Vision par ordinateur
1 - Introduction
Ecole Doctorale MIIS - 2017

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(Avec des diapos de Brendan Morris)

Agenda

- introduction générale
- modèle image, sténopé
- modélisation géométrique caméra et calibration
- coordonnées homogènes & transformations planaires
- filtrage linéaire et aspect fréquentiel et non-linéaire
- stéréovision
- vision omnidirectionnelle

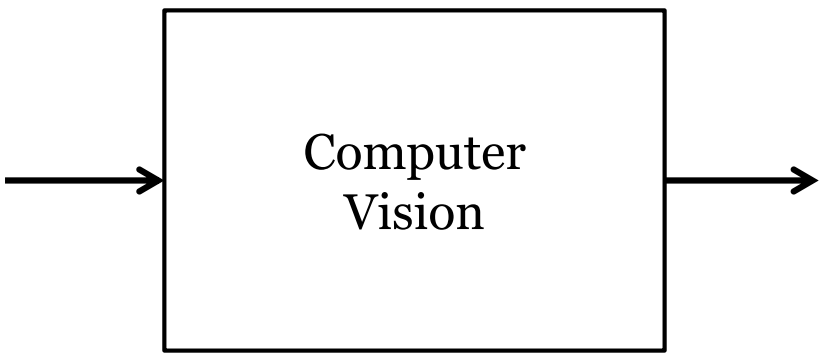
Sommaire

Computer Vision

- Interpretation and understanding of images

Input:

1. Image derived measurements
2. Models (prior knowledge)



Output:

Recognition of objects and events embedded in images and video

("Semantic" level classification)

Examples:

- Object recognition
- Face recognition
- Lane detection
- Activity analysis

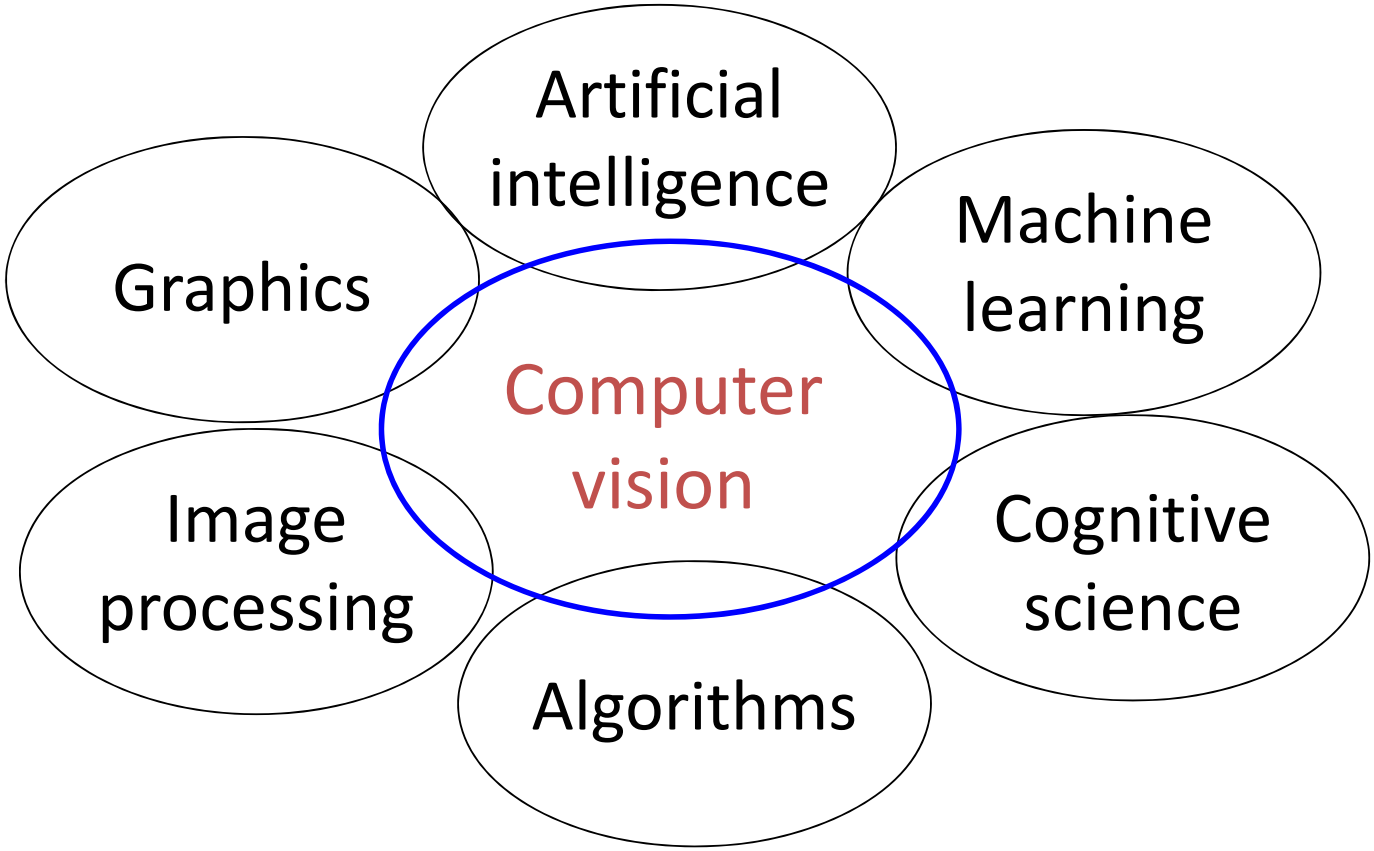
"Computer Vision"

Mise en œuvre d'un ensemble de techniques et de concepts

- Image processing
- Machine Learning
- Data Mining
- Pattern Recognition
- etc.

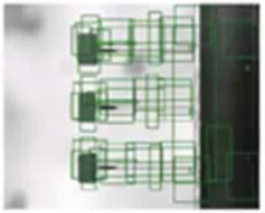
VOIR : CPP ON MARS + VIDEO GOOGLE CAR

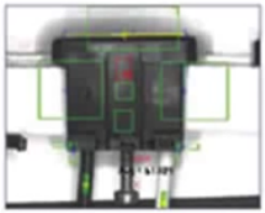
Related disciplines



Vision industrielle : 4 tâches

- Comptage
- Mesure
- Localisation
- Lecture d'information (code barres, OCR, ...)

