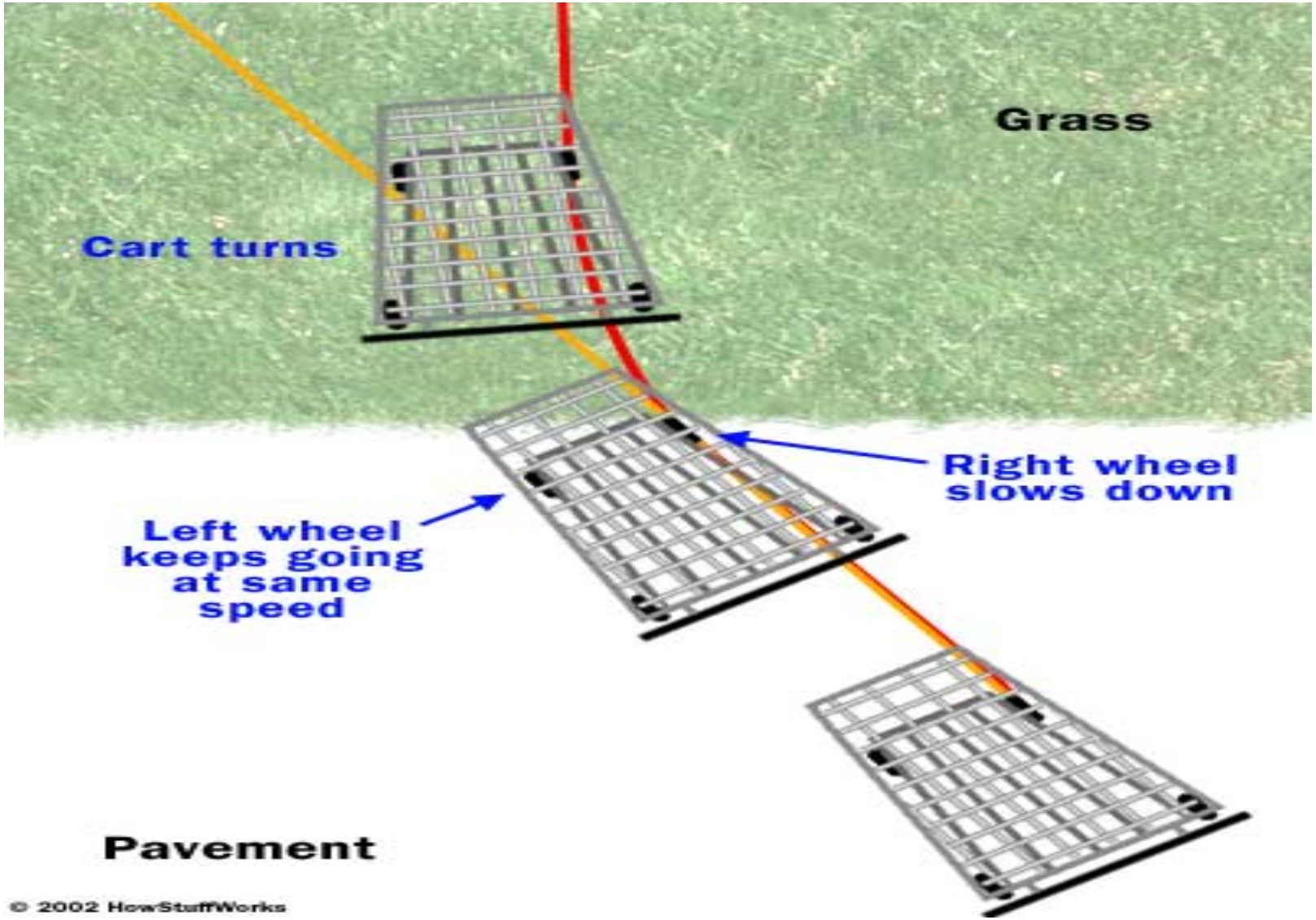
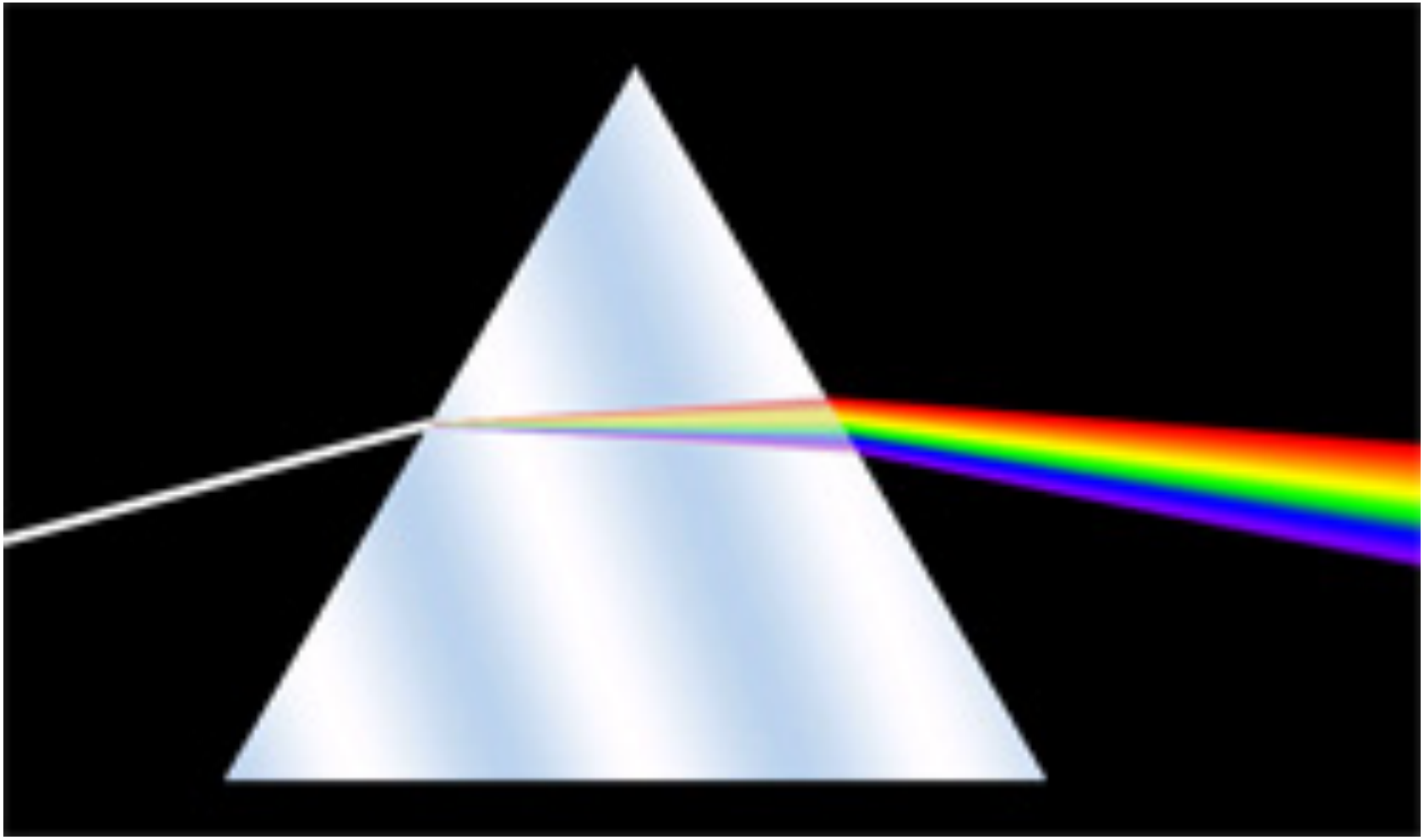
