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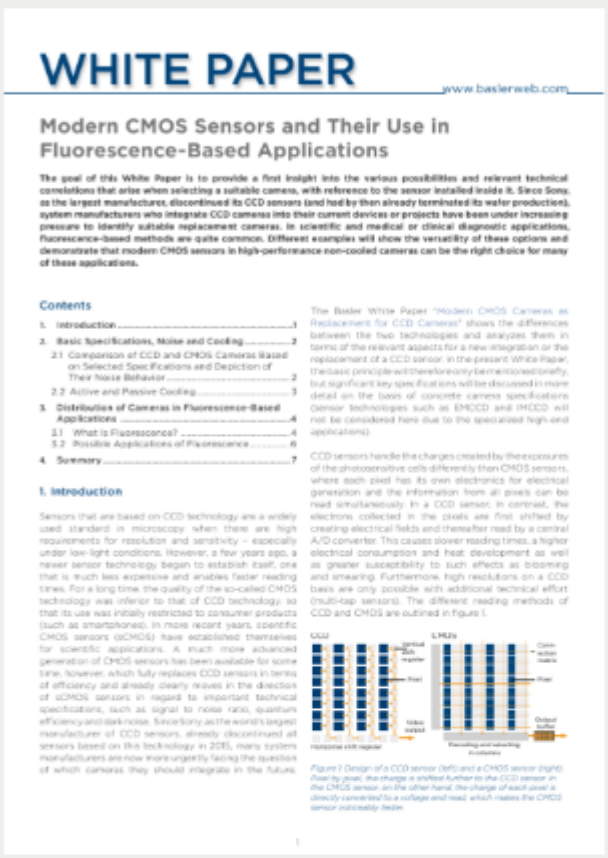
WHITE PAPER

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Modern CMOS Sensors and Their Use in Fluorescence-Based Applications

The goal of this White Paper is to provide a first insight into the various possibilities and relevant technical correlations that arise when selecting a suitable camera, with reference to the sensor installed inside it. Since Sony, as the largest manufacturer, discontinued its CCD sensors (and had by then already terminated its wafer production), system manufacturers who integrate CCD cameras into their current devices or projects have been under increasing pressure to identify suitable replacement cameras. In scientific and medical or clinical diagnostic applications, fluorescence-based methods are quite common. Different examples will show the versatility of these options and demonstrate that modern CMOS sensors in high-performance non-cooled cameras can be the right choice for many of these applications.

Contents

1. Introduction

Sensors that are based on CCD technology are a widely used standard in microscopy when there are high requirements for resolution and sensitivity – especially under low-light conditions. However, a few years ago, a newer sensor technology began to establish itself, one that is much less expensive and enables faster reading times. For a long time, the quality of the so-called CMOS technology was inferior to that of CCD technology, so that its use was initially restricted to consumer products (such as smartphones). In more recent years, scientific CMOS sensors (sCMOS) have established themselves for scientific applications. A much more advanced generation of CMOS sensors has been available for some time, however, which fully replaces CCD sensors in terms of efficiency and already clearly moves in the direction of sCMOS sensors in regard to important technical specifications, such as signal to noise ratio, quantum efficiency and dark noise. Since Sony as the world's largest manufacturer of CCD sensors, already discontinued all sensors based on this technology in 2015, many system manufacturers are now more urgently facing the question of which cameras they should integrate in the future.

The Basler White Paper "Modern CMOS Cameras as Replacement for CCD Cameras" shows the differences between the two technologies and analyzes them in terms of the relevant aspects for a new integration or the replacement of a CCD sensor. In the present White Paper, the basic principle will therefore only be mentioned briefly, but significant key specifications will be discussed in more detail on the basis of concrete camera specifications. Sensor technologies such as EMCCD and IMCCD will not be considered here due to the specialized high-end applications.

CCD sensors handle the charges created by the exposures of the photosensitive cells differently than CMOS sensors, where each pixel has its own electronics for electrical generation and the information from all pixels can be read simultaneously. In a CCD sensor, in contrast, the electrons collected in the pixels are first shifted by creating electrical fields and thereafter read by a central A/D converter. This causes slower reading times, a higher electrical consumption and heat development as well as greater susceptibility to such effects as blooming and smearing. Furthermore, high resolutions on a CCD basis are only possible with additional technical effort (multi-tap sensors). The different reading methods of CCD and CMOS are outlined in Figure 1.

Figure 1 Design of a CCD sensor (left) and a CMOS sensor (right)

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Dr. Felix Asche, Product Manager at Basler, outlines possibilities and application areas of modern CMOS sensor technology in medicine and science. System manufacturers whose devices are equipped with CCD sensors and who are therefore increasingly looking for a suitable camera replacement will find valuable explanations. Find relevant technical correlations and various examples to show the diverse opportunities and advantages of modern CMOS technology in high-performance, non-cooled cameras.

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