Lens

Machine Vision Component

MV Lab
All About Machine Vision

Lens
About

Type of Lenses

Aperture

Distortion

Depth of Field

Sensor Size

Working Distance

Field of View

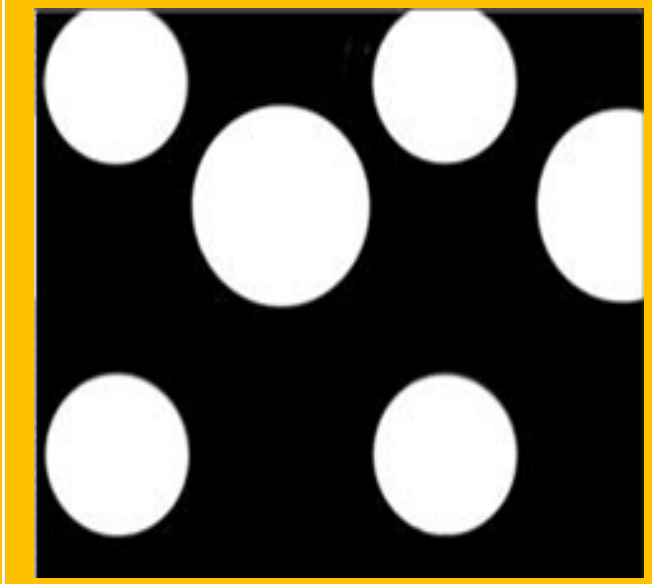
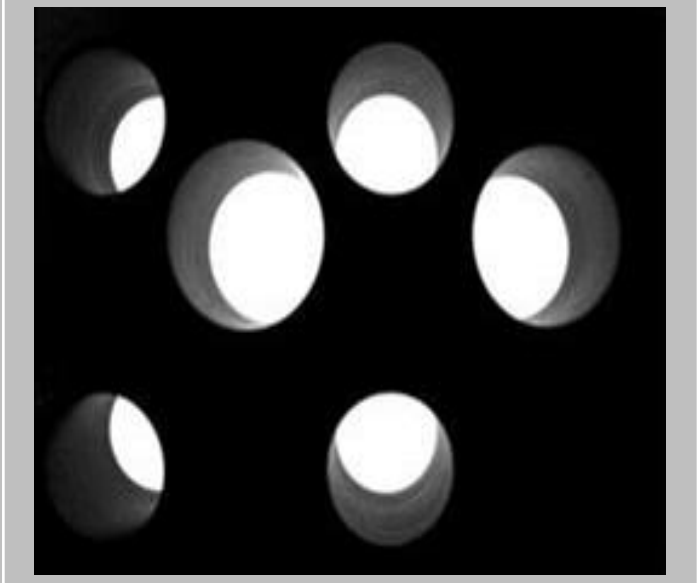
Lens

Type

Telecentric Lens

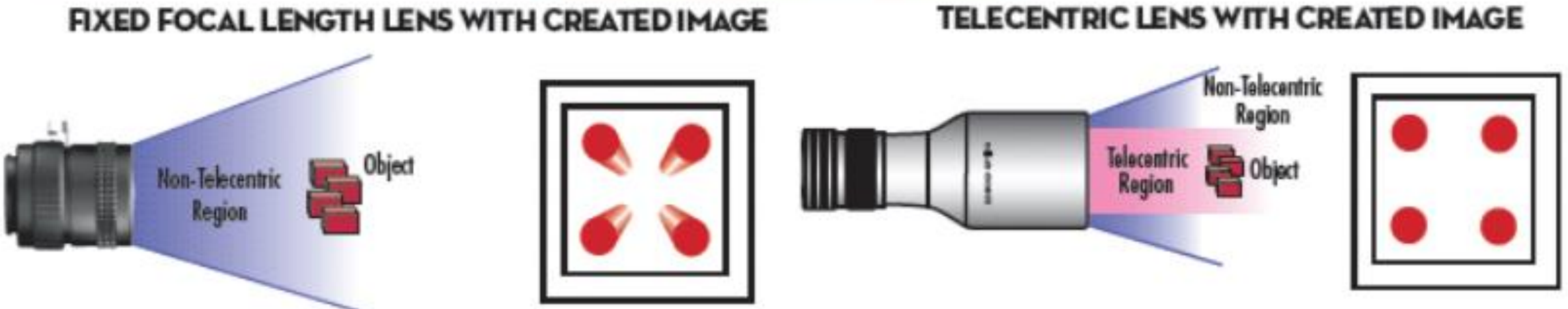
CCTV Lens

MV Lab
All About Machine Vision

Telecentric Lens			
Conventional Lens			

Lens

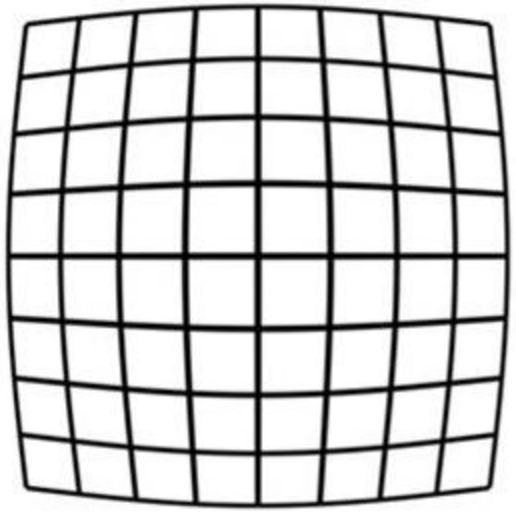

SETUP
FIXED FOCAL LENGTH LENS
TELECENTRIC LENS


FIXED FOCAL LENGTH LENS WITH CREATED IMAGE
TELECENTRIC LENS WITH CREATED IMAGE
Non-Telecentric Region
Object
Non-Telecentric Region
Telecentric Region
Object

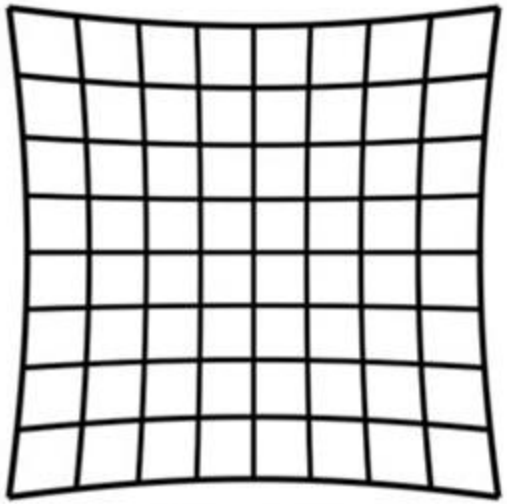
Lens
Distortion

Original

Negative Radial
"BARREL"



Positive Radial
"PINCUSHION"



MV Lab
All About Machine Vision

Lens

Distortion-Specification

Product Name	HF6XA-5M	HF8XA-5M	HF12XA-5M	HF16XA-5M	HF25XA-5M	HF35XA-5M
Focal length [mm]	6 (6.23)	8 (8.3)	12 (12.4)	16 (15.87)	25 (25.07)	35 (35.16)
Iris range (F. no)	F1.9-F16	F1.6-F16	F1.6-F16	F1.6-F16	F1.6-F16	F1.9-F16
Angle of view	74.7°×58.1° (2/3")	58.4°×44.6° (2/3")	40.1°×30.3° (2/3")	31.4°×23.7° (2/3")	20.0°×15.0°(2/3")	14.2°×10.7° (2/3")
Working distance (from front of lens barrel) [mm]	∞-100	∞-100	∞-100	∞-100	∞-100	∞-200
Operation of focus	Manual	Manual	Manual	Manual	Manual	Manual
Operation of iris	Manual	Manual	Manual	Manual	Manual	Manual
Filter thread [mm]	M37.5 x 0.5	M25.5 x 0.5	M25.5 x 0.5	M25.5 x 0.5	M25.5 x 0.5	M25.5 x 0.5
Mount	C-mount	C-mount	C-mount	C-mount	C-mount	C-mount
Weight (approx.) [g]	100 (T.B.D.)	79	79	71	72	60
Sensor size (max.)	2/3"	2/3"	2/3"	2/3"	2/3"	2/3"
Back focal distance (in air) [mm]	12.46	9.75	11.89	10.66	13.60	18.50
Flange back [mm]	17.526	17.526	17.526	17.526	17.526	17.526
Exit pupil postion (from image plane) [mm]	-46.78	-417.22	-123.16	-206.22	-79.47	-37.19
Front principle point (from Mount)	-30.92	-31.16	-24.44	-12.33	-5.38	-6.30
Rear principle point (from Mount)	11.30	9.23	5.13	1.65	-7.54	-17.63
Distance between the pincipal points	42.22	40.38	29.57	14.13	-2.16	-11.33
TV distortion [%]	-2.88	-1.99	-1.26	-0.60	-0.07	0.10
Dimension [mm]	φ39×51	φ29.5×51.5	φ29.5×51.5	φ29.5×46.0	φ29.5×46.5	φ29.5×41.5
Relative illmination (Apeture: at full open, Image heigh: at diagonal)	42	41	45	48	47	50
Operation Temperature	-10℃~50℃	-10℃~50℃	-10℃~50℃	-10℃~50℃	-10℃~50℃	-10℃~50℃

Lens
Factors

Field of View (FOV)

Lens Mount (Mounting)

Sensor Size (Camera)

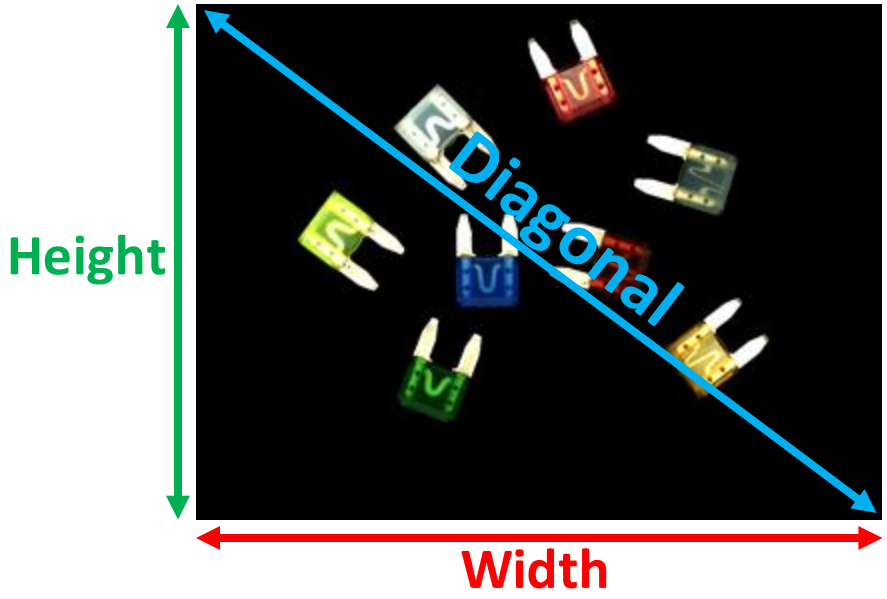
Depth of Field (DOF)

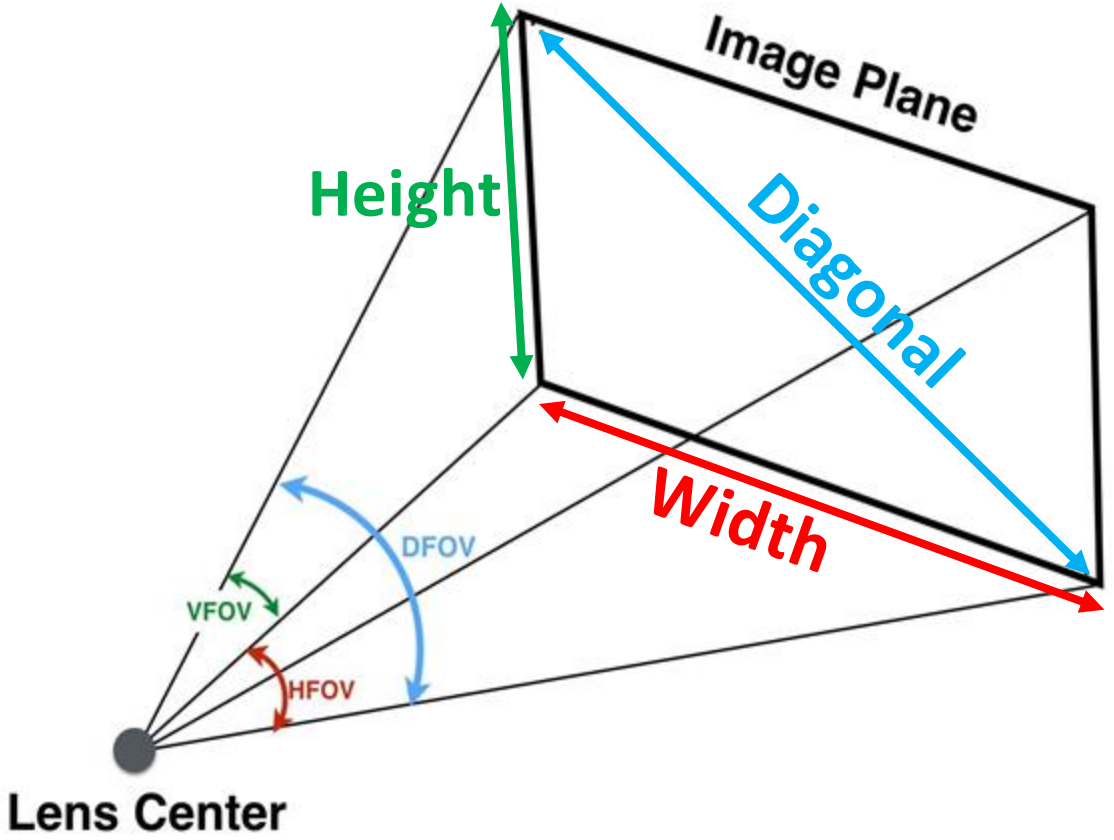
Working Distance (WD)

MV Lab
All About Machine Vision

Lens
Field of View

- **Field of View** is the maximum size that the lens can image (**Width** and **Height**).
- **Field Of View** depends on the Focal Length and Sensor Size





MV Lab
All About Machine Vision

Lens
Comparison

Camera	CCTV Lens	Image
 2/3”	 1”	
 2/3”	 2/3”	
 2/3”	 1/3”	