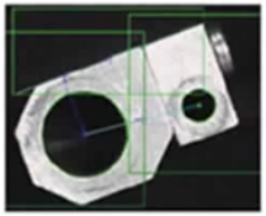

Complex, high speed inspection


Check for completeness


Shape inspection


Pattern comparison

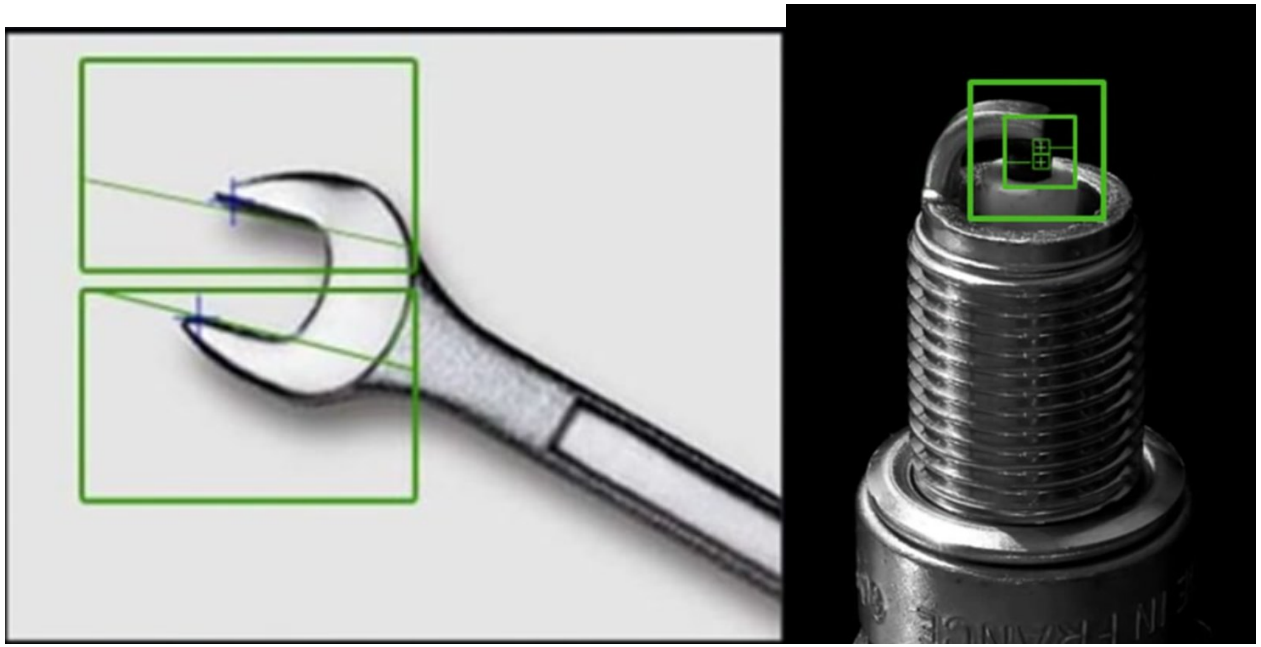

Measurement

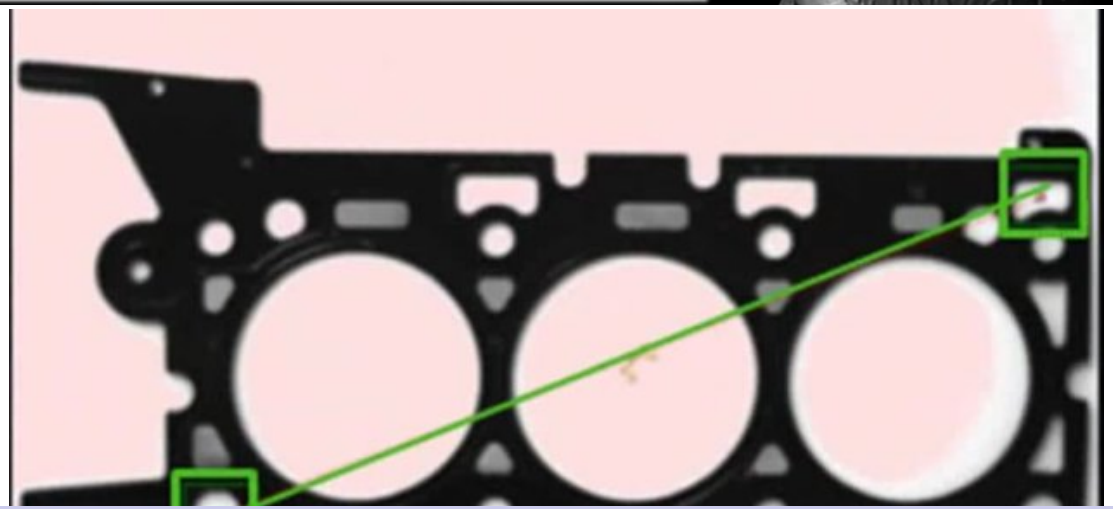

Position/angle detection

OCR reading


1D/2D symbol reading

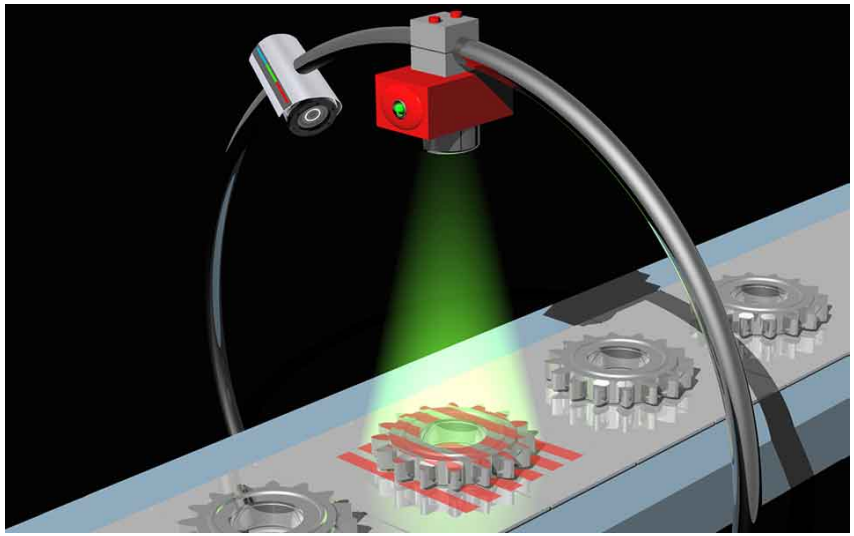
Vision industrielle





Process industriels

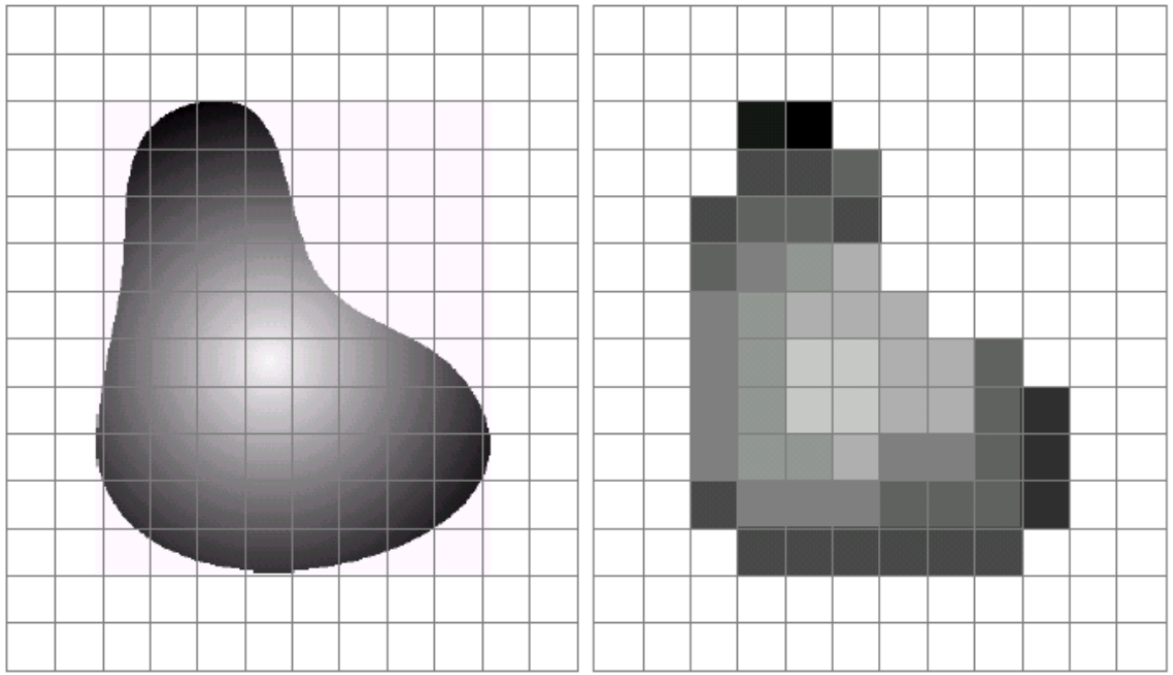
- Contexte :
  - Environnement et éclairage contraint
  - Situations identiques



Sommaire

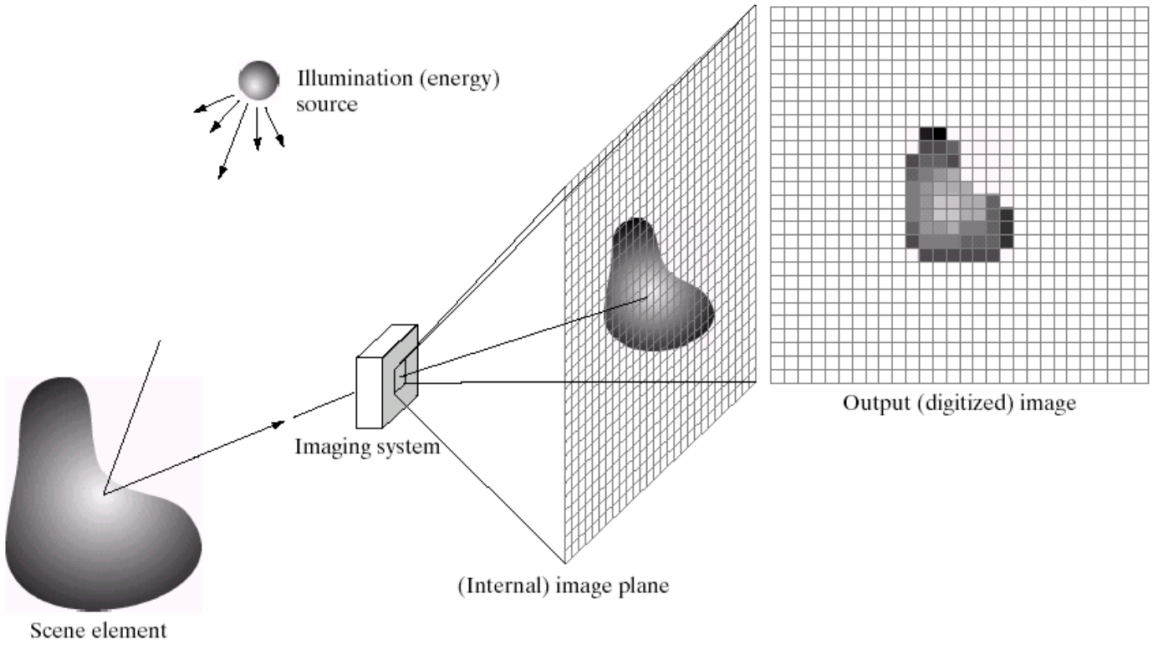
Rappel sur la notion d'image

- image = projection 3d $\rightarrow$ 2D
- image numérique : discrétisation et quantification de l'image continue



