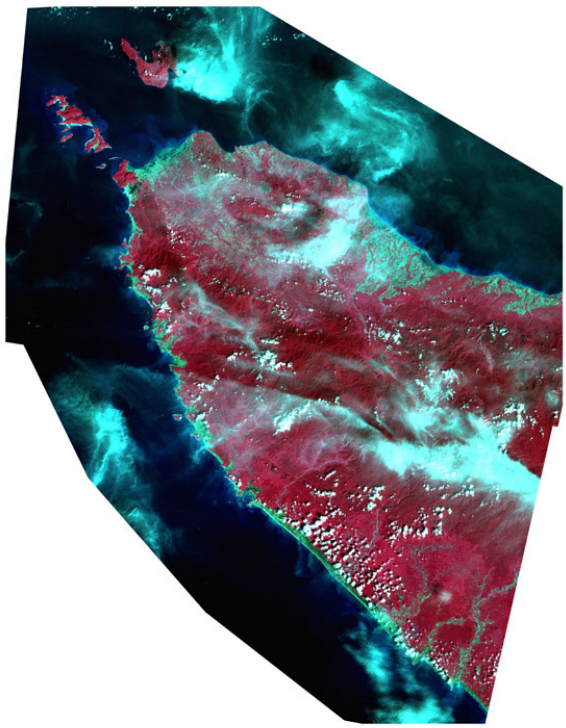
Examples of fields that use DIP

- Images based on radiation from electromagnetic spectrum



Examples

Landsat images after the tsunami in Indonesia 2004,



Left: in natural color (Landsat ETM+ bands 1,2,3 RGB)
Right: in false-color composite (Landsat ETM+ bands 4(near infrared),3,2 RGB). In this image vegetation appears in red, pink, and maroon; water appears in blue to black; urban and non-vegetated areas (including the tsunami damage regions) appear in bluish-greens and grays.

Examples

Landsat images before the tsunami in Indonesia 2004,

Before
(14/05/02)

In false-color composite (Landsat ETM+ bands 4,3,2 RGB). In this image vegetation appears in red, pink, and maroon; water appears in blue to black; urban and non-vegetated areas (including the tsunami damage regions) appear in bluish-greens and grays.

Examples

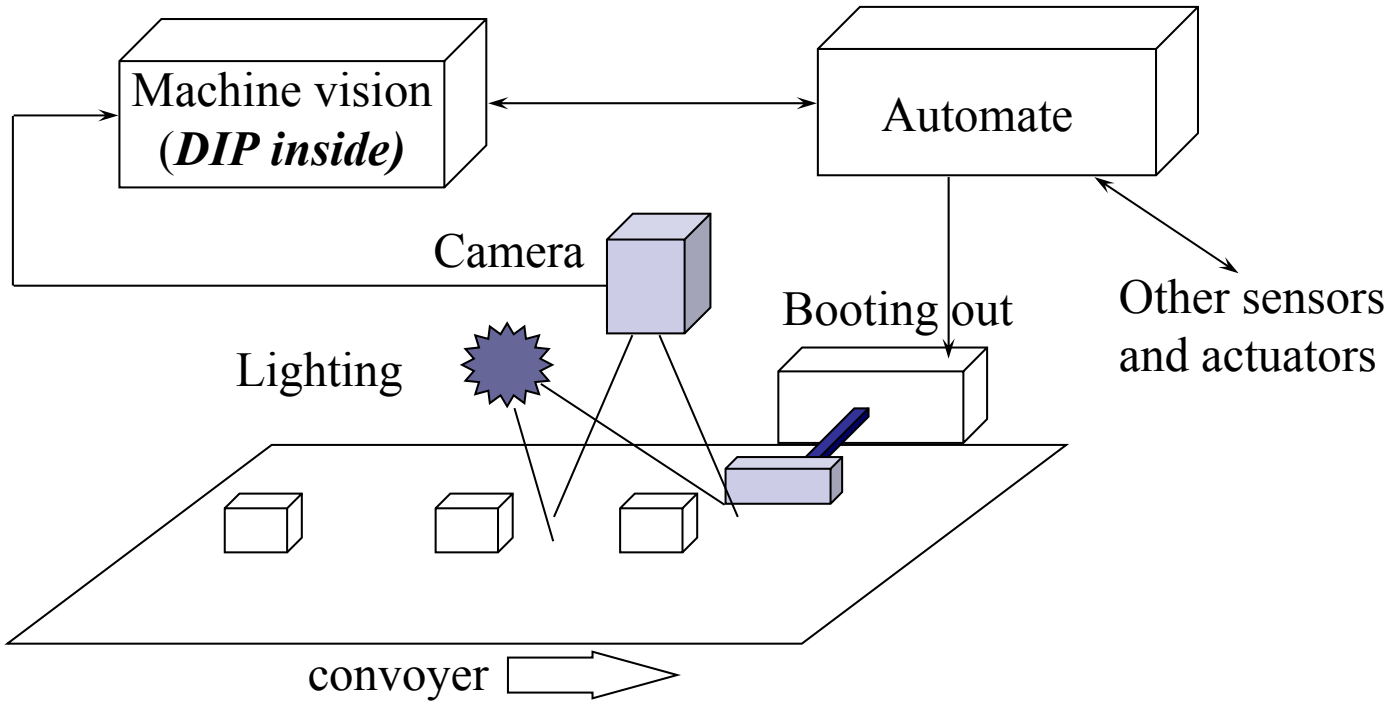
Landsat images after the tsunami in Indonesia 2004,