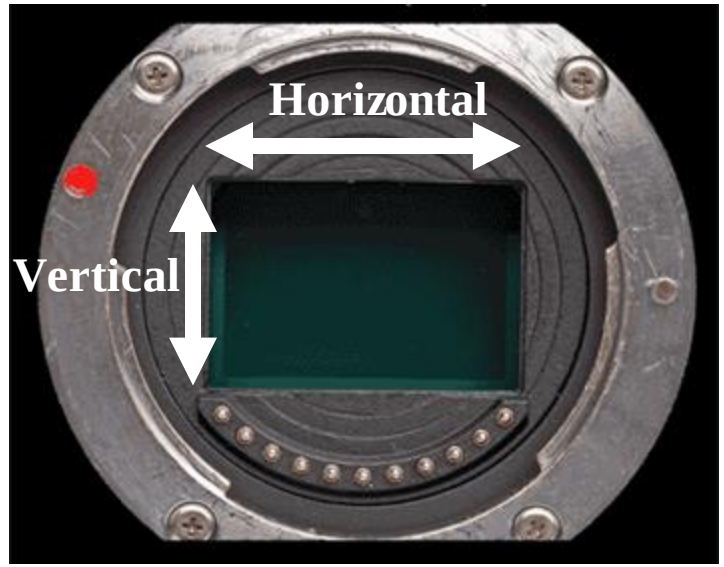
Vignetting Effect

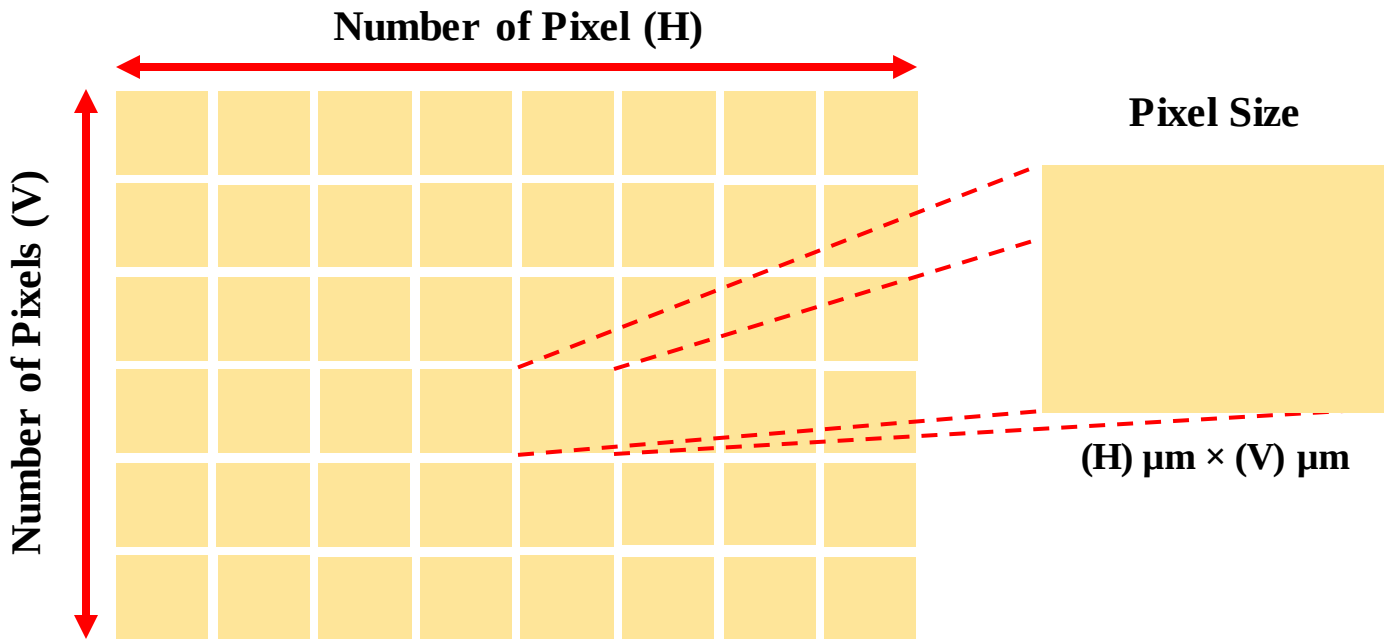
MV Lab
All About Machine Vision

Lens

Sensor Size (Camera)

Refers to the physical size of the sensor, and is typically not noted on specification sheets. The best way to determine sensor size is to look at the **Pixel Size** on the sensor and multiply by the **Resolution (Number of Pixels)**.





Lens

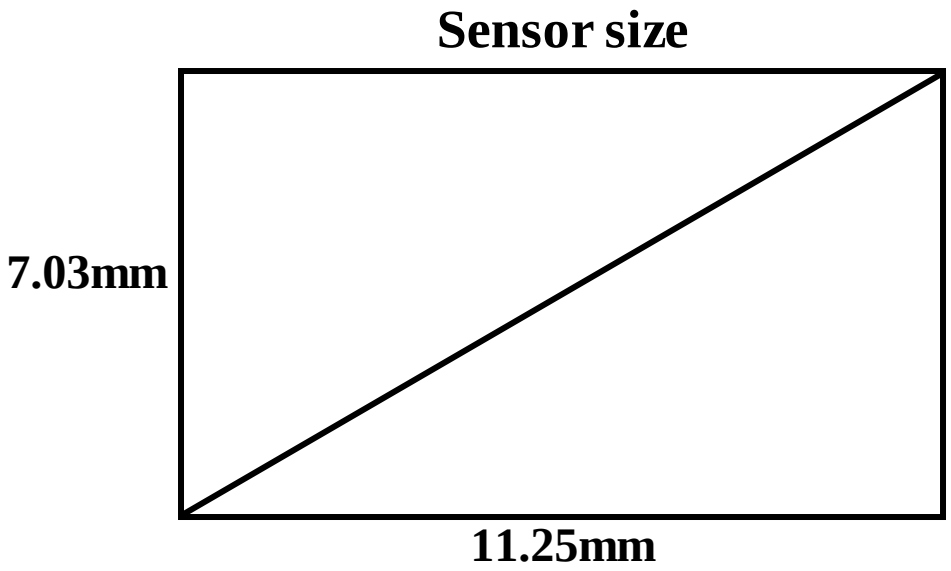
Sensor Size (Camera)

IMX249 Sony Pregius

Resolution : 2.3MP, 1920 x 1200

Pixel size : 5.86 x 5.86 [µm]

Optical format : 1/1.2“



Sensor size = Pixel size (H/V) × Effective Pixel Amount (H/V)

$$\text{Sensor size } (\mathbf{H}) = 0.00586 \times 1920 = 11.25\text{mm}$$

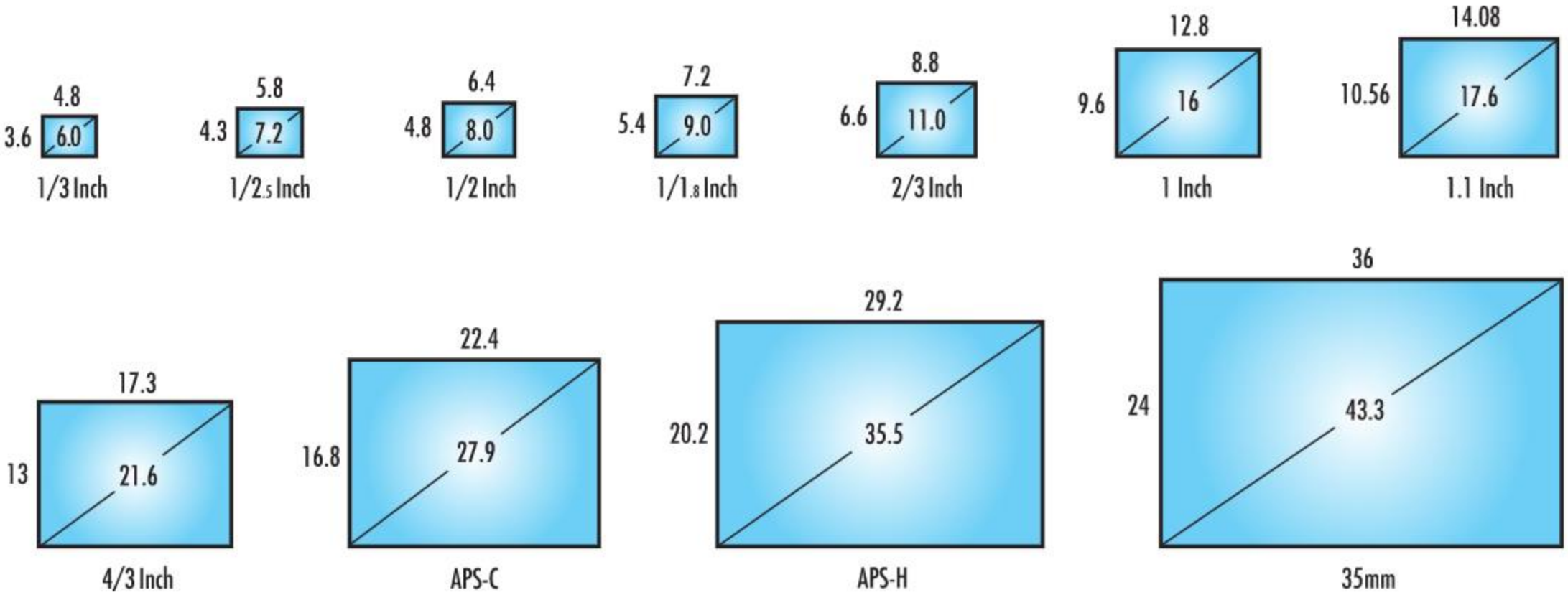
$$\text{Sensor size } (\mathbf{V}) = 0.00586 \times 1200 = 7.032 \text{ mm}$$

Sensor size = **11.25 mm × 7.03 mm**

Lens

Sensor Format (Camera)

