U1.2 Image Formation

SJK002 Computer Vision

Master in Intelligent Sytems

UNIVERSITAT
JAUME·I

Index

- Image formation.

- Projection models
  - "*Pinhole*" model (perspective)

- Optical systems.
  - Cameras with lenses.

Illumination.

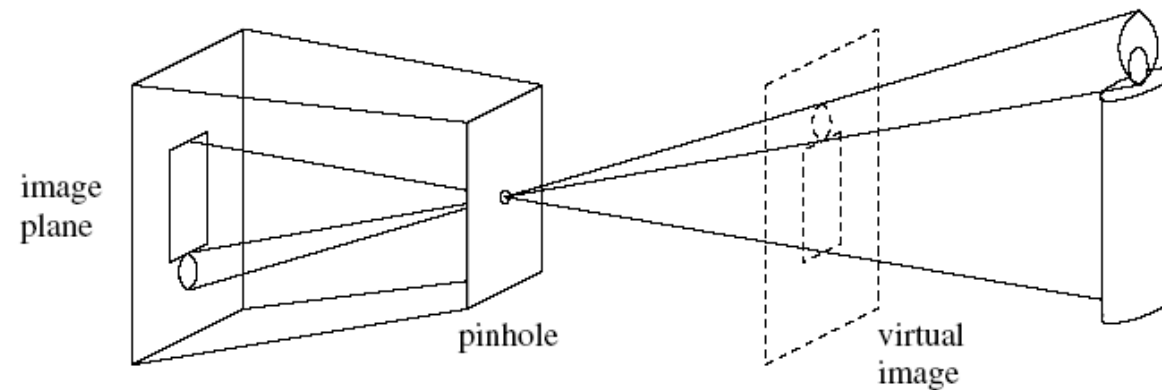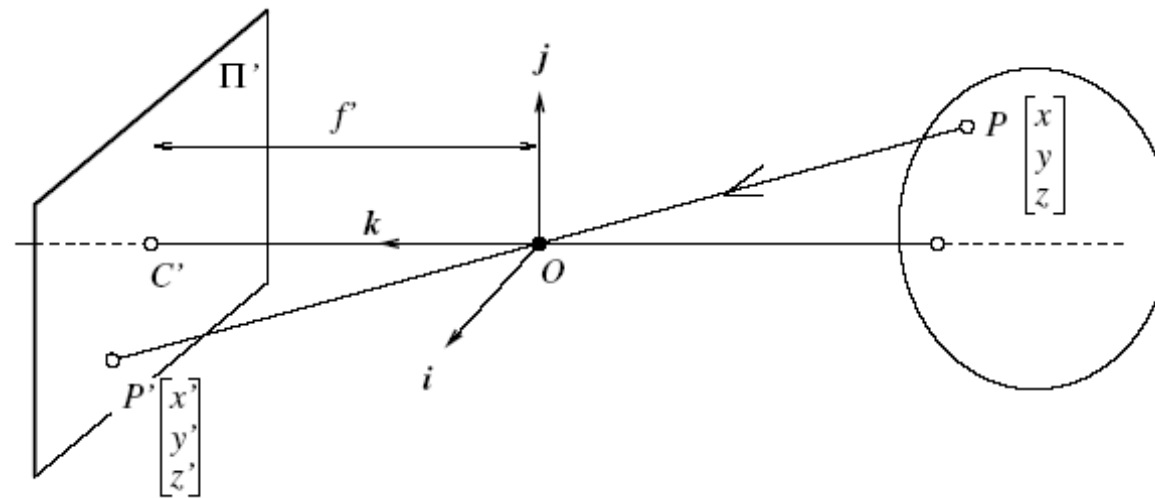Object surface reflection.

Projection into image plane.

