Lens Selection Guide:

Background and Purpose of this document:
In order to support a wide variety of applications, JAI cameras utilize standard lens mounts. With these standard lens mounts, users can select suitable lenses for their applications. This document describes a methodology to select a lens which is suitable for the application and the features of the camera.

1. Lenses for multi-sensor cameras with a prism

1.1. 3-sensor R/G/B (prism) area scan cameras

JAI offers a selection of these cameras in its Apex Series (model names start with either AP or AT). These cameras have C-mount lens mounts. For these cameras, specialized "prism compensated" lenses are recommended because normal CCTV lenses would cause color registration errors.

The recommended lenses are VS-H/3CMOS series by VS TECHNOLOGY.

https://vst.co.jp/vs-h-3cmos-series/

1.2. 3-sensor R/G/B or 4-sensor R/G/B/NIR (prism) line scan cameras

A lineup of these cameras can be found in JAI's Sweep+ Series (includes the SW-4000T-MCL, SW-2001T/Q-CL, and model names starting with LT or LQ). These cameras have F-mounts or M52 lens mounts. For these cameras, specialized "prism compensated" lenses are recommended because normal lenses would cause color registration errors.

Please contact JAI for a list of lens recommendations.

1.3. 2-sensor SWIR (prism) line scan cameras

A camera of this type can be found in JAI's Wave Series (WA-1000D-CL). This camera has an M52 lens mount. For this camera, a specialized "prism compensated" lens is also recommended because normal lenses would cause registration errors between the two wavebands.

Please contact JAI for a list of lens recommendations.

2. General guidelines for selecting a lens

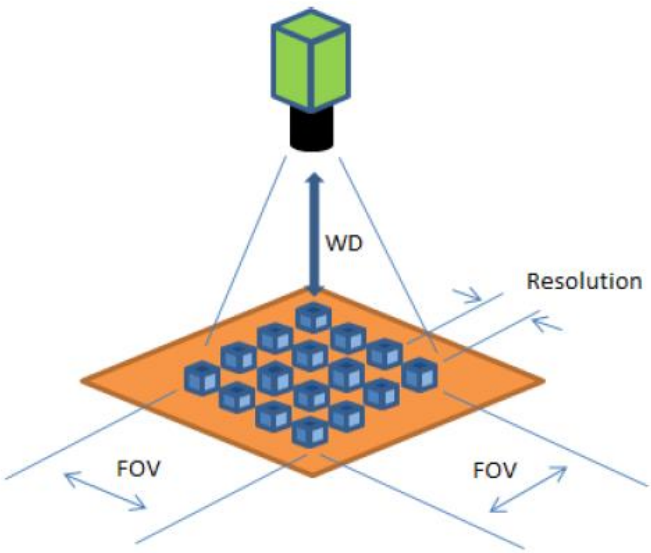
2.1. Parameters of the lens

To select an appropriate lens, the following optical parameters should be considered:

- Sensor Size: The effective size of the sensor which can be found in the data sheet or manual of the camera.
- Effective Image Pixels: The total count of pixels in the image which can be found in the data sheet or manual of the camera.
- Field of View (FOV): The size of the target object(s) to be captured by camera.
- Working Distance (WD): The distance between the front of the lens and the target object(s).
- Focal Length: The distance between the center of lens and the image sensor.
- Resolution (FOV Resolution): The size of the target object that will be captured by one pixel of sensor (*).

Note (*): In general, resolution has two meanings; a) Effective number of image pixels, i.e., the total count of pixels, and b) FOV resolution, which is the target size to be captured by one pixel. In this document, resolution refers to “FOV resolution” unless otherwise stated.

Also note that “size” as it pertains to the sensor, the FOV, and the FOV resolution, can be calculated in terms of width only (horizontal size), height only (vertical size), or both width and height (area) when selecting a lens.



2.2. How to select the lens

Using the parameters from the previous section, the lens should be selected to meet the actual environment of the system and the target object(s).

- Sensor Size: The lens must have a specification that supports the sensor size. If the size of sensor that is supported by the lens' optical format is smaller than the camera's sensor size, vignetting will occur. In general, if the sensor area covered by a lens' optical format is too close to the actual sensor size, avoiding vignetting cannot be guaranteed. Therefore, a lens which supports a little extra sensor size should be selected when possible.

- Focal Length: For machine vision, fixed focal length lenses are generally used. The following formula is used to correlate FOV, WD, Sensor Size, and Focal Length:

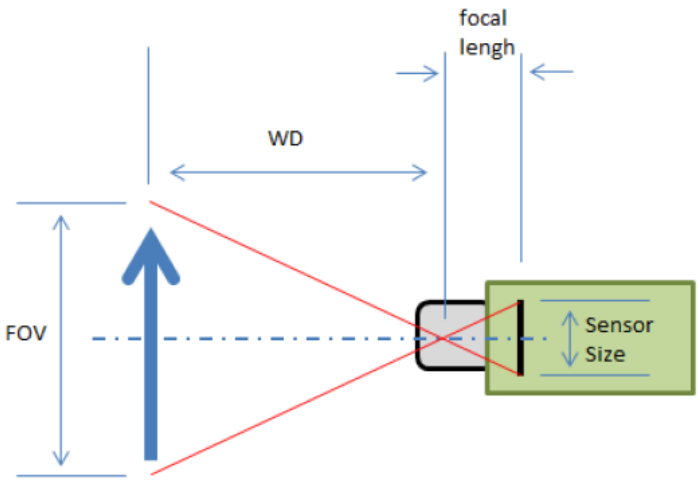
  FOV : WD = Sensor Size : Focal Length

  With this formula, we can calculate both the horizontal and the vertical focal length requirements of the actual environment as follows:

  Focal Length1 = (Horizontal Sensor Size × WD) / Horizontal FOV

  Focal Length2 = (Vertical Sensor Size × WD) / Vertical FOV

  To make sure we capture the whole area of our target object(s), the smaller (shorter) of the two Focal Length values (larger field of view) should be used to select the lens.



- Resolution (FOV resolution): Target resolution can be calculated by the following formula:

  Resolution = FOV / Effective Image Pixels.

  This parameter is related to how finely the target can be captured into the image. To capture smaller parts in detail, higher resolution is needed. To achieve it, high resolution lenses and cameras should be selected. Optionally, one might consider using multiple cameras.

- Minimum working distance: WD should be longer than the minimum working distance of lens.

- High resolution (total count of pixels): “resolution” in this paragraph means “effective image pixels / total count of pixels.” In order to use a high resolution camera, a high resolution lens is recommended. These lenses offer the capability to capture precise clear images across the large number of pixels in a high resolution camera.

The preceding items should all be considered when selecting lenses.

Of course, other items, such as aperture or “f number” (the ability for the lens to open wider when more image brightness is needed), size, weight, etc. may also be important to your lens selection. For these items, please refer to the manufacturer’s lens specification.

End.

Revision History

Revision	Date	Changes
1	2018/07/10	New release
2	2020/12/01	Updated lens recommendations