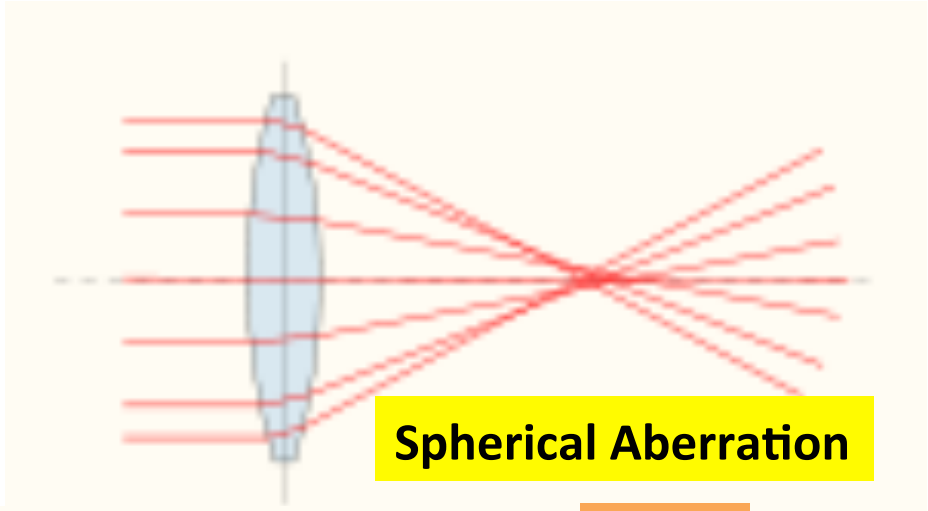
Geometry Depends on Colour !