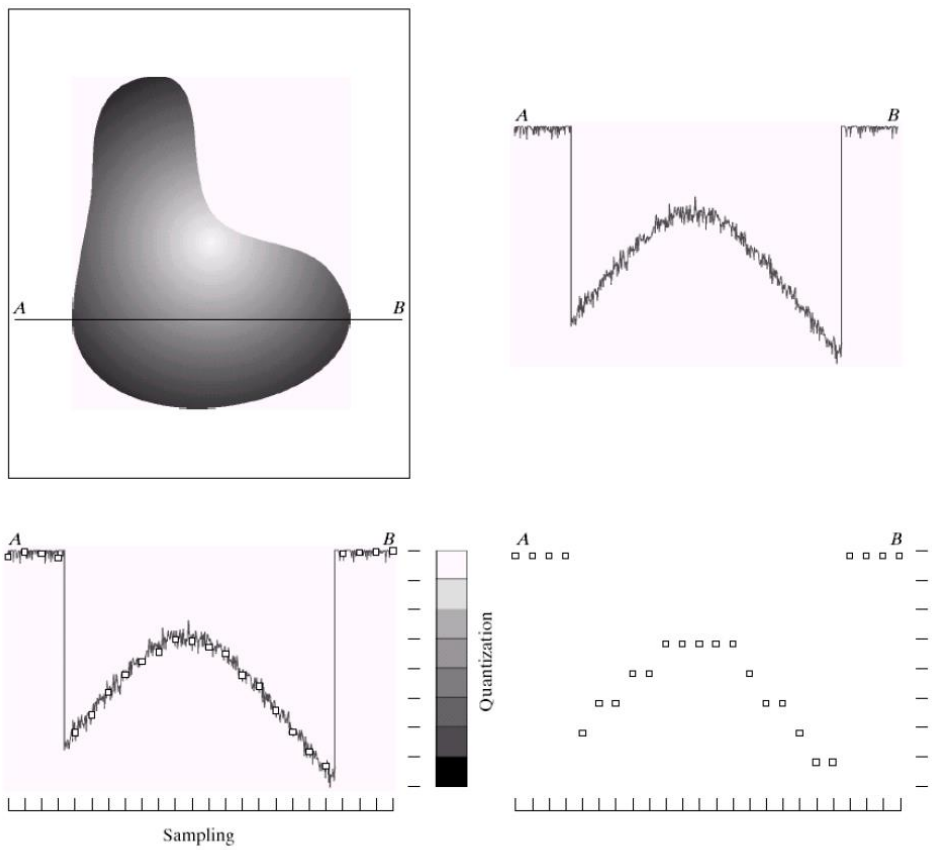
Conséquences : on passe du domaine **continu** au domaine **discret**

Processus complet



- Quantification : donne la dynamique de l'image résultante : combien de niveaux ?
- Echantillonnage : définition de l'image = nombre de pixels
  (A ne pas confondre avec la résolution : mesure de la densité de points par unité de distance (dpi ou ppi)

Quantization



a b
c d

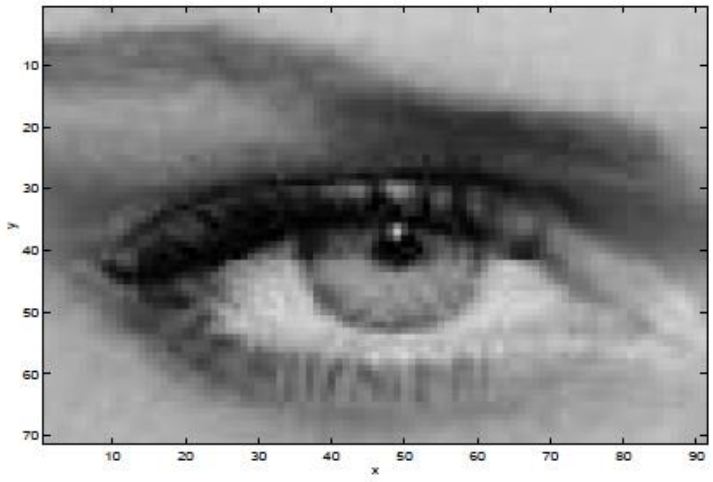
FIGURE 2.16 Generating a digital image. (a) Continuous image. (b) A scan line from *A* to *B* in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.

- Quantization gives the number of output levels L

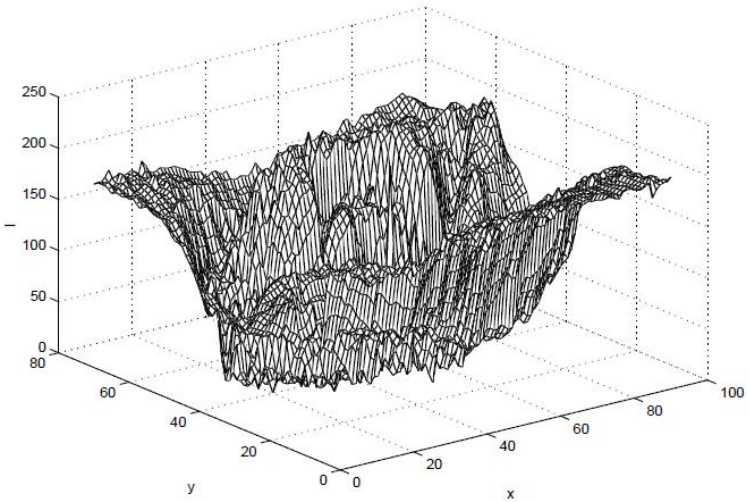
a) Continuous image
b) Scan line from A to B
c) Sampling (horizontal bar) and quantization (vertical bar)
d) Digital scan line – resulting effect of sampling and quantization