Light Sources

Film

$(\theta i, \phi i)$

X

Surface normal

N

$(\theta r, \phi r)$

P(x,y,z)

Q

(x',y')

d

α

f

Camera

Y
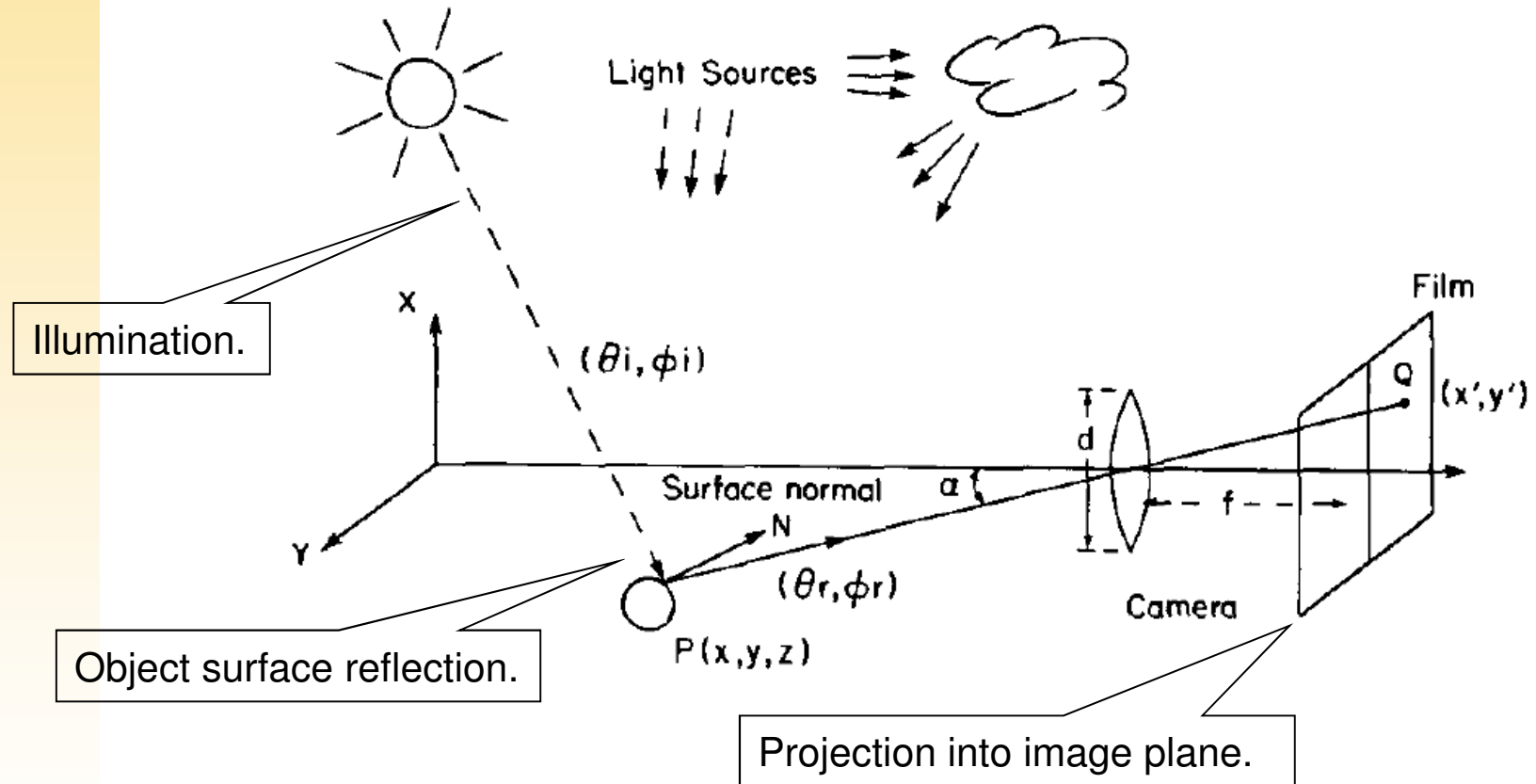
Pinhole model

- Projection of a 3D object in an 2D image (plane).
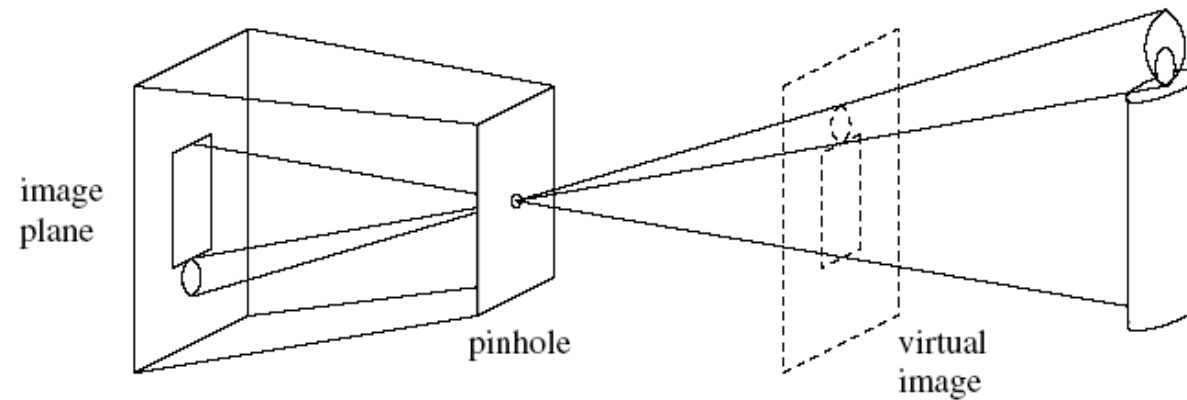
