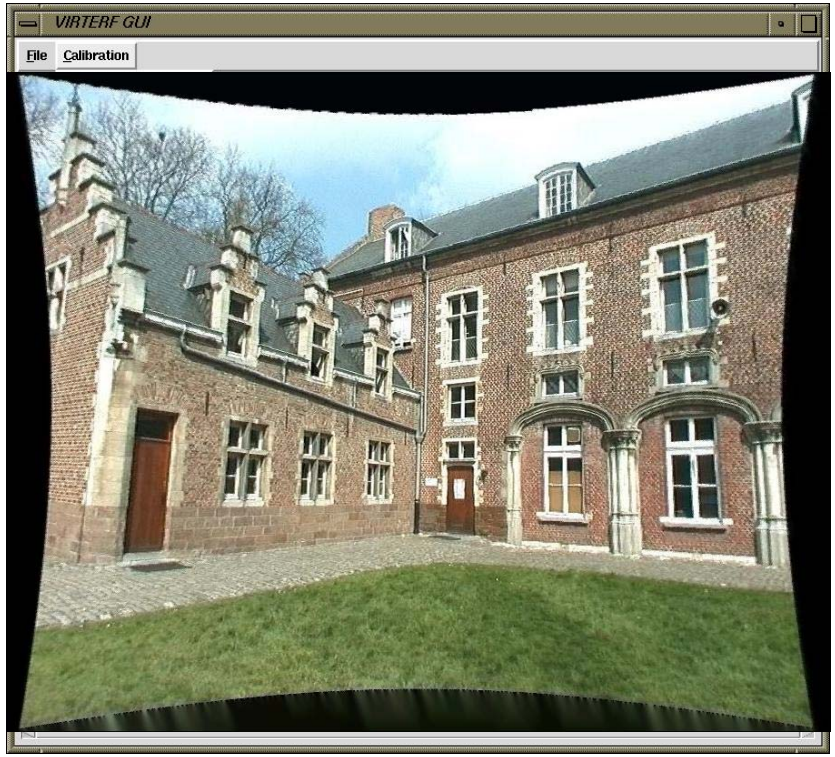
pincushion
(tele-photo)

barrel
(wide-angle)

Radial Distortion

magnification/focal length different
for different angles of inclination



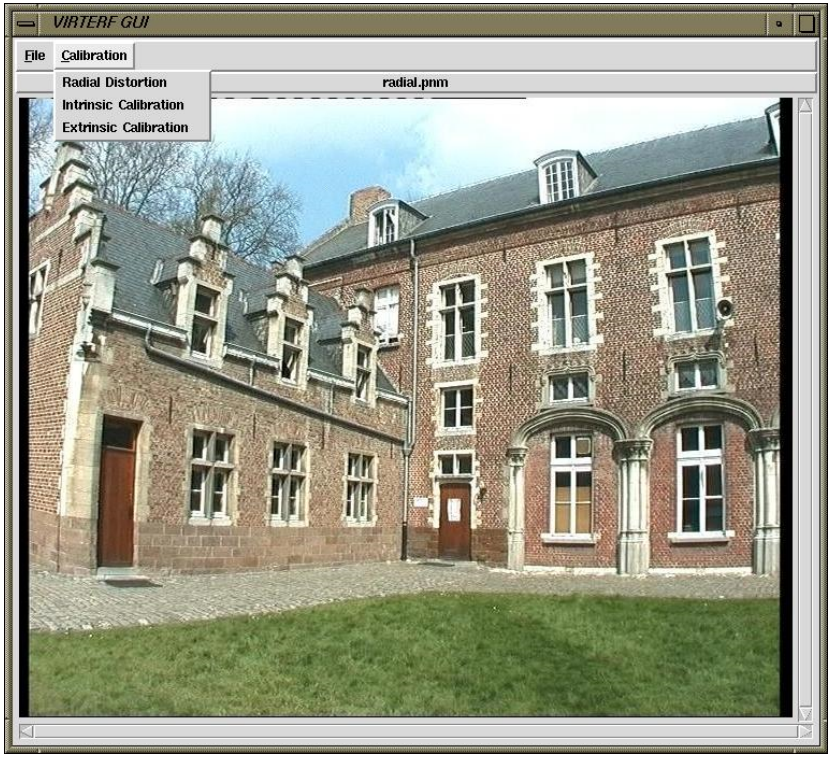
Can be corrected! (if parameters are know)

Radial Distortion

magnification/focal length different
for different angles of inclination

pincushion
(tele-photo)

barrel
(wide-angle)



pincushion
(tele-photo)

barrel
(wide-angle)