Image Representation

- Multiple equivalent representations
- Image



- Surface



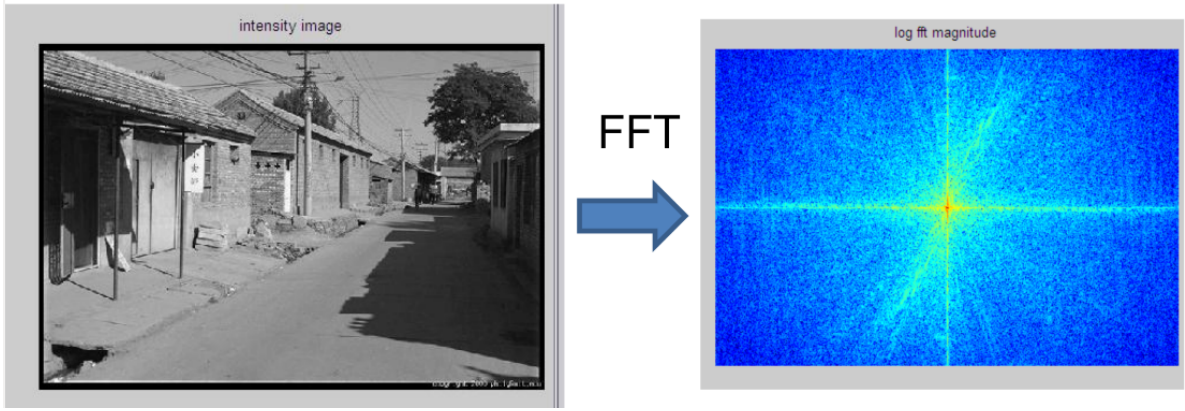
- Matrix

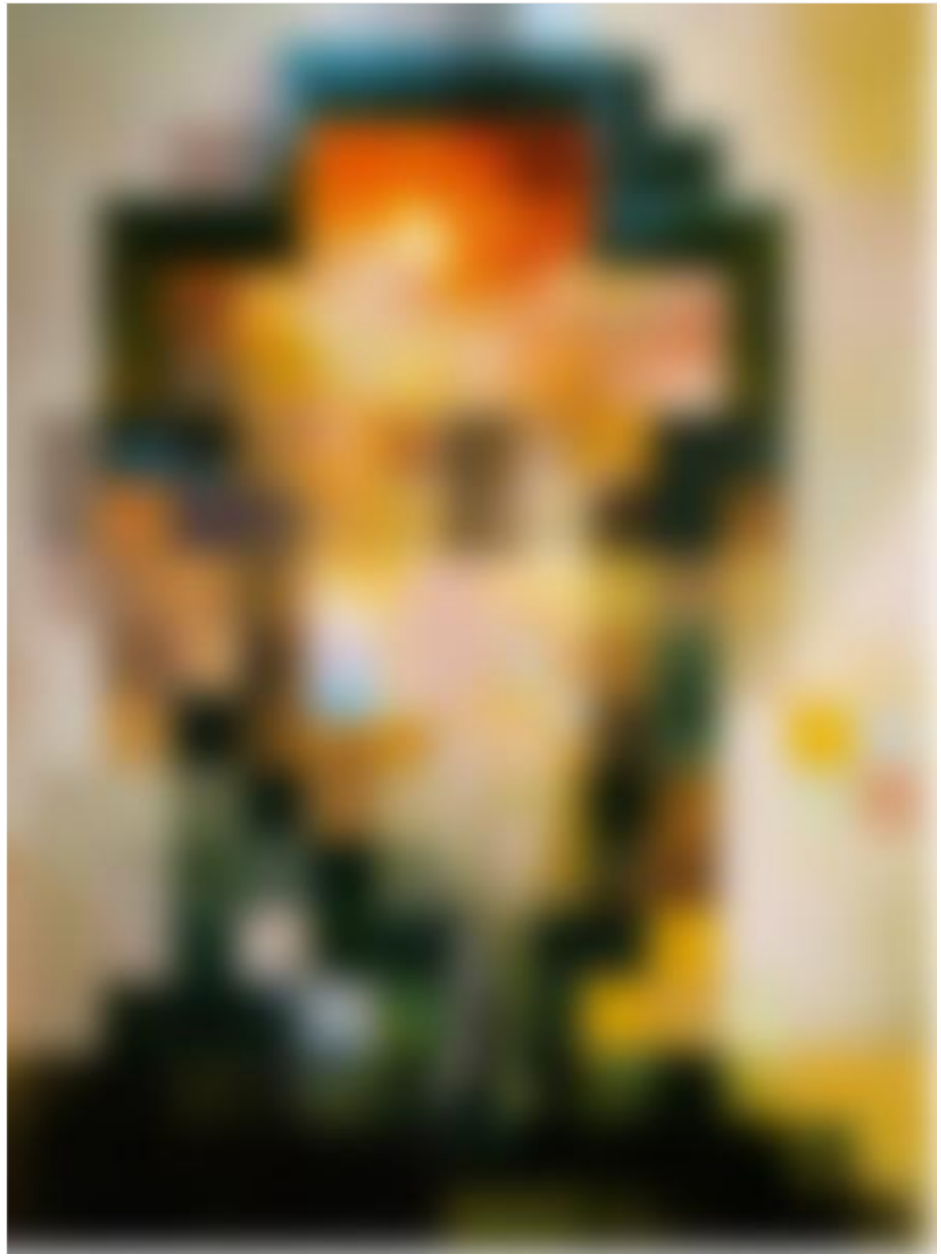
188	186	188	187	168	130	101	99	110	113	112	107	117	140	153	153	156	158	156	153
189	189	188	181	163	135	109	104	113	113	110	109	117	134	147	152	156	163	160	156
190	190	188	176	159	139	115	106	114	123	114	111	119	130	141	154	165	160	156	151
190	188	188	175	158	139	114	103	113	126	112	113	127	133	137	151	165	156	152	145
191	185	189	177	158	138	110	99	112	119	107	115	137	140	135	144	157	163	158	150
193	183	178	164	148	134	118	112	119	117	118	106	122	139	140	152	154	160	155	147
185	181	178	165	149	135	121	116	124	120	122	109	123	139	141	154	156	159	154	147
175	176	176	163	145	131	120	118	125	123	125	112	124	139	142	155	158	158	155	148
170	170	172	159	137	123	116	114	119	122	126	113	123	137	141	156	158	159	157	150
171	171	173	157	131	119	116	113	114	118	125	113	122	135	140	155	156	160	160	152
174	175	176	156	128	120	121	118	113	112	123	114	122	135	141	155	155	158	159	152
176	174	174	151	123	119	126	121	112	108	122	115	123	137	143	156	155	152	155	150
175	169	168	144	117	117	127	122	109	106	122	116	125	139	145	158	156	147	152	148
179	179	180	155	127	121	118	109	107	113	125	133	130	129	139	153	161	148	155	157
176	183	181	153	122	115	113	106	105	109	123	132	131	131	140	151	157	149	156	159
180	181	177	147	115	110	111	107	107	105	120	132	133	133	141	150	154	148	155	157
181	174	170	141	113	111	115	112	113	105	119	130	132	134	144	153	156	148	152	151
180	172	168	140	114	114	118	113	112	107	119	128	130	134	146	157	162	153	153	148
186	176	171	142	114	114	116	110	108	104	116	125	128	134	148	161	165	159	157	149
185	178	171	138	109	110	114	110	109	97	110	121	127	136	150	160	163	158	156	150

Point de vue fréquentiel

- Une image peut aussi être vue comme une fonction $y = f(u, v)$
  - u, v : position dans l'image
  - y : niveau de gris correspondant

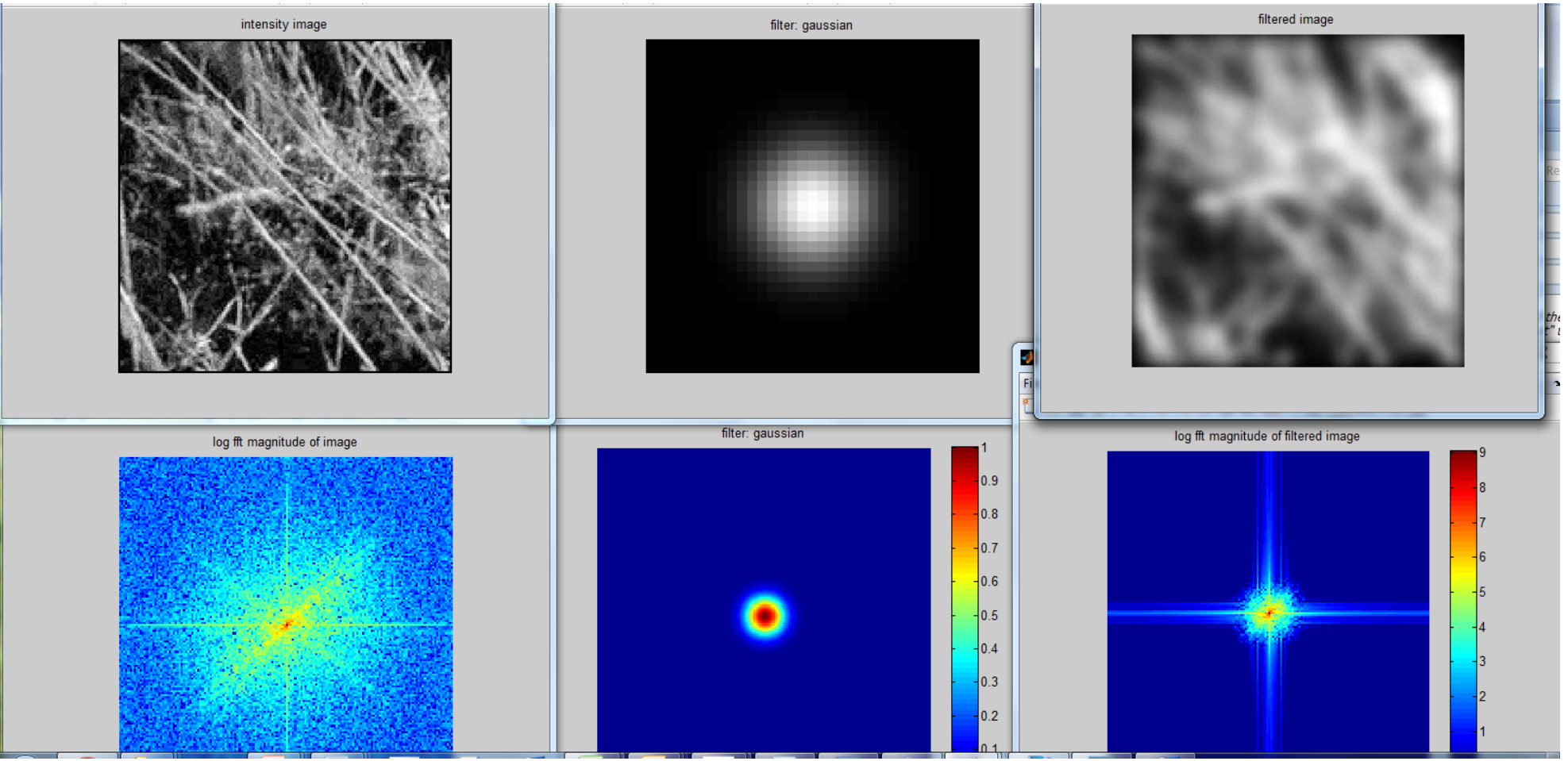
  On peut donc utiliser les outils de théorie du signal : dualité temps-fréquence (Fourier)



