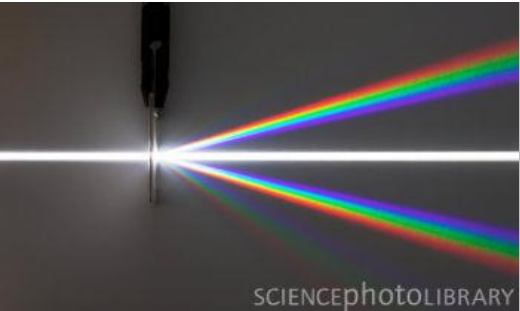
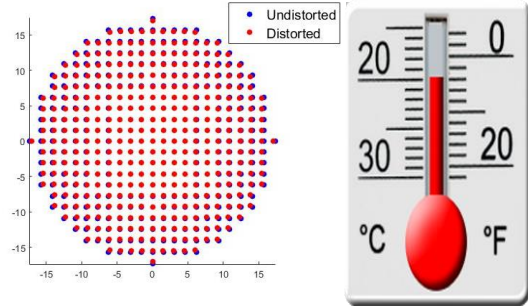


Data driven camera distortion correction model including effects from temperature variation and diffraction



- Lenses cause distortion (temperature, diffraction)
- Determine angles of arrival from distorted image

Michelle Hummel, Mark Van Benthem, Kyle Fuerschbach, Tammy Henson



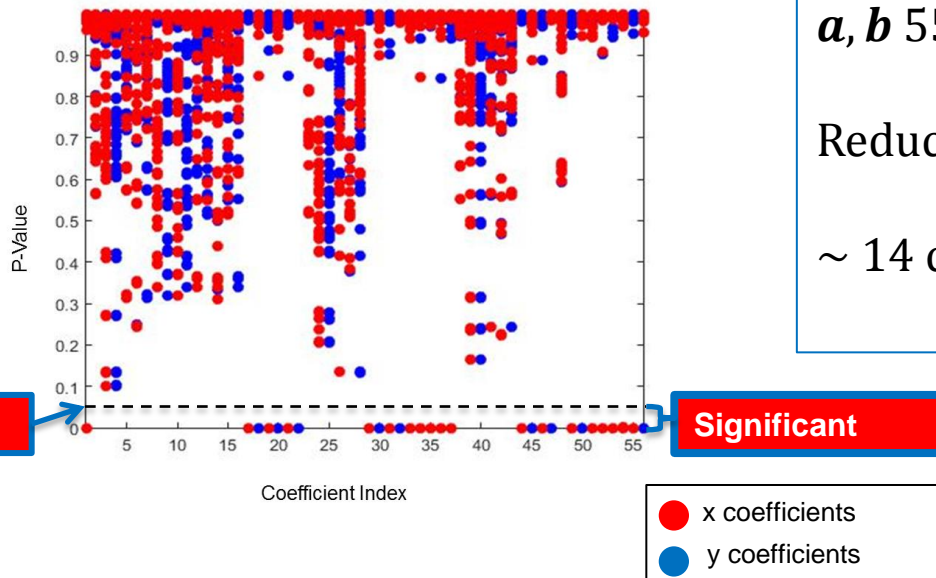
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Method

- 5th order polynomial fit $\theta_x = P(x, y, T)$, $\theta_y = Q(x, y, T)$
- Statistically determine significant coefficients (t-tests)
- Incorporate symmetry between diffraction orders



a, b 55 coefficients
 Reduced
 ↓
 ~ 14 coefficients

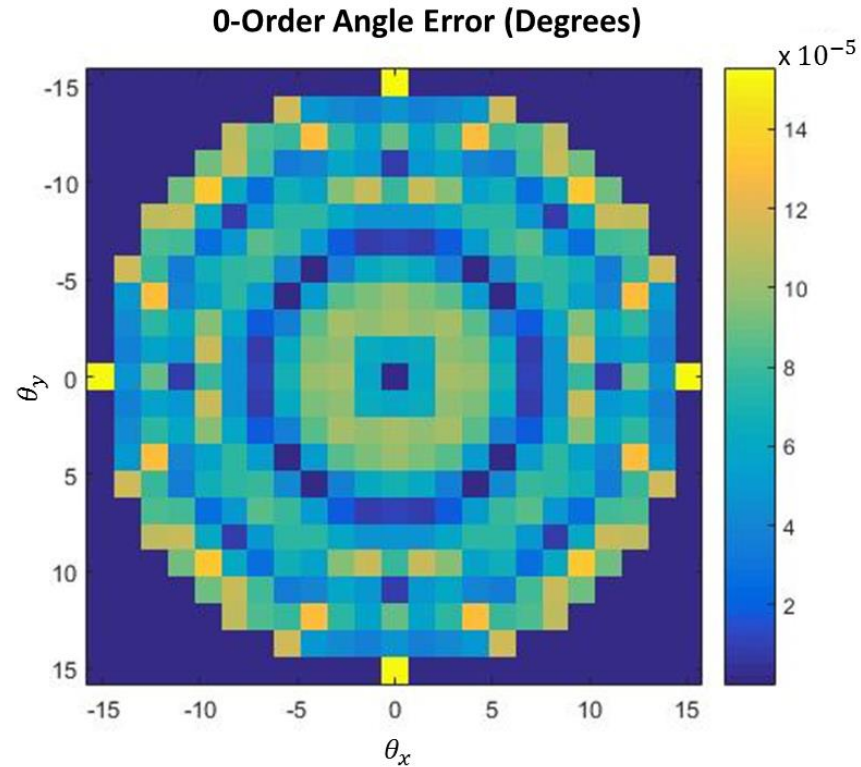
$$\begin{aligned} \Theta_x &= Va, \\ \Theta_y &= Wb \end{aligned}$$

44 Least Squares (LS)
 Reduced
 ↓
 11 Least Squares

$$\begin{bmatrix} V_+ \\ W_+P \\ V_-S \\ W_-SP \end{bmatrix} a = \begin{bmatrix} \Theta_x \\ \Theta_y \\ \Theta_x \\ \Theta_y \end{bmatrix}$$

Results

- Size of model reduced by 1/16
 - 5040 parameters \rightarrow 315 parameters
- Max angle error = $O(10^{-4})$



$$E = \max \sqrt{(\theta_x - \widehat{\theta}_x)^2 + (\theta_y - \widehat{\theta}_y)^2}$$

Model	# LS 0 order	# Params Per LS	# LS 1 order	# Params Per LS	Total # Params	Max Angle Error
Full	2	56	8 per λ	56	5040	2.5×10^{-4}
Reduced	1	9	2 per λ	12, 16	315	2.6×10^{-4}