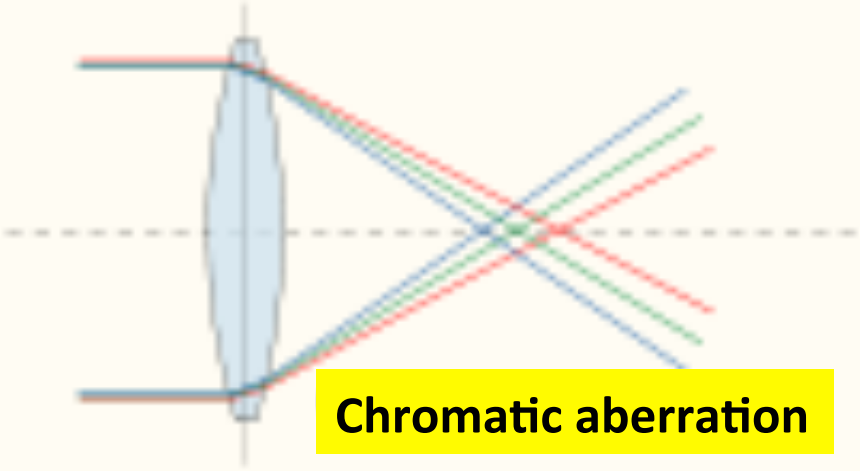

Grass
Cart turns
Right wheel slows down
Left wheel keeps going at same speed
Pavement
© 2002 HowStuffWorks



