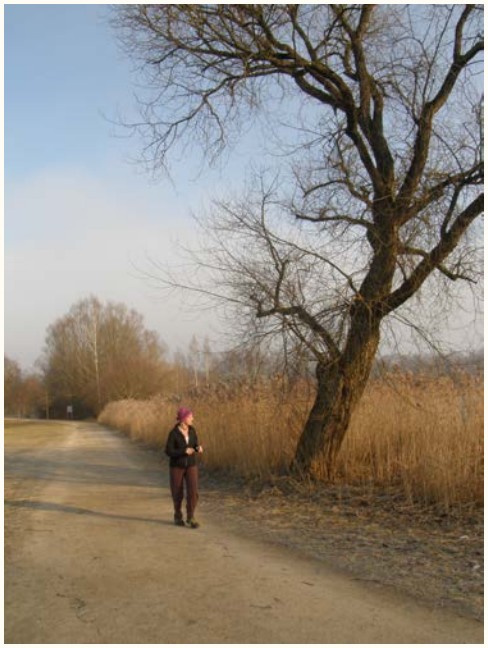
Chapter 1 Introduction

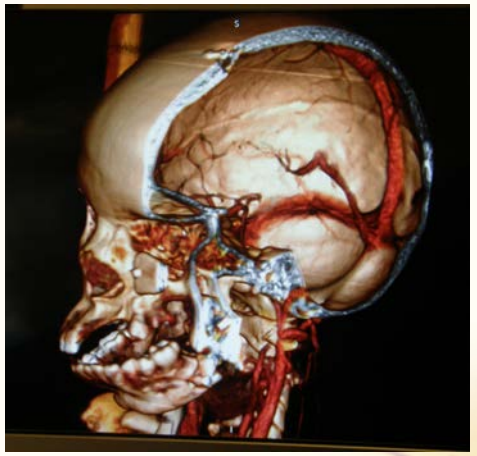
Outline

- 1.1 Motivation
- 1.2 Why is computer vision difficult?
- 1.3 Image representation and image analysis tasks

1.1 Motivation

- Vision allows humans to perceive and understand the world surrounding us.





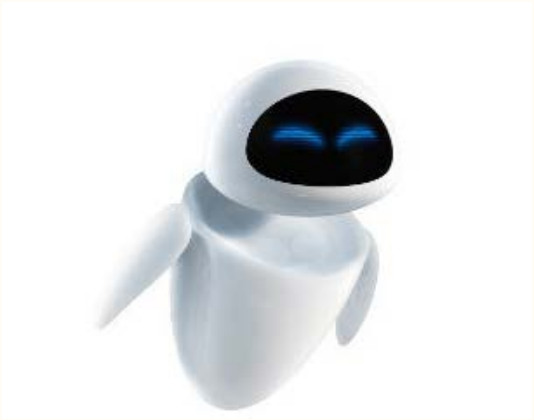
1.1 Motivation

Machine vision is also called as :

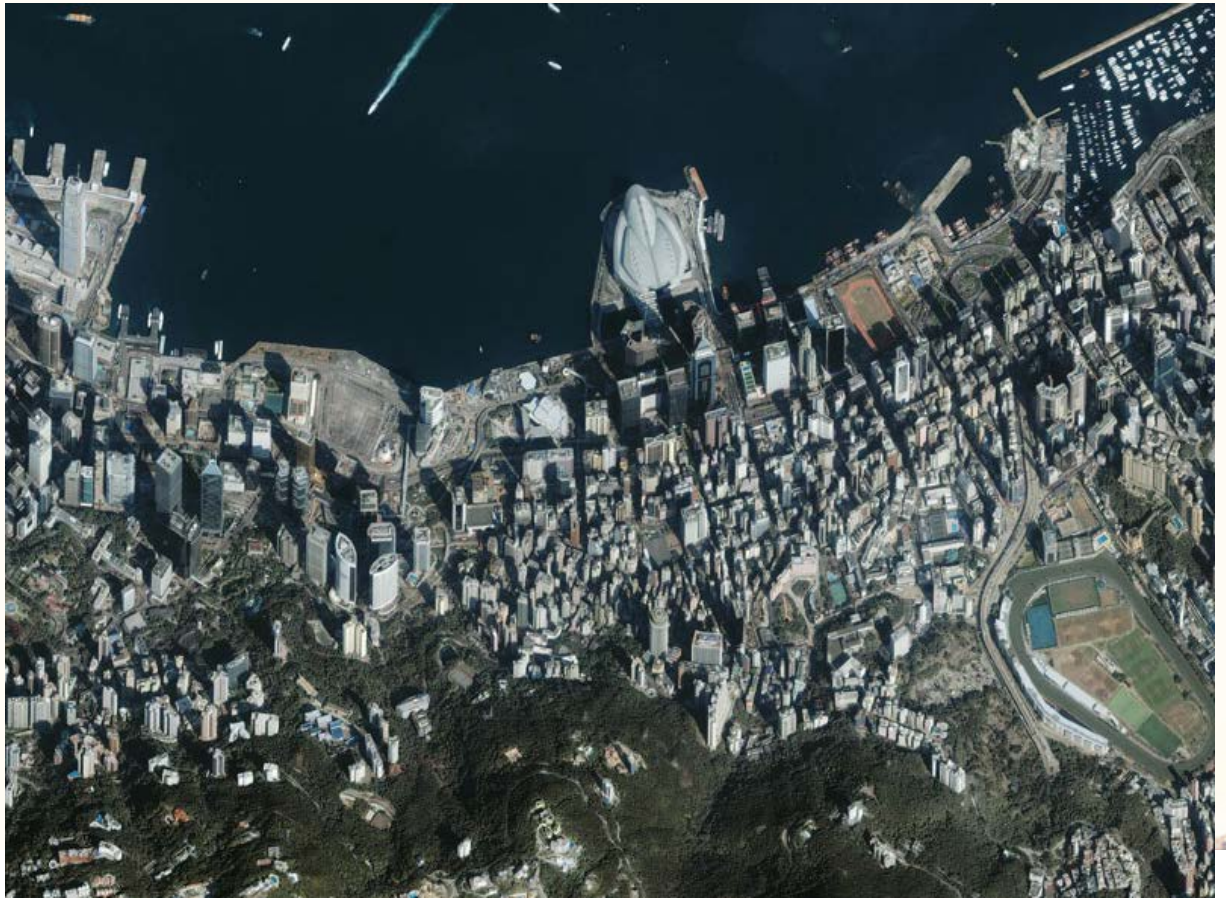
- Computer vision
- Robot vision
- Image understanding
- Scene analysis (in early years)

1.1 Motivation

- Computer vision (machine vision) aims to duplicate the effect of human vision by electronically perceiving and understanding an image

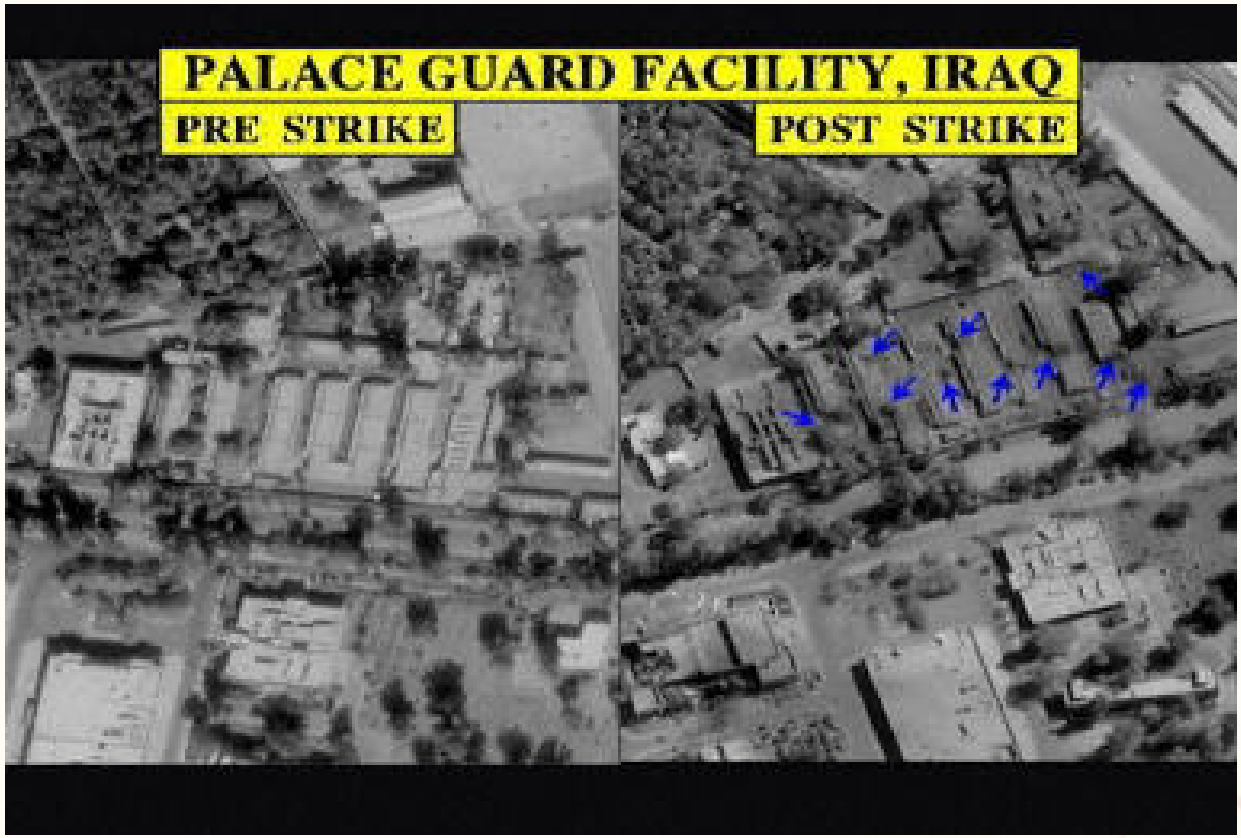


Applications



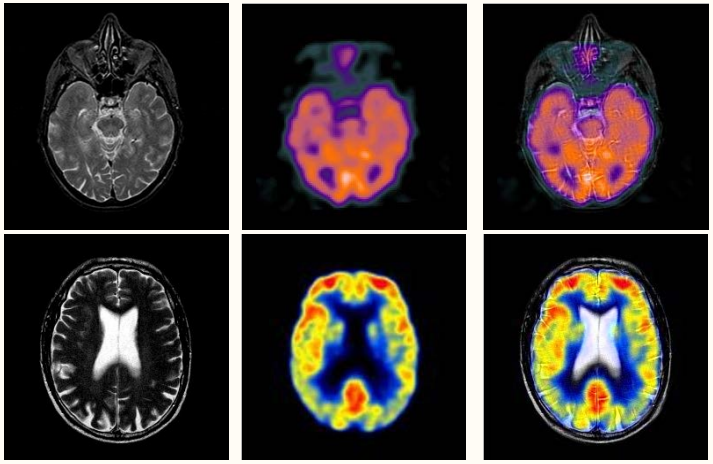
Recognition of a generic object

Applications



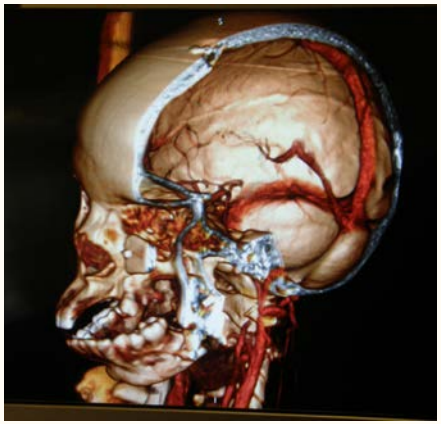
Inspection tasks: mensuration, verification that all parts are present, determination that surfaces have no defects