Note:
Lens Sensor Size needs to be SAME
or BIGGER than Camera Sensor Size

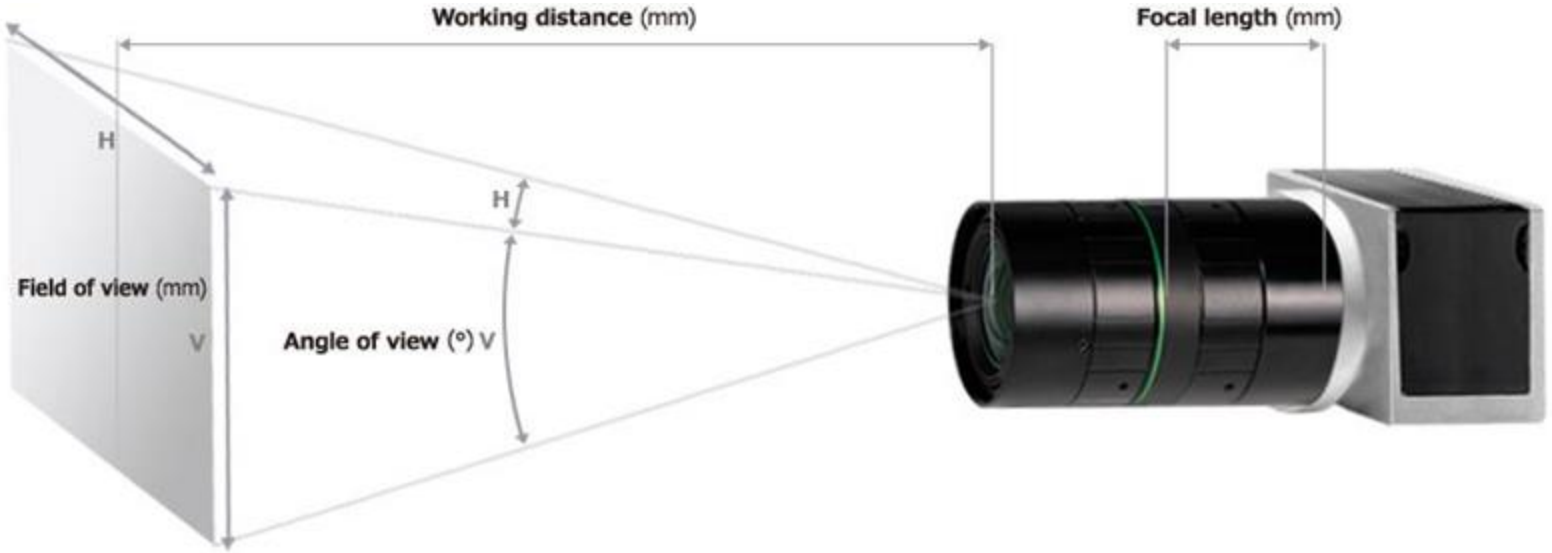


MV Lab
All About Machine Vision

Lens

Working Distance

- WD indicates the distance from the specimen surface to the front edge of the lens
- The Telecentric Lens will operate well in optimize working distance

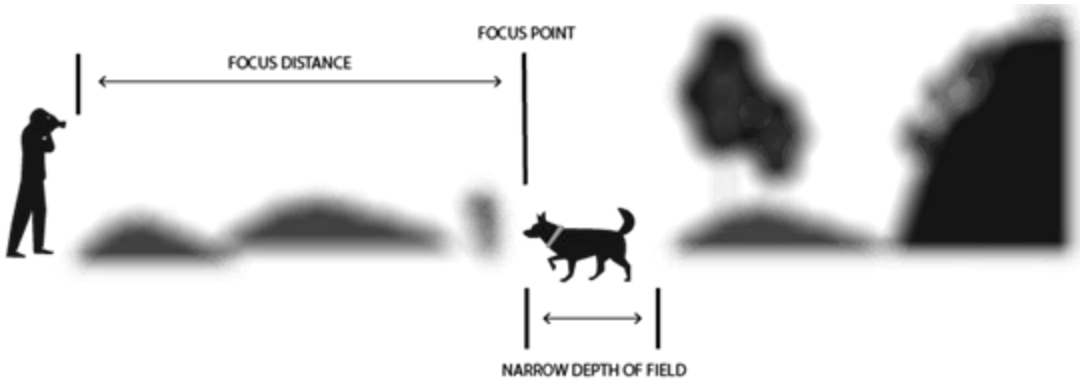


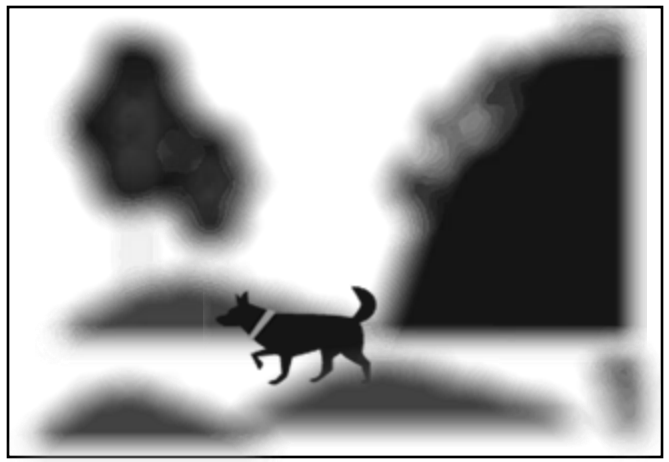
MV Lab
All About Machine Vision

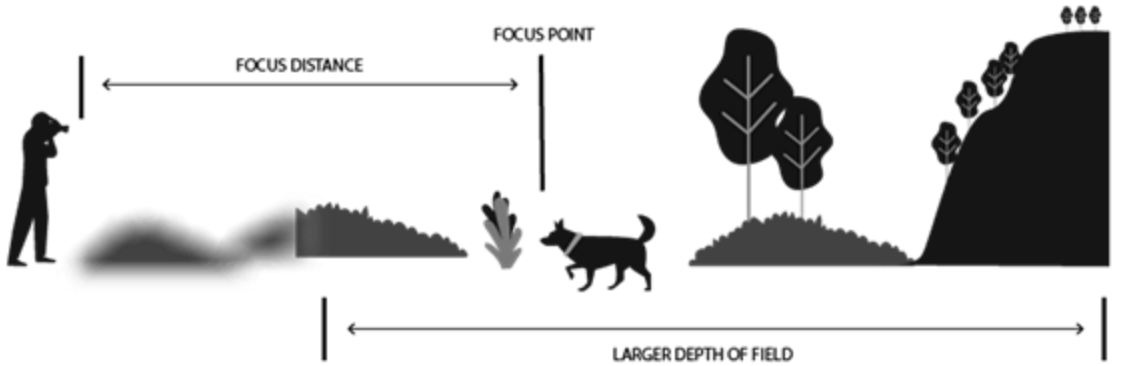
Lens

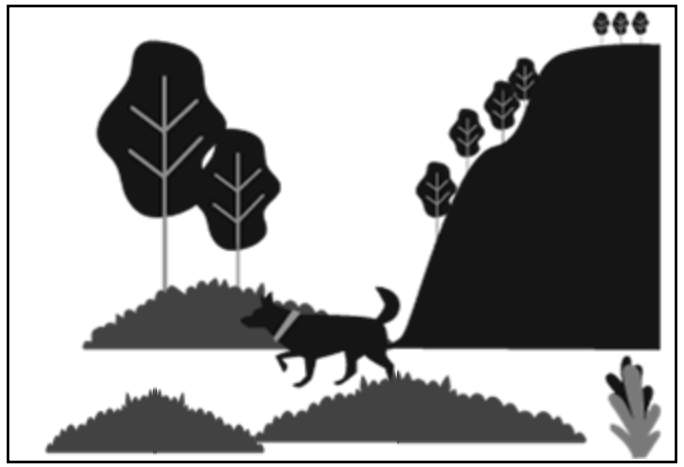
Depth of Field

- The range within the which the focus doesn’t run out (visible) when the object shift back and forth.
- It is the range of depth on the object side.