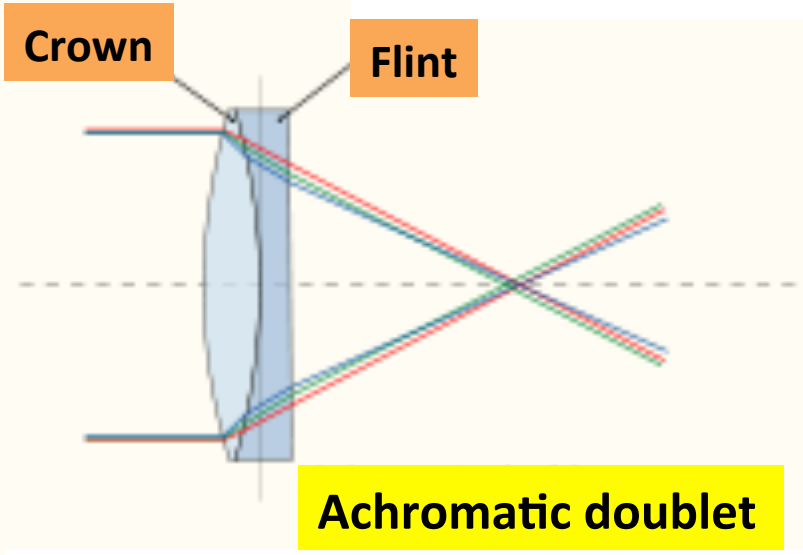
Aberrations



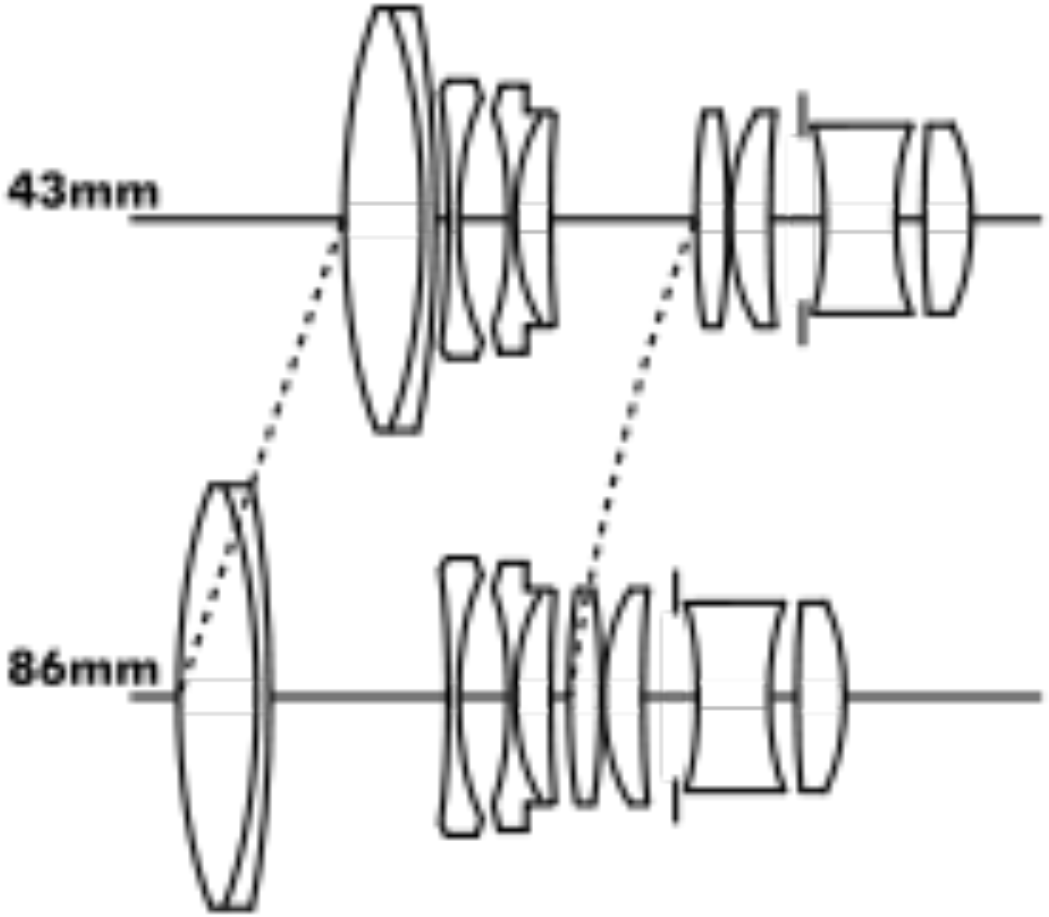
Spherical Aberration



Chromatic aberration



Achromatic doublet

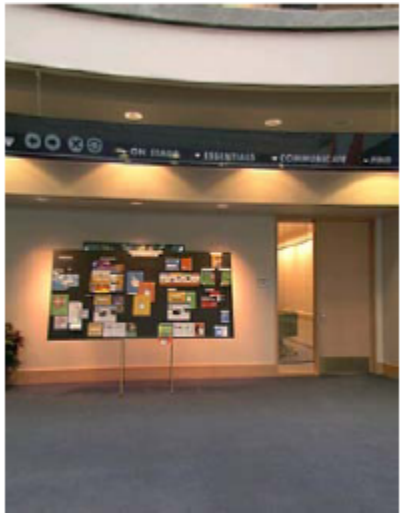


Nippon Kogaku (Nikkorex)
Zoom-Nikkor Auto 43-86mm f/3.5
1963

Lens Distortion

- straight lines become curves
- more severe with wide field of view lenses

barrel



pin-cushion

fisheye

- Radial distortion can be modelled as

$$x_d = x\left(1 + \kappa_1 r^2 + \kappa_2 r^4 + \kappa_3 r^6\right)$$
$$y_d = y\left(1 + \kappa_1 r^2 + \kappa_2 r^4 + \kappa_3 r^6\right)$$

