

Lenses for BIG Detectors and High Magnification: Part 1

Camera detectors continue to get smaller. And bigger.

On the one hand individual pixels are shrinking, annoyingly so, with the tiny 2 micron range now being available. Optics people tend to dislike this trend because as the pixels get smaller, lens performance must increase.

At the same time chip makers are producing some models with many more pixels, for both area and line scan cameras. The result being that overall detector sizes can get quite large, with some over 60mm long.

Yet most machine vision lenses aren't designed for these very large formats, or for good imaging with puny pixels. What's a poor end user to do?

There are at least two answers, and sometimes they work together beautifully. We'll discuss the first answer in this article. The second will come in Part 2.

Photographic and Enlarger Lenses

The classic 35mm format photographic camera lens is designed for creating big images. Not all the way up to 60mm, but they can cover a large majority of detector sizes. This is true even of the lenses designed for digital SLR cameras whose formats are usually a bit smaller. They can be pretty good tools, and adapters for their bayonet-style mounts are available. If you feel very ambitious you can find a way to utilize their autofocus/autoiris functions, but I never have.

One downside is that they are not usually designed for very low distortion and thus can present a challenge for critical gauging applications.

If you need excellent image reproduction, flat field, and low distortion, then photographic enlarger lenses could be your answer. You do remember photographic film from the Pleistocene Era, right? ☺ The film from cameras was developed and then projected onto large pieces of photographic developing paper using enlarger lenses. Reproduction geometry had to be nearly perfect.

Figure 1 shows the typical use, although the lens-to-paper distance is scaled much shorter.

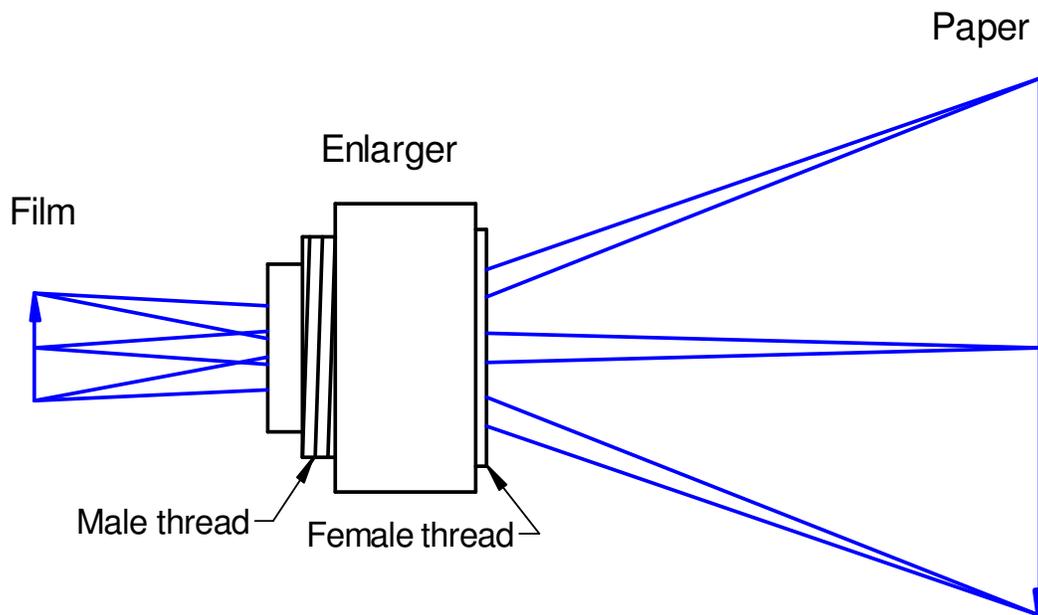


Figure 1: Enlarger Lens with Film

Rodenstock and Schneider (to name two) still make these lenses and they're terrific for use with large format detectors substituted for the film. That is, instead of projecting the film onto paper, you put your camera detector at the film plane and capture images of whatever you want.

These lenses typically come in focal lengths of 28mm, 35mm, 50mm, 60mm, 80mm, and 105mm and larger. The longer the focal length, the larger the film or detector format that can be used. The 28mm fl. lenses are for use with 18mm x 24mm film/detectors. At the top end focal lengths, 4" X 5" detectors could be used! (In fact, some of the old Nikon enlarger lenses could be used with 8" x 10" film plates! Alas, Nikon no longer builds enlargers.)

Typical reproduction ratios for the shorter focal length enlargers is 5X to 30X. This means that the film can be accurately projected as being 5 to 30 times larger depending on the film and paper distances. For machine vision purposes, an inspected object can be imaged onto the detector with a magnification of 1/5 to 1/30. Longer focal length lenses operate best at 2X to 10X (1/2 to 1/10)

In order to use these you will need an adapter to go from the enlarger lens male thread (39mm x 1/26") to your camera. Rodenstock at least provides such a beast, and there may be others. Edmund Optics sells the Rodenstock model. Be aware that unlike c-mount lenses or even photographic camera lenses, the back (or flange) focal lengths of enlargers vary with lens models.

The primary down side is that enlarger lenses typically don't come with minimum f-numbers smaller than F/2.8, and usually F/4 to F/5.6. (No need for a "fast" lens

when you can spend as much time as you want exposing the developing paper.) So if you need to operate with short exposure times, order up a truckload of photons.

One other thing: Enlargers don't come with focus rings. You adjust focus by adding or subtracting spacers, or use a separate accessory such as Rodenstock's "modular-focus" attachment. Here are some links:

<http://www.rodenstock-photo.com/>

<https://www.schneideroptics.com/ecommerce/CatalogSubCategoryDisplay.aspx?CID=173>

<http://www.edmundoptics.com/imaging/imaging-lenses/fixed-focal-length-lenses/rodagon-large-format-lenses/1416>

(NOTE: Edmund sells "Rodagon Large Format" lenses. These are one line of Rodenstock's enlarger lenses. They happen to be very good, 6-element designs.)

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