

Imaging Lab: Working Distance and Focal Length Basics

Introduction

The purpose of this experiment is to explore the relationship between working distance, field of view (FOV) and focal length, and the relative tradeoffs between short and long focal lengths. The experimenter will observe the images produced with two different fixed focal length lenses of the same field of view, for a fixed sensor size and a changing working distance. This experiment will demonstrate the concepts of Primary Magnification, Focal Length, Working Distance, Field of View and Resolution, and how they are all tied together in a system.

Parts List

12mm (58-001) and 25mm (59-871) CFF Lenses
High resolution (5MP) camera, 2/3" Sensor
Camera Stand with 1/4"-20 Camera Mount
Star Target Array (58-835)
Ruler
Backlight Illuminator

*These specific parts are recommended – user may need to swap products in or out for their specific needs

Procedure

1. With the camera mounted on the camera stand, carefully thread the 12mm CFF lens onto the camera and adjust the height so that the star target takes up the entire vertical FOV of the image. Measure the working distance (WD).
2. Set the iris of the lens to f/2.8 and adjust the focus until the target is sharp. Snap an image.
3. Following the iris and focus procedure of the preceding steps, remove the 12mm CFF and thread the 25mm CFF on the camera, adjust the working distance to obtain the same FOV. Similarly, snap an image and measure the WD.

Conclusion

- Examine and compare the images acquired in the previous steps. How does working distance change in relation to focal length?
- Having measured the field of view and knowing the 8.6mm horizontal dimension of the 2/3" sensor, what is the primary magnification in each image?
- How does field of view or angular field of view change with focal length? What are the angular fields of view for each lens?
- How does working distance change for different focal lengths to achieve the same field of view? Using this knowledge, what is the relationship between field of view and focal length?
- How does image quality change with focal length for the same field of view? Take into account the entire image, including the corners.