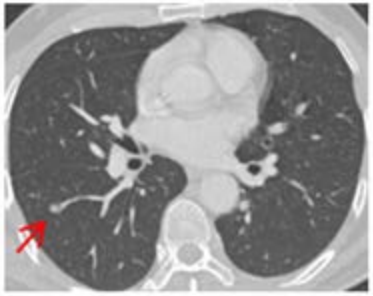
Applications



MRI-SPECT image

MRI-PET image





Medical CAD(Computer-aided Detection/Diagnosis)

1.1 Motivation

- Computer vision (machine vision) aims to duplicate the effect of human vision by electronically perceiving and understanding an image

Figure 1.1: A frame from a video of a typical farmyard scene: the cow is one of a number walking naturally from right to left. *Courtesy of D. R. Magee, University of Leeds.*

1.1 Motivation

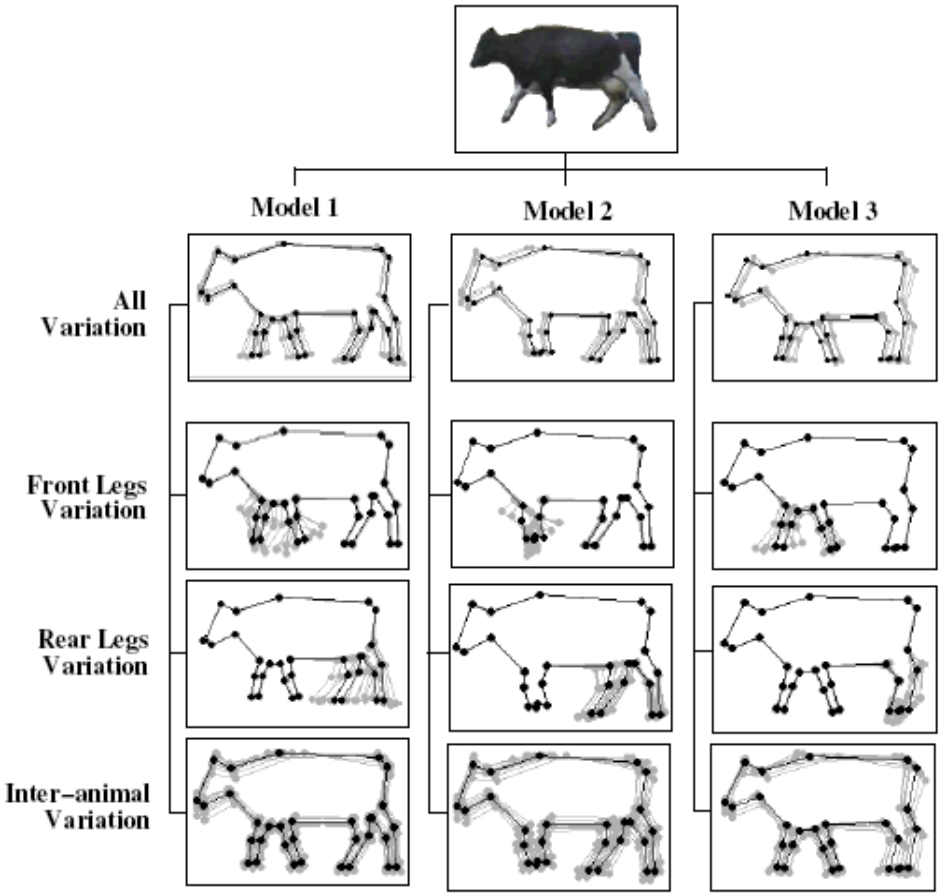


Figure 1.2: Various models for a cow silhouette: a straight-line boundary approximation has been learned from training data and is able to adapt to different animals and different forms of occlusion. *Courtesy of D. R. Magee, University of Leeds.*

Cow tracking

Image capture
↓
Preprocessing
↓
Segmentation
↓
Model fitting
↓
Motion prediction
↓
Conclusion (understanding)

virtualcow.mpg

track.mpg

1.2 Why is CV difficult?

- Giving computers the ability to see is not an easy task.
- - we live in a 3D world, and when computers try to analyze objects in 3D space, available visual sensors (e.g., TV cameras) usually give 2D images, and this projection to a lower number of dimensions incurs an enormous loss of information.

1.2 Why is CV difficult?

- Loss of information in 3D -> 2D

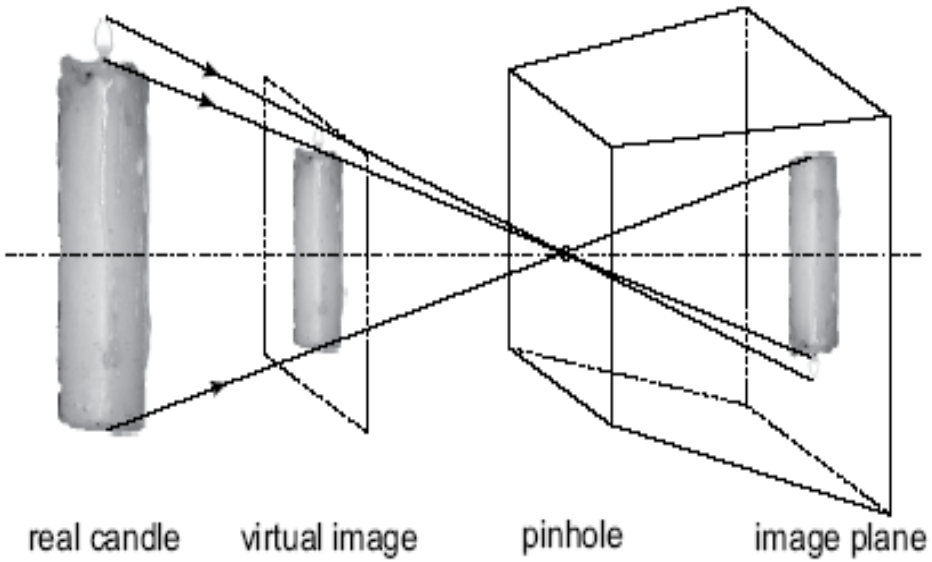
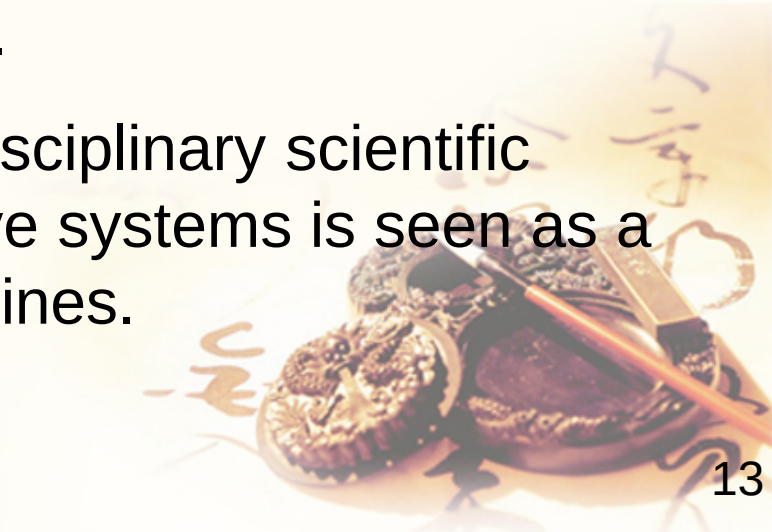


Figure 1.4: The pinhole model of imaging geometry does not distinguish size of objects.

1.2 Why is CV difficult?

- **Interpretation**
- Interpretation of images constitutes the principal tool of computer vision to approach problems.
- Human ability to reason allows representation of long-gathered knowledge, and its use to solve new problems.
- The practical ability of a machine to understand observations remains very limited.
- Attempting to solve related multidisciplinary scientific problems under the name cognitive systems is seen as a key to developing intelligent machines.

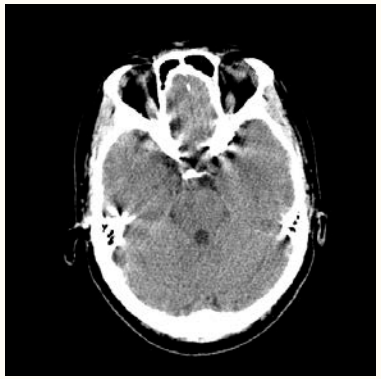


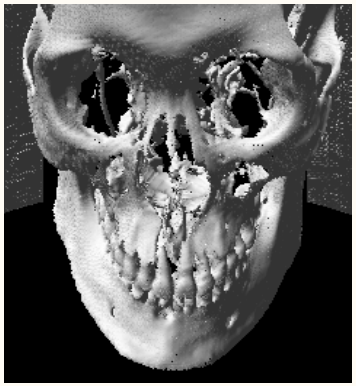
1.2 Why is CV difficult?

- **Noise**
- Noise is inherently present in each measurement in the real world.
- Its existence calls for mathematical tools which are able to cope with uncertainty; an example is probability theory.
- Of course, more complex tools make the image analysis much more complicated compared to standard (deterministic) methods.

1.2 Why is CV difficult?

- **Too much data (especially for real-time)**





Surface
volume rendering

A Video
Track.mpg

=

… + …
Many frames

A frame from a video

1.2 Why is CV difficult?

- **Brightness measured**
- Brightness measured in the image is given by complicated image formation physics. The inverse tasks are ill-posed.
- This is the reason why image capturing physics is often avoided in practical attempts aiming at image understanding.
- Instead, a direct link between the appearance of objects in scenes and their interpretation is sought.

1.2 Why is CV difficult?

- Local window vs. need for global view

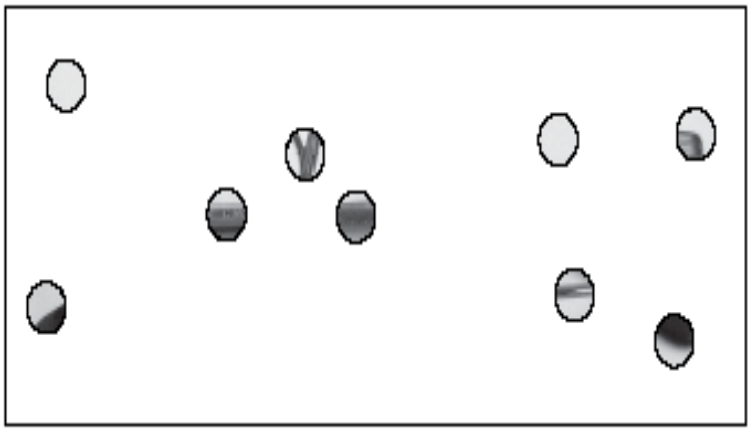


Figure 1.5: Illustration of the world seen through several keyholes providing only a very local context. Try to guess what object is depicted in the image. It is likely to be very difficult if the whole picture has not been seen yet. The complete image is shown deliberately on a different page, see Figure 1.6.

1.2 Why is CV difficult?

- Local window vs. need for global view

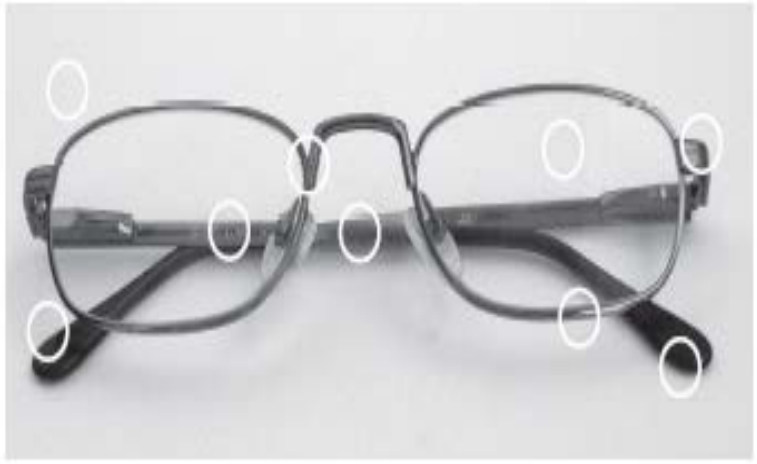


Figure 1.6: It is easy for humans to interpret an image if it is seen globally: compare to Figure 1.5.

This can be demonstrated pictorially, see Figure 1.5. How context is taken into account is an important facet of image analysis!

1.3 Image representation & image analysis tasks

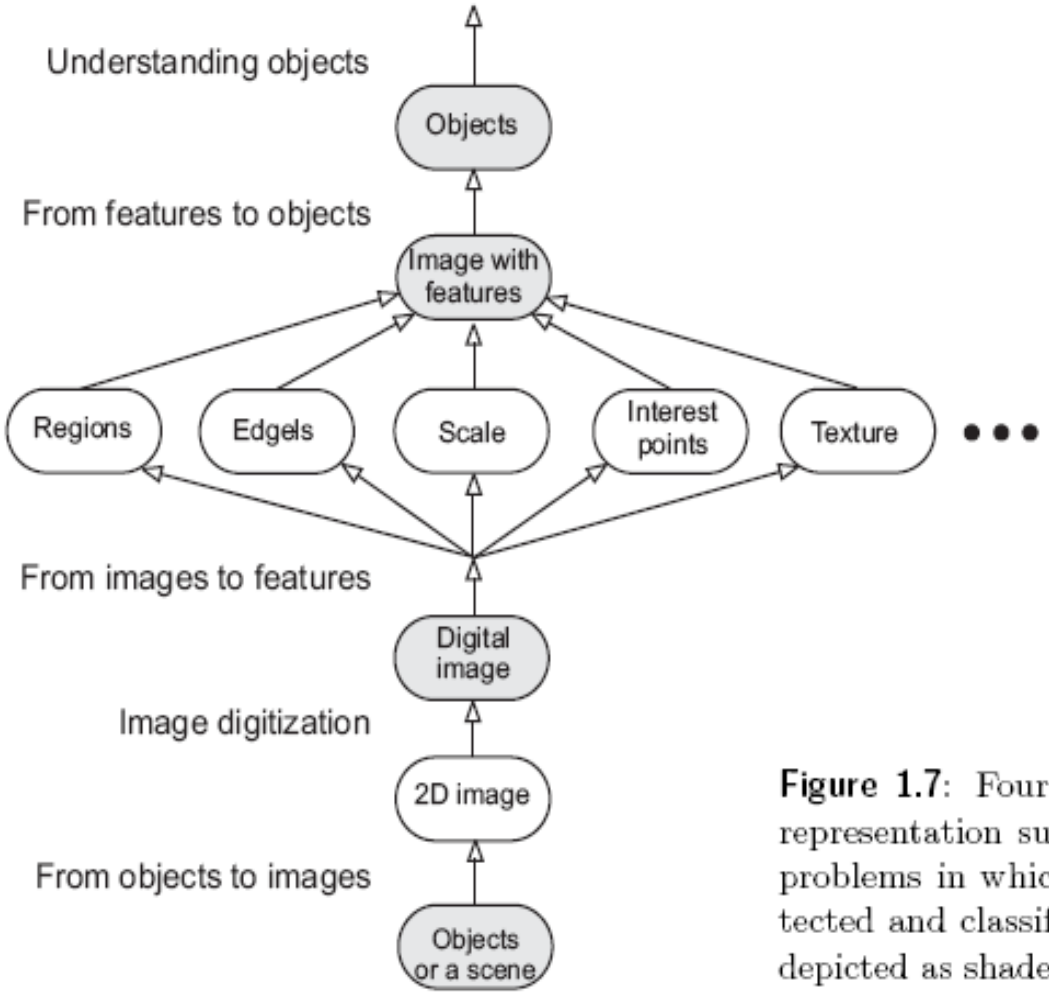


Figure 1.7: Four possible levels of image representation suitable for image analysis problems in which objects have to be detected and classified. Representations are depicted as shaded ovals.