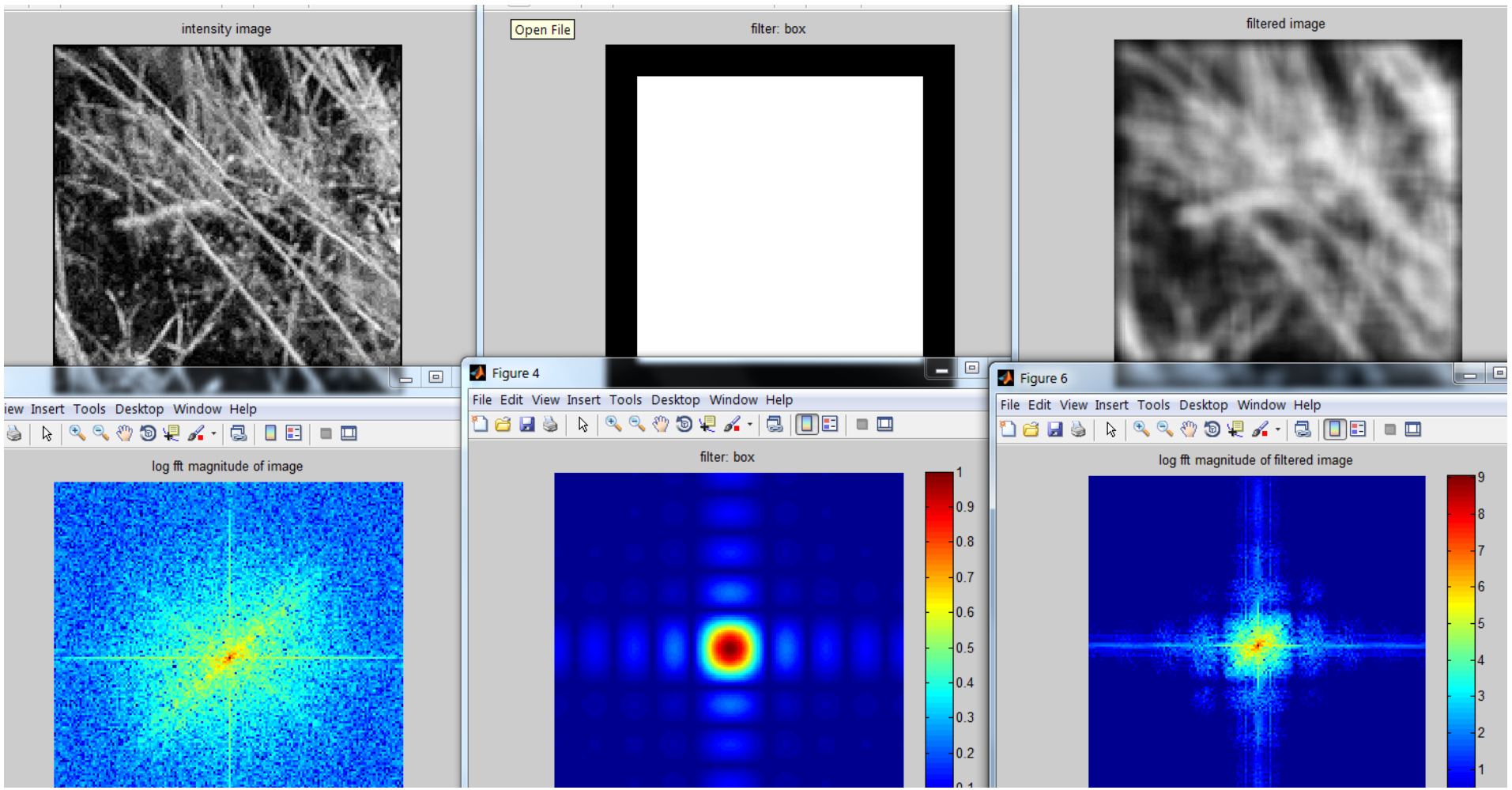


Salvador Dalí, "Gala Contemplating the Mediterranean Sea which at a distance of 20 meters is transformed into the portrait of Abraham Lincoln"

Gaussian


intensity image
filter: gaussian
filtered image
log fft magnitude of image
filter: gaussian
log fft magnitude of filtered image
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
9
8
7
6
5
4
3
2
1

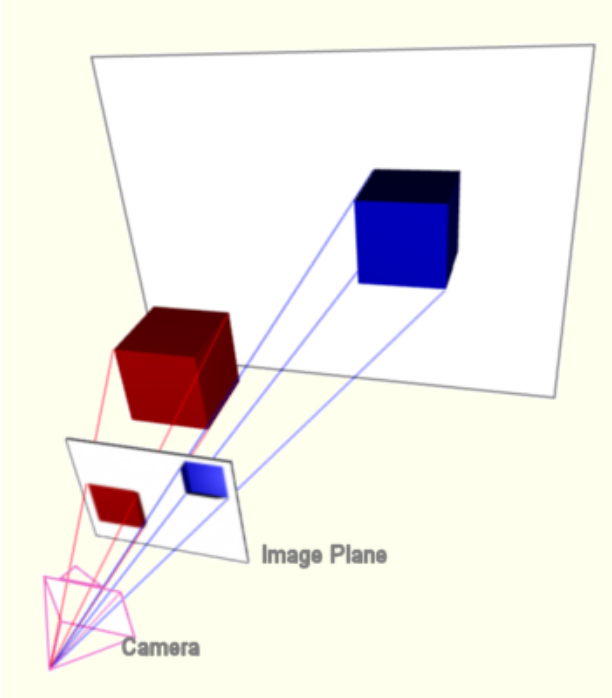
Box Filter


intensity image
Open File
filter: box
filtered image
Figure 4
File Edit View Insert Tools Desktop Window Help
log fft magnitude of image
filter: box
Figure 6
File Edit View Insert Tools Desktop Window Help
log fft magnitude of filtered image

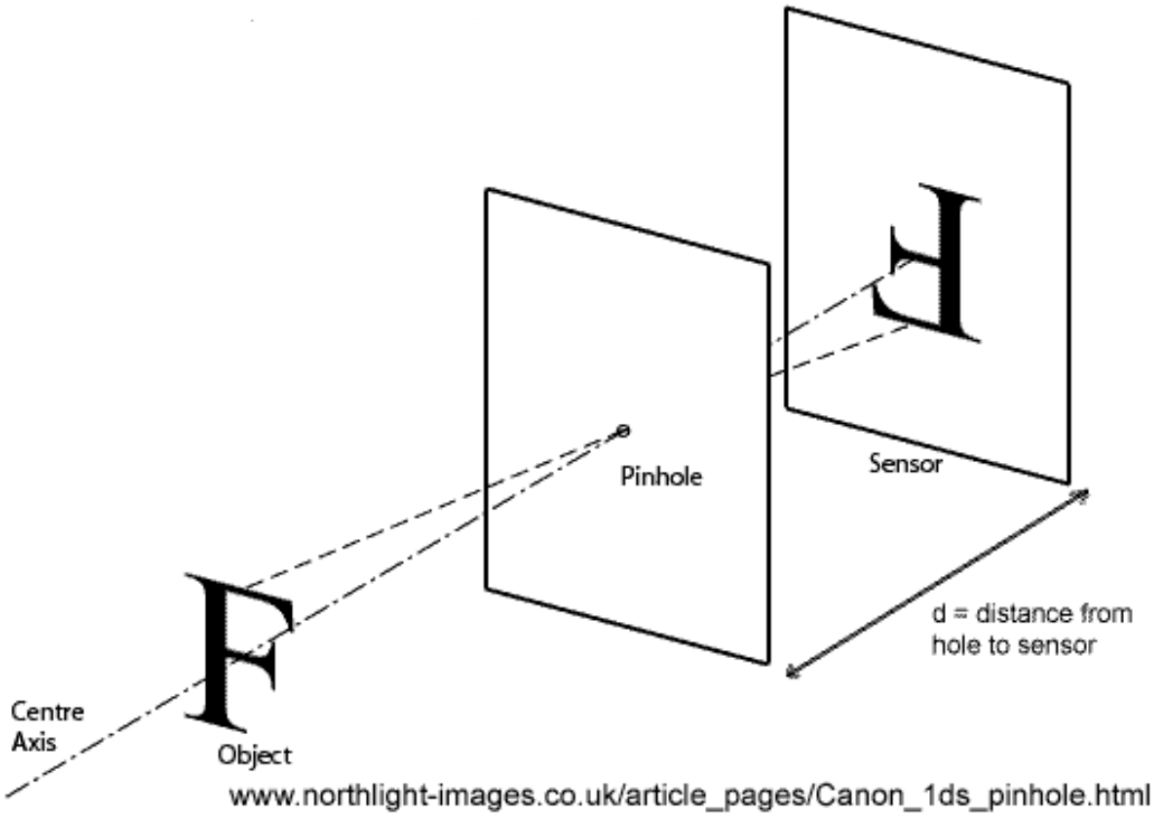
Sommaire

Acquisition : types de caméra

linéaire, perspective, omnidirectionnelle



Modèle de projection "pin hole" : 3D à 2D

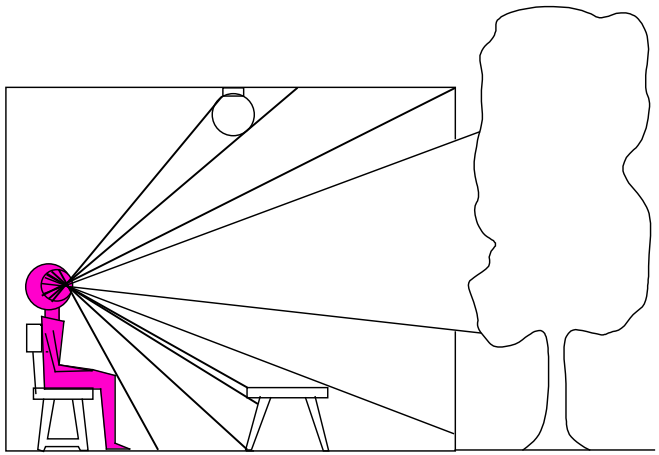


www.northlight-images.co.uk/article_pages/Canon_1ds_pinhole.html

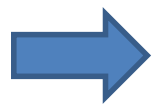
Dimensionality Reduction Machine (3D to 2D)