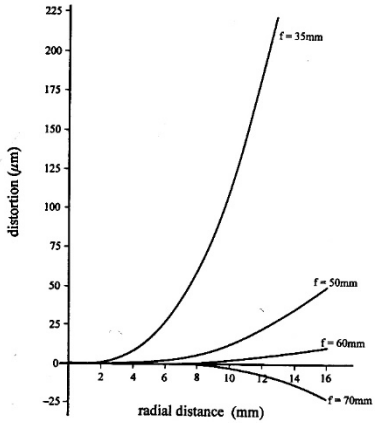
Radial Distortion

magnification/focal length different
for different angles of inclination

Can be corrected! (if parameters are know)

Radial Distortion

straight lines are not straight anymore



barrel dist.

pincushion dist.

http://foto.hut.fi/opetus/260/luennot/11/atkinson_6-11_radial_distortion_zoom_lenses.jpg

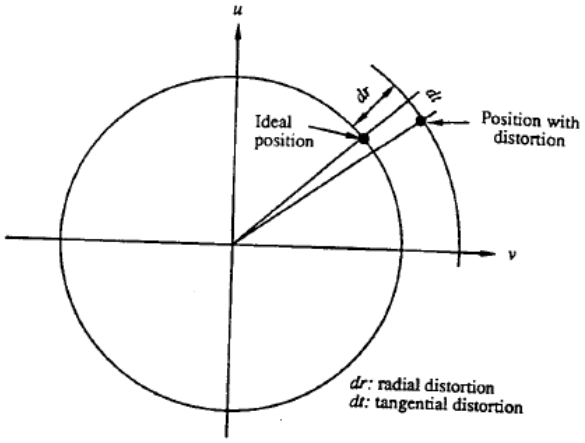


Fig. 2. Radial and tangential distortions.

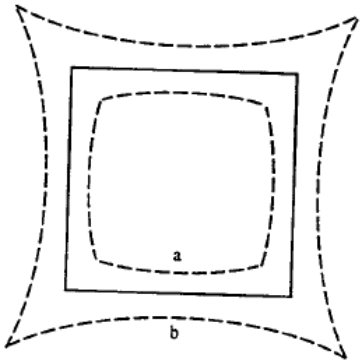
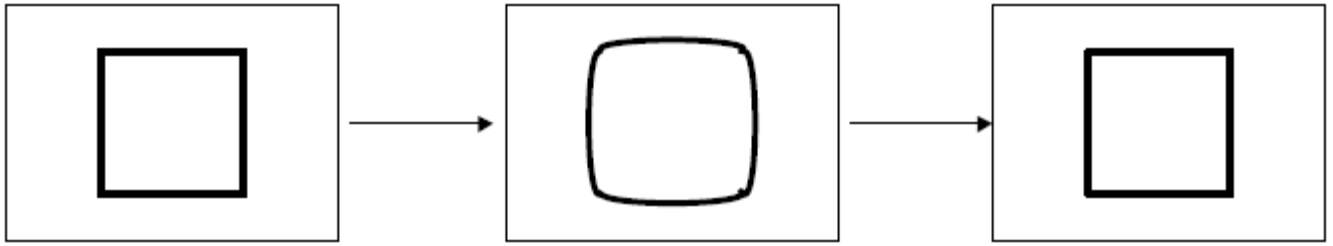


Fig. 3. Effect of radial distortion. Solid lines: no distortion; dashed lines: with radial distortion (a: negative, b: positive).

Radial Distortion

- We have assumed that lines are imaged as lines
- Not quite true for real lenses
  - Significant error for cheap optics and for short focal lengths



Scene Image Corrected image

Radial distortion

- Due to spherical lenses (cheap/wide angle)
- Model: (following Tsai 1987 et al.):

$$\vec{p} = \frac{1}{z} R^{-1} * K * \begin{pmatrix} {}^{C}_{W}R & {}^{C}_{W}\vec{t} \\ 0,0,0 & 1 \end{pmatrix} {}^{W}\vec{p}$$

$$R(x,y) = (1 + K_1(x^2 + y^2) + K_2(x^4 + y^4) + \ldots) \begin{bmatrix} x^{rad} \\ y^{rad} \end{bmatrix}$$

$$p = \frac{1}{Z} \begin{pmatrix} 1/\lambda & 0 & 0 \\ 0 & 1/\lambda & 0 \\ 0 & 0 & 1 \end{pmatrix} \mathcal{M}P$$

λ is a polynomial function of $\hat{r}^2 \stackrel{\text{def}}{=} \hat{u}^2 + \hat{v}^2$, i.e., $\lambda = 1 + \kappa_1 \hat{r}^2 + \kappa_2 \hat{r}^4 + \ldots$

Radial distortion example

Radial distortion example

Radial distortion example

Useful Links

Demo calibration (some links broken):

- http://mitpress.mit.edu/e-journals/Videre/001/articles/Zhang/CalibEnv/CalibEnv.html

Bouget camera calibration SW:

- http://www.vision.caltech.edu/bouguetj/calib_doc/

CVonline: Monocular Camera calibration:

- http://homepages.inf.ed.ac.uk/cgi/rbf/CVONLINE/entries.pl?TAG250