distorted coordinates

undistorted coordinates

distortion parameters

with

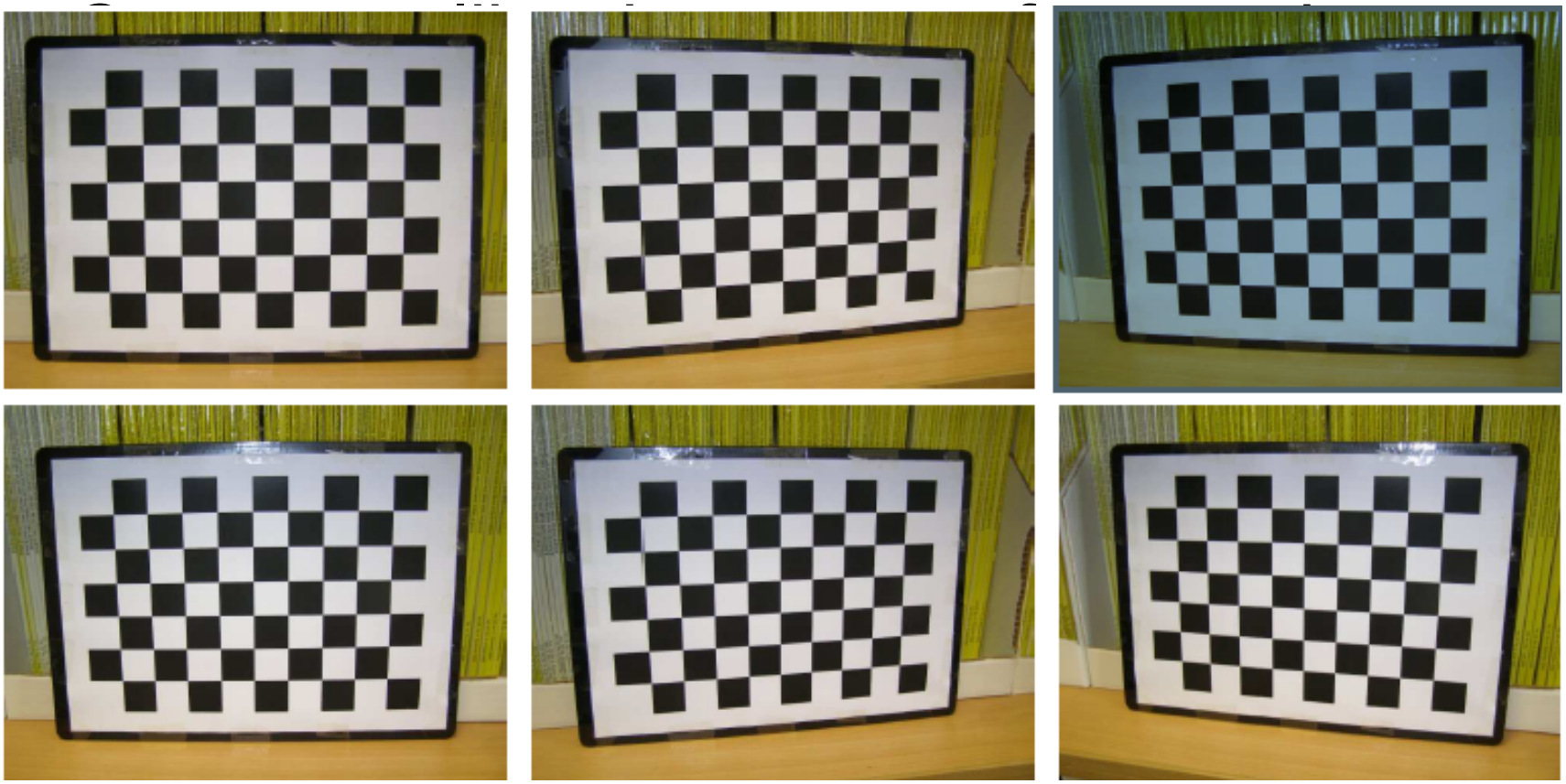
$$r^2 = x^2 + y^2$$

- Actual image coords

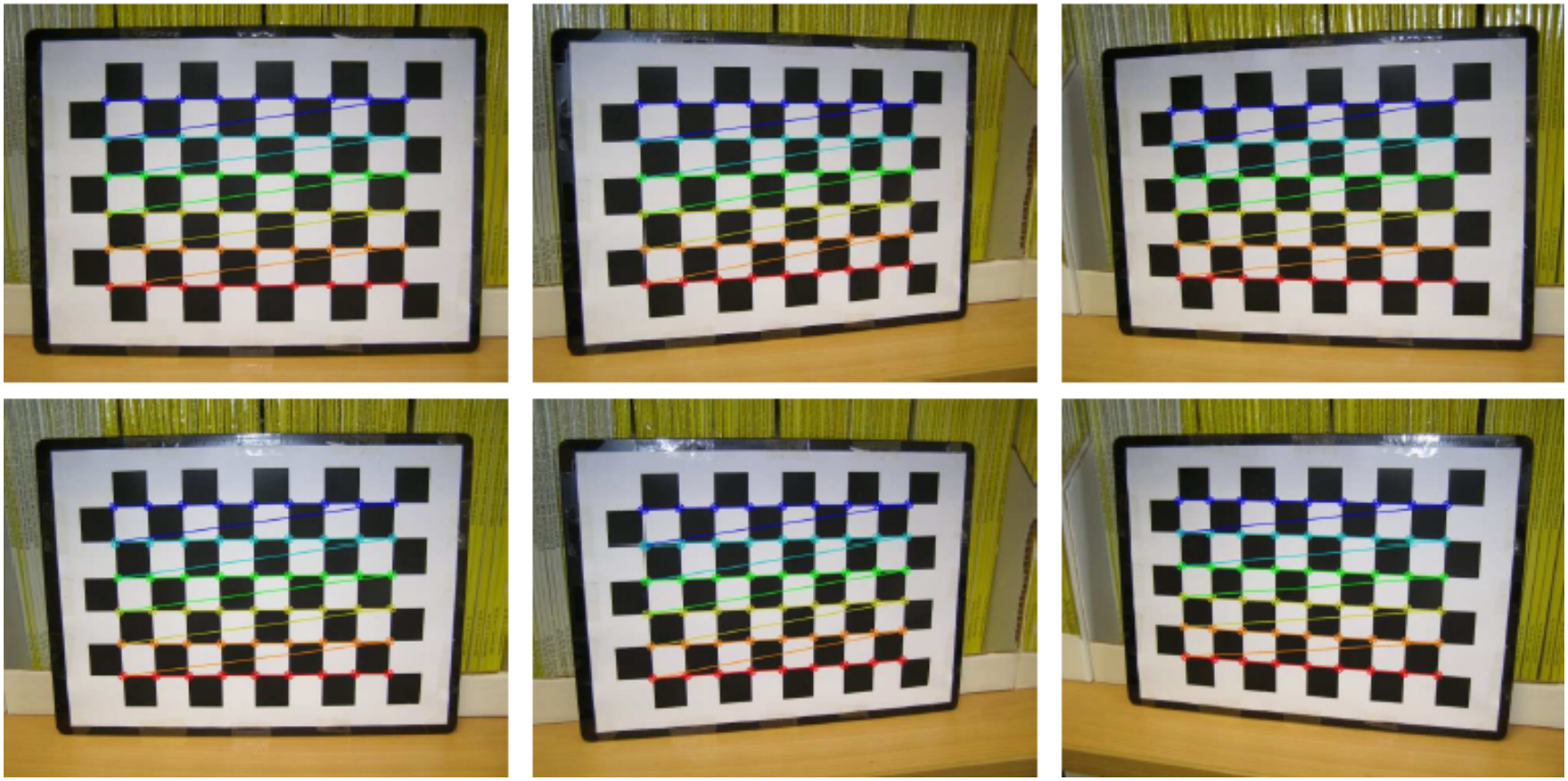
$$x_a = f_x\, x_d + c_x$$
$$y_a = f_y\, y_d + c_y$$

Camera Calibration

- Compute intrinsic / extrinsic parameters.



- Detect inner corners in images.



- Run calibration program (available in OpenCV).