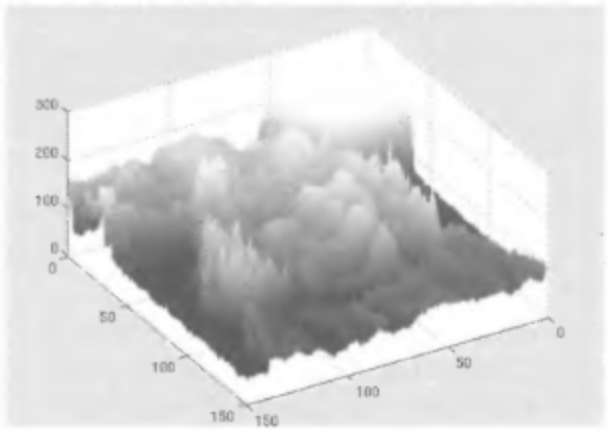
1.3 Image representation & image analysis tasks

- In order to simplify the task of computer vision understanding, two levels are usually distinguished;
- **low level** image processing and **high level** image understanding.

low level image processing

- Low-level processing: use very little knowledge about the content of images
  - Image compression
  - preprocessing for noise filtering, edge extraction, image sharpening

low level VS. high level



What is it?

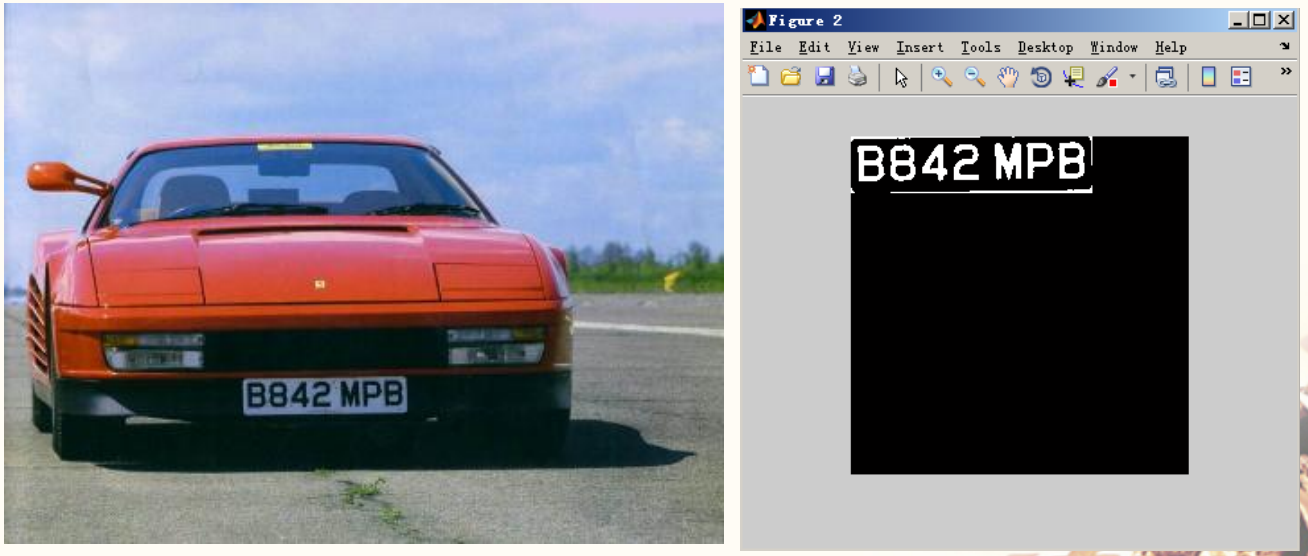
Figure 1.8: An unusual image representation.

A Girl !!

General knowledge, domain-specific knowledge, and information extracted from the image will be essential in attempting to ‘understand’ these arrays of numbers.

high level image understanding

- High-level processing:
  - based on knowledge, goals, and plans of how to achieve those goals, and artificial intelligence methods.



Vehicle License Plate Recognition System

Knowledge points

- Computer vision aims to duplicate the effect of human vision by electronically perceiving and understanding an image.
- Giving computers the ability to see is not an easy task.
- In order to simplify the task of computer vision understanding, two levels are usually distinguished; **low level** image processing and **high level** image understanding.

Questions and Practices

- See “Practice 1 How to process digital image using Matlab”