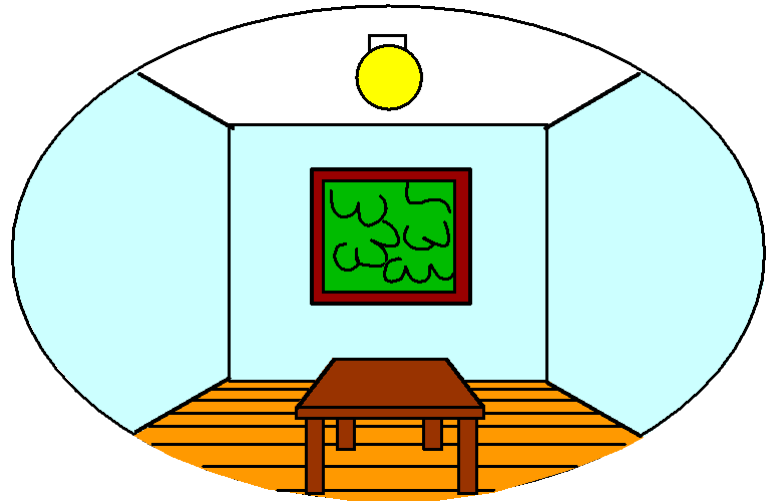
3D world

2D image



Point of observation





Slide source: Seitz

Projection can be tricky…

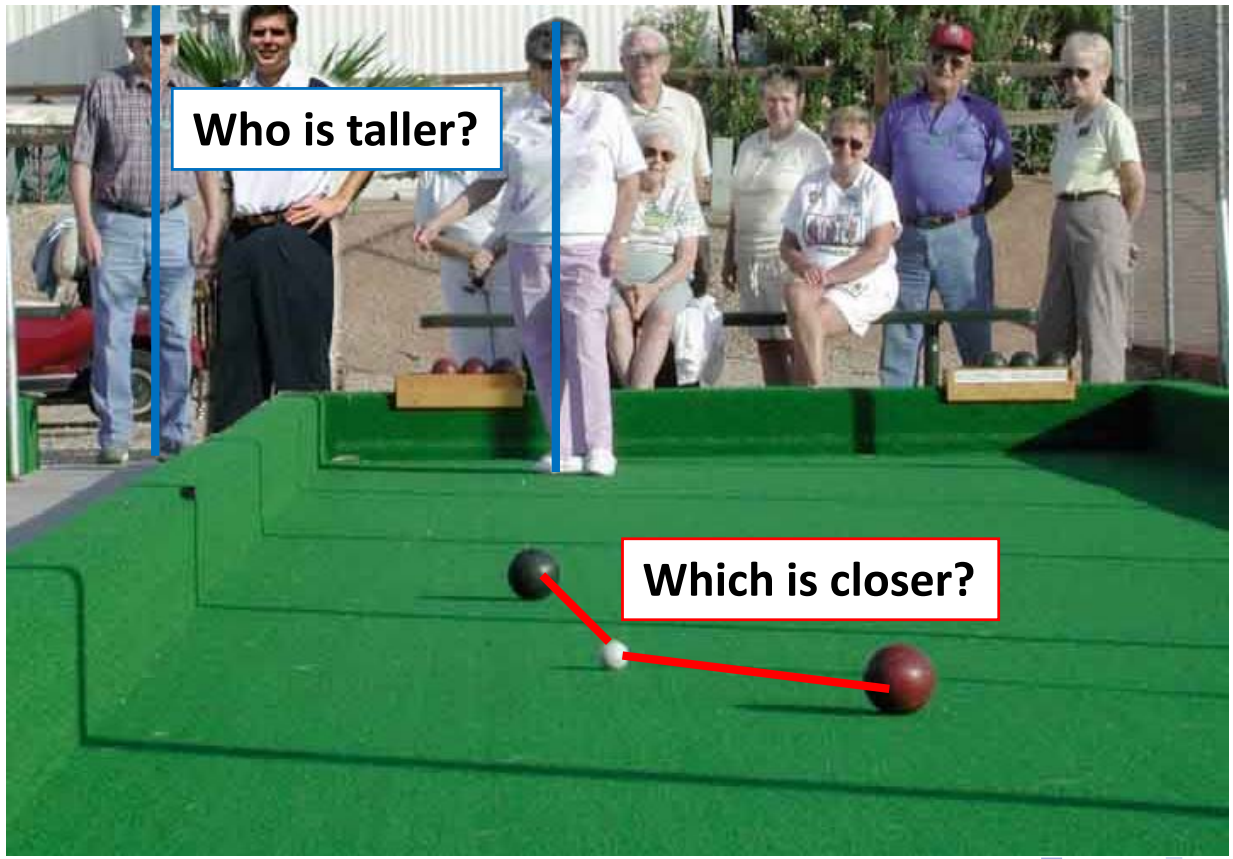
Slide source: Seitz

Projection can be tricky…

Projective Geometry

What is lost?

- Length



Length is not preserved

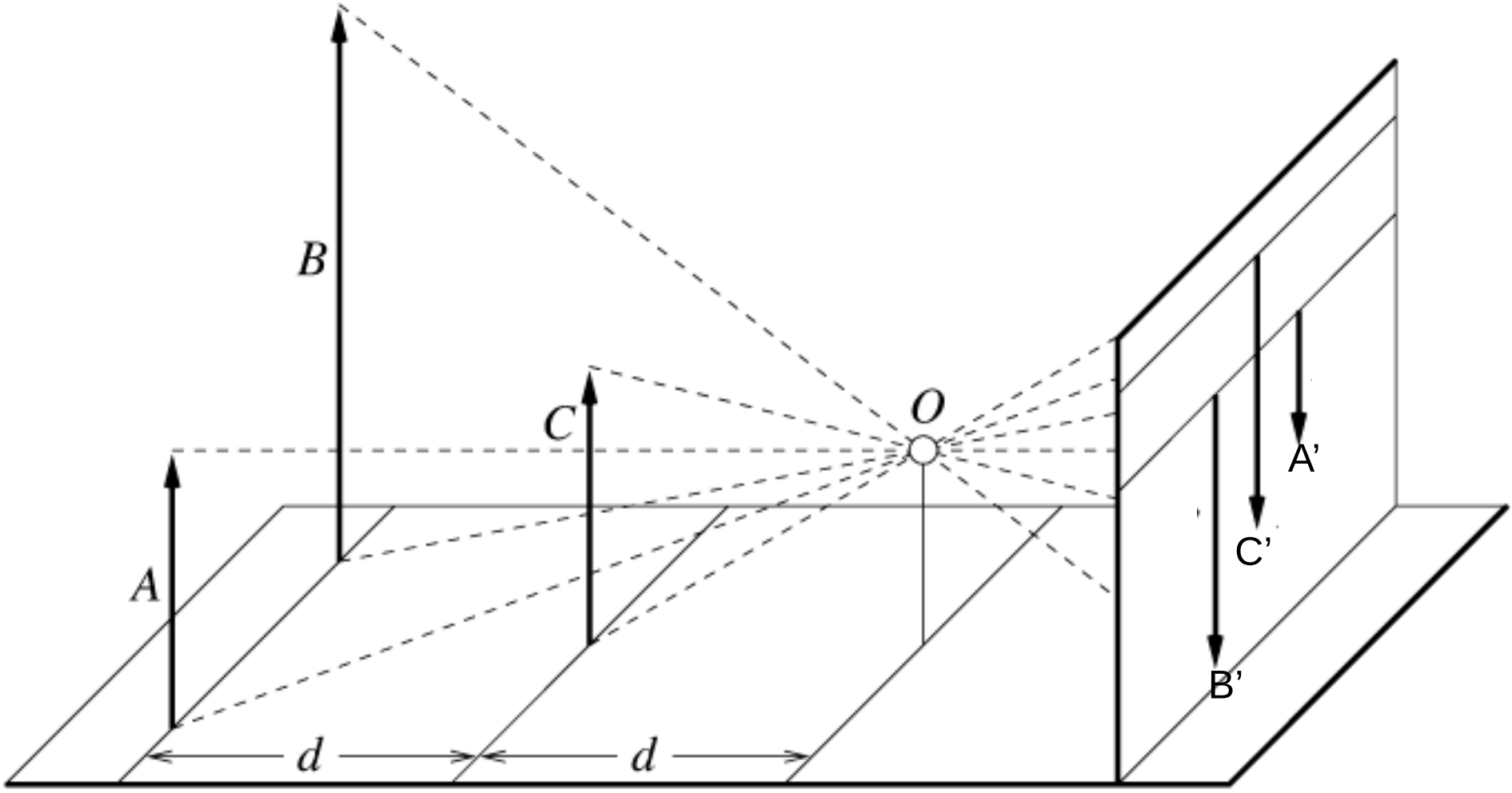
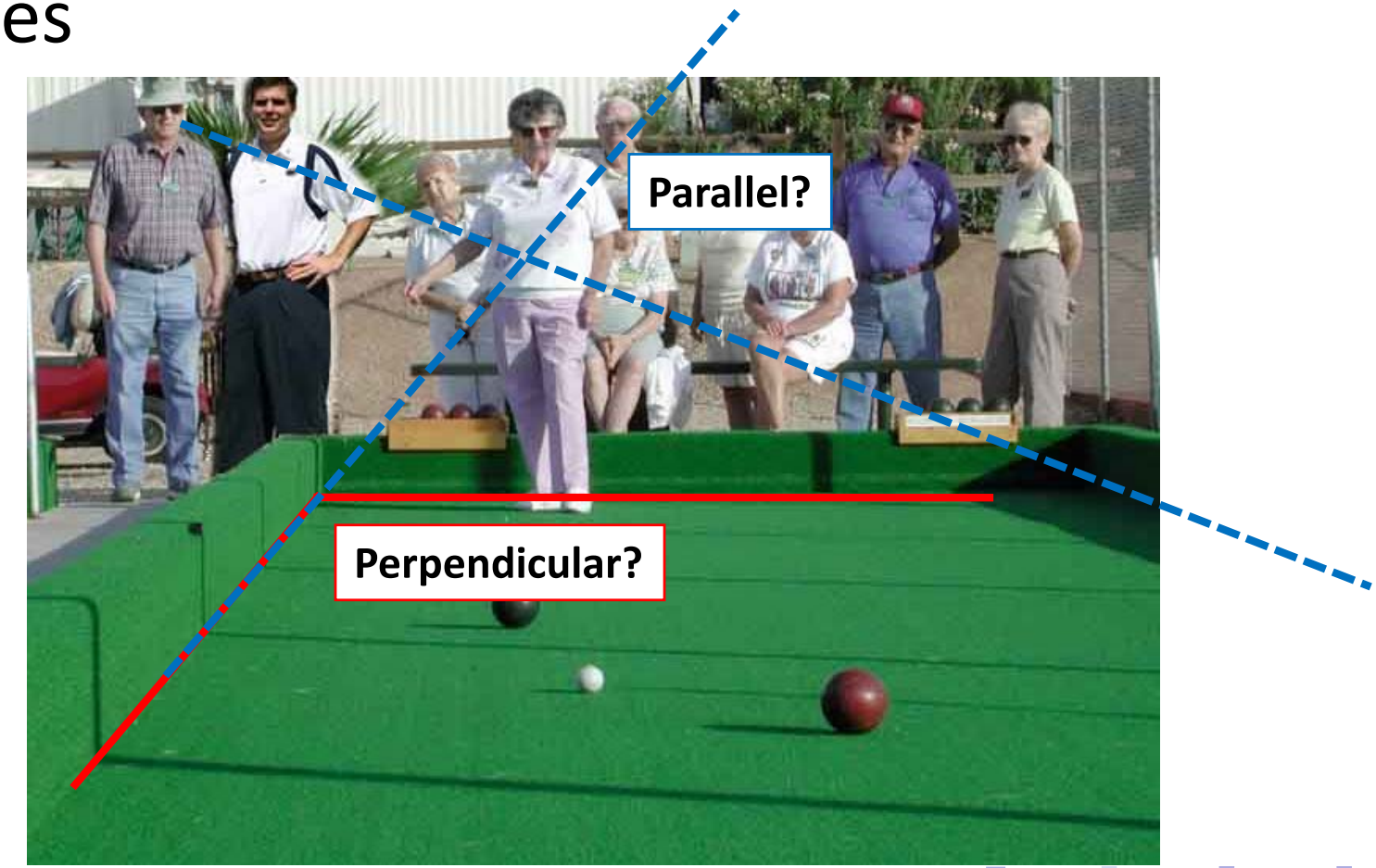


