

# IMAGE PROCESSING and COMPUTER VISION

## Goals:

- Understanding the theories, techniques and application of image processing and computer vision.
- Methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving
- Development and prototyping Computer Vision software by high programming language C++, or M-files in Matlab to implement computer vision algorithms.

## Objectives:

1. To introduce all the concepts needed to understand the "image" signals, from their acquisition until their processing, through the important questions of signal representation and approximation occurring during data transmission or interpretation.
2. To clearly explain the lines and relation between digital image processing and computer vision from image analysis concepts.
- 3.To understand the relation among relevant topics of computer vision and image processing with artificial Intelligence (AI).

The teaching methods include:

- Lectures
- Home works
- Assignments
- Laboratory

### Assessment Method:

Midterm Examination	20 %
Course Work and Assignments	10 %
Final Examination	70 %
<hr/>	
Total	100 %

### References:

- [1] Gonzales R.C. and Woods P., Digital Image Processing, Addison-Wesley, 4<sup>th</sup> edition, 2018
- [2] Forsth D. A. and Ponce J., Computer Vision: A Modern Approach, Prentice Hall, 2003.
- [3] Computer Vision and image processing , S.Nagabhushana, 2006.
- Image processing, Analysis, in and Machin Vision, 4<sup>rd</sup> edition, 2015.
- [4] Digital Image Processing and Analysis: Application with MATLAB and CVIPtools, 3rd Edition, SE Umbaugh, Taylor&Francis/CRC Press, 2018.

## Computer Imaging

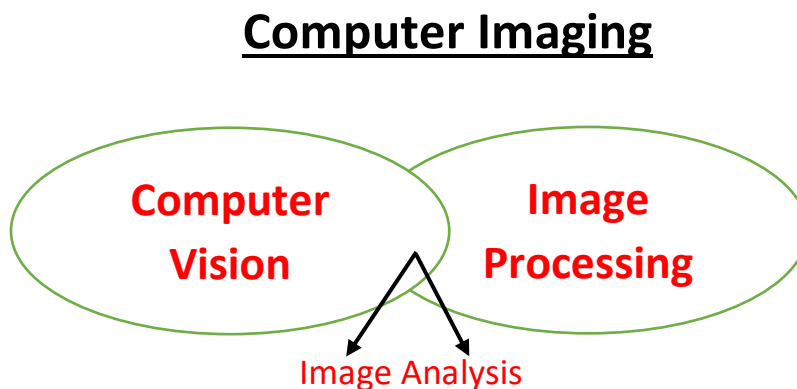
Computer imaging is a field that continues to grow, with new applications being developed at an ever increasing pace. It is a fascinating and exciting area to be involved in today.

The field of computer imaging separate into two primary categories:

### (1) Computer Vision, and (2) Image processing.

Image processing and Computer Vision both are very exciting field of Computer Science.

These two categories are not totally separate and distinct. Computer imagining can be separated into overlapping areas with image analysis being a key component in the development and deployment of both. Figure (1) below show that:



**Figure (1): The overlapping between image processing and computer vision with image analysis being part of both.**

## 1-Computer Vision:

Computer Vision is computer imaging, where the application does not involve a human being in the visual loop. In other word, the images are examined and acted upon by a computer. Computer vision systems used in many different areas within the medical community with only certainty being developed that the types of application will continue to grow. computing properties of the 3D world from one or more digital images, to make useful decisions about real physical objects and scenes based on sensed images. The construction of explicit, meaningful description of physical objects from images. Computer vision comes from modelling image processing using the techniques of machine learning. Computer vision applies machine learning to recognise patterns for interpretation of images.

In Computer Vision, computers or machines are made to gain high-level understanding from the input digital images or videos with the purpose of automating tasks that the human visual system can do. It uses many techniques and Image Processing is just one of them.