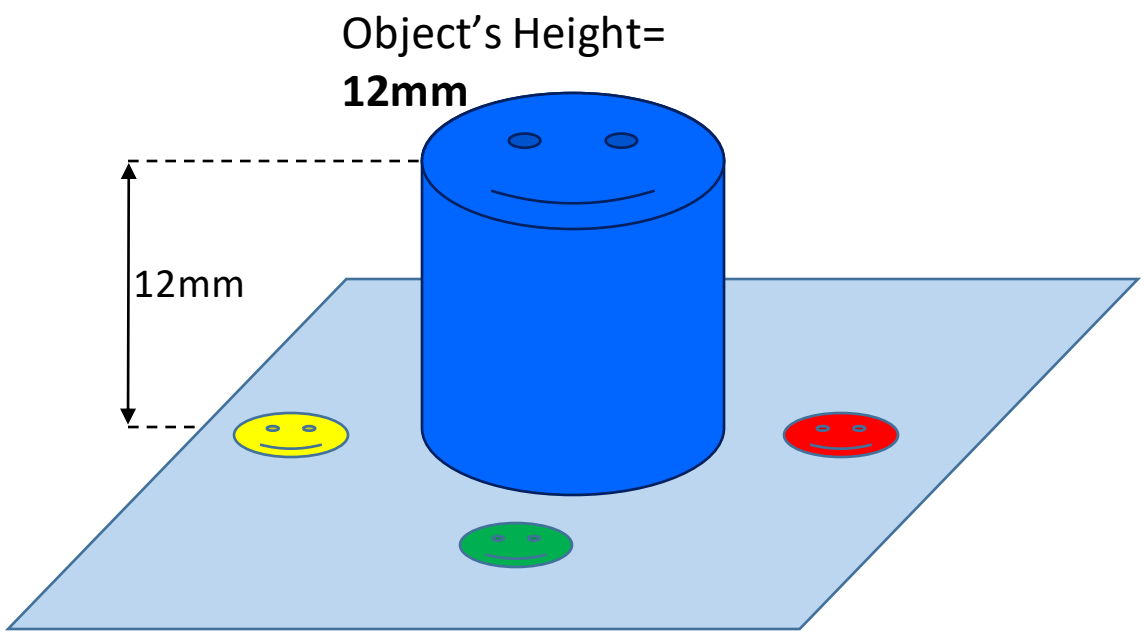




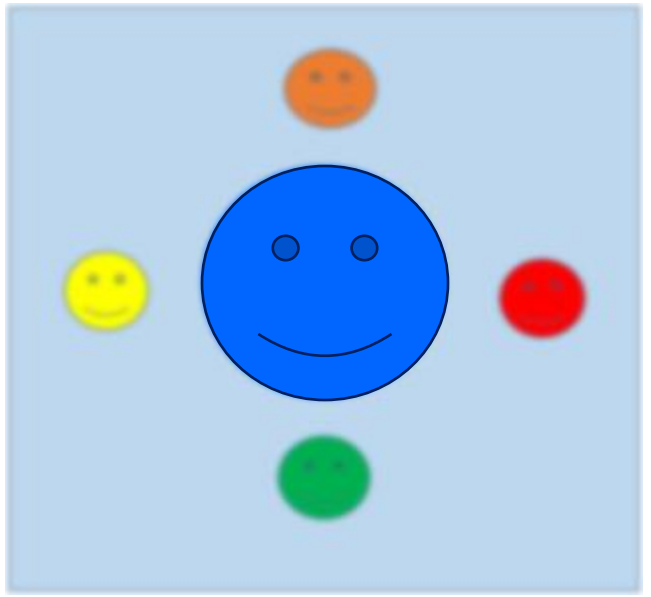
MV Lab
All About Machine Vision

Lens

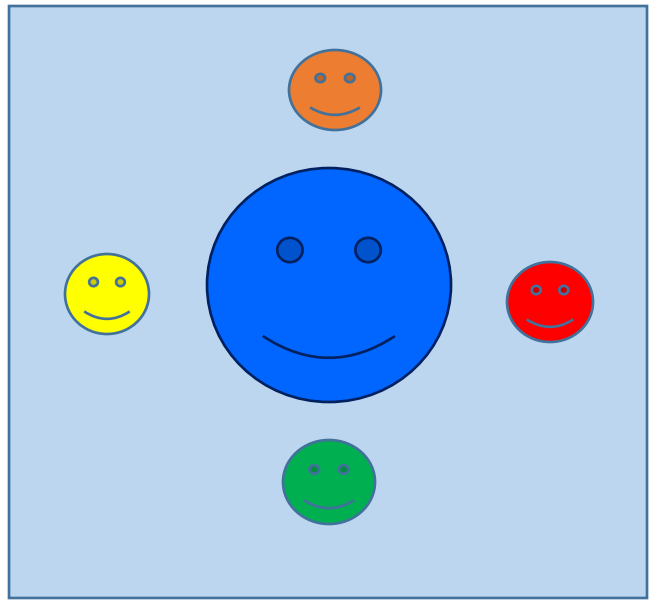
Depth of Field



Lens with
DOF = 8mm



Lens with
DOF = 15mm



MV Lab
All About Machine Vision

Lens

Depth of Field (Telecentric Lens)

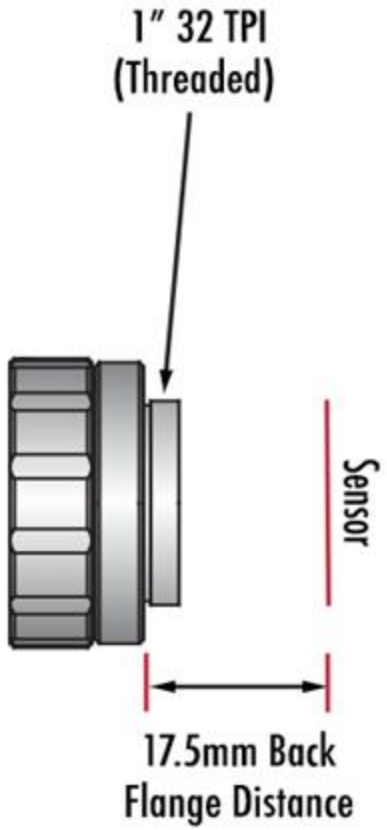
Model	Magnification	F No.	Object side NA	WD	OI	Depth of field	Resolution	TV distortion	Maximum Compatible sensor	Mount	Dimension
FTV05 -150	0.5x	6.3	0.040	152.6mm	294.1mm	2mm	8.4μ	0.00%	1.1"	C	
FTV07 -150	0.7x	9.0	0.039	151.1mm	292.2mm	1.47mm	8.6μ	0.00%	1.1"	C	
FTV08 -150	0.8x	8.1	0.050	151.1mm	296.8mm	1.01mm	6.8μ	0.00%	1.1"	C	
FTV10 -150	1.0x	9.1	0.055	151.9mm	298.8mm	0.73mm	6.1μ	0.00%	1.1"	C	
FTV15 -150	1.5×	11.8	0.064	150.7mm	316.3mm	0.42mm	5.3μ	0.00%	1.1"	C	
FTV20 -150	2.0×	13.5	0.074	150.7mm	339.6mm	0.27mm	4.5μ	0.00%	1.1"	C	
FTV30 -150	3.0×	17.4	0.086	150.1mm	350.2mm	0.16mm	3.9μ	0.00%	1.1"	C	
FTV40 -150	4.0×	22.0	0.091	150.1mm	354.8mm	0.11mm	3.7μ	0.00%	1.1"	C	
FTV60 -150	6.0×	33.0	0.091	150.1mm	365.9mm	0.07mm	3.7μ	0.01%	1.1"	C	
FTV05C -150	0.5x	6.3	0.040	152.6mm	294.1mm	2mm	8.4μ	0.00%	1.1"	C	
FTV07C -150	0.7x	9.0	0.039	151.1mm	292.2mm	1.47mm	8.6μ	0.00%	1.1"	C	
FTV08C -150	0.8x	8.1	0.050	151.1mm	296.8mm	1.01mm	6.8μ	0.00%	1.1"	C	