After
(29/12/04)

In false-color composite (Landsat ETM+ bands 4,3,2 RGB). In this image vegetation appears in red, pink, and maroon; water appears in blue to black; urban and non-vegetated areas (including the tsunami damage regions) appear in bluish-greens and grays.

Examples of fields that use DIP

- Industrial inspection, computer vision



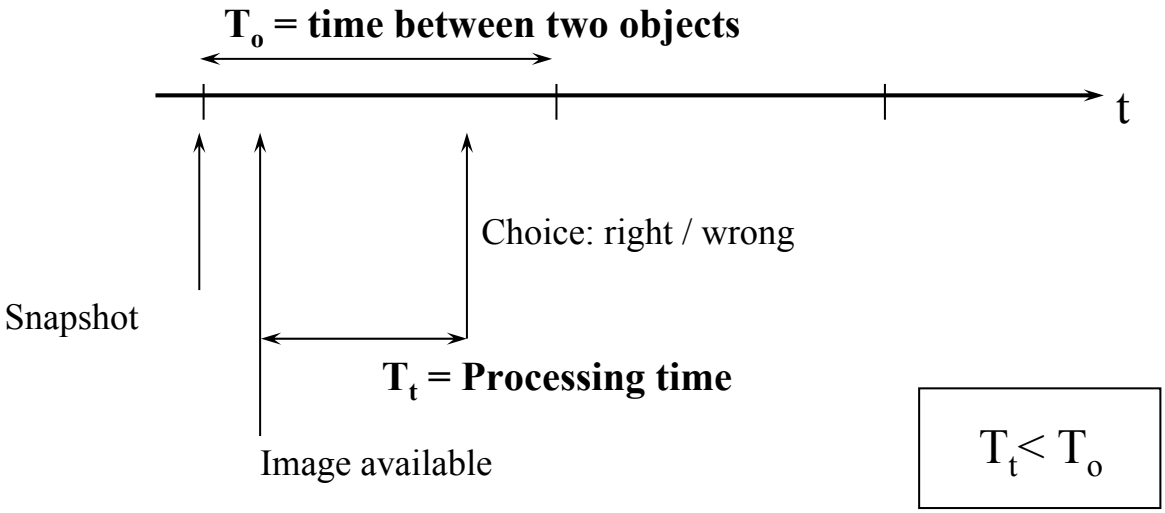
Computer vision constrains

- Robust in respect of
  - snapshot conditions
    - Lighting, camera settings...
  - (tolerated) variations of the product to control or monitor
    - Shape, position, color....
  - environment
    - Temperature, dust, moisture, place ...
  - Human being
    - User-friendly, efficiency, ...

