

## CCD versus CMOS for high resolutions

Innovative sensor technologies and camera developments

Essential camera properties such as resolution, frame rate and image quality are defined by the deployed image sensor – hence why it is of crucial importance in terms of performance in image acquisition. The present report outlines relevant sensing technologies and their applications as well as potentials in present-day camera developments.

### Strengths and weaknesses

Two basic technologies dominate the image sensor market: CCD and CMOS. Both provide different resolutions from VGA to 20 megapixel. CCD sensors utilize centralized pixel readout which allows for a very homogenous image. CMOS sensors typically combine a number of columns to an output which allows for very high and easily scalable frame rates. Furthermore, unlike CCD technology, CMOS allows individual pixels to be directly accessed which results in significantly higher frame rates where the resolution focus is on certain image details (ROI – region of interest).

### New talents

In terms of speed, the 12 megapixel sensor CMV12000 by CMOSIS is a standout. Its excellent image quality keeps up with the popular 2 and 4 megapixel CMOSIS sensors. Supporting 64 readout channels allowing 300 frames per second, the sensor provides sufficient reserve capacity in highly dynamic applications. The new LXG-120 camera by Baumer combines CMOS sensor technology and Dual GigE interface with a bandwidth of 240 MB/s. Thus, the camera will master demanding applications with very high requirements on resolution and speed. Integrated burst mode for short image sequences allows for even higher frame rates of up to 50 frames per second. Baumer's new



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LXG-200 camera utilizes the 20 megapixel CMOS full format sensor CMV20000 by CMOSIS. Its extremely high resolution and dynamic range make the sensor ideal for demanding applications where even the finest details must be reliably captured. Operating on a larger pixel size of 6.4  $\mu\text{m}$ , the sensor further excels with outstanding sensitivity. The LXG-200 therefore is the camera to choose for applications in dim light or where a very short exposure time is required to capture fast motion. Furthermore, operating at 30 frames per second the camera is much faster than conventional CCD-based cameras in this resolution class. In CCD technology, Baumer's PXU-60 camera with integrated SONY quad-tap sensor ICX694 sets new benchmarks with 6 megapixel resolution and a high frame rate of 25 frames per second. The integrated USB3 Vision interface combines easy integration with high bandwidth. Its

1-inch standard format flange allows for deployment of compact and cost-efficient C-mount lenses. Thanks to the included EXview HAD CCD II™ sensor technology by SONY, the PXU-60 camera is extremely low-noise and through its very high saturation capacity provides an outstanding dynamic range of approx. 65 dB. Both the excellent linearity and homogeneity of these cameras ensure reliable evaluation in demanding tasks in microscopy and 2D/ 3D metrology. The extremely low dark current of the sensor allows for camera implementation in fields like fluorescence microscopy and electroluminescence where very long exposure times are required while forgoing dedicated cooling.

### Outlook

While CMOS technology dominates the consumer market, CCD sensors are still most common in industrial image processing.

Where image quality is paramount and speed does not constitute a criterion there is no need for change. On the other hand, CMOS technology has caught up tremendously in recent years, becoming equal also in terms of image quality. Continuously enhanced by modern manufacturing processes, we expect CMOS technology to gain further ground. Moreover, the sensors

allowing for smaller and more cost-efficient cameras will continuously raise the market share of CMOS-based cameras. There might be no champion in the CMOS versus CCD competition other than the user. Numerous sensors in modern cameras provide high performance, but finally which technology to choose is determined by application-specific requirements.



*LX series by Baumer with 12 resp. 20 megapixel CMOS sensor and Dual GigE interface*



*PX series by Baumer with CCD sensors from 2,8 to 12 megapixel and USB 3.0 interface*



Author:  
Mirko Benz  
Product Management  
Competence Center Vision Technologies

 **Baumer**  
Passion for Sensors

Baumer Optronik GmbH  
Badstrasse 30 · DE-01454 Radeberg  
Phone +49 (0)3528 4386 0  
sales@baumeroptronic.com

[www.baumer.com/cameras](http://www.baumer.com/cameras)