## 2-Image Processing:

Image processing is computer imaging where the application involves a human being in the visual loop in other words the image is to be examined and acted upon by people the major to topics within the field of image processing include image restoration, image enhancement, and image compression. Image processing is a **subset** of computer vision. A computer vision system uses the image processing algorithms to try and perform emulation of vision at human scale.

images and videos, there seems to be lot of confusion about the difference about these fields of computer science.

## Key Points:

**Computer imaging:** The acquisition and processing of visual information by computer. It can be divided into two main application areas  
1) computer vision and 2) Image processing with image analysis.

**computer vision:** Imaging applications where the output images are used by a computer.

**image processing:** Imaging application where the output images are for human consumption.

**-Image restoration:** The process of taking an image with some known, or estimated, degradation, and restoring it to its original appearance.

**-Image Enhancement:** improving an image visually.

**-Image compression:** Reducing the amount of data needed to represent an image.

**-Image Segmentation:** used to find higher level objects from raw image data.

## Difference between Image Processing and Computer Vision:

Image Processing	Computer Vision
-Image processing is mainly focused on processing the raw input images to enhance them or preparing them to do other tasks	-Image processing is one of the methods that is used for computer vision along with other Machine learning techniques, CNN etc.

<ul style="list-style-type: none"><li>-Image processing uses methods like Anisotropic diffusion, Hidden Markov models, Independent component analysis, Different Filtering etc.</li><li>-Image Processing is a subset of Computer Vision.</li><li>-Examples of some Image Processing applications are- Rescaling image (Digital Zoom), Correcting illumination, Changing tones etc.</li></ul>	<ul style="list-style-type: none"><li>-Computer Vision is a <b>superset</b> of Image Processing, while image processing is a <b>subset</b> of computer vision</li><li>-Examples of some Computer Vision applications are- Object detection, Face detection, Hand writing recognition etc.</li></ul>
---	---

## Image analysis:

Image analysis involves manipulating the image data to determine exactly the information necessary to help solve a computer imaging problems.

Image analysis is primarily a data reduction process. As we have seen, images contain enormous an amounts of data, typically on the order of hundreds of K.B or even M.B. Image analysis is used in both computer vision and image processing applications.

Image analysis is central to the computer vision process and is often uniquely associated with computer vision, image analysis is an important tool for image processing applications as well as.

Image analysis: the examination of image data to solve a computer imaging problem.

The image analysis process involves two other topics:

**1-Feature extraction:** is the process of acquiring higher-level information such as shape or color information (Edges, corners)&( Local regions).

**2-Pattern classification:** is the act of taking this higher –level information and identifying within the image.

The image analysis process can be broken down into three primary stages:

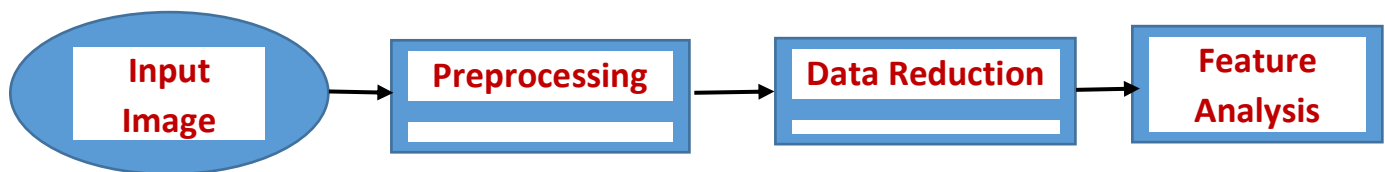
**1-Preprocessing** : is used to algorithms, techniques and operations in order to:

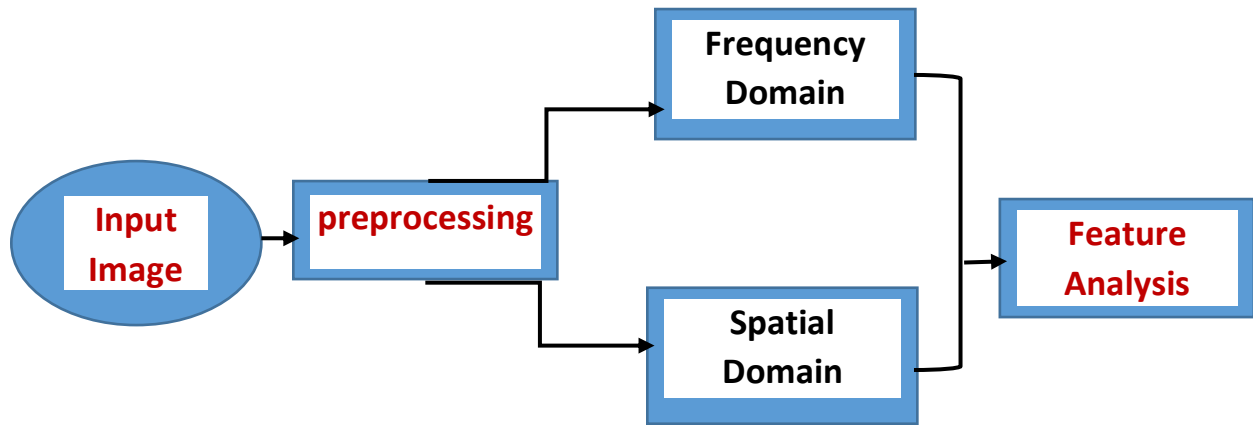
- remove noise and eliminate irrelevant visually unnecessary information.*
- *gray –level or spatial quantization (reducing the number of bits per pixel or the image size or finding region of interest).*
- *Perform initial processing that makes the primary data reduction and analysis task easier to enhancing specific image features, in both resolution and brightness.*

**2-Data reduction:** involves the data in the spatial domain or transforming it into another domain called the frequency domain and then extracting features for the analysis process.

**3-Feature extracted** by the data reduction process are examined and evaluated for their use in the application.

Illustrate in figure (2):