Computer vision constrains

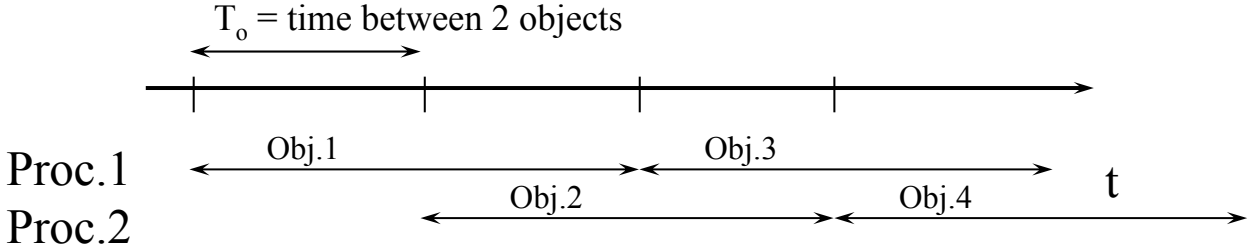
- Real Time processing

  ➔ Rate of the objects to control

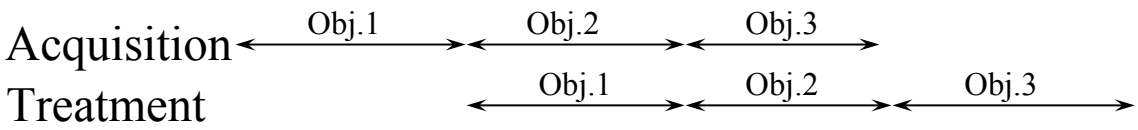


Technical solutions

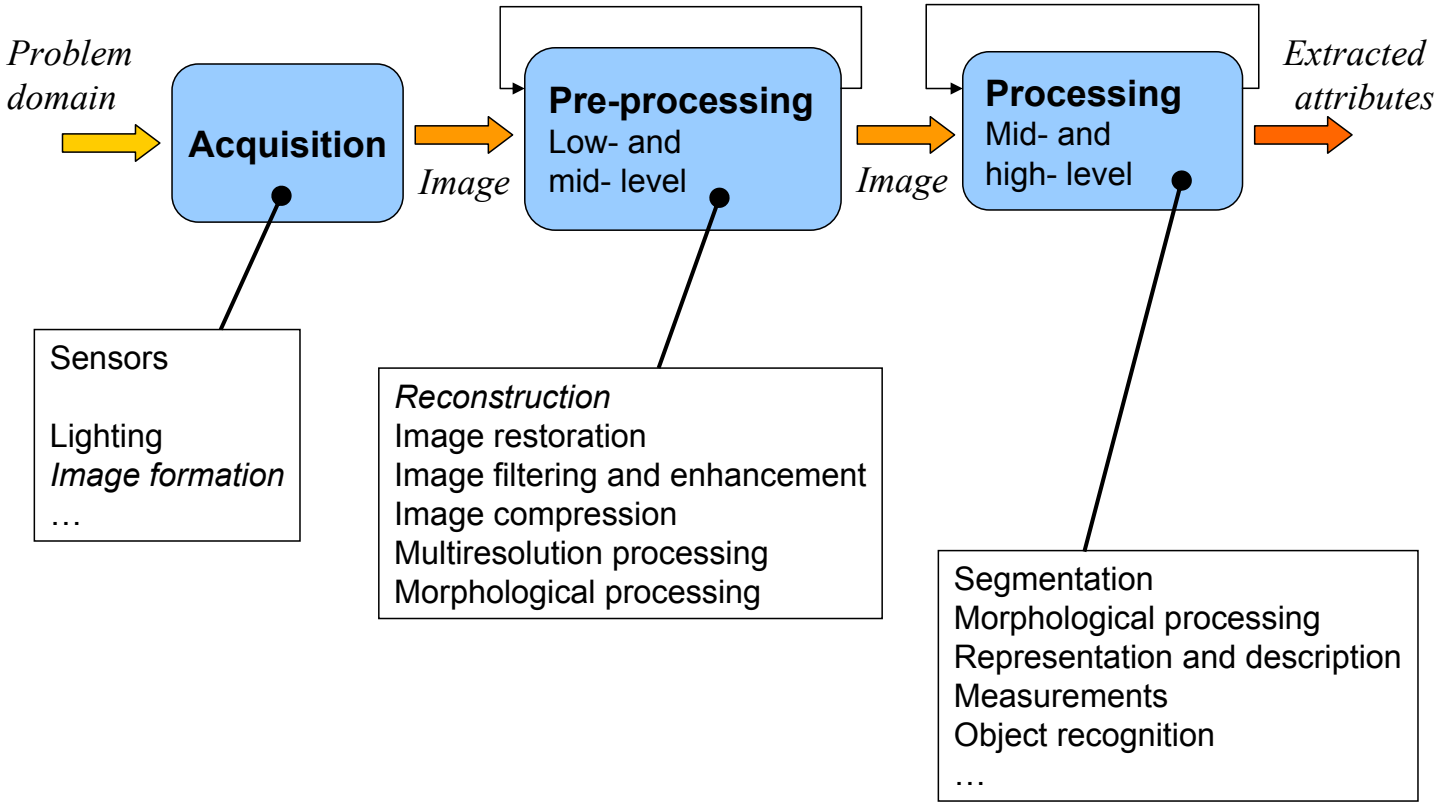
- A good lighting, a good snapshot are better than an elaborate processing
  - Image analysis can not bring any information that are not present in the image
- **For elaborate processing, you may use parallel processing**