$$\left\{ \begin{array}{l} x' = \lambda x \\ y' = \lambda y \\ f' = \lambda z \end{array} \right. \iff \lambda = \frac{x'}{x} = \frac{y'}{y} = \frac{f'}{z}$$

$$\left\{ \begin{array}{l} x' = f' \dfrac{x}{z} \\[2mm] y' = f' \dfrac{y}{z} \end{array} \right.$$
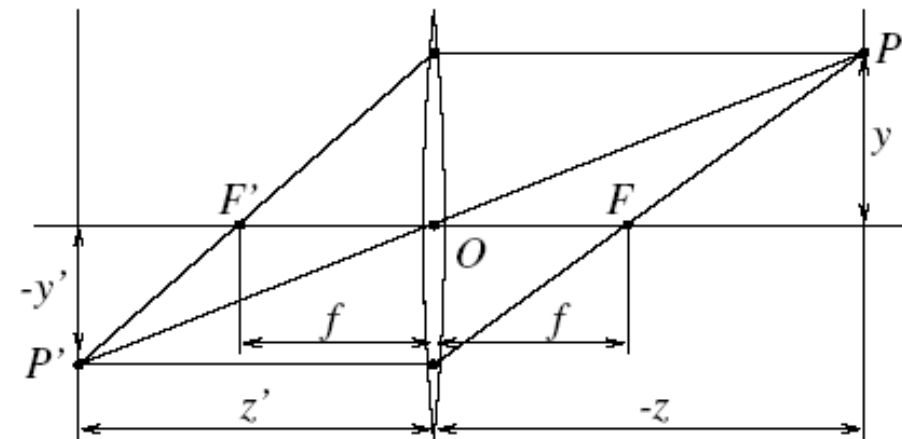
Perspective projection equations