————— Data Reduction —————

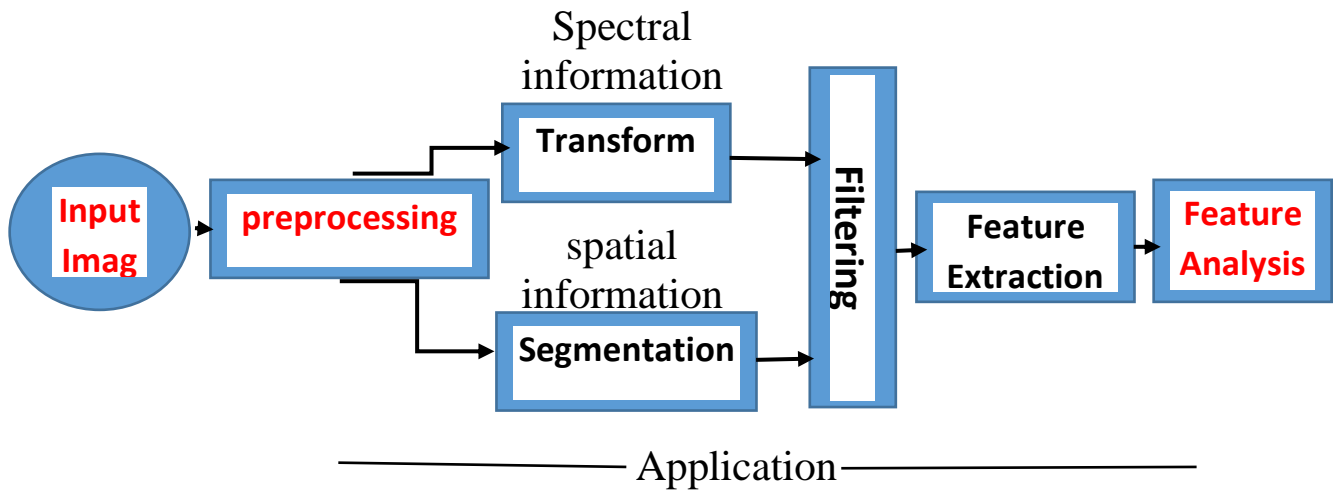
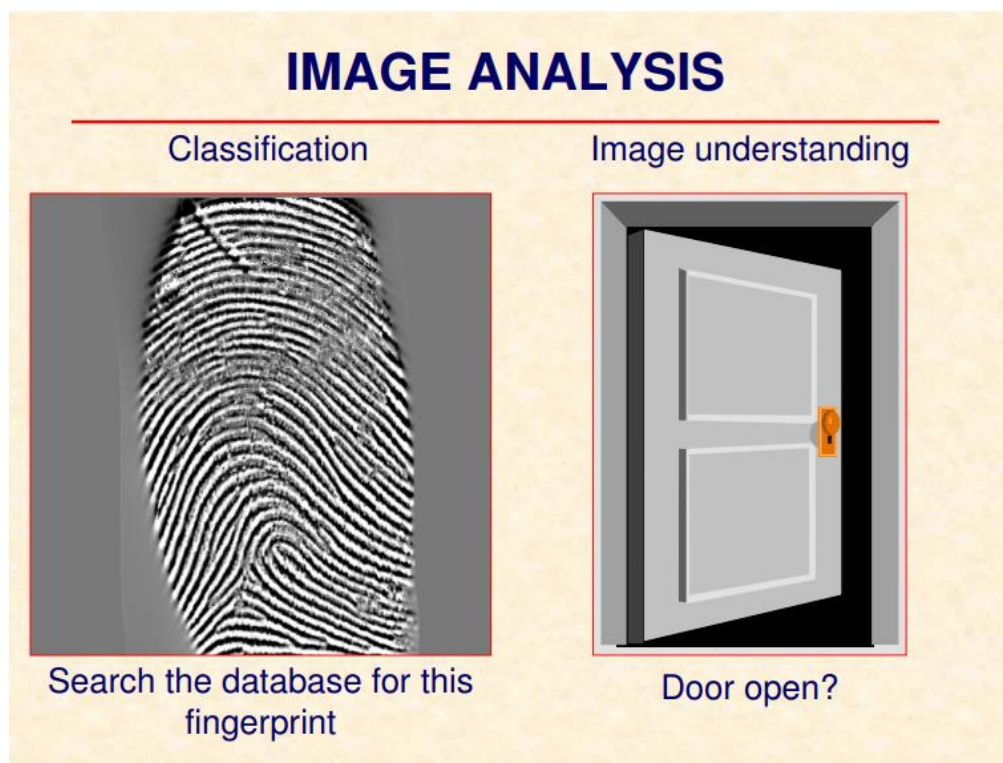


Figure 2: Primary stages of image analysis process.



Image analysis methods extract information from an image by using automatic or semiautomatic techniques termed: scene analysis, image description, image understanding, pattern recognition, computer/machine vision etc.). Image analysis differs from other types of image processing methods, such as enhancement or restoration in that the final result of image analysis procedures is a numerical output rather than a picture.

The techniques of image analysis is explain in figure(3).