Figure by David Forsyth

Projective Geometry

What is lost?

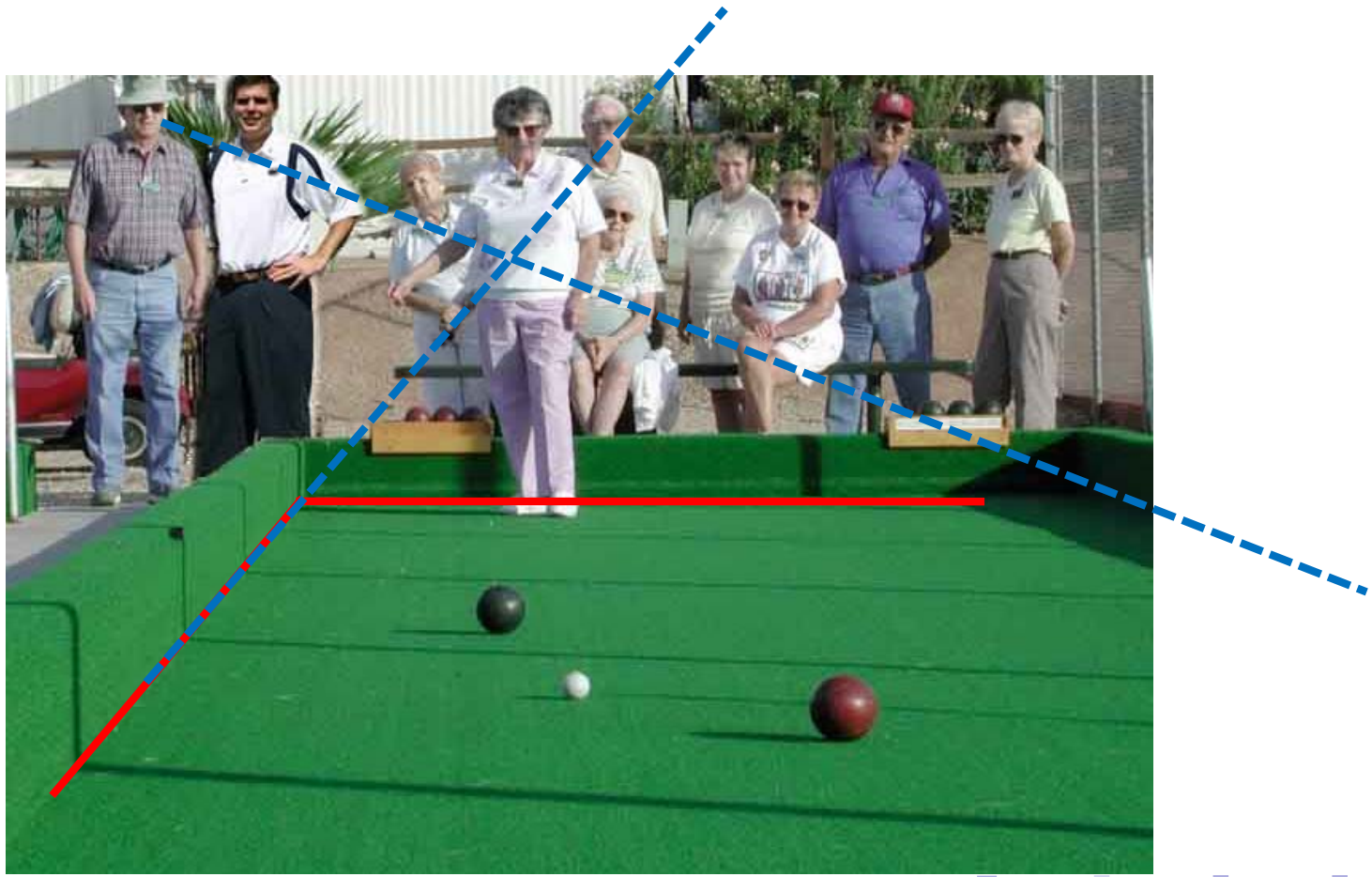
- Length
- Angles



Projective Geometry

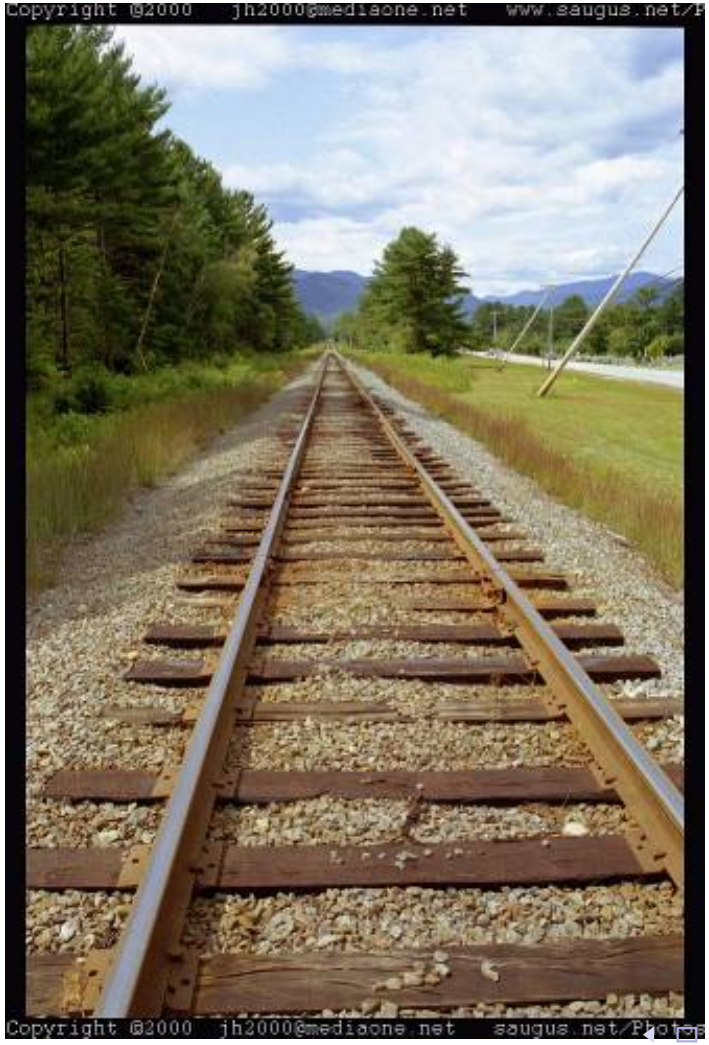
What is preserved?