Lens

Lens Mount

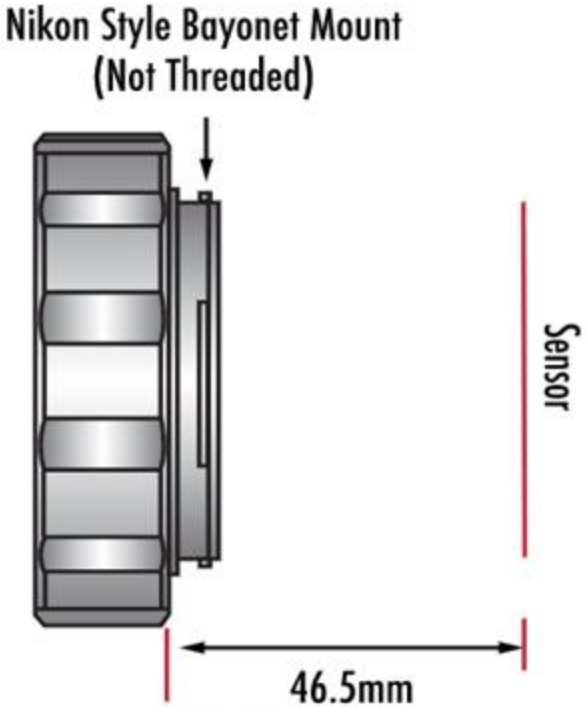
C-Mount

Max Sensor
Diagonal: 18mm



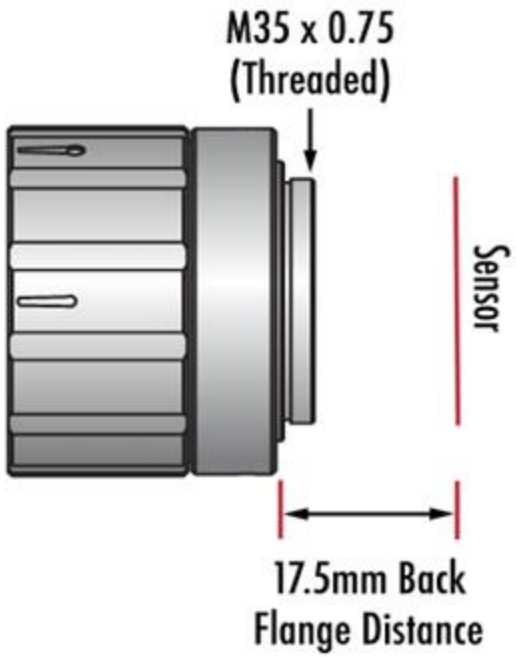
F-Mount

Max Sensor
Diagonal: 43.3mm



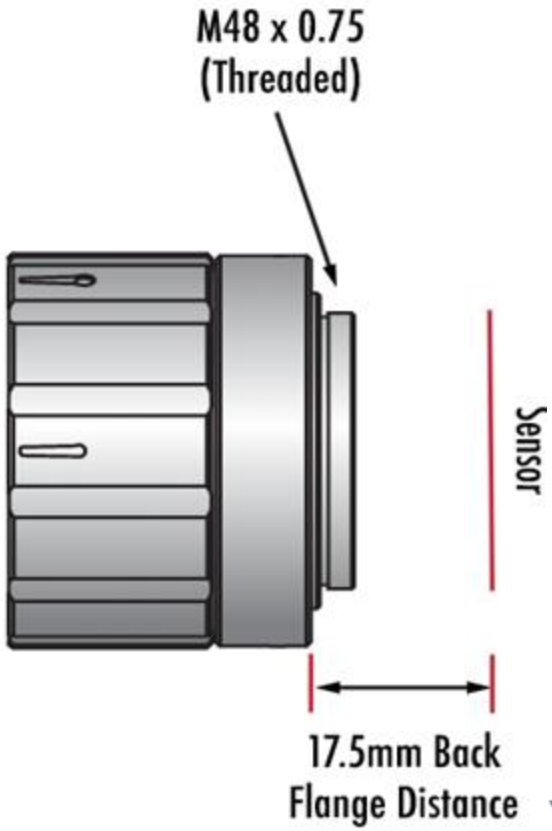
TFL-Mount

Max Sensor
Diagonal: 28mm



TFL-II Mount

Max Sensor
Diagonal: 35mm

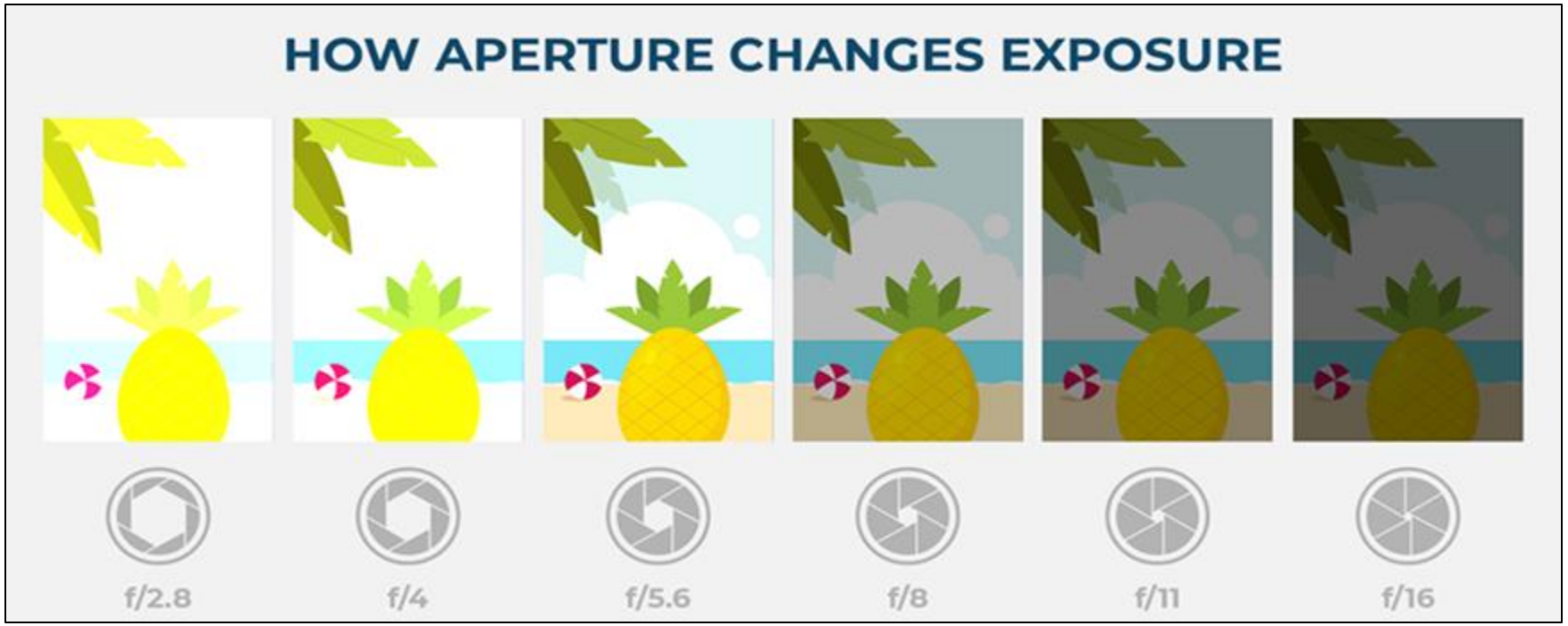


V Lab
All About Machine Vision

Lens

Aperture

- Aperture can be defined as the opening in a lens through which light passes to enter the camera.
- It is calibrated in f/stops and is generally written as numbers such as 1.4, 2, 2.8, 4, 5.6, 8, 11 and 16. Lower f/stops give more exposure because they represent the larger apertures.



MV Lab
All About Machine Vision

Lens

Aperture affects DOF

Increasing the f-number will **increase the DOF** because only the light travelling at shallower angles passes through the aperture. Because the angles are shallow, the light rays are within the acceptable circle of confusion for a greater distance.

MV Lab
All About Machine Vision

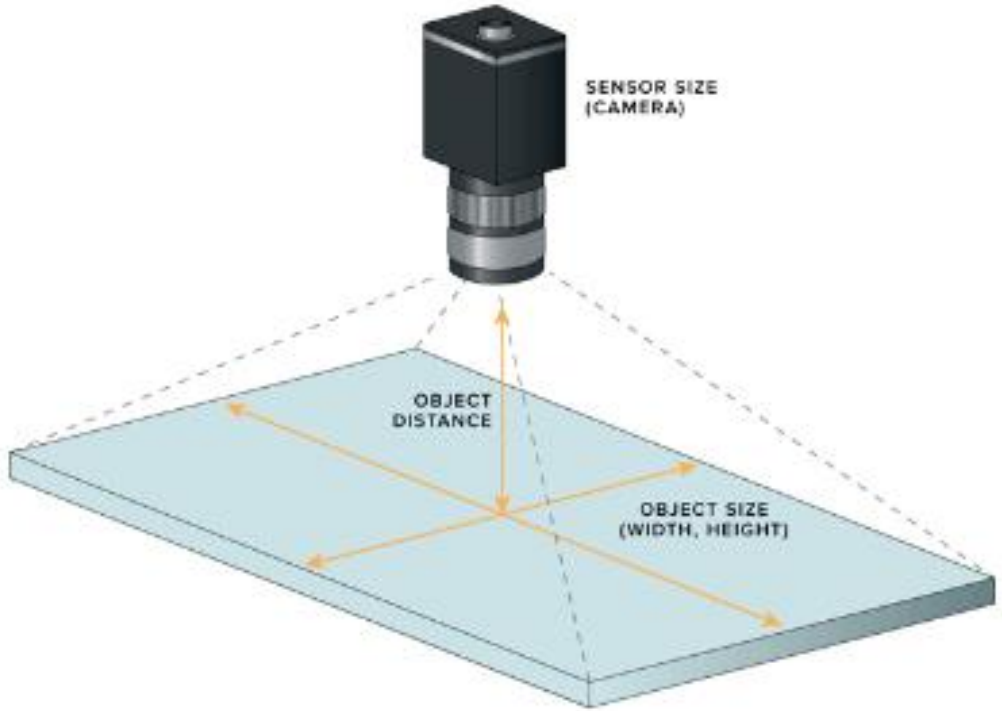
Lens
Calculation

MV Lab
All About Machine Vision

Lens
Focal Length

- Is ***CCTV*** lens calculation
- Distance from rear principal point (H_2) to the image plane.
- Required lens focal length of your application can be calculated by FOV, WD and sensor size.

