A New EMVA Standard for an Open Interface between Optical Components and Cameras — EMVA’s new OOCI Standard

Bernd Jähne

Board Member EMVA and Chair EMVA 1288 Standard
Heidelberg Collaboratory for Image Processing (HCI)
Heidelberg University, Germany
jaehne@emva.org

Stemmer Technologieforum Bildverarbeitung
München, 8.–9. Oktober 2019
I Where we are today?
Machine vision lens mounts are dump

(C-mount machine vision cameras; source Basler AG, Ahrensburg)

- Just mechanical connection
- Most commonly used screw mount (C-Mount, 1" × 32 TPI)
  - Flange focal distance 17.526 mm
  - Developed 90(!) years ago for 16 mm cine cameras
Is there something new?

(Sources ArduCam and Edmund Optics)

- S-mount for small imaging systems: M12 × 0.5
- CS-mount with 5 mm shorter flange focal distance than C-mount
- TFL-mount for larger sensors: M35 × 0.75
- System camera mounts (M42, Nikon F, ... used without electric interface)
Lens mounts of commercial system cameras:
Not really useful for machine vision

- Almost each manufacturer has its own bayonet
- Proprietary interfaces for control of focus, lens and communication of lens parameters → Reverse engineering required
- Bayonet mounts have too much play for many machine vision tasks

(Source www.kenrockwell.com)
II Why is an open optics camera interface needed urgently?
Reason 1: Pressure to implement standard features and ease of control of modern consumer system cameras into machine vision systems

- Control of focus (incl. 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
- Correction of lens shading by feedback of aperture dependent lens shading
- Correction of geometrical distortion and lateral chromatic aberration
- Compensation of camera vibration and motion during exposure
Reason 2: Modern optical components for machine vision require control

- Control of liquid lenses for autofocus
- Control of liquid lenses for depth imaging by focus series
- Control of filter wheel for multispectral camera
- Control of electrically tunable bandpass filter
- Control of angle of polarization filter
- Control of camera motion for structure form motion depth imaging

Modern photonics will bring in much more new elements . . .

Without an open standard only proprietary solutions are possible
Example: tunable and free form tunable microlens array

(from Berto et al., Nature Photonics, September 2019)
Reason 3: Embedded vision systems offer computing power on the edge

AVT Alviun ASIC  Intel (Movidus) Myriad Chip  Tulipp platform

using ASICs, vision/machine learning processors, heterogenous platforms with FPGA, DSP, GPU, general purpose CPUs transform camera into sensor
Reason 4: Enable new generation of vision systems: *Computational imaging*

Synergistic approach including optics and image processing to overcome limits of traditional image acquisition systems:

- Get *intelligent acquisition systems* using known lens data, illumination, and given requirements to select optimum combination of aperture, exposure time and camera gain (noise level in image)

- *Increase depth of field* without closing aperture and having less light (EDOF systems)

- *Reduce motion blur* without reducing exposure time

- Acquire *superresolution images*

- And much more . . .
III Elements of the EMVA

Open Optics Camera Interface (OOCI)
History Open Optics Camera Interface (OOCI)

- Idea first discussed on 2nd European Machine Vision Forum in Vienna, September 2017
- Spring 2018: EMVA board of directors decided to set up new standardization work group
- May 2018: Introduction of the new standardization initiative at International Vision Standards Meeting in Frankfurt
- Inaugural meeting of working group on July 9, 2018 at Heidelberg University with election of chairs (Marcel Naggatz, Baumer Optronics and Erik Widding, Birger Engineering)
- Since then two more meetings and several telephone conferences
Common communication protocol (first draft to be finished soon)

- Optical features to be included in the *Standard Feature Naming Convention* (SFNC) of the Generic Interface for Cameras to Computers (GenICam)
- OOCl device protocol built on top of GenICam *Generic Control Protocol* (GenCP) including a power negotiation strategy
- Examples for features of optical components
  - Focus
  - FocalLength
  - Aperture
  - Shutter
  - Filter
  - Stabilization
  - Additional axes (such as camera pan and tilt)
- Proprietary features can be added
- Support for multiple optical components, e.g., lens and tunable filter
Electrical interfaces (next task)

Definition of a mechanical and connector interface (next task)

- External device, utilizing external cabling — recommend specific JIIA standardized screw threads, electrical connector, and pinout
- External device without cable — recommend surface contact layout with, and potentially multiple, preferred bolt pattern(s) and contact location(s) for various camera body sizes
- Internal device with flex cable connection — recommend pinout and geometry of flex cable interface
- Open question: Inductive connection without direct electrical contacts?

This proposal covers whole range from miniature, even fully integrated systems (where lens cannot be separated from sensor) up to high-end metrological systems.
Need for novel lens mounts

- All currently used bayonet mounts are not stable enough for tasks that require precise knowledge of intrinsic orientation of camera (e.g., stereo and any multicamera setup).

- Standard threaded mounts are more stable, but not suitable to integrate an electrical interface?

Two big challenges:

- How to make new lens mounts compatible to existing lens mounts, especially most widely used C-mount?

- How to design a cheap lens mount with low play and electrical connections?
Conclusions

- Surprising that such an essential part of a vision system has been overlooked for years (Same happened with standardized interfaces for digital cameras)

- OOCI Standard of EMVA provides new opportunities for research and industry

- Will be essential for next generation of vision systems

Be part of this exiting opportunity and join the OOCI working group by contacting

- OOCI chair Marcel Naggatz (mnaggatz@baumer.com),
- EMVA standards manager Werner Feith (feith@emva.org) or
- speaker (jaehne@emva.org)
Literature

[1] Survey of optical mounts

[2] Lens working group of the Japanese Industrial Imaging Association (JIIA)

[3] Joint publication by the International Machine Vision Associations (AIA, EMVA, JIIA,

[4] Generic Interface for Cameras to Computers (GenICam)
    https://www.emva.org/standards-technology/genicam/.
Literature II

www.standard1288.org
https://zenodo.org/record/235942

[6] EMVA 1288 datasheets and further 1288 documents
According to template datasheets of Release 3.0 and 3.1:
https://zenodo.org/collection/user-emva1288

Tunable and free-form planar optics.
Nature Photonics, 2019, 13, 649–656,
http://dx.doi.org/10.1038/s41566-019-0486-3.
Literature III

*On the urgent need of an open camera to lens communication standard for vision systems.*
Poster, 2nd European Machine Vision Forum, Vienna, 2017

*Digital Image Processing.*

*Digitale Bildverarbeitung und Bildgewinnung.*