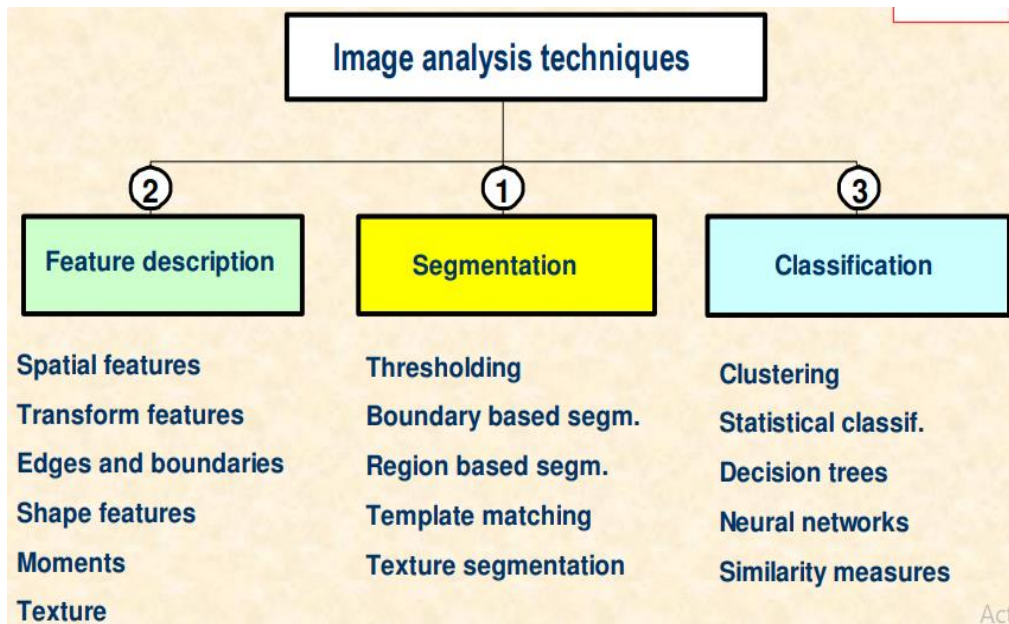


Figure (3):Image analysis tecniques.

## Applications:

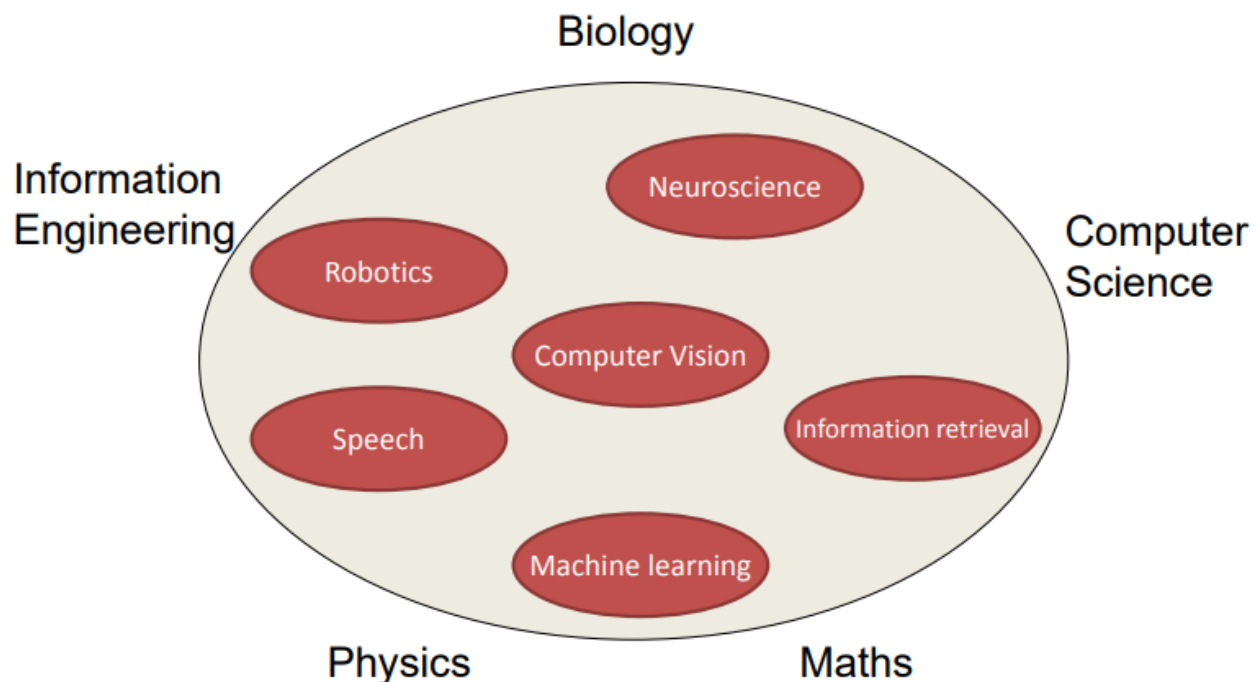
The field of computer vision may be best understood by considering different types of applications.