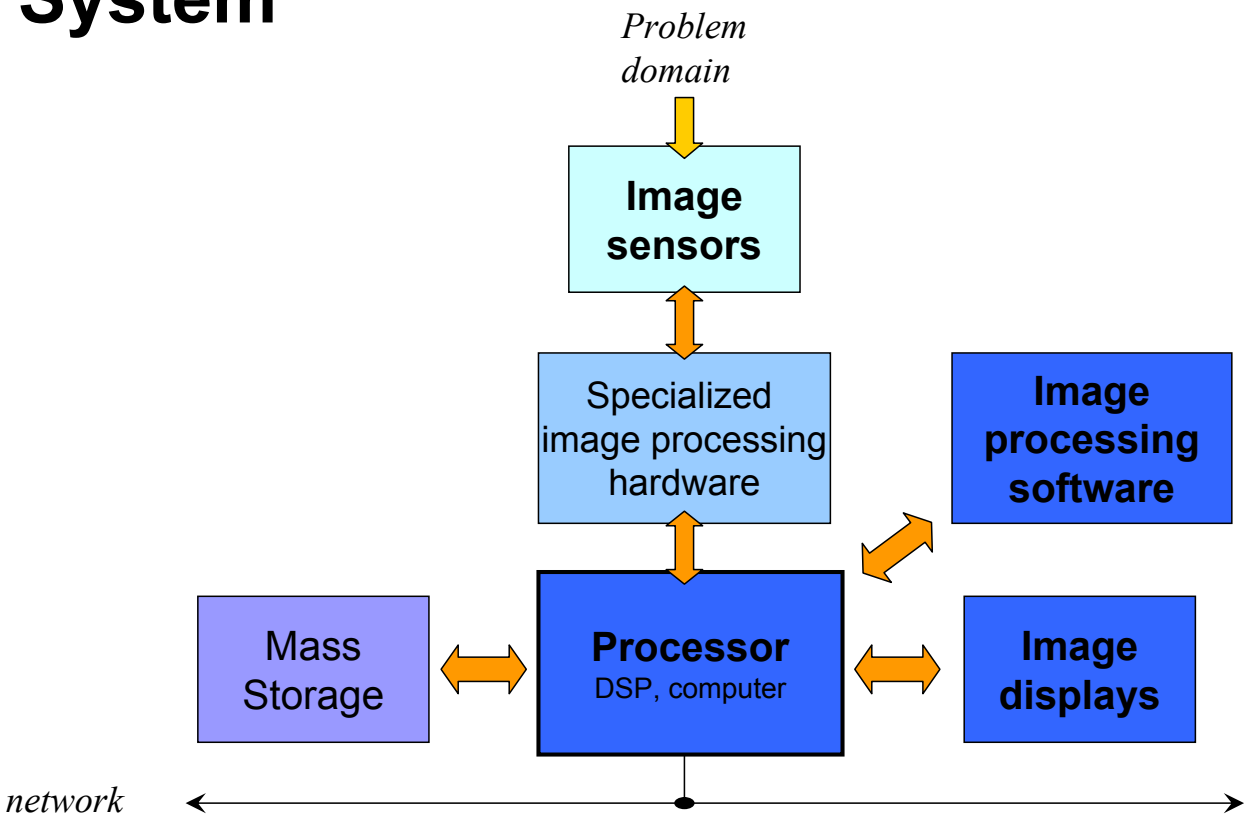
- **Or you may use *pipelines***



Fundamental steps in DIP

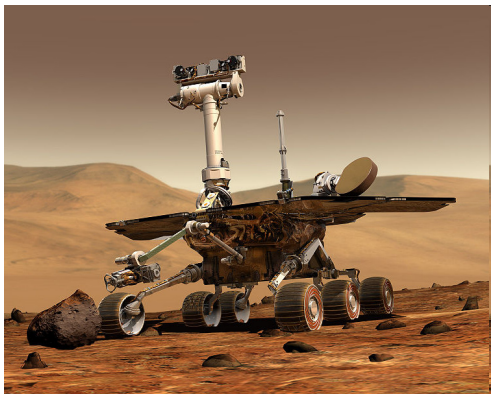


Components of an image processing System



And you ?

- Technical skills needed in computer vision *(including DIP)*
  - Optics, physics
  - Mechanics
  - Electronics
  - Control theory
  - Image processing
  - Artificial intelligence
  - Computer science
  - interpersonal relationship
  - ...



Mars Rover