Cameras with lenses

"*Pinhole*" camera

- Geometrical optics:
  - Light rays.
  - Straight lines.
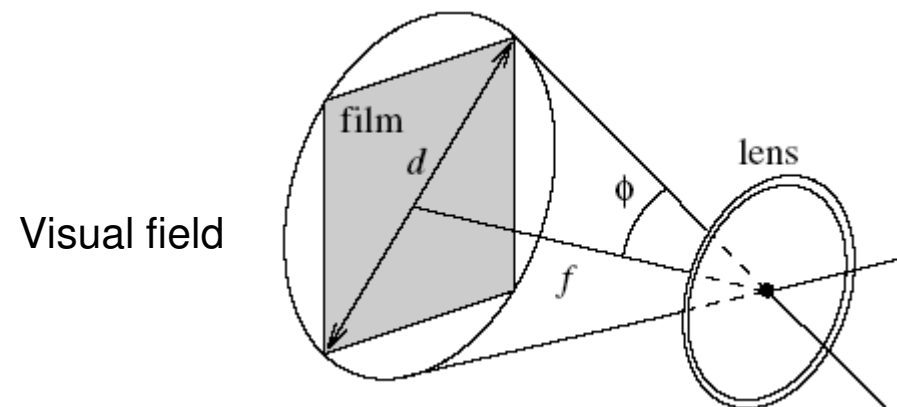

Convergent lens
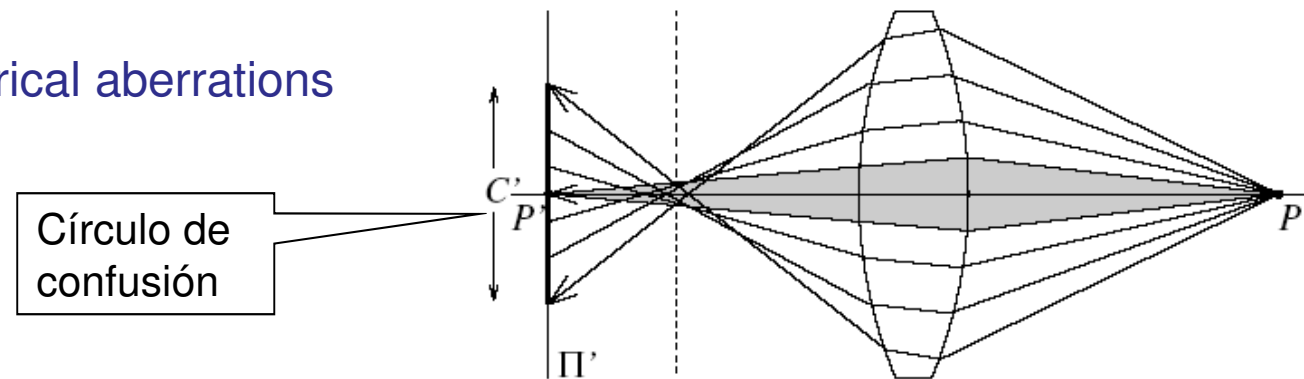
Focal point

Focal plane

F'

P'

$-y'$

O

f

F

f

z'