- **Document image analysis**
- **Industrial inspection and robotics:**
- **Remote sensing applications:** Plotting weather maps, Oil exploration.
- **Vision used for control:** Road traffic monitoring, passive surveillance, etc.
- **Medical Imaging:** Tumor detection, size/shape measurement organs, chromosome analysis, blood cell count.

- **Biometrics:** Finger print, face detection, target detection and identification.
- **Agriculture:** Satellite/aerial views of land, for example to determine how much land is being used for different purposes, or to investigate the suitability of different regions for different crops, inspection of fruit and vegetables—distinguishing good and fresh produce from old.
- **Digital cameras** are everywhere now....

A list of companies here: <http://www.cs.ubc.ca/spider/lowe/vision.html>

## What is the computer vision related to?

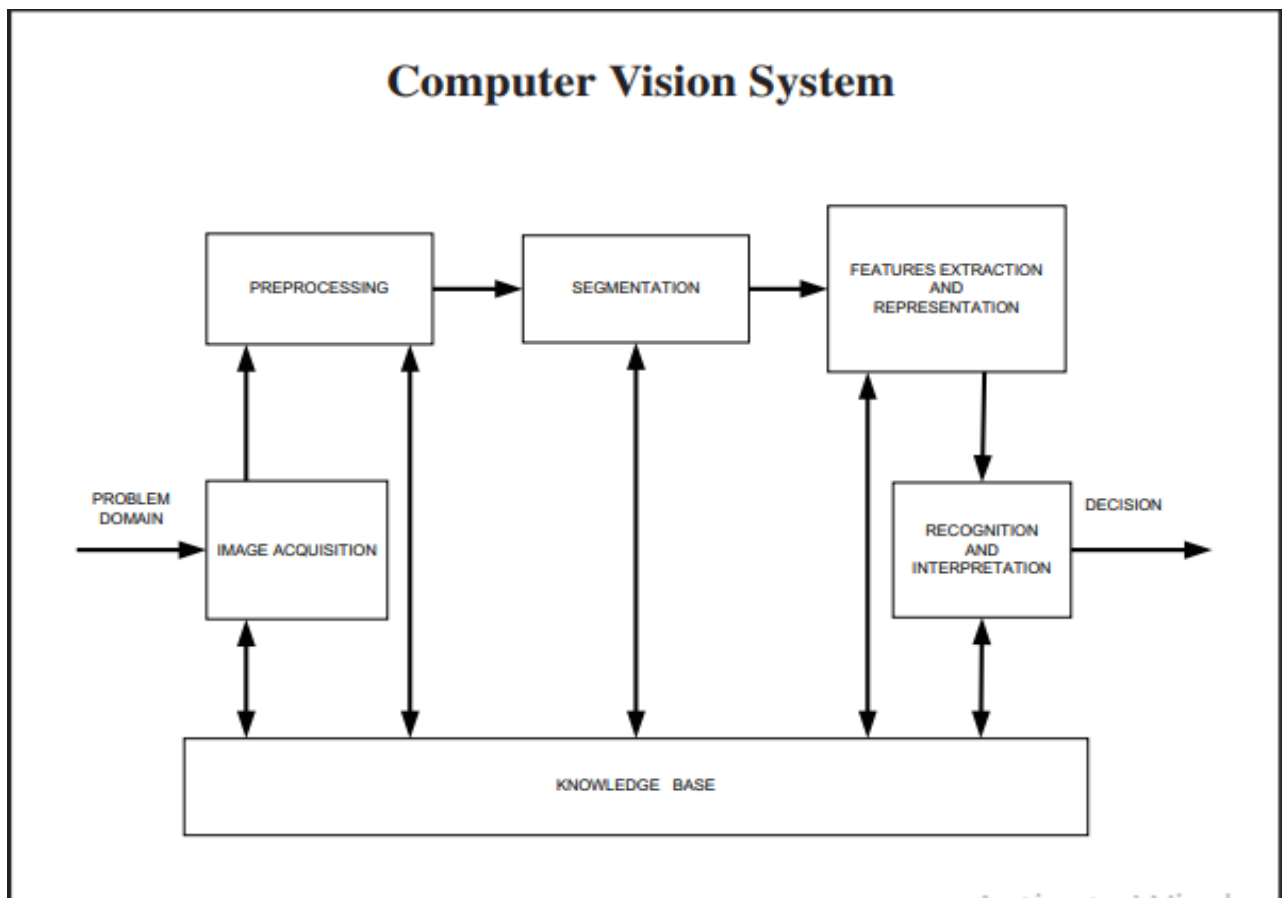
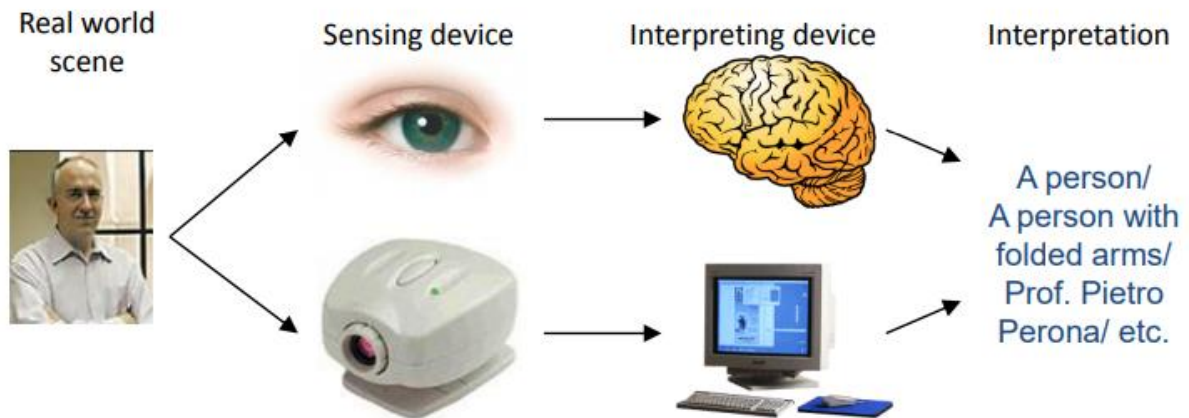


## Why study Computer Vision?

- Images and movies are everywhere.
- Fast-growing collection of useful applications – building representations of the 3D world from pictures – automated surveillance (who's doing what) – movie post-processing – face recognition.
- Replicate human vision to allow a machine to see – Central to that problem of Artificial Intelligence – Many industrial applications (Greater understanding of human vision)
- Gain insight into how we see – Vision is explored extensively by neuroscientists to gain an understanding of how the brain operates
  - Various deep and attractive scientific mysteries – how does object recognition work? – Beautiful marriage of math, biology, physics, engineering.

## What is the problems of computer Vision?

- \* **Want to make a computer understand images.**
- What is in the image ? - Object recognition problem
- Where is it ? - 3D spatial layout – Shape
  - How is the camera moving ?
  - What is the action ?
- \* **We know it is possible – we do it effortlessly.**



Below are the components of a standard machine vision system:

- Camera
- Lighting devices
- Lens
- Frame grabber
- Image processing software
- Machine learning algorithms for pattern recognition.
- Display screen or a robotic arm to carry out an instruction obtained from image interpretation.