Radial Distortion

magnification/focal length different for different angles of inclination

Can be corrected! (if parameters are known)
Radial Distortion

magnification/focal length different for different angles of inclination

pincushion (tele-photo)

barrel (wide-angle)
Radial Distortion

magnification/focal length different for different angles of inclination

Can be corrected! (if parameters are known)
Radial Distortion

straight lines are not straight anymore

barrel dist.
pincushion dist.

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.
Radial distortion

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

\[ \begin{align*}
\hat{p} &= \frac{1}{z} R^{-1} \ast K \ast \begin{pmatrix} C & R \\ W & t \end{pmatrix} \begin{pmatrix} 1 \end{pmatrix} \end{align*} \]

\[ R (x, y) = (1 + K_1 (x^2 + y^2) + K_2 (x^4 + y^4) + ...) \begin{pmatrix} x_{rad} \\ y_{rad} \end{pmatrix} \]

\[ p = \frac{1}{z} \begin{pmatrix} 1/\lambda & 0 & 0 \\ 0 & 1/\lambda & 0 \\ 0 & 0 & 1 \end{pmatrix} M P \]

\[ \lambda \text{ is a polynomial function of } \hat{r}^2 \overset{\text{def}}{=} \hat{u}^2 + \hat{v}^2, \text{ i.e., } \lambda = 1 + \kappa_1 \hat{r}^2 + \kappa_2 \hat{r}^4 + \ldots. \]
Radial distortion example
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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: