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On the urgent need of an open camera to lens communication standard for vision systems

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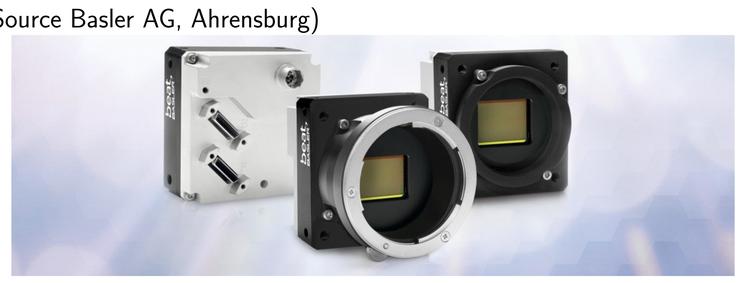
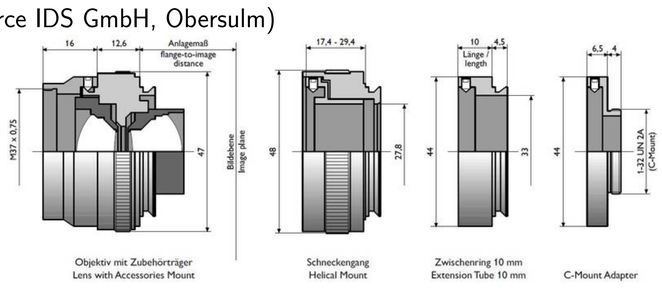
Machine Vision Lens Mounts

(Source Basler AG, Ahrensburg)



(Source Basler AG, Ahrensburg)

(Source IDS GmbH, Obersulm)



Schneider-Kreuznach macro lenses with V-mount and adapters

Machine vision lens mounts are dumb

- They do not support any communication between camera and lens
- For most the flange focal distance is defined (not for M12, V38, M52, M58, M72, and others)
- Most are pretty old.

C-mount: introduced ca. 1926 by Bell & Howell for 16 mm cine cameras

M42: Introduced 1938 by Carl Zeiss

F-mount: Introduced 1959 by Nikon for the 35 mm SLR camera

T-mount: Introduced 1962 by Tamron

Some commonly used lens mounts

(for more see Wikipedia under flange focal distance)

Name	Mount type/purpose	Flange focal distance
S-mount	Thread M12 × 0.5, board cameras	—
CS-mount	Thread 1" × 1/26"	12.50 mm
C-mount	Thread 1" × 1/26"	17.526 mm
E-mount	Bayonet, Sony mirrorless	18.00 mm
Micro Four Third	Bayonet, Olympus mirrorless	19.25 mm
FD-mount	Bayonet, Canon manual 35 mm SLR	42.00 mm
EF-mount	Bayonet, Canon autofocus 35 mm SLR	44.00 mm
M42	Thread M42 × 1, 35 mm SLR	(45.46 mm)
F-mount	Bayonet, Nikon 35 mm SLR	46.5 mm
T-mount	Thread M42 × 0.75, 35 mm SLR	55.00 mm
V-mount	groove, rotatable, macro lenses	—
Leica	Thread M39 × 1/26", macro lenses	(28.80 mm)
M72	Thread M72 × 0.75, line cameras	—

System Camera Lens Mounts

(Source www.kenrockwell.com)

(Source www.kenrockwell.com)

(Source www.kenrockwell.com)

System camera lens mounts are a mess

- The bayonets look all the same, but are different and have different flange focal distances
- Almost each vendor has his proprietary electrical lens/camera interface and communication protocol
- But with these interfaces a lot of useful things can be done, **which are all missing in machine vision**
- With suitable adapters all commercial system lenses can be mounted mechanically at machine vision cameras (most often used are C-mount adapters); but without enabling communication and autofocus
- There are some notable exceptions: Ximea offers their xiB-cameras with integrated Canon EF-mount control, SVS-Vistek offers EXO Tracer cameras with a Micro Four Third Mount

The camera to lens interface provides

- Power supply to the lens for autofocus motor and lens electronics
- Control of autofocus and feed back of focal distance
- Control of zooming and feed back of focal length
- Control of aperture and feed back of aperture setting
- Feed back of lens properties such as aperture dependent shading, geometrical distortion and lateral chromatic aberration of lens; camera can correct these aberrations

Need for Next Generation Vision Systems

Open camera to lens communication standard would enable wide-spread application of modern techniques, especially computational imaging in machine vision systems

This could include

- Autofocus sytems not only with traditional autofocus motors but also with liquid lenses
- Automatic acquisition of focus series for
- Control of zooming and feed back of focal length
- Control of aperture and feed back of aperture setting
- Feed back of lens properties such as aperture dependent shading, geometrical distortion and lateral chromatic aberration of lens; camera can then correct these aberrations
- Camera vibration and motion compensation during exposure
- Extended depth of field imaging: lens tells camera its MTF and camera corrects images correspondingly
- Intelligent imaging: with known lens data, aperture and illumination are set automatically to the required depth of field
- Autoadaption of the lens to the pixel size of the camera for optimal imaging without aliasing
- Superresolution imaging by steering camera pixels

Challenges Lens Mount Mechanics

- All currently used bayonet mounts are not stable enough for all tasks that require a precise knowledge of the intrinsic orientation of the camera (e. g., stereo and any multicamera setup).
- Threaded mounts are more stable, but not suitable to integrate an electrical interface
- How to construct a new type of lens mount that is stable enough and includes an electrical interface?
- How to ensure backward compatibility with existing lens mounts, especially C-mount lenses, so that they can still be used?

Challenges Communication Interface

An open communication should include

- Versatile power supply to the lens for control motors (focus, focal length, aperture and possibly other features) and lens electronics
- Bidirectional communication interface to communicate lens data to the camera but also camera data to the lens (in future systems the lens might adapt itself to the camera resolution)
- Same electrical interface even if the lens mount changes with the size of the lens and/or image sensor.

Conclusions and Take Home Message

The international machine vision community is well advised to start work on a new open standard for lens mounts including a camera to lens communication standard. Otherwise it will be much harder to realize many exciting new features of next generation vision systems.