- $\mathbf{f(mm)} = \dfrac{\boldsymbol{WD\ x\ Sensor\ size(H) or\ (V)}}{\boldsymbol{FOV(H) or\ (V)}}$



Lens

Focal Length - Calculation

1. Assume camera is MV-CE013-A0GM, calculate the FOV with a working distance 200mm for the following lens:

- **50mm**
- **35mm**
- **25mm**
- **16mm**
- **12mm**
- **8mm**

Model	MV-CA013-A0GM	MV-CA013-A0GC
Camera		
Sensor type	CMOS, global shutter	
Pixel size	4.8 µm	
Sensor size	1/2"	
Resolution	1280 × 1024	
Max. frame rate	92.8 fps @1280 × 1024	
Dynamic range	54 dB	
SNR	40.6 dB	
Gain	0 dB to 16 dB	
Exposure time	9 µs to 10 sec	
Exposure mode	Off/Once/Continuous exposure mode	
Mono/color	Mono	Color
Pixel format	Mono 8/10/10p/12/12p	Mono 8/10/12, Bayer RG 8/10/10p/12/12p, YUV 422 (YUYV) Packed, YUV 422 Packed, RGB 8, BGR 8
Binning	Supports 1 × 1, 2 × 2, 4 × 4	
Decimation	Supports 1 × 1, 2 × 2, 4 × 4	
Reverse image	Supports horizontal and vertical reverse image output	

Lens

Focal Length - Calculation

2. Assume camera is MV-CS060-10GC, working distance more than 300mm, fov 50mm x 50mm, find suitable lens

Model	MV-CS060-10GM	MV-CS060-10GC
Camera		
Sensor type	CMOS, rolling shutter	
Sensor model	Sony® IMX178	
Pixel size	2.4 µm × 2.4 µm	
Sensor size	1/1.8"	
Resolution	3072 × 2048	
Max. frame rate	19.1 fps @3072 × 2048	
Dynamic range	71.3 dB	
SNR	41.3 dB	
Gain	0 dB to 24 dB	
Exposure time	25 µs to 2.5 sec	
Exposure mode	Off/Once/Continuous exposure mode, supports Global Reset, Trigger Rolling, and Rolling	
Mono/color	Mono	Color
Pixel format	Mono 8/10/10p/12/12p	Mono 8/10/12, Bayer RG 8/10/10p/12/12p, YUV422Packed, YUV422_YUYV_Packed, RGB 8, BGR 8
Binning	Supports 1 × 1, 2 × 2	
Decimation	Supports 1 × 1, 2 × 2, 4 × 4	
Reverse image	Supports horizontal and vertical reverse image output	

MV Lab
All About Machine Vision

Lens

Magnification

- Is ***Telecentric*** lens calculation
- The magnification is the ratio of the image size to the object size
- How much a view can be magnified by a lens

$$Magnification = \frac{Sensor\ size\ (H) or (V)}{FOV\ (H) or (V)}$$

Lens

Magnification

$$Magnification = \frac{Sensor\ size\ (H) or (V)}{FOV\ (H) or (V)}$$

Example

Field of view(FOV) : 35mm (Vertical)

Sensor size : 1/2” (6.4mm x 4.8mm)

WD : more than 110mm

$$\text{Magnification (X)} = \frac{4.8}{35} = 0.137x$$

MV Lab
All About Machine Vision

Part number	Main optical specifications			Object field of view			Adva	
	Magnification	Image circle diameter	Max sensor size	1/3"	1/2"	2/3"	Working distance	Working ƒ/N
				4.80 x 3.60	6.40 x 4.80	8.50 x 7.09		
	(x)	(mm)		(mm × mm)	(mm × mm)	(mm × mm)	(mm)	
				1	1	1	2	3
TC23004	2.000	11	2/3"	2.40 x 1.80	3.20 x 2.40	4.25 x 3.55	56.0	11
TC23007	1.333	11	2/3"	3.60 x 2.70	4.80 x 3.60	6.38 x 5.32	60.1	11
TC23009	1.000	11	2/3"	4.80 x 3.60	6.40 x 4.80	8.50 x 7.09	62.2	11
TC23012	0.735	11	2/3"	6.53 x 4.90	8.71 x 6.53	11.56 x 9.65	53.9	14
TC13016	0.290	6	1/3"	16.55 x 12.41	ø = 16.55	ø = 20.69	43.1	8
TC12016	0.385	8	1/2"	12.47 x 9.35	16.62 x 12.47	ø = 18.42	43.1	8
TC23016	0.528	11	2/3"	9.09 x 6.82	12.12 x 9.09	16.10 x 13.43	43.1	8
TC13024	0.192	6	1/3"	25.00 x 18.75	ø = 25.00	ø = 31.25	67.2	8
TC12024	0.255	8	1/2"	18.82 x 14.12	25.10 x 18.82	ø = 27.80	67.2	8
TC23024	0.350	11	2/3"	13.71 x 10.29	18.29 x 13.71	24.29 x 20.26	67.2	8
TC13036	0.133	6	1/3"	36.09 x 27.07	ø = 36.09	ø = 45.11	102.5	8
TC12036	0.177	8	1/2"	27.12 x 20.34	36.16 x 27.12	ø = 40.06	102.5	8
TC23036	0.243	11	2/3"	19.75 x 14.81	26.34 x 19.75	34.98 x 29.18	102.5	8
TC13048	0.098	6	1/3"	48.98 x 36.73	ø = 48.98	ø = 61.22	133.4	8
TC12048	0.134	8	1/2"	35.82 x 26.87	47.76 x 35.82	ø = 52.91	132.9	8
TC23048	0.184	11	2/3"	26.09 x 19.57	34.78 x 26.09	46.20 x 38.53	132.9	8
TC13056	0.084	6	1/3"	57.14 x 42.86	ø = 57.14	ø = 71.43	157.8	8

$$\text{Magnification (X)} = \frac{4.8}{35} = 0.137x$$

Sensor size
= 6.4mm x 4.8mm

Mag: 0.134x

FOV
= 47mm x 35mm

MV Lab
All About Machine Vision

Lens

Telecentric lens - Calculation

1. Assume camera is MV-CS060-10GC, FOV 25mm x 25mm, for measurement purposes, find suitable lens

Model	MV-CS060-10GM	MV-CS060-10GC
Camera		
Sensor type	CMOS, rolling shutter	
Sensor model	Sony® IMX178	
Pixel size	2.4 µm × 2.4 µm	
Sensor size	1/1.8"	
Resolution	3072 × 2048	
Max. frame rate	19.1 fps @3072 × 2048	
Dynamic range	71.3 dB	
SNR	41.3 dB	
Gain	0 dB to 24 dB	
Exposure time	25 µs to 2.5 sec	
Exposure mode	Off/Once/Continuous exposure mode, supports Global Reset, Trigger Rolling, and Rolling	
Mono/color	Mono	Color
Pixel format	Mono 8/10/10p/12/12p	Mono 8/10/12, Bayer RG 8/10/10p/12/12p, YUV422Packed, YUV422_YUYV_Packed, RGB 8, BGR 8
Binning	Supports 1 × 1, 2 × 2	
Decimation	Supports 1 × 1, 2 × 2, 4 × 4	
Reverse image	Supports horizontal and vertical reverse image output	