$-z$

focal

P

y

Depth of field

$$\frac{1}{z'} - \frac{1}{z} = \frac{1}{f}$$

film

d

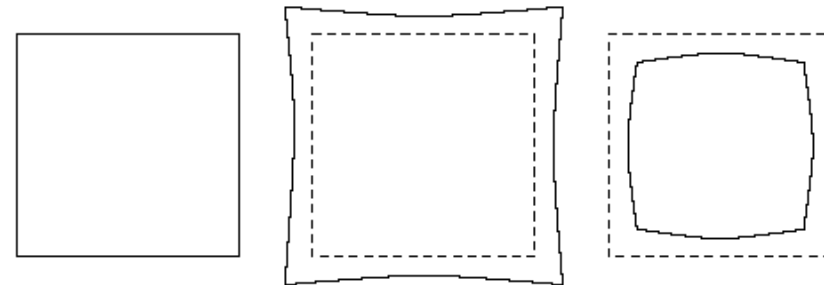ϕ

lens

f

Visual field
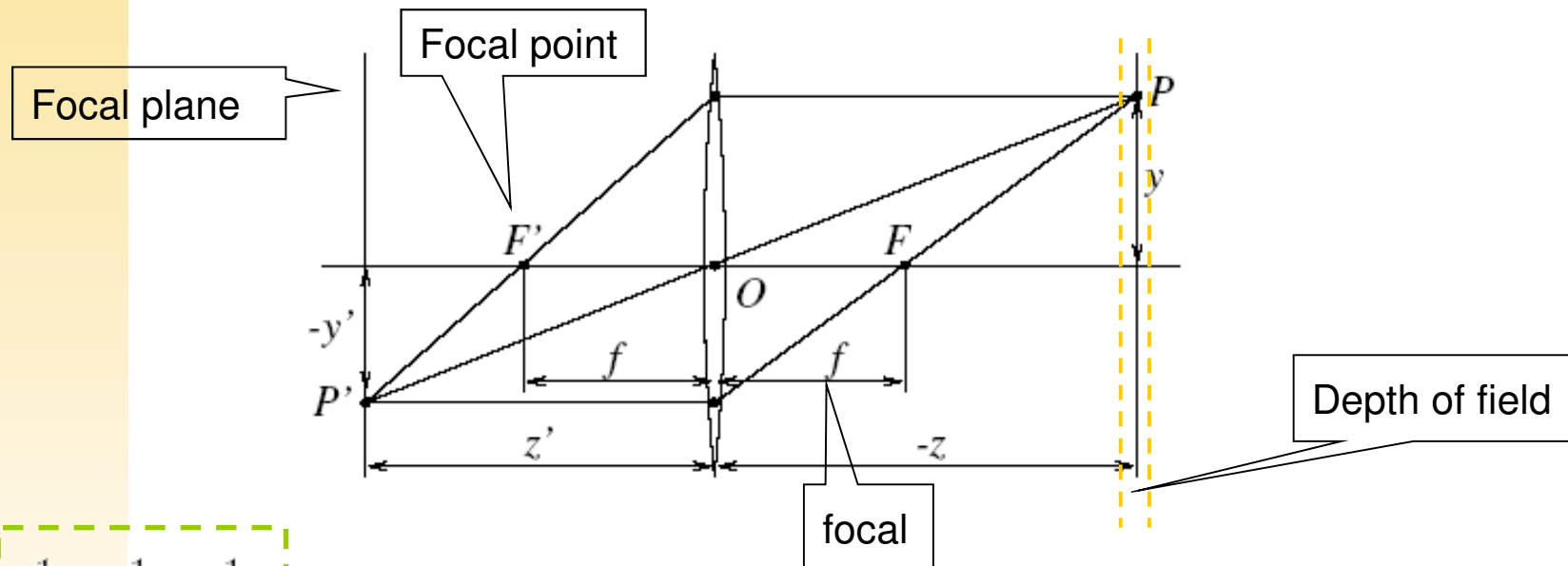
Real lenses. Aberrations

■ Spherical aberrations

Círculo de confusión

■ Primary aberrations:
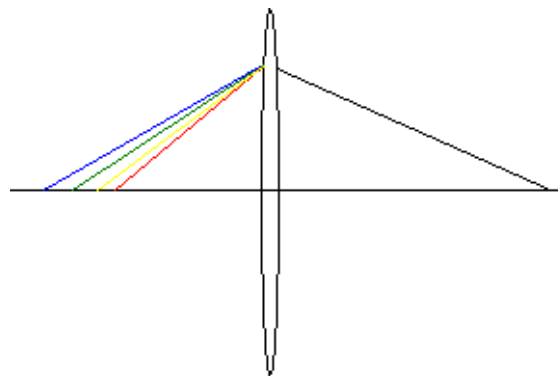- Coma.
- Astigmatism.
- Distortion.
- Filed curvature.

Distorsión: pincushion, barrel.

- Chromatic aberrations: $n(\lambda)$

Bibliography

- **Basic**:
  - Forsyth, D.A. and Ponce, J.; *Computer Vision: A Modern Approach*, Prentice Hall, 2003.

- **Complementary**:
  - Jähne, B. *Practical Handbook on Image Processing for Scientific Applications*, CRC Press, 1997.
  - Jain, R.; Kasturi, R.; and Schunck, B.G.; *Machine Vision*, McGraw-Hill Inc., 1995.
  - Shapiro, L. and Stockman, G.; *Computer Vision*, Prentice Hall, 2000.