- Straight lines are still straight

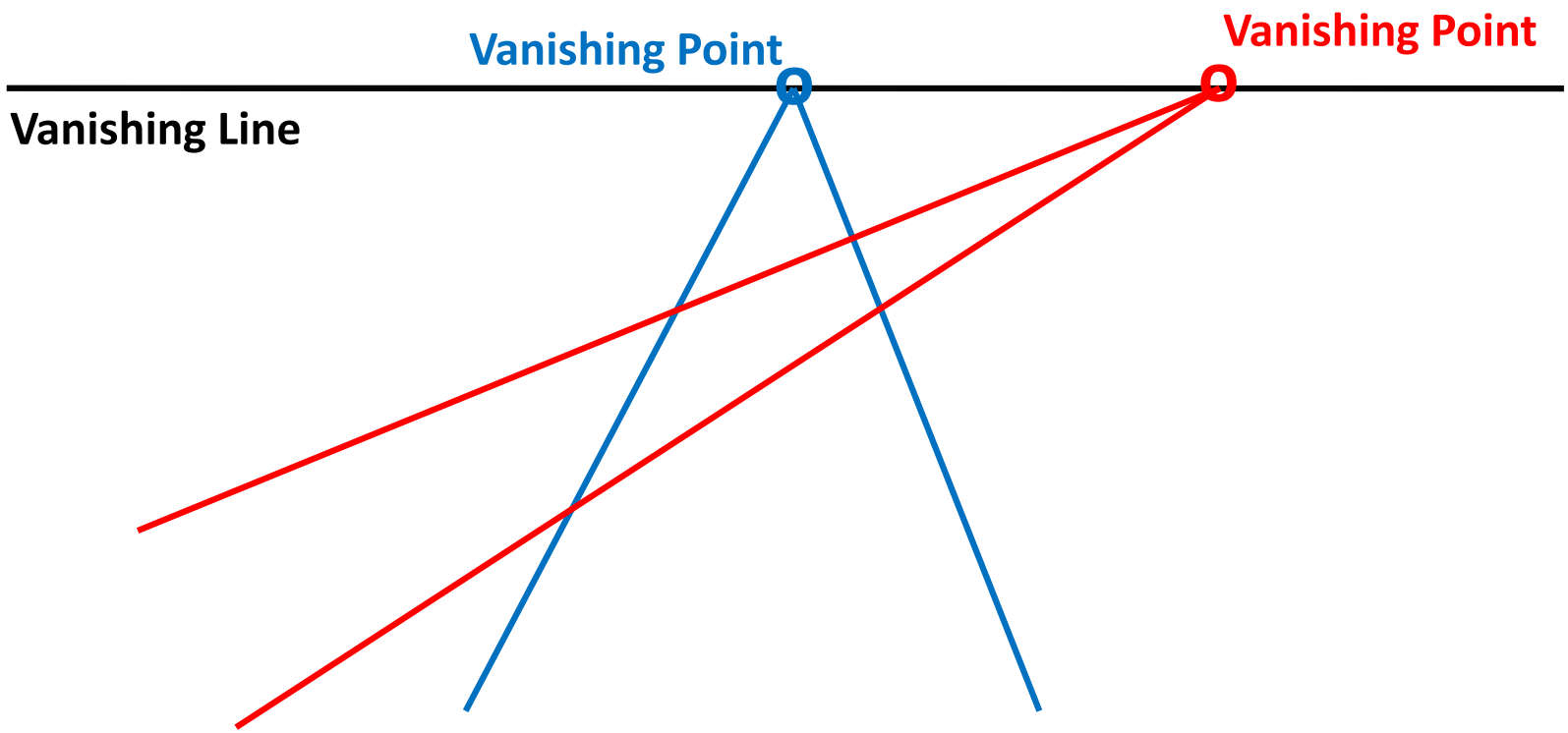


Vanishing points and lines

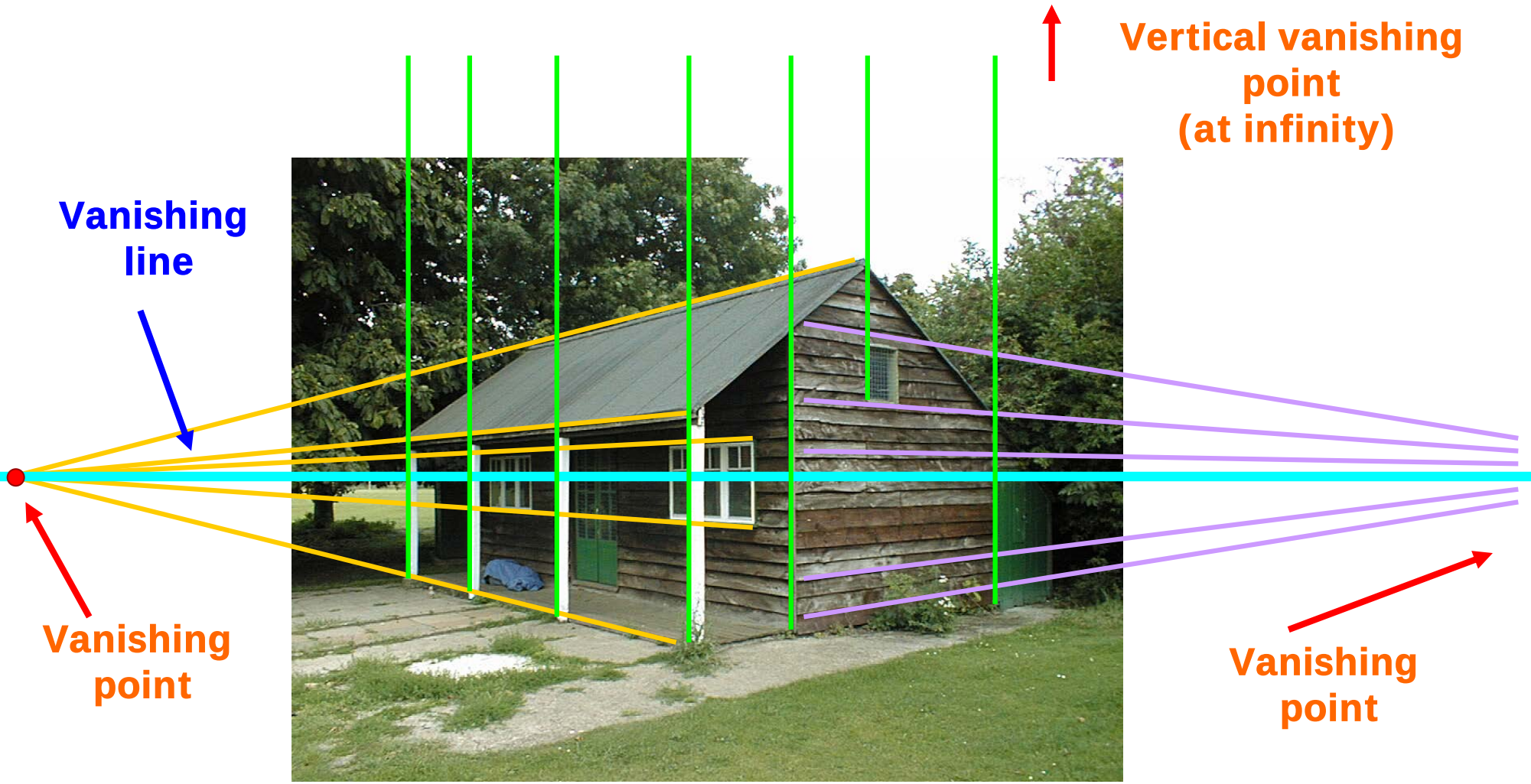
Parallel lines in the world intersect in the image at a “vanishing point”



Vanishing points and lines



Vanishing points and lines



Slide from Efros, Photo from Criminisi

Sommaire

Outils et bibliographie

- Outils
  - Matlab / Octave
  - Opencv → C++ (voire Python ?)
  - Pour la 3D : Point Cloud Library (PCL)

- Bibliographie
  - Computer Vision : Algorithms and Applications, Richard Szeliski (979 p.)
  - R. Hartley & A. Zisserman, *Multiple View Geometry in Computer Vision*, Cambridge University Press, 2003.
  - Cours de Brendan Morris, Trevor Darel, etc.
  - En français : cours de Anne Vialard