MV Lab
All About Machine Vision

	Main optical specifications			Object field of view			Advanced optical specifications					Mechanical specifications			
Part number	Magnification	Image circle diameter	Max sensor size	1/3"	1/2"	2/3"	Working distance	Working ƒ/N	Telecentricity typical (max)	Distortion typical (max)	Field depth	Mount	Phase adjustment	Length	Front diameter
				4.80 x 3.60	6.40 x 4.80	8.50 x 7.09									
	(x)	(mm)		(mm × mm)	(mm × mm)	(mm × mm)	(mm)		(deg)	(%)	(mm)			(mm)	(mm)
				1	1	1	2	3	4	5	6		8	9	
TC23004	2.000	11.0	2/3"	2.40 x 1.80	3.20 x 2.40	4.25 x 3.55	56.0	11	< 0.08 (0.10)	< 0.04 (0.08)	0.1	C	No	101.4	28
TC23007	1.333	11.0	2/3"	3.60 x 2.70	4.80 x 3.60	6.38 x 5.32	60.1	11	< 0.08 (0.10)	< 0.03 (0.08)	0.3	C	No	78.5	28
TC23009	1.000	11.0	2/3"	4.80 x 3.60	6.40 x 4.80	8.50 x 7.09	62.2	11	< 0.08 (0.10)	< 0.04 (0.08)	0.6	C	No	65.0	28
TC23012	0.735	11.0	2/3"	6.53 x 4.90	8.71 x 6.53	11.56 x 9.65	53.9	14	< 0.04 (0.10)	< 0.04 (0.10)	1.3	C	No	60.3	28
TC13016	0.290	6.0	1/3"	16.55 x 12.41	ø = 16.55	ø = 20.69	43.1	8	< 0.08 (0.10)	< 0.04 (0.08)	4.9	C	No	80.9	37.7
TC12016	0.385	8.0	1/2"	12.47 x 9.35	16.62 x 12.47	ø = 18.42	43.1	8	< 0.04 (0.10)	< 0.04 (0.08)	2.8	C	No	93.0	37.7
TC23016	0.528	11.0	2/3"	9.09 x 6.82	12.12 x 9.09	16.10 x 13.43	43.1	8	< 0.06 (0.10)	< 0.04 (0.07)	1.5	C	No	112.7	37.7
TC13024	0.192	6.0	1/3"	25.00 x 18.75	ø = 25.00	ø = 31.25	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	11.2	C	No	105.6	44
TC12024	0.255	8.0	1/2"	18.82 x 14.12	25.10 x 18.82	ø = 27.80	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	6.4	C	No	117.8	44
TC23024	0.350	11.0	2/3"	13.71 x 10.29	18.29 x 13.71	24.29 x 20.26	67.2	8	< 0.08 (0.10)	< 0.04 (0.10)	3.4	C	No	137.5	44
TC13036	0.133	6.0	1/3"	36.09 x 27.07	ø = 36.09	ø = 45.11	102.5	8	< 0.04 (0.08)	< 0.03 (0.08)	23.4	C	No	133.0	61
TC12036	0.177	8.0	1/2"	27.12 x 20.34	36.16 x 27.12	ø = 40.06	102.5	8	< 0.03 (0.08)	< 0.04 (0.10)	13.2	C	No	145.2	61
TC23036	0.243	11.0	2/3"	19.75 x 14.81	26.34 x 19.75	34.98 x 29.18	102.5	8	< 0.04 (0.08)	< 0.04 (0.10)	7.0	C	No	164.9	61
TC13048	0.098	6.0	1/3"	48.98 x 36.73	ø = 48.98	ø = 61.22	133.4	8	< 0.08 (0.10)	< 0.06 (0.10)	43.1	C	No	167.9	75
TC12048	0.134	8.0	1/2"	35.82 x 26.87	47.76 x 35.82	ø = 52.91	132.9	8	< 0.07 (0.10)	< 0.06 (0.10)	23.1	C	No	181.5	75
TC23048	0.184	11.0	2/3"	26.09 x 19.57	34.78 x 26.09	46.20 x 38.53	132.9	8	< 0.08 (0.10)	< 0.05 (0.10)	12.2	C	No	201.0	75
TC13056	0.084	6.0	1/3"	57.14 x 42.86	ø = 57.14	ø = 71.43	157.8	8	< 0.04 (0.08)	< 0.04 (0.08)	58.7	C	No	191.5	80

Lens

Focal Length - Calculation

1. Assume camera is MV-CE013-A0GM, calculate the FOV with a working distance 200mm for the following lens:

- 50mm (24mm x 19mm)

- 35mm (35mm x 28mm)

- 25mm (49mm x 39mm)

- 16mm (76mm x 61mm)

- 12mm (102mm x 81mm)

- 8mm (153mm x 122mm)

Camera Resolution	1280	1024
Camera Pixel Size (mm)	0.0048	0.0048
Camera Sensor Size	6.144	4.9152
focal length	50	
camera sensor size	6.144	4.9152
working distance (mm)	200	
fov (mm)	**24.576**	**19.6608**

Lens

Focal Length - Calculation

2. Assume camera is MV-CS060-10GC, working distance more than 300mm, fov 50mm x 50mm, find suitable lens

	Horizontal (X-axis)	Vertical (Y-axis)
Camera Resolution	3072	2048
Camera Pixel Size (mm)	0.0024	0.0024
Camera Sensor Size	7.3728	4.9152
Working Distance	300	
FOV	60	55
Lens Focal Length	36.864	26.81018182

focal length	35	
camera sensor size	7.3728	4.9152
working distance (mm)	300	
fov (mm)	**63.19542857**	**42.13028571**

focal length	25	
camera sensor size	7.3728	4.9152
working distance (mm)	300	
fov (mm)	**88.4736**	**58.9824**

Lens

Telecentric lens - Calculation

1. Assume camera is MV-CS060-10GC, FOV 25mm x 25mm, for measurement purposes, find suitable lens

	Main optical specifications			Object field of view			Advanced optical specifications					Mechanical specifications			
Part number	Magnification	Image circle diameter	Max sensor size	1/3"	1/2"	2/3"	Working distance	Working f/N	Telecentricity typical (max)	Distortion typical (max)	Field depth	Mount	Phase adjustment	Length	Front diameter
	(x)	(mm)		4.80 x 3.60 (mm x mm) 1	6.40 x 4.80 (mm x mm) 1	8.50 x 7.09 (mm x mm) 1	(mm) 2	3	(deg) 4	(%) 5	(mm) 6		8	(mm) 9	(mm)
TC23004	2.000	11.0	2/3"	2.40 x 1.80	3.20 x 2.40	4.25 x 3.55	56.0	11	< 0.08 (0.10)	< 0.04 (0.08)	0.1	C	No	101.4	28
TC23007	1.333	11.0	2/3"	3.60 x 2.70	4.80 x 3.60	6.38 x 5.32	60.1	11	< 0.08 (0.10)	< 0.03 (0.08)	0.3	C	No	78.5	28
TC23009	1.000	11.0	2/3"	4.80 x 3.60	6.40 x 4.80	8.50 x 7.09	62.2	11	< 0.08 (0.10)	< 0.04 (0.08)	0.6	C	No	65.0	28
TC23012	0.735	11.0	2/3"	6.53 x 4.90	8.71 x 6.53	11.56 x 9.65	53.9	14	< 0.04 (0.10)	< 0.04 (0.10)	1.3	C	No	60.3	28
TC13016	0.290	6.0	1/3"	16.55 x 12.41	ø = 16.55	ø = 20.69	43.1	8	< 0.08 (0.10)	< 0.04 (0.08)	4.9	C	No	80.9	37.7
TC12016	0.385	8.0	1/2"	12.47 x 9.35	16.62 x 12.47	ø = 18.42	43.1	8	< 0.04 (0.10)	< 0.04 (0.08)	2.8	C	No	93.0	37.7
TC23016	0.528	11.0	2/3"	9.09 x 6.82	12.12 x 9.09	16.10 x 13.43	43.1	8	< 0.06 (0.10)	< 0.04 (0.07)	1.5	C	No	112.7	37.7
TC13024	0.192	6.0	1/3"	25.00 x 18.75	ø = 25.00	ø = 31.25	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	11.2	C	No	105.6	44
TC12024	0.255	8.0	1/2"	18.82 x 14.12	25.10 x 18.82	ø = 27.80	67.2	8	< 0.08 (0.10)	< 0.04 (0.08)	6.4	C	No	117.8	44
TC23024	0.350	11.0	2/3"	13.71 x 10.29	18.29 x 13.71	24.29 x 20.26	67.2	8	< 0.08 (0.10)	< 0.04 (0.10)	3.4	C	No	137.5	44
TC13036	0.133	6.0	1/3"	36.09 x 27.07	ø = 36.09	ø = 45.11	102.5	8	< 0.04 (0.08)	< 0.03 (0.08)	23.4	C	No	133.0	61
TC12036	0.177	8.0	1/2"	27.12 x 20.34	36.16 x 27.12	ø = 40.06	102.5	8	< 0.03 (0.08)	< 0.04 (0.10)	13.2	C	No	145.2	61
TC23036	0.243	11.0	2/3"	19.75 x 14.81	26.34 x 19.75	34.98 x 29.18	102.5	8	< 0.04 (0.08)	< 0.04 (0.10)	7.0	C	No	164.9	61
TC13048	0.098	6.0	1/3"	48.98 x 36.73	ø = 48.98	ø = 61.22	133.4	8	< 0.08 (0.10)	< 0.06 (0.10)	43.1	C	No	167.9	75
TC12048	0.134	8.0	1/2"	35.82 x 26.87	47.76 x 35.82	ø = 52.91	132.9	8	< 0.07 (0.10)	< 0.06 (0.10)	23.1	C	No	181.5	75
TC23048	0.184	11.0	2/3"	26.09 x 19.57	34.78 x 26.09	46.20 x 38.53	132.9	8	< 0.08 (0.10)	< 0.05 (0.10)	12.2	C	No	201.0	75
TC13056	0.084	6.0	1/3"	57.14 x 42.86	ø = 57.14	ø = 71.43	157.8	8	< 0.04 (0.08)	< 0.04 (0.08)	58.7	C	No	191.5	80

Sensor size:
7.37mm x 4.9mm

mag: 0.184x

Wd: 132.9mm

Fov: 40mm x 26mm

MV Lab
All About Machine Vision