Contrast Based Autofocus

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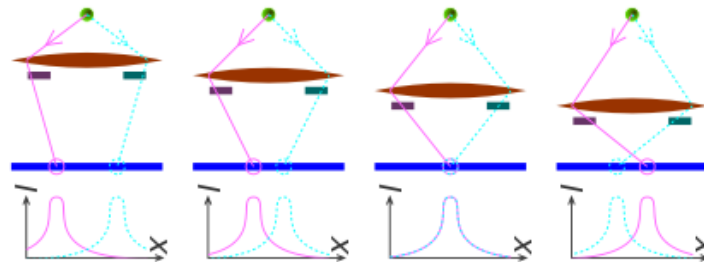
Focal length

- The distance to focus depends on the distance between the object and camera (u)
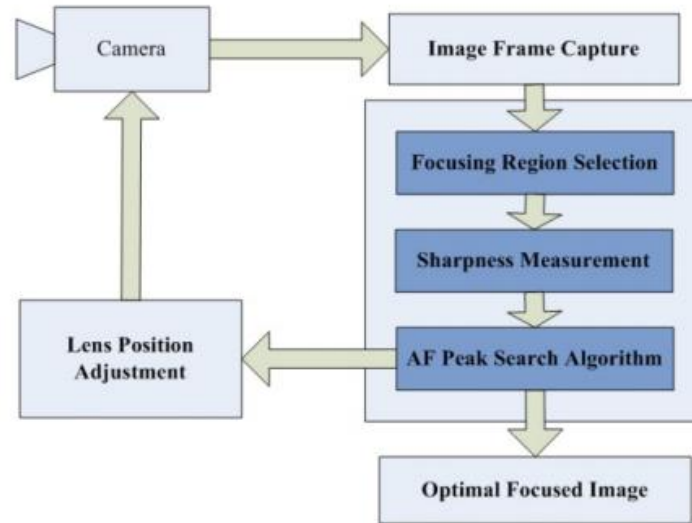
$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Types of Autofocus

- ## Active AF:
  - Sensor to measure distance (laser, infrared, ultrasonic)
- ## Passive AF:
  - Phase Detection (needs hardware - extra sensor):

  - Contrast Detection (only computational!)
- ## Hybrid AF:
  - Complex, using both passive and active AF, may also detect objects (eg. face detection)

Contrast Based Autofocus

- 5 tries:
  - Standard deviation of intensity
  - Standard deviation of intensity with noise reduction
  - Standard deviation of histogram
  - Standard deviation along axes
  - Contrast Measure based on Squared Laplacian (CMLS)

CMLS

- ## Square Laplacian

$$\Delta f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} \longrightarrow \quad L = \frac{1}{J*K} \sum_{x=1}^{J} \sum_{y=1}^{K} G(x,y)^2$$

$$G(x,y) = \sum_{i=x-1}^{x+1} \left| I(x,y) - I(i,y) \right| + \sum_{j=y-1}^{y+1} \left| I(x,y) - I(x,j) \right|$$

- ## Considering noise

$$F(x,y) = \frac{1}{J*K} \sum_{x=1}^{J} \sum_{y=1}^{K} G(x,y)(\sqrt[n]{G(x,y)+1} - 1)$$

$$n = \begin{cases} 1 & m \leq T_1 \\ 2 & T_1 < m < T_2 \\ 3 & m \geq T_2 \end{cases}$$

References

- Xin Xu, Yinglin Wang, Jinshan Tang, Xiaolong Zhang and Xiaoming Liu. **Robust Automatic Focus Algorithm for Low Contrast Images Using a New Contrast Measure.** http://www.mdpi.com/1424-8220/11/9/8281/pdf [access 12/09/2015]

- **Laplace Operator.** https://en.wikipedia.org/wiki/Laplace_operator [access 12/09/2015]

- **Autofocus.** https://en.wikipedia.org/wiki/Autofocus [access 12/09/2015]

- **A lot of discussion forums ...**